INSTITUTIONAL INVESTORS AND LOW CARBON INFRASTRUCTURE AS AN ASSET CLASS

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ABSTRACT

Achieving net zero emissions will require an unprecedented transformation of our infrastructure system. Different economies will face varying challenges, but the transformation of the global economy to be environmentally sustainable and resilient includes decarbonising industry and transport, building smart energy systems, and increasing access to affordable, clean energy. Understanding the role of the private sector and financial markets will be crucial in achieving a decisive transition.

At the same time, institutional investors such as pension funds are facing increasingly complex and challenging macro-conditions and financial markets. Investors are searching for organizational innovation and reconfiguration of their investment models to meet their long-term objectives. Following the Covid crisis with an increasing interest in sustainability among investors, there is an opportunity to scale up institutional investment in low carbon infrastructure and to protect and grow the retirement savings of fund members. Reframing finance will help to respond to the urgent need to act on energy transition while at the same time supporting the economy.

Objective of this thesis is to examine the of role institutional investors and in particular pension funds in sustainable and low-carbon infrastructure, diversifying sources of finance and fostering the development of infrastructure as an asset class. To illustrate how long term investors can promote a more inclusive and sustainable financial system while contributing to the real economy I have adopted an economic geography and bottom up approach benefitting from the unique access to micro data for infrastructure analysis. Following this approach, this thesis builds on literature on financial intermediation and the theory of finance, design and governance of infrastructure, the geography of finance, pension fund research and emerging debates on "relational geometries."

Beyond the lack of data, there is a lack of analysis in academia and policy institutions on the connection between policies affecting investors' portfolios strategies and political decisions for low carbon infrastructure.The institutional investor's investment strategies and the decision to invest in infrastructure are based on strategic asset allocation and asset-liability management considerations. This thesis has analyzed how the changing nature of long-term savings is shaping the current and future demand for long-term assets and the impact of demographic and financial pressure on infrastructure investment. Asset allocation analysis has shown the overall trend to diversify investment portfolios in private markets, impact of ESG investment integration and increasing interest in low carbon infrastructure investment.

At the same time government choices about different types of private funding models and forms of financing of infrastructure are based on short-term political priorities and national constraints. Renewable energy investment is growing, being part of infrastructure asset allocations. However the limited overall investment in low carbon infrastructure is showing major disconnections between investors and governments expectations. As seen in the thesis, partnership models are emerging as a way to leverage traditional bank and utility finance in primary markets and share risks as well as organizational capacity and expertise in support of the financing of infrastructure projects. Well-functioning and deep capital markets, supported by pooling assets, securitization, yieldcos and new listed vehicles could widen the access to and improve transparency of infrastructure investment while diversifying risk and lowering the cost of capital.

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Raffaele Della Croce

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« Le monde dans lequel chacun vit dépend de la façon de le concevoir, laquelle diffère pour chaque tète ; selon la nature des intelligences, il paraitra pauvre, insipide et plat, ou riche, intéressant et important »

Schopenhauer

(Sagesse dans la vie)

Aphorismes

CHAPTER 1: OVERVIEW OF THE THESIS

1.1 INTRODUCTION

Establishing pathways to reach the goals of the Paris Agreement will require large- scale private investment in low-emission infrastructure and innovative technologies, and reallocation of investment away from carbon-intensive assets. Infrastructure, new or old, will also need to be made resilient to climate impacts. Investment in emerging economies and developing countries also needs to be aligned with the Sustainable Development Goals (SDGs). Understanding the role of the financial sector supporting the private sector in the transition will be crucial in achieving a decisive transition.

Recent decades have seen a shift towards greater involvement of the private sector in the delivery and financing of infrastructure in favour of the traditional procurement model. Efficiency improvements have been a key component of the rationale for privatisation in an attempt to reduce the budgetary burden caused by inefficiencies of state enterprises. New initiatives are specifically targeting institutional investors.

Innovative partnerships have been launched to invest in low carbon infrastructure and financing models are emerging for energy efficiency and renewable energy projects. New models are also driven by technological change, as seen in the telecommunication sector with the impact of mobile telephony or more recently in the transport sector

Diversifying the types of financial stakeholders and sources of finance for such investment through new financing and funding structures and innovative financial tools, can help align public and private sector interest in infrastructure provision and management, while optimising the capital structure and reducing the cost of capital for the public sector[1].

[1] See G20/OECD Guidance Note on Diversifying Instruments for Infrastructure and SMEs, endorsed by G20 Leaders in September 2016

In the case of long-term investors such as institutional investors, despite increasing interest, total amounts of investment in infrastructure remain relatively limited, considering the large pool of available capital. This puzzle of under-investment in the face of capital availability suggests that other factors are likely holding investor returns too low in many infrastructure markets (Blundell-Wignall and Roulet, 2015). Therefore, identifying and understanding potential market and government failures that may be contributing to this under-investment remains a central challenge in order for governments to effectively mobilise further private investment into domestic infrastructure markets.

Institutional investors such as pension funds are facing increasingly complex and challenging macro-conditions and financial markets. Some of these investors are searching for organizational innovation and reconfiguration of their investment models to meet their long term objectives. Following the Covid crisis with an increasing interest in sustainability among investors, there is an opportunity to scale up institutional investment in low carbon infrastructure and to protect and grow the retirement savings of fund members. Responding to the urgent need to act on energy transition and achieving net zero emissions, can also help to kickstart the economy.

This thesis seeks to explore how geography moderates the ability of financial institutions such as pension funds to deliver sustainable infrastructure investment. Through this thesis, I will support stronger efforts in independent data collection and objective information provision in the field of infrastructure investment. While the quantitative and qualitative evidence collected through the survey will be of prime value to the ultimate investors, it will also be used to inform regulators and other policymakers complementing national and supra-national statistical data collection with a view to better capture infrastructure flows and understand the role of institutional investors in this sector. This project will leverage past and current work of the OECD Institutional Investors and Long Term Investment project, informing academia the OECD and G20 on future policy and research needs

In this chapter I describe the motivations and possible significance of the research with an examination of the limitations of the research project itself.

1.2 BACKGROUND AND CONTEXT

1.2.1 The urgency of achieving net-zero emissions: the infrastructure investment imperative

The UN estimates that the world would need to increase its efforts between three- and five-fold in order to restrict climate change to a maximum temperature rise of 1.5°C rise and avoid escalating the climate damage already taking place around the world (UN 2019). “The climate emergency is a race we are losing, but it is a race we can win”, in the words of United Nations Secretary-General António Guterres.

To win this race we need to reduce carbon emissions to zero by mid-century, in an effort to keep average global warming well below 2˚C as per the 2015 Paris Agreement stipulating that a “balance” between anthropogenic sources and sinks of greenhouse gases must be reached by 2050-2100. Governments, businesses, and civilians around the world need to rise to the challenge.

At the Climate Action Summit in September 2019, the European Union committed to net zero CO2 emissions by 2050, along with 65 other countries. The UK’s new target to reach net zero greenhouse gas emissions by 2050 means the UK is the first major economy in the world to set such a target into law, putting clean growth at the heart of its modern Industrial Strategy.

Achieving net zero emissions will require an unprecedented transformation of our infrastructure system. Different economies will face varying challenges, but the transformation of the global economy to be environmentally sustainable and resilient includes decarbonising industry and transport, building smart energy systems, and increasing access to affordable, clean energy.

Major infrastructure decisions need to be made in the near future and implemented quickly to avoid the ‘lock-in’ of fossil fuels infrastructure and carbon-intensive assets. Infrastructure projects also need

to be resilient to extreme weather events and flooding, which are becoming more commonplace as the effect of climate change makes itself felt more readily.

How much infrastructure will need to be developed will depend on the specific pathway to achieving net zero emissions. Decisions about the pathway, taking into consideration the role of innovation and societal change, have important implications for required investment and finance.

The UN's estimates are understandably imprecise. But what is clear is that to meet the Paris Agreement target, the amount of finance deployed into low carbon infrastructure must be significantly expanded. This is typified by the IEA's estimate that an additional $1.1 trillion will need to be invested annually in both supplying power and altering how end users consume power between now and 2040 to meet the IEA Sustainable Development Scenario (IEA 2018).

The private sector--working through the financial markets—will have a key role to play in facing this challenge. Delivering this systemic change requires deploying private financial flows in pursuit of clean, resilient and environmentally sustainable economic growth.

1.2.2 Pension Funds as long term investors

Institutional investors are increasingly important players in financial markets and sources of long term financing. In 2017, major asset owners in the OECD area, comprising pension funds, insurance companies, and public pension reserve funds, who together represent key segments of the institutional investment market, held USD 63.7 trillion in assets. In that same year, the combined GDP of OECD countries was USD 51.0 trillion – asset owners together totalled 125% of the OECD region's GDP. Growth has been strong in the pensions segment, where assets increased USD 10.7 trillion over the past ten years (OECD 2018).

Institutional investors such as pension funds, life insurers and mutual funds that operate in retirement savings systems - have been seen as sources of long-term capital and financial market development.

The exemplary case are pension funds, which start collecting contributions when individuals enter the workforce and only start paying benefits with the assets accumulated thirty to forty years later.

Long-term investment horizon in principle allows these investors to take advantage of any above average returns which alternative investments such as infrastructure and venture capital can deliver. However, there are also major challenges potentially constraining investors to higher allocations to such assets and their capability of being long term investors. Demographic and financial pressure with regulation are major factors defining the profile of pension liabilities and ultimately asset allocation.

The profile of liabilities and the asset-liability link are major drivers of defined benefit (DB) pension fund asset allocation. For pension funds based on the predictability of liabilities there may be the need to match the profile of investment with more or less liquid assets. Illiquid investments may be unsuitable for an investor with a short time horizon because the investor may not have time to recover from investment losses for example. The design of default investment options in defined contribution (DC) pension plans has major implications on asset allocations with the specific allocation to risky assets (such as equities) at different ages a matter of much debate, both in academic and policy circles[2].

In a context of aging of populations and constraints on public budgets Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) have recently gained importance within the financial system as effective investment vehicles for realizing future liabilities and achieving some balance between generations (Blundell-Wignall et al. 2008) and (Clark and Monk 2011)[3].

[2] There is also an on-going debate on the relative merits of deterministic investment strategies with a fixed glide-path over the life-cycle and dynamic strategies that take into account some supposedly long-term features of asset returns, such as mean-reversion See Antolin P., Payet S., Yermo J. (2010)

[3] Although there is no single widely accepted definition, Sovereign and Public Pension Reserve Funds (PPRFs) could be defined as funds set up by governments or social security institutions with the objective of contributing to finance the relevant pay-as-you-go pension plans (Blundell-Wignall et al., 2008) . It is not utilised a strict definition of Large Pension Funds LPFs, following OECD practice is intended here to capture the largest investors in the world, compared on an absolute basis, followed by the largest investors within specific countries

However, these supposedly long-term institutional investors are also recurrently being labelled as "short-termist", of feeding asset price bubbles with a herd-like mentality and of being "asleep at the wheel" as company managers abuse their power to the detriment of shareholders (Della Croce, Stewart and Yermo 2011). These concerns have led to calls for more "responsible" and longer-term investment among institutional investors, often associated with sustainable infrastructure investment.

At the same time, among investors there is increased recognition of ESG factors - such as climate change - as potential drivers of future portfolio risk and return affecting their ability to meet future obligations. This is having an impact on securities valuation models and asset allocation decisions reflected for example in an interest for active investing and ESG integration. New investment strategies will have implications on the role pension funds can play in providing a source of stable long term capital.

1.2.3 Infrastructure as an Asset Class

Infrastructure theoretically matches the long-term appetite of investors such as pension funds, benefitting the economy more broadly. While the low-risk, geographically varied returns associated with infrastructure match the diversification objectives of pension fund portfolios, involvement of long-term investors can also improve the quality of public investment programs for low carbon infrastructure (Torrance 2009; Gelb 2014 and Clark 2018)

Asset allocation trends show gradual globalisation of portfolios, with increased interest in emerging markets and diversification into new asset classes. Infrastructure is often included in the alternative investments part of the portfolios as in principle the long-term investment horizon of pension funds and other institutional investors should make them natural investors in less liquid, long-term assets.

New research is trying to demonstrate how the inclusion of infrastructure is able to provide better diversification and shift the efficient frontier, allowing better risk-return combinations of investment

portfolios (Litterman 2004 and Blanc-Brude 2013). However, such exercises need to be interpreted with a high degree of caution given the issues with the underlying data and concepts for infrastructure assets (Inderst 2010 and Ansar 2014).

Despite the theoretical ideal match between a large source of capital and an asset class in need of investment, the overall level of investment in infrastructure by institutional investors has been modest and insufficient to overcome the financing gap.

Infrastructure investing offers different characteristics from other asset classes which could represent barriers to entry to potential investors. High upfront cost, lack of liquidity and long asset life involved in infrastructure projects, require significant scale and dedicated resources to understand the risks involved, resources that many investors are lacking. These characteristics **imply that infrastructure investment – at least in the forms it is currently offered – may not be a suitable proposition for all investors.**

1.2.4 Re-conceptualization of intermediation: Looking for a new Era of Investing

The challenges to institutional investors represented by the underlying economy dynamics and the increasingly complex and challenging financial ecosystem, are highlighting the need to "reframe finance" (Clark and Monk 2017). This is becoming even more urgent with the rise in AI, big data and social networking, tech innovations transforming financial services.

Macro-economic conditions challenge the ability of institutional investors to meet long-term obligations to their beneficiaries. The slowdown in the economy apparent even before the COVID crisis and global central bank policy of zero or near-zero interest rates (and in some cases negative interest rates), have major implications on asset allocation.

At the same time the recurrent crises in the global financial system are evidence of systemic risks in developed economies' financial markets (Haldane and May 2011).This has put into question the hegemony of financial markets and core assumptions and beliefs at the base of capitalist system

development in the last fifty years, attached to an intellectual programme including modern portfolios theory and the efficient market hypothesis EMH4. With reduced confidence in the viability of existing models of institutional investment intermediation, many investors are re-evaluating the manner in which they will attempt to hit their high expected return targets, through new and innovative models of investing.

Major constraints for institutional investors in infrastructure relate to the relatively high cost of financial intermediation and the pervasive mis-alignment of interests embedded in their principal-agent based investment model (Ambachtsheer 2016; Monk and Sharma 2018). Relevant in particular for infrastructure many funds recognize that the long chain pf principal agent relationship has allowed for a distortion of their overarching objectives (Ambachtsheer 2013). A re-conceptualization of intermediation, reframing finance will lead to a revitalization of infrastructure as an asset class and a new era of infrastructure investing (Clark, Monk, Orr, Scott (2011).

The infrastructure financing market has gone through a process of radical transformation starting from the mid-2000s. Different reasons – a changed macroeconomic environment, more stringent regulations on financial intermediaries, a modified appetite for long-term asset investments – have led to a reallocation of flows from the banking sector to the institutional investors sector. This trend is expected to be confirmed for the years to come.

As governments seek greater levels of private finance in infrastructure and in particular pension fund investment, efforts are underway to develop new models and financial instruments for infrastructure procurement and create infrastructure as an asset class. Supporting private capital for public assets, changes the risk allocation between the private sector, taxpayer and consumer and imply different capital structures for infrastructure and the specific role for institutional investors.

[4] Underpinning the emerging hegemony of financial markets was an intellectual programme that sought to formalize and systematize investment norms and conventions into an overarching set of rules for investment. This movement has been described in many ways (see Bernstein 1996) and includes modern portfolios theory followed by the efficient market hypothesis EMH and the Black scholes theorem

As the market for infrastructure continues to grow and information about the asset classes becomes more readily available a number of initiatives have been developed to pool the financial and internal resources of large institutional investors to invest jointly in infrastructure projects and assets.

1.3 G20 AND POLICY WORK ON INFRASTRUCTURE

The G20 and other fora, along with international organisations (IOs) and multilateral development banks (MDBs), have taken steps over the years to make infrastructure more of an investible asset, suitable for investment by a large and diverse pool of investors, including institutional investors. The G20 launched a Roadmap to Infrastructure as an Asset Class with a number of work streams seeking to improve project development, enhance the investment environment, and promote greater standardisation (see box 1).

Despite much policy attention in recent years on institutional investors' potential to expand investment in infrastructure, progress to date appears to be marginal. The general barriers and constraints in infrastructure investment for institutional investors, especially pension funds, have been flagged in the past (Inderst 2010 and Della Croce 2012). There are constraints on the supply (e.g. regulatory uncertainties, lack of suitable projects) and demand side (e.g. investor resources and capability), as well as in the intermediation process (e.g. inappropriate, expensive investment vehicles). The G20/OECD High-Level Principles for Long-Term Investment Financing by Institutional Investors provides specific guidance on ways governments can facilitate and promote long-term investment by institutional investors.

In addition to a lack of projects, there seems to be a **major intermediation issue** between institutional investors strong appetite for infrastructure assets (i.e. low risk, operational phase assets) and the availability of opportunities - present at the moment or to come to the market- not matching their needs (i.e. greenfield projects and emerging markets). In order to encourage greater amounts of private

investment in infrastructure a better understanding of the expected risk and return characteristics, as well as the existing and potential risk mitigation instruments, is necessary. This is relevant for the private sector in general and, in particular, for institutional investors with specific objectives and risk appetites.

Analysis and evaluation of how to mobilise institutional investment in low carbon infrastructure has been constrained by the lack of granular data and information on institutional investment. To increase the flow of bankable clean energy projects policy makers need to better understand the risks faced by investors and design policies that allow for the efficient allocation and management of these risks, which are key determinants of the cost of capital (IEA 2019). What is needed is a combination of policy and financial know supported by independent analysis and reliable and authoritative data.

The discussions in G20 and regulatory fora have recognised that there is great need for more analysis and transparency on long-term investment and a new approach from policy makers . Especially when it comes to the drivers and impediments of investments in infrastructure, there is a need to resort to fully-fledged multivariate econometric analyses and micro-based data in order to separately identify demand and supply factors. This need is the result of the analytical challenges linked to assessing investment financing through national accounts. Actual trends in long-term investment financing are the combined effect of several factors such as: the business cycle, capital expenditures, corporate credit risk, investors' risk aversion, banks' propensity to lend and funding conditions, regulatory developments, etc.

It is also recognised the importance of using micro-data (at firm/project level) for long term financing, pointing towards the development of new datasets, and acknowledging the opportunity for a collective action driven by the private and public sector's common interests. Several policy and industry initiatives have been launched to try to get a better understanding of infrastructure at the macro and micro level and to establish financial and ESG infrastructure investment benchmarks (see ANNEX 1). Taken together, all of these data sources and methods may be applied to help closing the data gap in

infrastructure. However, many efforts are still needed, specifically at the micro level, with a potentially leading role for the G20.

Box 1: Key G20 initiatives to promote Infrastructure as an asset class

The effort to promote infrastructure as an asset class, has been guided by the **G20 Roadmap to Infrastructure as an Asset Class** that draws together, in a holistic and forward looking way, the critical steps needed to develop infrastructure as an asset class and promote investible projects. The initiative also focusses especially on the quality and sustainability aspects of infrastructure, included in the Roadmap and extended widely in the new **G20 Principles for Quality Infrastructure Investment** .

The G20 Roadmap to Infrastructure as an Asset Class seeks to address common barriers to the emergence of infrastructure as an asset class, including the heterogeneous nature of infrastructure assets, the lack of a critical mass of bankable projects, and insufficient data to track asset performance. The Roadmap is organised into three overarching pillars with the objectives of: i) improving project development; ii) improving the investment environment for infrastructure and iii) promoting greater standardisation.

The G20 Principles for Quality Infrastructure Investment set out a set of voluntary, non-binding principles that reflect a common strategic direction and aspiration for quality infrastructure investment within the G20, which are: (i) Maximising the positive impact of infrastructure to achieve sustainable growth and development; (ii) Raising economic efficiency in view of life-cycle cost; (iii) Integrating environmental considerations in infrastructure investments; (iv) Building resilience against natural disasters and other risks; (v) Integrating social considerations in infrastructure investment; and (vi) Strengthening infrastructure governance.

As part of the billion to trillions commitment an enhanced focus on crowding-in commercial finance has been reaffirmed through the **Principles of MDBs Strategy for Crowding in Private Sector Finance for Growth and Sustainable Development[5],** highlighting commitment of G20 member countries and the MDBs to foster effective approaches to maximize the mobilization and catalyzation

of private sector resources to support countries with the implementation of the 2030 Development Agenda. Given the unique value added of MDBs in advancing the post-2015 agenda, the G20 is committed to using these institutions to their full potential. As stated in the **MDBs Action Plan to Optimize Balance Sheets**[6]: Fully utilizing MDBs requires shareholders to advance voice and capital discussions, to ensure that the institutions are properly capitalized with shareholdings reflective of the distribution of the global economy. It also requires that limited MDB capital resources are used as efficiently as possible. To advance the efficiency side of this agenda, the G20 began calling on MDBs to work through their Boards to optimize balance sheets, in order to increase lending without substantially increasing risks or damaging credit ratings.

G20/OECD Report on the Collaboration with Institutional Investors and Asset Managers on Infrastructure: Investor proposals and the way forward (OECD 2020a) This report presents the outcomes of a prolonged dialogue with private sector investors in infrastructure, as part of a collaboration facilitated at the initiative of the G20 Infrastructure Working Group (IWG) under the Saudi G20 Presidency, supported by the OECD. It seeks to convey the perspectives of asset owners and managers on ways to overcome the infrastructure investment gap, by identifying selected key issues and challenges, and providing proposals for G20 Finance Ministers and Central Bank Governors.

[5] G20 – IFA WG Principles of MDBs' strategy for crowding-in Private Sector Finance for growth and sustainable development April 2017

[6] Multilateral Development Banks Action Plan to Optimize Balance Sheets

1.4 RESEARCH AIMS AND OVERVIEW OF THE THESIS

The general objective of this research proposal is to examine the role institutional investors and in particular pension funds can play in meeting the infrastructure investment needs, as well as identifying the policies that will facilitate the mobilisation of financing at the necessary scale. Principle aim of this thesis is to propose a framework for attracting pension fund investment in sutainable and low-carbon infrastructure, diversifying sources of finance and fostering the development of infrastructure as an asset class. A secondary goal of the thesis is to illustrate how long term investors can promote a more inclusive and sustainable financial system while contributing to the real economy.

The thesis looks at institutional investors with a particular focus on pension funds and other private sector institutions (i.e. corporates, banks and asset managers) and public stakeholders (i.e. governments, development community) to illustrate both how different organisations interact with the issues of sustainable infrastructure and long term investment and how geography plays a moderating role in this interaction.

To conduct this analysis, I will use unique data sources leveraging OECD work I coordinated and developed over the last eight years[7], based on a definition of infrastructure relevant from an asset management point of view i.e. investable physical assets that generate cash flows from external users. This broad definition includes infrastructure firms active in the telecommunication (satellite, wireless, fixed line, cable), transport (airports, ports, highways, rail) and utility sector (generation, transmission and distribution for electricity, water and gas). The focus of the thesis however is on low carbon infrastructure sectors serving the energy transition such as renewable energy.

[7] https://www.oecd.org/pensions/private-pensions/institutionalinvestorsandlong-terminvestment.htm

Infrastructure as a new asset class is considered to have several distinct and attractive investment characteristics for institutional investors trying to optimize their portfolio allocation. New research is trying to demonstrate how the inclusion of infrastructure is able to provide better diversification and shift the efficient frontier, allowing better risk-return combinations of investment portfolios (Litterman, B. 2004, Blanc-Brude, 2013). However such exercises need to be interpreted with a high degree of caution given the issues with the underlying data and concepts for infrastructure assets (Inderst 2010).

Following Merton and Bodie (1995 and 2005) approach infrastructure could be defined by virtue of its functional role in an investment portfolio. By this measure, it is normally an asset class although the managers of other asset classes often like a share of infrastructure assets. For example, fixed income managers believe that infrastructure provided or at least promised a predictable flow of income which could be monetised. At the same time, infrastructure depends upon managers' skills and expertise which tend not to overlap with other asset classes. Indeed, in many cases, infrastructure investing requires long-term commitment and with that different skills and expertise than simply trading securities.

Beyond asset allocation considerations, for this thesis we will use the term “Infrastructure as an Asset Class” in the broader sense of private sector investment, as intended in key international fora such as the G20, G7 and APEC where several important policy initiatives are coming together all with the purpose of promoting bankable projects and institutional investors participation. For example, the Argentinian presidency of the G20 in 2018 has developed a roadmap for infrastructure as an asset class organized in three pillars with the objectives of: i) improving project development ii) promoting standardization iii) improving the investment environment for infrastructure. The G20 presidencies of Japan in 2019 and Saudi Arabia in 2020 have been focusing on the implementation of this agenda.

To better understand the role of pension funds as long-term investors in infrastructure further analysis is needed on the changing nature of retirement landscape, the future evolution of pension policies and regulation affecting the liabilities side and consequences for portfolio allocations and infrastructure

investment. Framing this analysis at country level and considering also infrastructure governance and policies will results in effective policy implications in the pension fund and infrastructure areas.

A country dimension encompassing local and regional governance factors has been adopted to better understand specific problems encountered and solutions proposed by responsible institutions. While infrastructure investments are considered globally, opportunities depend on the availability of specialist information in the region of investment (Torrance 2009). Country level infrastructure resources - as well as the different varieties of capitalism - have an impact on relationship between actors (Wójcik et al., 2018).

By answering four top level research questions, and several more detailed ones, I believe the overarching aim of the thesis will be reached. The questions are:

- What is the importance of pension funds in financial markets ? What are the major constraints to long term investment in the future? What are the factors of growth for pension fund investment in infrastructure at country level?
- What are the main asset allocation investment trends concerning long term investment in alternative asset classes ? How are sustainability and ESG taken into account in infrastructure portfolio allocations?
- How are investors approaching low carbon infrastructure investment? How much is invested in infrastructure and renewables and where does it fit in the portfolio allocation? What has been the evolution of pension fund investment in infrastructure over the years?
- How to align institutional investors to long term assets? What are the models used and the products and instruments needed for low carbon infrastructture?

The thesis employs a four-paper approach to explore these top-level questions. The abstract for each of the papers is presented in Section 6.

The starting point of this thesis are some widely cited hypotheses in policy areas, academia and the investment community about i) the huge investment opportunities in the infrastructure market for private financing and ii) the important role that institutional investors are expected to play as long term investors looking for low market risk and stable and predictable cash flows properties attached to infrastructure as an asset class. These hypotheses though are supported by very limited empirical evidence.

Often cited among asset managers and policy makers is the potential role of institutional investors as alternatives sources of finance for infrastructure. However, despite the huge needs and potential future investment, current opportunities are limited, due to a lack of projects and available opportunities. The size of the infrastructure market will depend on current and future political decisions made about how to deliver infrastructure services to the public. In fact, the investment opportunities and vehicles that make up the global institutional infrastructure market are made possible by governments that have adopted privatisation or public-private partnership policies.

At the same time, in order to encourage greater amounts of institutional investors investment an understanding of what are the channels and where infrastructure fit in the total portfolio allocation is needed. This is relevant for the private sector in general and for policy makers in particular, designing financial instrument matching investors specific objectives and risk appetites.

The challenge of mobilizing greater private sector financing for infrastructure implies a better understanding the changing roles of actors and sources of finance the differences between traditional actors such as utilities and commercial banks, and non-traditional ones such as institutional investors and capital markets, of the relationship between the participants in infrastructure financing.

Academic literature in relation to long term investing has been focusing on risk appetite and whether long-term investors should pursue a higher level of risk in their portfolio because of their longer investment horizon. Normative studies on long term investments have been focusing on SWFs,

endowments and alternative investment. There is a complete lack of research on pension funds in infrastructure framing the discussion from a pension policy design point of view.

Despite the increasing interest in alternative investments, official data and academic analysis on pension fund investment in infrastructure is scarce.

National statistical agencies do not currently collect separate data on these investments and the different forms available to investors to gain exposure to these asset classes means that information is often buried under different headings. Only a limited amount of information has historically been available regarding the investment strategies actually implemented by pension funds, sovereign wealth funds or PPRFs. Granular statistical data is scarce at asset or sector level forcing the literature to focus on the use of case studies of selected investors or more normative studies on asset allocation[8]. This has led to considerable uncertainty about the exact nature of the strategies of the broader market and their evolution over time.

There is also little evidence on actual investment ultimately flowing to the infrastructure sector. For alternative investments and infrastructure, official data on pension fund flows, is scarce as national statistical agencies do not currently collect separate data on these investments. The different forms available to investors to gain exposure to these asset classes means that information is often buried under different headings.[9] This makes difficult to draw comparison even when data is actually available.

Beyond the lack of data, there is a lack of analysis in academia and policy institutions on the connection between policies affecting investors' portfolios strategies and political decisions for infrastructure. The institutional investor's investment strategies and the decision to invest in infrastructure are based on strategic asset allocation and asset-liability management considerations. At

[8] Though not publicly available, there are a few exceptions of relevant databases including CEM benchmarking and EDHEC Infrastructure.

[9] For example, infrastructure investment may not occupy a separate allocation, appearing instead as part of private equity or reaestate allocations. Pension fund investment in listed infrastructure vehicles is reported by national statistics agencies as national or foreign equities and infrastructure lending is reported as fixed income, while direct investment or participation in private equity vehicles is sometimes reported within the category "other".

the same time government choices about different types of private funding models and forms of financing of infrastructure are based on political priorities and national constraints. In order to ensure alignment of interest and long-term sustainability of infrastructure investment better understanding is needed of market opportunities in light of investor and government objectives.

1.5 RELEVANCE

This thesis is a contribution to current research found in different disciplines such as economic and finance, fields of study such as infrastructure, pension fund and public policy and analytical logics that include institutional, relational and intermediation analysis. Economic geography literature has been focusing on the growing presence of private finance and non-state organizational structures such as institutional investors in infrastructure. Following this approach this thesis builds on literature on financial intermediation and the theory of finance, design and governance of infrastructure, the geography of finance, pension fund research and emerging debates on "relational geometries."

Given the lack of academic literature and macro data, it is proposed a bottom up qualitative and quantitative approach to the role of institutional investors and the development of infrastructure markets, benefitting from the unique access to micro data for infrastructure analysis. In the first place it allows to interrogate existing theories and accepted perspective on infrastructure investment, a key element in the development of knowledge in any discipline. In addition, this approach is due to the lack of data common to private markets and the heterogeneous nature of infrastructure calling for a multi-methods and interdisciplinary analysis.

Research will benefit a wide array of stakeholders. In the first place encouraging a competitive market where pricing and associated risks in infrastructure assets are transparent allows investors to evaluate the risk/return opportunities with enough confidence to make well-informed investment decisions. Besides financiers, operators as well as governments and regulators have a genuine interest in the investment characteristics of the assets that they manage, privatise, or regulate. Governments need to institute conducive policies of regulatory independence and effective risk mitigation mechanisms.

To understand institutional investors role in low carbon infrastructure is needed a concrete quantitative assessment of how much can be shifted by type of investor as well as to which types of investments.

This thesis presents latest efforts to map, current institutional (pension funds) holdings in low carbon infrastructure, i.e. their stock of investment. The mapping provides first of its kind independent information and aims to cover crucial data gaps identified in the literature (G20, 2018). The quantitative exercise conducted for this thesis contributes to wider efforts to enhance data quality and availability (Global Infrastructure Hub/ EDHEC - Quality Infrastructure Database 2020; Private Participation in Infrastructure World Bank Group 2020; G20 Infrastructure Data Initiative, 2020; FSB, IMF, OECD, WBG 2014; and G20 2018).

To arrive at a full understanding of the drivers and impediments of infrastructure investment, micro-based analysis is needed. By analysing pools of long-term savings in domestic markets, policy makers will gain insights into the drivers behind asset allocation decisions and the conditions needed to attract long-term savings. The main objective of such analysis would be to provide a factual description of changes and policies that can be empirically tested and analysed "internally" by people with decision-making authority over sector policy, regulation, governance, and investment.

This thesis is relevant for numerous infrastructure stakeholders and **has implications** for **both investment management and public policy.**

Institutinal investors and asset managers would benefit from improved information on performance evaluation and for asset allocation decisions. A better understanding of risk properties reduces the information gap on this alternative asset class, helping to match suitable investments with investor preferences. A potential outcome could be opening new channels of funds to infrastructure.

The findings can support policy makers (regulators) in setting prices for infrastructure services by appropriately including risk charges in the costs of capital. Indeed, the same need to create new knowledge on the risks of long-term investment is also patent on the regulatory side. More accurate risk measures may imply lower capital charges, and the more effective and efficient intermediation of long term capital. The results also would highlight which risk management strategies and investment screening capabilities are needed for infrastructure investing.

Describing with strong empirical evidence the role of infrastructure investments in the asset allocation process, allows the integration of infrastructure assets into the asset/liability investment framework. In this thesis I draw from the geography and theory of finance to interpret infrastructure as an asset class in the investment contemporary world, speaking the same language of investors, while acknowledging limitations especially when looking at asset pricing and sustainable aspects. This translates into looking at infrastructure in a risk-return and portfolio optimization framework subject though to major issues with data and concepts for infrastructure assets and more broadly with conventional investment theory and practice.

Placing infrastructure assets in a "real asset" category conceptually fits the purported properties of infrastructure, however; a closer look at expected performance and a clearer understanding of these expectations is warranted in order to reduce the risk of asset allocation errors and misspecifications. Additionally, regardless of strategic asset allocation objectives, infrastructure may have a role in meeting liability-driven investment objectives. A strong infrastructure investment mandate can also improve asset/owner governance and alignment of interests.

Such work will shed light on ESG criteria in infrastructure investment, and provide valuable analysis on clean energy projects and green infrastructure. Sustainability, including ESG criteria, is an emerging theme in institutional investment and also infrastructure investment. Investors are increasingly factoring ESG into investment decision and risk management processes. Given their usually large scale and long-term nature, as well as the involvement of many public and private stakeholders, infrastructure assets can be exposed to a series of environmental, social and regulatory risks. While the definition of "sustainable infrastructure" varies between investors and can include for example clean energy projects or social housing, the idea that governance practices and environmental considerations affect long-term risk is today widely accepted. Transparent parameters allowing for adequate monitoring of ESG performance is also important.

Financial intermediation though contracts in infrastructure allows also an understanding of institutional design and deliver models for infrastructure and more specifically, the ways in which investors approach risk and uncertainty. An understanding of what are the channels and where carbon infrastructure fit in the total portfolio allocation is relevant for the private sector in general and for policy makers in particular, trying to mobilize investment, designing financial instrument matching investor's specific objectives and risk appetites.

The thesis offers an assessment of current and perspective models, from a long-term investors point of view, in particular pension funds and insurers. Overcoming limitations in the literature and scarce evidence this chapter takes into account institutional investors' risk preferences and return expectations not accommodated by commonly used models for low carbon infrastructure. Defining expected contribution and limitations of institutional investors will also clarify the role of governments in delivering low carbon infrastructure and developing infrastructure as an asset class.

Ultimately, the work of this thesis will be instrumental to improve public infrastructure procurement as well. A better understanding of the risks and expected financial performance of long-term public-private contracts should both optimise the value-for-money of such contracts from the point of view of the tax payer and help minimise political risk for investors by increasing transparency. Governments get a better understanding of the risks of public infrastructure investments and the risk exposure potentially shifted to the private sector, ensuring efficiency of risk sharing mechanisms (i.e. risk guarantees and pricing of contracts).

The Table below summarizes the main stakeholders this thesis is addressing.

Table 1 –Key Stakeholders addressed in the Thesis

Chapter	Constituency	Topic of Relevance
Chapter 3: Mapping risks and financing for low carbon infrastructure	Academia	Financial Intermediation
Chapter 4. Country Survey: Pension Fund Investment In Infrastructure – The Demand for long term investment in Infrastructure	Policy makers and investors	The changing nature of long-term savings
Chapter 4	Policy makers and Regulators	Pension and regulatory reforms for long term investing
Chapter 4	Academia	Asset Management/ Financial Economics
Chapter 5. ESG, Private Markets impacts on Institutional Investment in Infrastructure	Investors and Regulators	As part of the alternative asset allocation, an increasing number of funds are also investing in unlisted infrastructure
Chapter 5	Investors and Regulators	ESG and green strategies for low carbon infrastructure
Chapter 5	Academia	Theory of finance and financial intermediation
Chapter 6. Low Carbon Infrastructure Investment	Investors and Regulators	Renewable energy as a global asset class
Chapter 6	Investors and Regulators	Renewable energy as a global asset class
Chapter 6	Academia	Asset Management/ Financial Economics
Chapter 7. Partnering with Instituional Investors and Recycling capital for low carbon infrastructure	Investors/Asset Managers	Pooling Institutional Investors Capital for low carbon infrastructure
Chapter 7	Investors/Asset Managers	Developing Secondary markets for low carbon infrastructure
Chapter 7	Policy Makers/ Regulators	Developing Secondary markets for low carbon infrastructure
Chapter 7	Policy Makers/ Development Institutions	Catalyse institutional investors for low carbon infrastructure
Chapter 7	Policy Makers/ Energy Agencies	Ultimately, financial market developments need to be accompanied by major energy reforms.
Chapter 7	Academia	Theory of Contract/Relational Investing

1.6 STRUCTURE OF THE THESIS

The thesis employs a four-paper approach. The abstract for each of the papers and the structure envisaged are presented in this section. As the thesis is building on research and analysis I have authored over the last eight years at the OECD, relevant references are provided.

1. Overview of the Thesis

I describe the motivations and possible significance of the research with an examination of the limitations of the research project itself. The chapter examines background and context to pension fund investment in infrastructure framing the discussion of infrastructure as an asset class also including an overview on G20 work on Data Gaps for Long Term Investment (LTI) relevant for the thesis

2. Literature Review

This chapter includes first an overview on existing academic and policy work on infrastructure investment with main research questions at stake for mobilising institutional investors and pension funds in infrastructure. The last sections provide background on methodology and use of micro data for the analysis of infrastructure investment, the nature of the data available and recent initiatives on data collection.

3. Mapping risks and financing for Low Carbon Infrastructure: the role of Institutional Investors

This chapter is intended to provide a structured framework for understanding the range of instruments and vehicles for infrastructure finance that may complement traditional sources of finance such as commercial banks, MDBs and governments. Instruments and vehicles are related to infrastructure risk and returns to understand related best souces of finance across the lifecycle and the role of institutional investors.

This chapter is drawing from OECD research completed for the G20, the OECD *Infrastructure Financing Instruments and Incentives: a Taxonomy* and the G20/OECD Guidance Note on Diversifying Sources of Finance for Infrastructure and SMEs.

Aim of this work is to diversify the types of financial stakeholders and sources of finance for infrastructureand align public and private sector interest in infrastructure provision and management, while optimising the capital structure and reducing the cost of capital for the public sector.

This framework is used in the thesis to map international trends in low carbon infrastructure on the equity and debt side analyzing the different types of private sector participants that are important for infrastructure investment (i.e. corporates, banks and institutional investors) and the various constraints they face in financing infrastructure projects, including business considerations, long-term strategies related to climate change, and the regulatory environment. This approach supported the G20 report "Investing in Climate, Investing in Growth" delivered by the OECD in May 2017.

This paper is building on OECD analysis in the context of G20, in particular on

- OECD (2017) "Mobilising financing for the transition" Chapter 7 of the report "*Investing in Climate, Investing in Growth"* launched 23rd May 2017, Berlin
- G20/OECD (2016) Guidance Note on Diversifying Sources of Finance for Infrastructure and SMEs, endorsed by G20 Leaders in September 2016
- OECD (2020), Green Infrastructure in the Decade for Delivery: Assessing Institutional Investment, Green Finance and Investment, OECD Publishing, Paris, https://doi.org/10.1787/f51f9256-en.
- Della Croce, R. and Gatti S. (2014), Financing infrastructure – International trends, OECD Journal: Financial Market Trends, Vol. 2014/1.

- OECD (2015) *Infrastructure Financing Instruments and Incentives: a Taxonomy* - a report delivered to the G20 in September 2015.

4. Country Survey: Pension Fund Investment In Infrastructure – The Demand for long term investment in Infrastructure

This chapter looks at the evolution and drivers of growth of pension fund investment in infrastructure in a context of changing retirement landscape. A country dimension has been adopted to better understand specific problems encountered and solutions proposed by responsible institutions. While infrastructure investments are considered globally, opportunities depend on the availability of specialist information in the region of investment (Torrance 2009). For policy makers looking to attract long-term financing in infrastructure, the composition of local pension markets, regulations and openness to foreign investment can influence how capital is invested.

Findings are mainly based on interviews with industry professionals as the existing data sources are limited, particularly with regard to infrastructure investment policy and risk management. The information acquired in interviews complements that obtained from a literature review, selected pension fund annual reports, and an analysis of the available data sources.

This analysis is building also on national account statistics on pension funds gathered by the OECD and qualitative country surveys within the framework of the OECD Long Term Investment Project and G20 work[10]. A first survey part of the Transcontinental Infrastructure 2030-2050 project focused on pension funds in Canada, Australia, the United States, South Korea and a number of funds in Europe . Subsequent studies have been looking even more in details at the comparison between Australia, Canada and G20 countries experiences (G20/OECD 2016 and Inderst Della Croce 2012)

[10] The OECD Global Institutional Investors Database also benefits from the joint OECD, IOPS and World Bank Global Pension Statistics exercise.

This chapter draws mainly on:

- OECD Pension Market in Focus 2019, 2018, 2017
- Della Croce (2011): “Pension funds investment in infrastructure: a survey” OECD working papers on finance, insurance and private pensions, no. 11
- Della Croce (2011) “Pension funds investment in infrastructure: policy actions” OECD working papers on finance, insurance and private pensions, no. 12
- Inderst, Della Croce (2012) Pension fund investment in Infrastructure: a comparison between Australia and Canada OECD working papers on finance, insurance and private pensions

5. ESG, Private Markets impacts on Institutional Investment In Infrastructure

Aim of this chapter is to identify the flows and better capture the underlying trends in asset allocation and investment strategies of pension funds focusing on alternative assets (i.e. private markets) and sustainable/ESG investment relevant for infrastructure investment. Unique access to OECD microeconomic data of two distinct pools of long-term savings – LPFs and PPRFs - allow deep insights of the general trends observed at national level in chapter 4 – Country Survey: Pension Fund Investment in Infrastructure. This chapter also leverages a new survey conducted for the annual OECD Business and Finance publication on ESG investing (OECD 2020).

The OECD in 2011 launched the first annual quantitative survey covering Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) among the largest in their respective economies, and comparatively, amongst the largest in the world. In 2019, the survey reviewed the trends in assets and asset allocation of 125 LPFs and PPRFs, which in total managed USD 12.4 trillion in assets in 2017, approximately one third of the total worldwide assets held by this class of institutional investor.

This chapter leverages the first part of the survey using when possible comparable samples of different publications to draw conclusions valid for the last decade. It first looks at trends in strategic asset allocation and alternative investment monitoring evolution in the last years. It then looks at sustainability investment including green and social aspects.

This work draws on:

- OECD (2018, 2015, 2014, 2013, 2012) Annual Survey of Large Pension Funds and Public Pension Reserve Funds
- Della Croce, Stewart and Yermo (2011), "Promoting Longer-Term Investment by Institutional Investors: Selected Issues and Policies", OECD Journal: Financial Market Trends, Vol. 2011/1. http://dx.doi.org/10.1787/fmt-2011-5kg55b0z1ktb
- Della Croce (2012) Trends in Large Pension Fund Investment in Infrastructure, OECD Working Papers on Finance, Insurance and Private Pensions, No.29, OECD Publishing.
- OECD (2020), Business and Finance Outlook: Sustainable and resilient finance, Chapter 7 "ESG and Institutional investment in Infrastructure"

6. Low Carbon Infrastructure Investment

Aim of this chapter is to describe with strong empirical evidence the role of low carbon infrastructure investments in the asset allocation process looking at different portfolio approaches taken by major investors and measuring investment evolution over the last decade. Unique access to OECD microeconomic data of two distinct pools of long-term savings – Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) - allows to complement trends observed at portfolios level as strategic asset allocation in chapter 5.

This chapter leverages the second part of the Annual Large Pension Fund Survey – for several years of publication - first looking at different approaches taken by institutional investors to infrastructure

investment its allocation in the total portfolio. It reports on allocation to infrastructure investments, either in the form of unlisted infrastructure equity, listed equity, or debt, measuring infrastructure investment and monitoring its evolution over the last years across regions and countries. It finally looks at major trends such as infrastructure vehicles, green investment, geographic exposure.

This work draws on:

- Della Croce and Yermo (2013), "Institutional Investors and Infrastructure Financing", OECD Working Papers on Finance, Insurance and Private Pensions, No. 36, OECD.
- OECD (2018, 2015, 2014, 2013, 2012) Annual Survey of Large Pension Funds and Public Pension Reserve Funds
- G20/OECD (2015) Guidance Note for Diversifying Financial Instruments for Infrastructure and the OECD *Infrastructure Financing Instruments and Incentives* - a report delivered to the G20 in September 2015

7. Partnering with Institutional Investors and Recycling capital for low carbon infrastructure

This chapter covers an examination of new models and instruments for private sector and institutional investors financing of low carbon infrastructure. With climate change posing new challenges to traditional providers of finance and opening new opportunities for partnership, focus of this chapter is on institutional investors' role as 'recyclers of capital', taking operational assets off balance sheets of short-term financiers, thereby freeing up capital for new investment.

Findings are mainly based on interviews with industry professionals, as the existing data sources are limited. The information acquired in interviews complements that obtained from a literature review, selected pension fund annual reports, and an analysis of the available data sources. This chapter leverages case studies and a wide recent consultation process with asset managers and asset owners conducted by the OECD for the G20/OECD Report on the Collaboration with Institutional Investors and Asset Managers on Infrastructure .

The chapter first looks at the evolution of infrastructure financing market and current and future challenges for institutional investors as key sources of low carbon infrastructure. The second part of the chapter introduces the new initiatives to pool institutional investors capital, that have developed in response to the drawbacks and early inefficiencies, highlighting specific case studies of co-investment platforms, government-led initiatives and revised unlisted infrastructure funds. The last section focuses on the creation of a secondary market for infrastructure looking at initiatives conducted by green investment banks and multilaterals, the creation of listed equity instruments and the role of securitization.

This chapter draws on:

- OECD (2017) "Mobilizing financing for the transition" Chapter 7 of the report "*Investing in Climate, Investing in Growth"* launched 23rd May 2017, Berlin www.oecd.org/environment/cc/g20-climate/)
- Della Croce, Gatti (2014), Financing infrastructure – International trends, OECD Journal: Financial Market Trends, Vol. 2014/1.
- Della Croce and Sharma (2014), "Pooling of Institutional Investors Capital, Selected Case studies in Unlisted Equity Infrastructure", OECD Working Papers on Finance, Insurance and Private Pensions, No.38, OECD.
- Della Croce (2012) Trends in Large Pension Fund Investment in Infrastructure, OECD Working Papers on Finance, Insurance and Private Pensions, No.29, OECD Publishing.

8. Conclusions - A policy framework to attract private sector financing and actions for G20

This chapter serves as the final chapter of the thesis. In this chapter, I present the major conclusions of the thesis, further areas of work borne out of the research process and policy implications of this research, including a policy framework to attract private sector and pension funds to infrastructure.

Addressing the mis-alignment of policies for infrastructure investment will require different actions tackling the investment climate, governance and financial dimensions of the barrier investors are facing. The proposed distinct but inter-related actions part of this research agenda - to be proposed to the G20/OECD Taskforce on Long Term Investment - would build on each other (often using similar or related datasets) aimed at overcoming the silo approach often used in the different academic and policy areas related to infrastructure (i.e. financial regulation, development finance, green finance).

1.7 LIMITATIONS AND FURTHER WORK

The first limitation of the thesis has to do with the choice of research methods. The methods employed in the thesis are qualitative and quantitative descriptive statistics to define the trends in private sector financing and the role of institutional investors, whereas in looking at new models and products in infrastructure I use a case studies approach. I have opted for a mix of qualitative and quantitative approach due to the lack of data common to private markets. While I was informed by numerous quantitative studies as part of conducting literature reviews, the results emerging from the qualitative research can be complemented by further quantitative enquiries.

The second limitation has to do with the scope of the DPhil thesis. While I believe I am able to provide several important contributions to the economic geography, private sector role and sustainable finance literature and policy, the DPhil thesis focuses mainly on a government/public use of the findings in a G20 context in two specific policy areas: pension funds and infrastructure investment.

The time and resource limitation of the DPhil implies that the study does not expand in further asset allocation empirical studies on asset management side or infrastructure delivery models in the infrastructure governance area.

To better understand of long-term investors in infrastructure further analysis is needed on pension design and regulation affecting the liabilities side and consequences for portfolio allocations and infrastructure investment. Framing this analysis at country level and considering also infrastructure governance and policies will results in effective policy implications in the pension fund and infrastructure areas.

Despite the increasing interest in long term investors, only a limited amount of information has historically been available regarding the investment strategies actually implemented by pension funds, sovereign wealth funds or PPRFs. Granular statistical data is scarce at asset or sector level forcing the literature to focus on the use of case studies of selected investors or more normative studies on asset

allocation. This has led to considerable uncertainty about the exact nature of the strategies of the broader market and their evolution over time.

Beyond the lack of data, there is a lack of analysis in academia and policy institutions on the connection between policies affecting investors' portfolios strategies and political decisions for infrastructure. The institutional investor's investment strategies and the decision to invest in infrastructure are based on strategic asset allocation and asset-liability management considerations. At the same time government choices about different types of private funding models and forms of financing of infrastructure are based on political priorities and national constraints. In order to ensure alignment of interest and long-term sustainability of infrastructure investment better understanding is needed of market opportunities in light of investor and government objectives.

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ANNEX 1 – G20 AND POLICY DATA WORK

The G20 Infrastructure Data Initiative (the IDI) is a leading effort recognised by G20 countries that seeks to bring together many stakeholders in the financing of infrastructure, with the aim to increase the availability and quality of data and information that describes infrastructure investment. As part of the IDI, the OECD, and the Global Infrastructure Hub (GI Hub), along with key members of the public sector such as national and sub-national governments, MDBs, and academia, are partnering with key members of the private sector in order to develop a platform for the sharing of infrastructure data and ESG factors. Beyond recommendations to develop infrastructure as an asset class, OECD work is focusing on use of micro data for the analysis of infrastructure investment, the nature of the data available, methodological aspects and recent initiatives on data collection for financial and ESG benchmarking.

There are only a limited number of empirical studies on the investment characteristics of this alternative asset class. To address this point the FSB, IMF, OECD and World Bank initiated a project in 2014 to develop a set of key quantitative indicators for long-term investment finance (see FSB et al (2014)). In the G20 context, the OECD followed up on the project's recommendations, in cooperation with other countries and international organisations (IOs), e.g. Canada, Italy and the BIS; see OECD (2015)[11].

The OECD has supported the IDI over the course of 2017 and 2018, organising four Workshops on Data Collection for Long-term Investment as part of the G20/OECD Task Force on and Long-term Investment, gathering over 400 participants. To inform these discussions **the OECD report, "Breaking Silos: Actions to Develop Infrastructure as an Asset Class"** supported by the current G20 Argentinian presidency was presented to the G20 Infrastructure and Investment Working Group in November 2017. On data collection and financial and sustainability performance benchmarking for infrastructure see

[11] OECD (2015) "Addressing Data Gaps in Long Term Investment: an Agenda for Research" developed in cooperation with other countries an international organisations for the G20 (e.g. Canada, Italy and the BIS) and FSB, IMF, OECD, WBG (2014),"Development of quantitative indicators of long-term investment finance".

also OECD Workshop on Data Collection for Long-term Investment (3 May 2018); *Workshop on Data Collection for Sustainable Infrastructure (2 November 2017)*; Workshop on Data Collection for Long-term Investment (10 May 2017)

With the publication in March 2020 of the European Commission Taxonomy, momentum is gathering to further clarify and disclose climate change risks, both from the perspective of institutional investor portfolios (pension funds and insurance companies) and corporations[12]. As such, a number of countries and industry-led associations, have put into place reporting requirements or voluntary disclosure of ESG practices by institutional investors .

Building on the G20 GFSG/UNEP initiatives, the Network for Greening the Financial System (NGFS) recommends that the appropriate public authorities share data of relevance to Climate Risk Assessment (CRA) and, whenever possible, make them publicly available in a data repository[13] In that respect, the NGFS is setting up a joint working group with interested parties to bridge existing data gaps. The deliverable of this group would be a detailed list of data items that are currently lacking but which are needed by authorities and financial institutions to enhance the assessment of climate-related risks and opportunities – for example, physical asset level data, physical and transition risk data or financial assets data.

[12] https://ec.europa.eu/info/publications/sustainable-finance-teg-taxonomy_en

[13] https://www.banque-france.fr/sites/default/files/media/2019/04/17/ngfs_first_comprehensive_report_-_17042019_0.pdf

CHAPTER 2: THEORETICAL FRAMEWORK

2.1 INTRODUCTION

The theoretical frameworks which underpin the main assumptions of the thesis lie at the intersection between financial intermediation and theory of finance (Arjaliès et al. 2017; Clark 2017), the governance of infrastructure (Burger and Hawkesworth 2010; Helm and Tindall 2009, Modigliani and Miller M. 1958) financial geography, asset allocation and portfolio optimization (Clark and Wójcik 2007; Wojcik et al., 2013; Markowitz 1952, Fama 1970, Litterman 2004).

As an economic geographer I have opted for a bottom up approach to analyze the role of pension funds in infrastructure for several reasons. In the first place it allows to interrogate existing theories and accepted perspective on infrastructure investment, a key element in the development of knowledge in any discipline. But also, given the limited amount of literature and macro data, academic focus has been in recent times on micro data for infrastructure analysis (OECD 2015b). The thesis benefits from unique access to these sources of data.

This approach - based on world observed, measured either through interviews or markets performance -will help understand the interplay between financial institutions such as institutional investors and government decisions about infrastructure investment. The thesis looks at institutional investors with a particular focus on pension funds and other private sector institutions (i.e. corporates, banks and asset managers) and public stakeholders (i.e. governments, development community) to illustrate both how different organizations interact with the issues of sustainable infrastructure and long term investment and how geography plays a moderating role in this interaction.

This thesis is a contribution to current research found in different disciplines such as economic and finance, fields of study such as infrastructure, pension fund and public policy and analytical logics that include institutional, relational and intermediation analysis. This thesis is also about the geography of finance – a world in which global financial markets increasingly price national institutions and economic structures whatever their geography and history (Clark and Wojcik 2007). The world of finance is analyzed using the perspectives and skills of economic geographers, using techniques aimed at better understanding the evolving economic map of the world and its people (Clark and Wojcik 2007).

This chapter includes first an overview on overarching themes and key academic literature used for this thesis with main research questions at stake for mobilizing pension funds in infrastructure. It then provides background on use of micro data for the analysis of infrastructure investment, the nature of the data available and considered for the thesis. It ultimately introduces research methods adopted for the thesis.

This chapter builds on earlier reports I have authored for the G20, in particular: OECD (2017)"Breaking Silos: Addressing the Information Gap and Developing Infrastructure as an Asset Class"; OECD (2015) "Addressing Data Gaps in Long Term Investment: an Agenda for Research", which was developed in cooperation with other countries and international organizations for the G20 (e.g. Canada, Italy and the BIS) and a FSB, IMF, OECD, WBG (2014) report on "Development of quantitative indicators of long-term investment finance".

2.2 LITERATURE REVIEW

2.2.1 Economic Geography

Economists and geographers have joined together to develop the field of economic geography using techniques aimed at better understanding the evolving map of the world and its people (Clark, Wojcik 2007). This thesis draws on three basic assumptions of economic geography outlined in the *Oxford Handbook of Economic Geography* to examine the crucial issues facing pension funds looking to invest in infrastructure: the world is heterogenous in terms of its institutions and economic practices; the differentiation is not only the product of history and geography but also the product of ongoing market processes; disequilibrium is the characteristic status of time and space (Clark, Wojcik 2007).

Economic geography literature has been focusing on the growing presence of private finance and non-state organizational structures such as institutional investors in infrastructure. Following this approach this thesis includes literature on financial intermediation and the theory of finance, design and governance of infrastructure, the geography of finance, pension fund research and emerging debates on "relational geometries."

In the past forty years infrastructure provision and operation in advanced nations have been transformed from a sector dominated by state-owned utilities with a number of emerging modes of private financing options. The modern city was the spatial instrument that enabled this resolution (O'Neill 2017).

Relational investing is becoming crucial in implementing strategies for investing in the infrastructure, since the bidding on and ensuing ownership and management of infrastructure assets around the world require a combination of financial, legal, and technical expertise. This is reflected in academic literature and new approaches. Torrance (2009) discussing the growing interest of institutional investors in investing in the infrastructure landscape, shows how infrastructure assets have specific geographies of information embedded in their investment return.

A relational perspective is important for this thesis due to the information asymmetries associated with infrastructure investing and the often-long term and complex relationships with many agents and stakeholders, public and private. Knight and Sharma (2016) focusing on the role of financial markets for urban infrastructure propose a relational model that contributes to theoretical understandings of how financial products are intermediated over time and space.

At the same time the growing presence of private capital in the urban spaces bring challenges to economic relations within cities. O'Neill (2016) explores the theoretical challenges focusing on urban governance and economic geography, concluding with the argument that prioritization of the generation of consistent, long-term financial returns diminishes infrastructure's capacity to generate the public good and positive socio-environmental externalities once seen as intrinsic to urban infrastructure.

Further understanding is needed on the role of financial markets and institutional investors in infrastructure. Clark (2000) argues that if we are to understand the long-term future of the western economies (in general) and our communities (in particular), we need also to understand how institutional investors allocate assets, mobilize funds, and make investment decisions.

An economic geographer approach is important to reconcile and analyze the international and world dimensions of financial markets and portfolio allocation in contrast with the local and national infrastructure policy views. In fact, investors when beginning the strategic asset allocation process, consider as place to start the world investment market as it describes the aggregate portfolio of all investors and it can also be interpreted as the portfolio allocation of the average investor (Doeswijk et al. 2014).

The concepts of the Global Market Portfolio build off of prior work from Doeswijk et al. (2014), BlackRock (2014b) and HEK (2014) with some exceptions. This picture of the GMP only includes capital assets and excludes consumable and store of value assets such as commodities, gold, art, or fringe areas like wine. The GMP includes those asset classes where a fundamental value can be determined, by discounting a stream of future cash flows.

Attempts at quantifying the future size of the infrastructure market depend on how assets will be made available for private investment. The public sector ultimately needs to decide whether or not to finance and build infrastructure itself by hiring outside contractors (the traditional procurement model) or by delegating part of the risk to the private sector who invest in infrastructure delivery (Blanc-Brude 2013).

A country dimension encompassing local and regional governance factors has been adopted to better understand specific problems encountered and solutions proposed by responsible institutions. While infrastructure investments are considered globally, opportunities depend on the availability of specialist information in the region of investment (Torrance 2009). Country level infrastructure resources - as well as the different varieties of capitalism - have an impact on relationship between actors. (Wójcik et al., 2018).

2.2.2 Financial Intermediation

This thesis draws on the theory of financial intermediation to analyze the role of financial intermediaries in facilitating economic activity. Following Clark (2017) I argue that the source of savings is important, just as the organizational form of intermediation matters in mitigating or accelerating the spatial–temporal concentration of financial assets in certain markets. Clark (2018) observes that intermediation is common throughout the global financial services industry suggesting that realizing a planned rate of return is as much dependent upon optimizing and governing the chains of intermediaries that makeup the production process (Arjaliès et al. 2017; Clark 2018).

Pension fund investment in urban infrastructure relies upon the financial intermediation process -- an institutional process of mobilizing and managing pension fund assets for placement in unconventional sectors and products (Clark , Evans J. 1997). Whereas so much of financial activity takes for granted the existence of markets, networks of exchange and information, one of the most important functions of intermediation is to organize disparate sources of funds and relevant investment opportunities in circumstances where markets are eitherhu missing or transaction costs are so significant that existing

market institutions have few incentives to spontaneously price risk and allocate funds (Houthakker and Williamson 1996).

In this context, intermediation is particularly important for infrastructure investment where the opportunities of project-specific investments cut-against the attraction of relatively lower risk investments in infrastructure trusts (Clark and Evans 1997).

2.2.2.1 Role of financial sector

The financial sector plays an essential role in providing and channeling financing for investment. The importance of long-term finance lies in its pivotal role in satisfying long-term physical investment needs across all sectors in the economy and specifically in key drivers of growth, competitiveness and employment such as the infrastructure, real estate, R&D and new ventures.

In the transition to a sustainable economy, companies and investors are increasingly adopting the goal of long-term value creation, which integrates financial, social and environmental value (Schoenmaker, Schramade 2020). The OECD launched a project on Long Term Investment identifying a set of criteria for long-term investment by institutional investors including productive, patient and engaged capital[14], often associated with sustainable infrastructure investment. (Della Croce, Stewart and Yermo 2011).

Traditionally, banks have been a key player in the financial system, transforming savings into long-term capital to finance private sector investment. Over time, two main changes have taken place in the structure of the financial system (OECD 2014). First, the banking model has evolved, becoming increasingly dominated by wholesale markets and in particular derivatives, to the detriment of the

[14]For more on the project (www.oecd.org/finance/lti). For long term investment is meant: productive capital, providing support for infrastructure development, green growth initiatives, SME finance etc., leading to sustainable growth; patient capital allowing investors to access illiquidity premia, lowers turnover, encourages less pro-cyclical investment strategies and therefore higher net investment rate of returns and greater financial stability; engaged capital which encourages active voting policies, leading to better corporate governance.

more traditional deposit-taking and lending activities. Second, disintermediation and the growth of capital markets has led to a shift in the structure of the financial sector, with institutional investors such as pension funds, insurance companies, mutual funds, and, most recently, sovereign wealth funds, also becoming central players as providers of long-term capital. Clark (2017) drawing on the theory of intermediation, suggests that, over the past twenty-five years or so, in developed economies banks have lost out to new forms of financial intermediation that have been more successful in growing national and global financial markets.

Also the infrastructure financing market has gone through a process of radical transformation starting from the mid-2000s. Different reasons – a changed macroeconomic environment, more stringent regulations on financial intermediaries, a modified appetite for long-term asset investments – have led to a reallocation of flows from the banking sector to the institutional investors sector (Della Croce, Gatti 2014)

The past decade has revealed systemic faults in many countries' financial systems. Engelen et al. (2011) argue that the causes of the financial crisis lay in the bricolage and innovation in financial markets, resulting in long chains and circuits of transactions and instruments that enabled bankers to earn fees, but which did not sufficiently take into account system risk, uncertainty, and unintended consequences. Clark (2017) suggests that the global financial crisis and mismanagement of its aftermath are evidence of a profound failure of intermediation

There seems to be a two-sided paradox at the heart of the financial systems of many developed economies: on the one side a global surplus of savings – a product mainly of the growth of many countries' saving systems or increase in capital markets from the early to mid-1980s - on the other side is the search for investment returns outside financial markets and established financial practices Clark (2017).

With over USD 70 trillion in assets, institutional investors (such as pension funds and insurance companies) are frequently cited as an alternative source of financing. Given the low interest rate environment and volatile stock markets of recent years, institutional investors are increasingly looking for new sources of long-term, inflation protected returns. Investments in real, productive assets, such as infrastructure could potentially provide the type of income which these investors require supporting investment and driving growth.

2.2.3 Financial Intermediation Through Contracts

Various mechanisms supporting private capital financing public assets, change the risk allocation between the private sector, taxpayer and consumer and imply different capital structures for infrastructure and the specific role for institutional investors. This thesis looks at contractual solutions and design of infrastructure investment products to problems of financial intermediation involving public infrastructure.

Economic geography literature is limited on the financial intermediation process in areas such as pension fund investment in urban infrastructure linking portfolio asset management investment with the provision of infrastructure. Clark and Evans (1997) concentrate on infrastructure investment projects that involve long term contracts which bind parties (like governments and pension funds) together for the provision of urban infrastructure in exchange for an agreed allocation of risks and returns. Clark (2018) looked at the allocation of risk and uncertainty in green infrastructure investment with implications for climate change policy.

The focus of my thesis requires broader literature and analytical perspectives than that apparent in the urban studies and economic geography literatures. I use literature on risk allocation and theory of contract for public procurement linked to optimal capital structure to relate new initiatives specifically targeting institutional investors.

Alternative risk and profit-sharing approaches may create choices that are attractive to investors and sponsors with risk preferences and return expectations not accommodated by commonly used models.

Risk can be broken down into two essential components: exposure and uncertainty, exposure being an important part of this definition (Holton 2004). In the case of financial investments, downside risk (or the risk of loss), and its severity, are key points to be made. For example, the probability of default on a debt is a distinct risk with its own probability of occurrence. The recovery rate on the debt (loss severity) depends on the credit exposure and resolution of default and is itself a range of outcomes with associated probabilities. Loans to project companies are non-recourse; recoveries in event of default are driven solely by the value of collateral.

Risk allocation by means of contractual arrangements between the procuring authority and the project company is the key risk management strategy in project finance and public-private partnerships (PPPs). Effective contractual arrangements align the service delivery objectives of the public sector with the private sector's objectives to generate profits at an expected level of risk. The growth and spread of PPPs around the world are closely linked to the development of project finance, a financial technique based on lending against the cash flow of a project that is legally and economically self-contained. Project finance arrangements are highly leveraged, and lenders receive no guarantees beyond the right to be paid from the cash flows of the project. Moreover, as the assets of the project are specific, they are illiquid and have little value if the project is a failure (Yescombe 2007).

Different types of private funding models imply different capital structures for infrastructure and the specific role for investors. Understanding the likely leverage will give an indication of the amount of debt and equity that may be needed to finance an infrastructure opportunity and will help determine the cost of the transaction because equity carries more risk than debt and is also a more expensive form of finance

In perfect capital markets Modigliani and Miller concluded that a firm cannot change the total value of its securities just by dividing its cash flows into different streams. Infrastructure corporates and projects have unique characteristics influencing the decisions about optimal capital structure. Infrastructure is characterized by the long-term importance of their underlying business (sometimes delivering a public

service), an asset-heavy and capital-intensive nature, as well as generally a low-to-manageable business and operating risk relative to other corporate industrial issuers (Moody's 2015). For infrastructure corporates and projects, these characteristics support the company ability to sustain long-term debt, often at higher levels of leverage than is typical for similarly-rated issuers.

As governments seek greater levels of private finance in infrastructure and in particular pension fund investment, efforts are underway to develop new models and financial instruments for infrastructure procurement and create infrastructure as an asset class.

2.2.4 Geography of Finance and Theory of Finance

2.2.4.1 Asset pricing and sustainability for infrastructure as an asset class

The geography of finance has emerged with the rising importance of financial markets across the world. I have adopted a geographer approach in my thesis to decodify the set of theorems and applications "the language of finance" originating from the exponential growth of Anglo-American financial institutions and used by institutional investors and financial services worldwide.

In this thesis I draw from the geography and theory of finance to interpret infrastructure as an asset class in the investment contemporary world, speaking the same language of investors, while acknowledging limitations especially when looking at asset pricing and sustainable aspects. This translates into looking at infrastructure in a risk-return and portfolio optimization framework subject though to major issues with data and concepts for infrastructure assets and more broadly with conventional investment theory and practice (Inderst 2010 and Ansar 2014).

The neo-classical paradigm of portfolio theory and efficient markets captures financial value in its financial risk and return framework. Modern financial theory is based on the assumed relationship between risk and return: market participants should expect to be compensated for taking higher risks with higher returns (Ho and Lee 2004). At the same time new research is trying to demonstrate how the inclusion of infrastructure is able to provide better diversification and shift the efficient frontier, allowing better risk-return combinations of investment portfolios (Litterman, 2004, Blanc-Brude, 2013). However, such exercises need to be interpreted with a high degree of caution given the issues with the underlying data and concepts for infrastructure assets (Inderst 2010 and Ansar 2014) and more broadly issues with conventional investment theory and practice.

Infrastructure as a new asset class is considered to have several distinct and attractive investment characteristics including the low-risk, geographically varied returns matching the diversification

objectives of pension fund portfolios (Torrance 2009). In asset classes such as infrastructure characterized by information asymmetries, however, the assumed relationship between risk and return may not be sufficient as the basis for framing investment strategy. Even in an integrated system of financial markets, such as that which obtains between global financial centers, there can be a significant premium on local information (Stiglitz 2000, Clark and Wójcik 2007).

2.2.4.2 Efficiency of Capital Markets

Financial markets are considered broadly efficient by the classical financial economics theory and the efficient markets hypothesis assumes that all relevant information of a company is incorporated in that company's stock or market price (Jensen, 1978 and Fama, 1970). This has major implications on strategic asset allocation mainly based on modern portfolio theory, combining investor's constraints and objectives with long term capital market expectations. In fact, the market is supposed to be so efficient that it immediately incorporates all relevant new information, making it impossible for investors to "beat the market" to leverage superior insights or information and achieve higher returns. Hence the drive into passive investment strategies and the big growth of asset managers as Vanguard and Blackrock.

Modern portfolio theory stresses that risk is an inherent part of higher reward. Markowitz H. (1952) provided the theory behind the concept of diversification and its application to investments which represents the foundation for modern portfolio theory (MPT). The main conclusion is that investors should not only hold portfolios but should also focus on how individual securities are related to one another. According to Markowitz's Mean-Variance Portfolio Theory (1952), an investor's investment opportunity set would be improved if the efficiency frontier of the reference portfolio shifts to the left because of the additional asset.

Sharpe (1964), Lintner (1965), demonstrated the role that portfolios play in determining the appropriate individual asset risk premium (i.e. the return in excess of the risk-free return expected by investors as a compensation for the asset's risk). According to Capital Asset Market theory, the only

risk affecting the asset's price should be the systematic or non-diversifiable one as the priced risk of an individual security is affected by holding in a well-diversified portfolio. Hence for a given level of risk an efficient frontier of optimal portfolios can be constructed to maximise expected return, leading to an efficient economic allocation.

After the 2008 financial crisis, given the failure of asset-class based allocation to provide diversification, the notion of asset class has been losing its relevance in investment management (e.g., Ilmanen and Kizer 2012). Other approaches such as factor-based asset allocations aim to explain the performance of financial assets through the identification of factors including size and value premiums Fama and French (1992), the term and default premiums Fama and French (1993), and the momentum anomaly identified by Jegadeesh and Titman (1993).

The Black-Litterman model (1990, 1991, 1992) is commonly used for optimized asset allocation considering specific risk profiles. By analyzing historical performance data, the BL model - building on mean-variance (MV) optimization model and CAPM - incorporates investors risk preferences to generate expected returns on hypothetically constructed portfolios, while eliminating possible investor bias. Idzorek (2004) stated that different to the Markowitz mean-variance approach, the BL asset allocation model is expected to "overcome the problem of unintuitive, highly-concentrated portfolios, input-sensitivity, and estimation error maximization".

Contrary to the efficient market hypothesis assuming that all available information is incorporated in stock prices several studies find evidence of abnormal returns in alternative asset and private markets. Literature has been focusing on private equity, venture capital funds (Jegadeesh, Kräussl, Pollet 2009; Fang, Ivashina and Lerner 2014 Harris , Jenkinson,, Kaplan 2014).

There is evidence that markets are not always efficient as behavioral finance literature has shown that people including investors are not always rational Barberis and Thaler (2003). Behavioural finance indicates that such lack of rationality has important implications for financial markets, which can be seriously overvalued or undervalued for extended periods of time. Lo (2012) based on adaptive

markets hypothesis (AMH) implies that markets are not always efficient but are usually competitive and adaptive, varying in their degree of efficiency as the environment and investor population change over time.

Financial geography illustrates that information in financial markets is not ubiquitous and is not available to all actors at a negligible cost (Wójcik, 2011). Furthermore, geographic contextual intangible information is rarely efficient and its incorporation in financial decision making can bring substantial benefits for investors and companies.

Also there is increasing evidence supported by a growing body of academic research of market inefficiencies in mis-pricing ESG and private markets factors and better financial performance related to sustainability criteria in investments and ESG factors (Khan and others 2015; Friede Busch and Bassen 2015; Amel-Zadeh and Serafeim 2017)

2.3 USE OF MICRO DATA FOR INFRASTRUCTURE ANALYSIS

To arrive at a full understanding of the drivers and impediments of infrastructure investment, micro-based analysis is needed. The main objective of such analysis would be to provide a factual description of changes and policies that can be empirically tested and analysed "internally" by people with decision-making authority over sector policy, regulation, governance, and investment.

Official statistics produced by national statistical offices (NSOs) have traditionally focused on macro-based statistics and indicators, particularly in an international context. But as the world economy becomes more global, complex and diverse, comprehensive and good quality of micro-data has become an important tool for evidence-based decision making on complex issues. At the same time, rapid advances in computational capabilities have allowed for the processing of large databases of micro-data (OECD 2010). However, a number of technical, legal and statistical constraints still hinder the international dissemination of official micro-data.

The creation and maintenance of databases gathering project and firm-level information across a wide range of countries has attracted a lot of attention in recent years; commercial databases are largely used within the business community and, more recently, by academic scholars. Micro-data are also increasingly used at the OECD not only for econometric analysis that aims at capturing the heterogeneity of economic actors but also for different and more detailed ways of data aggregation (e.g. by geographical unit, firm size, industry). Examples of micro-data analysis at the project/firm level include:

- *The measurement of productivity and its determinants.*
- *Innovation – identifying the characteristics of innovative firms and people (ICT, R&D) and their benefits.*
- *Globalisation – looking at whether multinationals are more efficient and productive than domestically owned firms, the types of businesses that have benefited most from globalisation or the role played by outsourcing.*

- *Impact evaluation and development economics.*

The increased use of micro data for analytical and policy purposes has three main drivers. The first is the progress and evolution of expectations on evidence for effectiveness of infrastructure interventions among the key stakeholders (i.e. governments, development community) to be based on reliable quantitative evidence of an explicit causal link between interventions and observed effects[15]. The second is the need from the private sector community for more evidence on the risk and return characteristics of their investments (i.e. development of infrastructure as an asset class). The third is increased interest in how to measure infrastructure support for economic development and wealth creation, describing further the factors and determinants of the magnitude of impact.

2.3.1 Use of micro sources of data for infrastructure analysis

The use of micro sources of data is of particular importance for infrastructure analysis, however defined, not only because of its unique characteristics involving substantial financial amounts of finance for individual projects, but also because of its more generic benefits for the economy at large and its potential to increase future growth prospects of an economy.

The limited availability of consistent information on public and private investment in infrastructure has been an important barrier for more detailed empirical undertakings. As highlighted by Wagenvoort et al. (2010), there is a lack of comparable cross-country information on infrastructure investment as often comprehensive data by the government, SOEs and the private sector are not readily available. National statistics are useful, but often lack the required level of sector disaggregation for more detailed analysis

[15]According to Estache (2010) the academic evaluation field has been able to grow so fast in recent years thanks to: (i) significant improvement in the volume and the quality of household income and consumption surveys conducted in developing countries; (ii) major improvements in micro-econometrics and general equilibrium modelling techniques, (iii) the increased ability of personal computers to process large data sets quite fast. Since the mid-2000s, the interest in analytically robust evaluations of the impact of projects, programs or policies has exploded among development academics and field workers. There is a particularly keen interest in evaluations based on randomized field experiments and quasi-experiments, now mainstreamed in many health, education and infrastructure activities in which international development agencies are involved.

and policy insights. As such, the empirical literature has often explored the effects of policies and other determinants on investment in aggregated infrastructure sectors if not all combined.

Recent research has focused on infrastructure investment, looking at the "productivity" of capital and the determinants of investment and its financing, whether public or private (IMF, 2014; OECD, 2015). It has become clear that more evidence is needed on how to measure infrastructure support for economic development and wealth creation, describing further the factors and determinants of the magnitude of impact. In addition to understanding public policy decisions regarding investment in infrastructure, for which more detailed information on the impact of infrastructure investment at the macro level is needed, information on viability issues of individual projects at the micro level is also lacking. Important questions relate to how and to which extent increased private investment in specific infrastructure sectors (potentially through different contractual modalities) affects firm productivity, innovation, and product upgrading and diversification.

ADB analysis tried to better understand how much countries have been investing in infrastructure by looking at country infrastructure expenditures from government budget plus information on private investment in infrastructure from a World Bank database[16]. (ADB 2017). In recent work on infrastructure (ADB, IMF, OECD), several data sources at micro and macro level have been used to derive proxies for infrastructure investment. *See table below*

[16] As national accounts have severe data limitations the ADB proceeded as follows: "three alternative measures of infrastructure investment. Building on this it was created a database covering 33 DMCs (with at least one measure each)— though years and number of economies covered vary by measurement method . The first measure uses government budget information taken from official country websites plus World Bank PPI Project database figures to capture private investment in infrastructure. The second measure mainly includes the civil engineering component of GFCF data from national accounts statistics, which covers all types of investors. And the third measure is derived from general government GFCF or GFCF(GG) available from the International Monetary Fund (IMF) plus the PPI Project database figures" ADB (2017).

Table 1 Available macro and micro data for infrastructure and their respective sources

Measurement	Sources	Description	Items covered	Items not covered
1. Budget Spending on Infrastructure	Country Budget Offices	Capex in Transp, Comm, Energy, water made by GOVERNMENT Infra Investment by SOE using budget transfers	Capex by GENERAL GOVERNMENT in chosen infra sectors	CAPEX by SOEs using self raised funds typically not covered in budget data
2. Gross Fixed Capital Formation for General Government- GFCF (GG)	National Accounts	Public Investment by general government - national/subnational gov	Government investments in fixed assets (infra and non infra)	Infra investment by SOEs not covered
3. GFCF on Construction excluding Buildings or GFCF - mainly civil enegineering works	National Accounts	Investment in construction other than buildings	Infra investment by GOV, SOEs and the private sector in structures including highways, roads, railways, airfield runaways, bridges, tunnels subways, waterways, harbors, dams, sewer systems, mines, pipelines, communication cables, transmission lines, power lines and sports fields Some non infra including mines and industrial plants	Buildings and machinery and equipment in infra projects are excluded to avoid overestimation
4. Private participation in infrastructure (project/firm)	Commercial databases	Investment in Transp, ICT, energy, water projects owned or managed by private companies	Some private investment with info from publicly available sources	Private infra investments without publicly available info are not covered by the databases
5. Financial performance - Cash flows	Public Authorities, Investors, banks, investment funds	Investment and financing across sectors	cashflow, investment and balance sheet data collected from infrastructure investors and creditors.	

Source: Adapted from ADB 2017 and OECD 2015

2.3.2 Public vs Private Data Available for Infrastructure

Sources of data on individual projects can come from publicly listed infrastructure corporations and public utilities or private sources such as portfolios of commercial bank loans for construction projects, development banks and project finance, investment managers, or even institutional investors themselves.

The main problem with listed data, is that most indices include firms that have an infrastructure theme based on sectors but are not exclusively focused on physical infrastructure assets. Classification of infrastructure firms by sector does not necessarily explain the performance of underlying infrastructure investments, not providing a sufficiently precise definition. In fact, each of these sectors comprises a variety of economic activities along its respective vertical value chain. For example, the ports sector may include operators of port facilities such as piers and terminals as well as providers of ancillary port services such as tugging, fuelling, and ship maintenance.

In the in-depth analysis conducted by EIOPA for the re-calibration of Solvency II, the infrastructure definition covered investments in infrastructure project debt and equity (both directly and via funds). Debt and equity of corporates in the infrastructure sector were excluded as a clear delineation was not feasible to prevent non-infrastructure activities benefitting from a potentially more favourable treatment in the Solvency II regime[17].

Most of the necessary information is private and scattered amongst numerous firms. Data collection, when it exists, is ad hoc and relies on existing practices instead of promoting data collection according to the requirements of proper asset pricing and risk measurement methods. Some specialist publications and data providers have details of various transaction terms, yet many transactions are subject to non-disclosure agreements.

The amount of available data is limited in scope, since not all types of infrastructure projects exist in large numbers, and in time, because infrastructure investments may have multi-decade lives and available records are unlikely to span such periods. When transactions reach financial close, procuring authorities receive the final transaction documents containing the commercial terms for each deal. However, few governments collect data at a central level in a systematic way and procuring authorities are under no legal obligation to provide this information. For example, a report of the National Audit Office in the UK found that despite the long experience with PPPs and PFIs, government departments are lacking comprehensive data on the costs of debt and equity of their deals[18].

While private equity managers could be more transparent and aim to provide performance measures that are more relevant to long-term investors, taken individually, none of them has access to enough

[17] See work conducted by Eiopa and the Call for advice from the European Commission on the identification and calibration of infrastructure investment categories, July 2 2015

[18] In the UK for example until 2011 information on all PPP deals (including PFI) was collected by Partnerships UK (PUK). According to NAO (2014) this data is incomplete – only 31% of entries in the database provided information on debt and equity returns and no information on the financial terms of the 58 deals of 2010 and 2011 was requested. Since 2012 HM Treasury has requested summary financial close data from each procuring authority for centrally supported PFI projects and it has data for 86% (25 of 29 projects) that reached financial close since 2012.

information to answer the private equity asset allocation question. Without the constant feedback of market prices, long-term investment increases information asymmetry between investors and their managers, as well as investors' corollary demand for monitoring and reporting. On the other hand, although overall investment is still limited, some investors have built over the last decades a significant allocation to the sector and have been monitoring their investments for some time.

2.3.3 Challenges Related to the Existing Infrastructure Investment Databases

A number of commercial databases are relevant when investigating infrastructure investment. In Table 3 and in ANNEX are reviewed data providers with systematic data across multiple countries (covering both cross border and domestic finance), investors and financiers. The OECD has also developed relevant work on data sources for estimating private climate finance (See Caruso and Jachnik 2014).

Using firm or project data in the infrastructure sector faces several challenges such as the lack of a commonly applied definition for infrastructure (i.e. by sector, stage of development or geographic region); the different routes to invest in infrastructure (i.e. infrastructure funds, listed companies, corporates etc.), issues with confidentiality and privacy of necessary data. Challenges are due to the fact that projects are often very different from one another and dependent on the regulatory framework or concession agreement, and more broadly on the type of contract used. For example, differences in geographical size, legal framework, and the dispersion of population are important factors affecting investment in infrastructure.

Also, commercially available project-level database, are not subject to any official validation and may be subject to coverage shortcomings and inconsistencies. Although what is reported may include data beyond project finance, also corporate finance for certain databases it may not represent the full spectrum of private investment possibilities. Data may include also Public-Private Partnerships (PPPs), which may involve public support and investment, although capital expenditures in PPPs are normally privately financed. Also, it only records investment at the time of commitment, not when actual disbursements are made.

These limitations are exacerbated when discussing low-carbon and climate resilient infrastructure sectors as individual assets may not be labelled as such, which requires assumptions as to the perspective carbon footprint of an infrastructure asset.

Table 2 Main Infrastructure Financing Commercial Databases

	Corporate	Projects/ Transactions	Investment Funds	Others
Bloomberg	✓	✗	✗	✗
Bloomberg New Energy Finance	✗	✓	✗	✗
Thomson Reuters - Worldscope	✓	✗	✗	✗
Thomson Reuters ESG research data	✗	✗	✗	✓
Thomson Reuters Global Syndicated Loans	✗	✗	✗	✓
Thomson Reuters ONE	✗	✗	✓	✗
Orbis	✓	✗	✗	✗
Osiris (Bureau van Dijk)	✓	✗	✗	✗
Dealogic Project Finance	✗	✓	✗	✗
Dealogic M&A	✗	✓	✗	✗
Thomson Reuters - Project Finance International	✗	✓	✗	✗
IJ Global - Infrastructure Journal	✗	✓	✗	✗
Preqin	✗	✗	✓	✓
CEM Benchmarking	✗	✗	✓	✗
State Street	✗	✗	✓	✗
Financial Times	✗	✗	✗	✓
FactSet	✗	✗	✗	✓
Clean Energy Pipeline	✗	✗	✗	✓

Note: See ANNEX 1 for a detailed description of the databases

2.4. DATA AND METHODOLOGY

The methods employed in the thesis are qualitative and quantitative descriptive statistics to define the trends in private sector financing and the role of institutional investors, whereas in looking at new models and products in infrastructure I use a case studies approach. I have opted for a mix of qualitative and quantitative approach due to the lack of data common to private markets and the heterogeneous nature of infrastructure calling for a multi-methods and interdisciplinary analysis.

The difference between economists and geographers is the significance attached by the former to stylized facts and the very different significance attached by the latter to the diversity of economic life (Clark 1998). This significance has driven a debate between traditional and alternative economists with implications for research and methods of analysis.

Krugman's models of spatial resource allocation and trade convey robust theoretical insights with a parsimonious lucidity that appeals strongly to modern economists' tastes (David 1999). However, those pedagogical virtues may limit the models' utility in guiding empirical research on the dynamic processes ostensibly being addressed.

Theory-enslaved stylized facts may impoverish theoretical innovation in economic geography and the claimed virtues of objectivity, and the supposed dangers of subjectivity are disputed (Clark 1998). According to Clark the former is compromised by its reliance upon a ready-made world, while the dangers of the latter are exaggerated by an implied commitment to an uncontested truth. Among reasons to worry about this approach is that they are meant to explain a set of "stylized" facts that abstract from important observed in homogeneities in the geography of development (David 1999)~~)~~

On this basis the approach considered by this thesis leverages the virtues of close dialogue in economic geography and in the geography of finance in particular. A multidisciplinary approach

allows a holistic view and analysis on the subject of pension fund investment in infrastructure benefitting from finance, governance, infrastructure and pension policies theories.

The rest of this section details for each chapter data and methods used. A further description of main sources of data and analysis is also included.

2.4.1 Data and Methods

The analysis for this thesis benefits from primary sources of data through unique access to OECD national accounts statistical data on institutional investors and quantitative surveys undertaken at the OECD focusing on asset allocation of investors. The thesis is building on national account statistics on pension funds gathered by the OECD. The OECD Global Institutional Investors Database also benefits from the joint OECD, IOPS and World Bank Global Pension Statistics exercise.

Chapter 3 first looks at the evolution of infrastructure financing market and current and future challenges for key players such as banks and corporates as key sources of low carbon infrastructure. This study of infrastructure financing considers power (including renewable and fossil fuel generation, transmission and distribution) transport and water sectors as key sectors for the low-carbon transition. It focusses specifically on private financing, and cases where both public and private financing occurs, but excludes a discussion of public financing for infrastructure. Quantifying the investible infrastructure market is difficult – lines are often blurred amongst equity and debt categories and data is hard to define. In order to capture the size of the infrastructure market, data from existing databases providing information at infrastructure project level is used. Databases includes Dealogic, Thomson Reuters, IJ Journal, Infra-News, Bloomberg New Energy finance.

Chapter 4 of the thesis is building on qualitative country surveys within the framework of the OECD Long Term Investment Project and G20 work[19]. A first survey part of the Transcontinental

[19] The OECD Global Institutional Investors Database also benefits from the joint OECD, IOPS and World Bank Global Pension Statistics exercise.

Infrastructure 2030-2050 project focused on pension funds in Canada, Australia, the United States, South Korea and a number of funds in Europe. Subsequent studies have been looking even more in details at the comparison between Australia, Canada and G20 countries experiences (G20/OECD 2016 and Inderst Della Croce 2012).

Findings are mainly based on interviews with industry professionals as the existing data sources are limited, particularly with regard to infrastructure investment policy and risk management. The information acquired in interviews complements that obtained from a literature review, selected pension fund annual reports, and an analysis of the available data sources.

Chapter 5 and 6 leverage unique access to OECD microeconomic data of two distinct pools of long-term savings – LPFs and PPRFs. The OECD in 2011 launched the first annual quantitative survey covering Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) among the largest in their respective economies, and comparatively, amongst the largest in the world. In 2019, the survey reviewed the trends in assets and asset allocation of 125 LPFs and PPRFs, which in total managed USD 12.4 trillion in assets in 2017, approximately one third of the total worldwide assets held by this class of institutional investor

Chapter 7 introduces selected case studies for pooling of institutional investors showing new initiatives that have developed in response to the drawbacks and early inefficiencies, such as co-investment platforms, government-led initiatives and revised unlisted infrastructure funds that are providing opportunities for institutional investors interested in investing in unlisted equity infrastructure assets.

2.4.2 About the qualitative surveys - methodology

Chapter 4 and 7 are building on qualitative surveys within the framework of the OECD Long Term Investment Project and G20 work. In my role at the OECD I have been drafting relevant reports, conducting interviews and participating to meetings and conferences. This allowed me to gather a considerable amount of material and information for the thesis. Covering a considerable long period of ~~time~~ approx. 8 years in the same position also offered considerations on evolution of the issues under analysis.

A first qualitative survey focusing on pension funds in Canada, Australia, the United States, South Korea and a number of funds in Europe was launched by the OECD within the framework of the OECD Project on Transcontinental Infrastructure 2030-2050. The focus of the survey was mainly on (unlisted) equity investment given the different dynamics and drivers underlying pension fund investment in debt infrastructure and different subjects involved in the investment decision.

Over sixty interviews - for a value of over US4 trillion -were conducted through mainly face to face meetings or if not possible through conference calls starting with a first period between May and December 2010, supporting early research. Additional interviews and comments were subsequently provided during the drafting of the document (see annex 3 to Chapter 4). The inputs also incorporate advice and guidance from participants in the Steering Group of the OECD Project, as well as work and publications of line Directorates of the OECD (see annex 2 to Chapter 4).

A subsequent survey has been looking even more in details at the comparison between Australia, Canada (~~Inderst Della~~ Croce 2012). 24 interviews were conducted covering asset managers, pension funds and industry associations (for a list of interviewees see Annex 4 to Chapter 4). Focus of the survey was on factors such as infrastructure policies, the pension system, investment strategies, asset allocation and governance of pension funds.

Interviews have been supporting also the G20/OECD Guidance Note on diversified financing instruments for infrastructure was endorsed by the G20 Finance Ministers and Central Banks Governors

in 2016, and also by the G20 leaders at the Hangzhou Summit that took place on 4-5 September 2016. This report substantially draws on G20 members and meetings I have coordinated being responsible for the G20/OECD Task Force on Long Term Investment. Inputs from other organisations such as the IMF, the WBG and GIH were also received. Numerous comments on this report were provided at meetings and in written form, reflecting a dialogue and collaboration on the issues covered in the analysis

Chapter 7 leverages and updates case studies first presented by ~~Della Croce, R and Sharma, R . (2014,~~ The cases provide examples of mechanisms used to facilitate institutional infrastructure investment in various locations around the world, including co- investment platforms, revised/investor-friendly unlisted funds and government-led equity fund initiatives. Approximately 20 interviews for the major case studies presented in the chapter have been undertaken (see table Appendix 2 for a ~~list~~

A wide consultation process with asset managers and asset owners was conducted by the OECD for the G20/OECD Report on the Collaboration with Institutional Investors and Asset Managers on Infrastructure (OECD (2020 see Appendix 1)). This report reflects discussions held over several seminars supporting the G20 including meetings under the Japanese Presidency in particular a workshop I have organized for the OECD and held in October 2019 back to back with the meetings of the G20/OECD Task Force on Long-term Investment.

Interview process and lessons learned

To better understand the point of view of the interviewee open-ended questions were asked in a semi structured way to focus on concrete example and situations. In general for the surveys undertaken, the selection of interviewees was biased towards large-sized defined-benefit, occupational pension funds, since these funds represent a large share of overall infrastructure investment and in some cases have developed investment policies specific to infrastructure. Another considerable bias of investors selected was towards OECD countries, following the more developed nature and sophistication of those countries and the potential to invest in infrastructure.

Nature and quality of responses varied based on role and seniority in the organization. An infrastructure manager was able to respond to the specific issues of the projects in his portfolio, an Alternative Investment manager could give some comparison among asset classes such as private equity and real estate, a Chief Investment Officer could offer a broader investment portfolio approach with some political context.

Besides pension funds themselves, a number of investors from the insurance sector, and prominent financial consultants, infrastructure funds, multilaterals, academics, advisors to treasury and infrastructure departments, were also consulted. The interviews lasted on average 45 minutes with subsequent follow up if needed for clarifications and were conducted in person for the majority of the US and European countries.

Disclosure is often limited in financial sector and at a first approach, I found some reticence to speak openly in the interviews. Confidentiality and anonymity of responses were paramount to accept the interviews. In addition to overcome these issues and gain trust I have established a network of investors eager to support the research to access first hand information and at the same time explore opportunities of collaboration with peers.

2.4.3 About the OECD Large Pension Fund and Public Pension Reserve Funds Survey

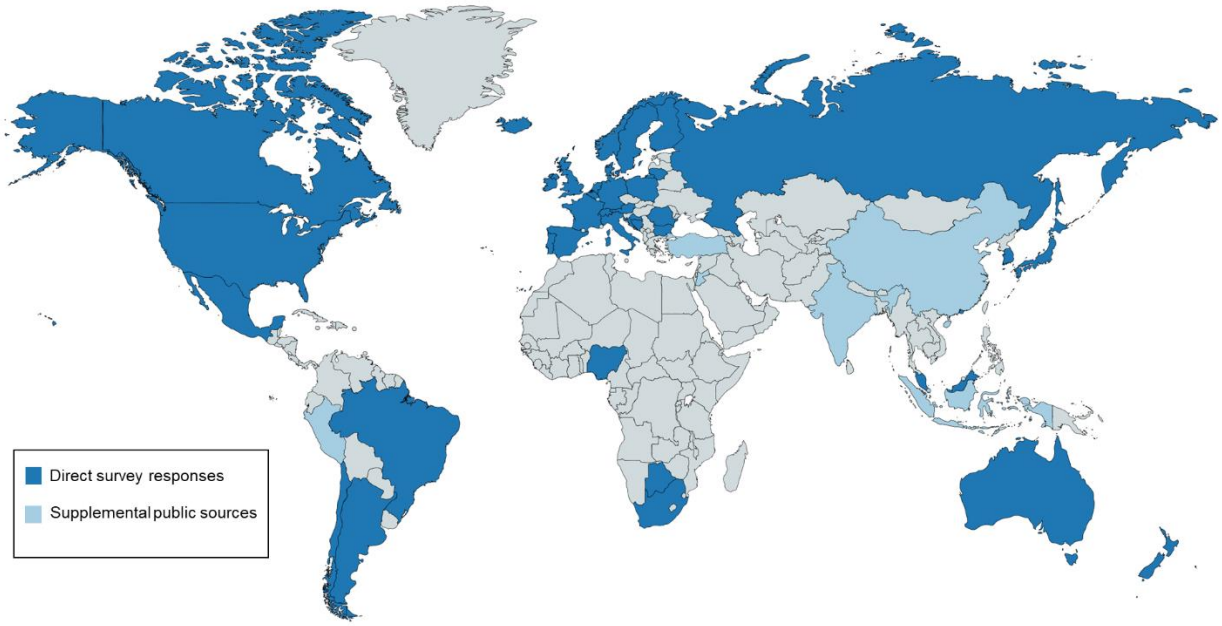
This survey is based on a qualitative and quantitative questionnaire sent directly to large pension funds (LPFs) and public pension reserve funds (PPRFs). It helps to provide detailed investment information and insights which complement the administrative data gathered by the OECD at a national level through the Global Pension Statistics and Global Insurance Statistics projects. This survey is part of the OECD Project on Institutional Investors and Long-term Investment and the work of the G20/OECD Task Force on Long-term Investment Financing by Institutional Investors. In 2019, the sixth survey report has been published since the data collection exercise was first established in 2011.

In 2019, the survey reviewed the trends in assets and asset allocation of 125 large pension funds (LPFs) and public pension reserve funds (PPRFs),[20] which in total managed USD 12.4 trillion in assets in 2017, approximately one third of the total worldwide assets held by this class of institutional investor. Information was provided through the survey for 99 out of the 125 investors. Data for the 26 remaining funds came from publicly available sources. Altogether, data was compiled from funds representing 46 countries around the world including non-OECD countries such as Brazil, China, India, Malaysia, Nigeria, the Russian Federation, and South Africa.

The survey report is divided into three sections. Part A – Portfolio Analysis focuses on pension fund size and growth, asset allocation, international exposure, and investment performance, and is divided into two sets of investors: large pension funds and public pension reserve funds. Part B – Infrastructure Investment focuses on capital flows in infrastructure, investment structures, sector and geographies. Part C – ESG and Infrastructure focuses on green investment and social impact investment.

[20] PPRFs are reserves/buffers to support otherwise PAYG financed public pension systems as opposed to pension funds which support funded pension plans in both public and private sectors. The survey included some SWFs such as Norway's Government Pension Fund – Global that have at least a partial pension objective.

Figure 1 Global survey coverage representing USD 12.4 trillion in assets under management in 2019



Source: OECD Laege Pension Fund Survey 2019

The pension fund sector includes private entities, public institutions, and SWFs with retirement purposes. ~~Namely~~ PPRFs are reserves/buffers to support otherwise PAYG financed public pension systems as opposed to pension funds which support funded pension plans in both public and private sectors. defined as by the OECD (Blundell-Wignall et al., 2008). The survey does not utilize a strict definition of a large pension fund but seeks to capture trends by looking at the largest investors in the world, compared on an absolute basis, followed by the largest investors within specific countries. The survey includes some SWFs such as Norway's Government Pension Fund – Global that have at least a partial pension objective.

2.5 CONCLUSIONS

Economic geography literature has been focusing on the growing presence of private finance and non-state organizational structures such as institutional investors in infrastructure. Following this approach this thesis builds on literature on financial intermediation and the theory of finance, design and governance of infrastructure, the geography of finance, pension fund research and emerging debates on "relational geometries."

This thesis draws on the theory of finance and financial intermediation to explain how the world of finance has developed over the last decades focusing on institutional investors as potential sources for long term financing. Financial intermediation though contracts in infrastructure allows also an understanding of institutional design and deliver models for infrastructure and more specifically, the ways in which investors approach risk and uncertainty.

In this thesis I draw from the geography and theory of finance to interpret infrastructure as an asset class in the investment contemporary world, speaking the same language of investors, while acknowledging limitations especially when looking at asset pricing and sustainable aspects. This translates into looking at infrastructure in a risk-return and portfolio optimization framework subject though to major issues with data and concepts for infrastructure assets and more broadly with conventional investment theory and practice.

To arrive at a full understanding of the drivers and impediments of infrastructure investment, micro-based analysis is needed. The main objective of such analysis would be to provide a factual description of changes and policies that can be empirically tested and analysed "internally" by people with decision-making authority over sector policy, regulation, governance, and investment.

Given the lack of academic literature and macro data it is proposed a bottom up approach to the role of institutional investors and the development of infrastructure markets, focusing on micro data for

infrastructure analysis (OECD 2015b). The methods employed in the thesis are qualitative and quantitative descriptive statistics to define the trends in private sector financing and the role of institutional investors, whereas in looking at new models and products in infrastructure I use a case studies approach. I have opted for a mix of qualitative and quantitative approach due to the lack of data common to private markets and the heterogeneous nature of infrastructure calling for a multi-methods and interdisciplinary analysis.

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ANNEX 1 - EXISTING DATABASES

Table 3 Main databases for infrastructure financing

Type of Data Source	Public/Private	PROVIDER	DESCRIPTION
Corporate	Commercial database	Bloomberg	Extensive equity and debt capital markets data for listed corporates, municipals and sovereigns. This includes equity, bond markets, foreign exchange markets, credit markets, as well as an important set of pricing and data analytics tools.
	Commercial database	Thomson Reuters - Worldscope	Listed Companies Data – both equity and debt capital markets.
	Commercial database	Orbis	Over 99% of the companies on *Orbis* are private. Private company information is more difficult to obtain, as the legal obligation to file accounts varies widely from country to country.
	Commercial database	Osiris (Bureau van Dijk)	Osiris has information on listed, and major unlisted/delisted, companies around the world. The information is very detailed and includes a lot more than financial reports. Different templates are used to show accounts in the correct formats for their company type and location.
Projects/Transactions	Commercial database	Dealogic Project Finance	Project Finance Transactions database. The database covers all infrastructure sectors and geographies. It provides both aggregate data on transactions as well as on specific tranches, including pricing details when available.
	Commercial database	Dealogic M&A	Database global capital markets information - global equity and fixed income transactions
	Commercial database	Thomson Reuters - Project Finance International	Project Finance Transactions database. The database covers all infrastructure sectors for all geographies. Limited details on the transactions and difficult to access and use.

Type of Data Source	Public/Private	PROVIDER	DESCRIPTION
	Commercial database	IJ Global	Infrastructure project and transaction database. The database covers all infrastructure sectors (social and defence, mining, oil and gas, renewable energy, water, and transport), for all geographies and both project finance and corporate balance sheet financing transactions. The data base provides extensive details on the transaction, including pricing details when available. However, public financing transactions, as well as China are not covered.
	Public database	World Bank Group	This database reports project-level information in energy, transport, telecommunications, and water and sewerage sectors for 139 low and middle income countries. The database includes projects with at least 20% private participation. Details are also available on type of project—whether a project is a management and lease contract, a brownfield project, a greenfield project, or a divestiture
Investment Funds	Commercial database	*Preqin*	Private Equity and Venture Capital modules of alternative asset funds and deals. Infrastructure investments and fund module
	Commercial Database	CEM Benchmarking	Pension fund analysis and benchmarking services including defined benefit, defined contribution, benefit administration with best practices and health care. Also provides benchmarking information for endowments/foundations and sovereign wealth funds.
	Commercial Database	State Street	Financial data analytics for institutional investors. Amongst its offering, State Streets provides benchmarks, indices and indicators.
	Commercial database	BNEF	BNEF database of clean energy and carbon investments (equities, corporate and asset-backed bonds, syndicated debt, VC, PE and M&A). BNEF database that includes information on

Type of Data Source	Public/Private	PROVIDER	DESCRIPTION
			financial transactions associated with "new energy" (defined as renewable energy generation, energy storage, carbon capture and storage, etc.). According to the metadata, the database covers all relevant projects worldwide above a certain threshold capacity. For example, projects with at least 1 MW of installed capacity in geothermal, solar and wind energy generation, 1-50 MW for hydropower, and all marine energy projects are included (BNEF 2012).
	Public database	UNEP Risø Centre	Clean Development Mechanism project pipeline.
Other	Commercial database	Thomson Reuters ESG research data	ESG database.
	Commercial database	Thomson Reuters Global Syndicated Loans	industry-leading syndicated loan transaction information
	Commercial database	Thomson Reuters ONE	ThomsonOne database of project finance transactions, PE and VC, as well as M&A data
	Commercial database	Financial Times	fDi Markets database of cross-border greenfield investments
	Commercial database	FactSet	FactSet's databases on private equity transactions, M&A, and private company ownership
	Commercial database	Clean Energy Pipeline	Clean energy and low-carbon investment database (equities, corporate and asset-backed bonds, syndicated debt, VC, PE and M&A). Good transactions type and geographic coverage.

Type of Data Source	Public/Private	PROVIDER	DESCRIPTION
	Public database	OECD	Directorate for Financial and Enterprise Affairs' aggregate FDI statistics
	Public database	United Nations Conference on Trade and Development	FDI statistics including a one-time attempt (in 2010) to measure low-carbon FDI

ANNEX 2 - DATA INITIATIVES

World Bank Private Participation in Infrastructure Projects Database

The World Bank Private Participation in Infrastructure Projects Database identifies and disseminates information from publicly available sources on private participation in infrastructure projects in low- and middle-income countries. The database highlights the contractual arrangements used to attract private investment, the sources and destination of investment flows, and information on the main investors. By providing these data to government policy-makers, consumer representatives, the donor community, and other stakeholders, the database contributes to the public debate on the private provision of infrastructure (finance).

This database currently reports project-level information in energy, transport, telecommunications, and water and sewerage sectors for 139 low and middle income countries. The database includes projects with at least 20% private participation. It provides information on the project level, including country, financial closure year, infrastructure services provided, type of private participation, technology, capacity, project location, contract duration, private sponsors, and development bank support[21]. globally launched in January 2016. SOURCE is now used by 40 governments.

The ESG performance of infrastructure assets

Many international standards, such the Global Infrastructure Basel's SuRe, have been developed in order to integrate sustainability and resilience aspects into infrastructure development and upgrade. In addition to the project-focused tools such as SuRe, initiatives such as GRESB address infrastructure sustainability issues at the asset and the fund levels. In practice, GRESB provides a tool coupled with a scoring methodology that assesses ESG performance of assets in line with international standards such as PRI standards.

[21] The data and methodology can be found at: http://ppi.worldbank.org/.

CHAPTER 3: MAPPING RISKS AND FINANCING FOR LOW CARBON INFRASTRUCTURE - ROLE OF INSTITUTIONAL INVESTORS

3.1 INTRODUCTION

Achieving low emission pathways will require significant investment in low-carbon infrastructure and a reallocation of capital away from carbon-intensive assets. Existing and new infrastructure will also need to be resilient to climate impacts, requiring additional investment. Understanding the role of the private sector and financial markets in the transition will be crucial in achieving a decisive transition.

Recent decades have seen a shift towards greater involvement of the private sector in the delivery and financing of infrastructure in favour of the traditional procurement model. Efficiency improvements have been a key component of the rationale for privatisation in an attempt to reduce the budgetary burden caused by inefficiencies of state enterprises New initiatives developing in response to the drawbacks and early inefficiencies are specifically targeting institutional investors.

At the same time, the infrastructure financing market has gone through a process of radical transformation starting from the mid-2000s. As governments seek greater levels of private finance in infrastructure, efforts are underway to develop new financing and funding structures to align public and private sector interest in infrastructure provision and management. Increasing as well as diversifying the investor base, this also has the potential to lower the cost of funding and increase the availability of financing for low carbon infrastructure.

A change in the risk allocation between the private sector, taxpayer and consumer will also imply different capital structures for infrastructure and the specific role for institutional investors. Increasing levels of private investment and financing will entail certain risk transfers to the private sector, with appropriate risk allocation being crucial for long-term viability. The choice of financing and delivery models will affect the

allocation of risk and influence the attractiveness of the investment opportunities for institutional investors and the cost of capital for the public sector.

This chapter is intended to provide a structured framework for understanding the range of instruments and vehicles for low carbon infrastructure financing that may complement traditional sources of finance such as commercial banks, MDBs and governments. Instruments and vehicles are related to infrastructure risk and returns to understand related best souces of finance across the lifecycle and the role of institutional investors.

This chapter is drawing from OECD research completed for the G20, the OECD *Infrastructure Financing Instruments and Incentives: a Taxonomy* and the G20/OECD Guidance Note on Diversifying Sources of Finance for Infrastructure and SMEs. Aim of this work is to diversify the types of financial stakeholders and sources of finance for infrastructure and align public and private sector interest in infrastructure provision and management, while optimising the capital structure and reducing the cost of capital for the public sector.

This framework is used in the thesis to map international trends in low carbon infrastructure on the equity and debt side analyzing the different types of private sector participants that are important for infrastructure investment (i.e. corporates, banks and institutional investors) and the various constraints they face in financing infrastructure projects, including business considerations, long-term strategies related to climate change, and the regulatory environment. This approach supported the G20 report "Investing in Climate, Investing in Growth" delivered by the OECD in May 2017 and follow up work (see ANNEX 2).

3.2 LITERATURE REVIEW

3.2.1 Infrastructure and Renewable investment risk dynamics

Private sector investment in infrastructure is based on the matching of the expected risks and returns of infrastructure assets with the investor's own desired returns and risk tolerances. If done properly, the involvement of the private sector can also help to increase efficiency, thus providing support beyond mere financing (Clark 2018). In this section we look at the allocation of risk and uncertainty in infrastructure investment, the cost of capital and institutional investors appetite for low carbon infrastructure.

There is no single, consistent definition of risk in the literature on infrastructure. Formally, risk is defined as the measurable probability that the actual outcome will deviate from the expected (or most likely) outcome (OECD 2008). Keynes (1921) and Knight (1921) distinguished between risk and uncertainty. Knight's (1921) definition of risk states that statistical (objective) probabilities reflect measurable risk while subjective probabilities, which are largely based on opinion, represent unmeasurable uncertainty (Holton 2004). Hence probability is often used as a metric of uncertainty, but its usefulness is limited; probability therefore quantifies perceived uncertainty (ibid).

In the case of financial investment in infrastructure there are key points in relation to risks. Breaking down risk into exposure and uncertainty, allows to consider exposure as downside risk (or the risk of loss), and its severity, (Holton 2004). For example, the probability of default on a debt is a distinct risk with its own probability of occurrence. The recovery rate on the debt (loss severity) depends on the credit exposure and resolution of default and is itself a range of outcomes with associated probabilities. Loans to project companies are non-recourse; recoveries in event of default are driven solely by the value of collateral.

A distinction can be drawn **between micro and macro-level risks**, along with how risks affect infrastructure assets at the project level, and at the system-wide level. For instance, lengthy or convoluted permitting processes can cause delays and increase risks system-wide; ineffective mechanisms for dispute

resolution, or frequent changes in tariff regulation, can increase the cost of finance for all projects (OECD 2020).

To ensure the energy transition and achieve the policy objectives for renewables, these technologies must become cost-competitive with fossil fuel–based technologies (FFT) in advanced and developing countries (Egli 2020). As low/zero carbon generation as renewables are capital intensive reductions in the financing cost (the WACC) increase their cost competitiveness (Hirth and Steckel, 2016). In emerging economies this is particularly relevant as the cost of investing in wind power is 40 percent higher than in developed countries with higher cost of debt and equity (Waissbein et al. 2013).

The positive link between risk and return implies that declines in low carbon infrastructure risk premiums should coincide with a change in investment risk (Merton, 1973). As institutional investment is about the allocation of risk and uncertainty (Ho and Lee 2004), a reduction in investment risks will attract private capital and in particular large institutional investors to low carbon infrastructure (Waissbein et al., 2013; Kaminker and Stewart, 2012).

Investment risks in infrastructure and renewables have a dynamic nature. Recent research shows that the cost of capital for renewables energy has decreased over time (Donovan and Li 2018; Ecofys 2016; Egli et al. 2018). Portfolio diversification potential and technologies development are major factors (Kitzing et al., 2018; Masini and Menichetti 2012; Wüstenhagen and Menichetti 2012). Technology reliability at a lower cost, better assessment tools and stable policies are considered as major factors in the diminishing investment risk analysed in Germany, Italy and the UK (Egli 2020).

In India, better financing terms, with supportive policies and falling costs have lowered risks for investors and led to reductions in power purchasing tariffs for utility-scale solar PV and wind. India's renewable power investment has doubled over the past five years, reaching nearly $20 billion in 2018, and now exceeds that for coal power. The debt risk premium to benchmark bank lending rates decrease by around 75 basis points, combined with lower economy-wide interest rates, improved debt financing makes over a 15% difference to the levelised cost of electricity (LCOE) for solar PV (IEA 2019).

3.2.2 Capital structure matters – the mix of debt and equity

Infrastructure corporates and projects have unique characteristics influencing the decisions about optimal capital structure.The expected leverage will quantify debt and equity and define the cost of the transaction as equity is more expensive than debt bearing more risk.

Infrastructure corporates and projects have the ability to sustain long-term debt, often at higher levels of leverage than is typical for similarly-rated issuers.This because infrastructure main investment characteristics including the long-term importance of their underlying business (often delivering a public service), an asset-heavy and capital-intensive nature, as well as generally a low-to-manageable business and operating risk relative to other corporate industrial issuers (Moody's 2015).

In the early 2000' the emergence of private equity and infrastructure funds brought substantial financial engineering and extremely leveraged balance sheets. Increased gearing has, on the one hand, introduced the **discipline of debt upon management** which had engaged in substantive diversification, and on the other provided **an arbitrage** between the weighted average cost of capital used to calculate the allowed return, and the lower marginal cost of debt (Helm Tindall 2009)

Project finance is used worldwide to support infrastructure financing. Project finance debt has started to be used in the USA since the early 1930s in oilfield development and later in Europe at the beginning of the 1980s. It has been systematically used since then in a number of sectors in association with large-scale infrastructure projects. Debt has been used in the form of syndicated loans, with a pool of banks headed by one or more Mandated Lead Arrangers (MLAs) that organise the financing package for a single borrower (Gatti 2014).

Infrastructure corporates which have portfolios of assets benefit from the diversification of revenue streams which can help to smooth earnings before debt service.**This introduces the concept of an "optimal" capital structure**. The after tax cost of debt is low compared to the cost of equity, which can lower the weighted average cost of capital (WACC). This is a counter-intuitive quality of **project finance** which challenges Modigliani and Miller's theory that capital structure has no effect on firm value (Blanc-

Brude 2013). Although this does eventually diminish – as more debt is added, the risk to equity and thus the cost of equity increases. An optimal debt-to-equity ratio will vary depending on the circumstances of each individual asset. Balancing the benefits of debt against the risk of financial leverage is paramount in order to fully benefit from debt finance. The use of debt and equity is therefore self-reinforcing: overall financial sustainability of an infrastructure asset can be improved when both debt and equity are used at optimal levels.

There are also benefits to using debt besides **capital structure optimisation**. The contractual nature of debt incentivises debt holders to monitor managers and the risks that they take. Some studies have shown that governments are less likely to default against debt holders as opposed to equity investors, even when the same parties hold both debt and equity instruments, which can protect overall project viability (Wells and Gleason 1995, Sawant 2010).

Taxation has been a powerful tool used by governments and regulators to shape capital markets. **Low interest rates combined with the benefits of the tax shield has had the effect of lowering the weighted average cost of capital (WACC) for** infrastructure projects, enhancing returns to equity holders (Bitsch et al. 2010). On the investor side of the equation, tax exemption of interest income on municipal bonds in the United States or corporate bonds in Nigeria, for example, also has the effect of lowering the cost of debt for issuers while creating itself new channels of demand - taxable investors can earn a tax-free yield on savings. The U.S. municipal bond market, which includes some infrastructure-related issues, is a huge market that remains a low-cost alternative for local governments to finance infrastructure projects.

3.3 MAPPING RISKS AND FINANCING FOR LOW CARBON INFRASTRUCTURE

The increased growth and globalisation of the infrastructure market has been fuelled by ample liquidity in financial markets and high demand from private sector and investors for long-term investments in infrastructure. Despite the abundance of capital now available in financial markets, driven by exceptionally low interest rates in a number of advanced economies, access to long-term finance remains constrained for certain low carbon infrastructure projects with high costs of financing. Sustainable infrastructure often is more capital-intensive, which makes (low-cost) finance even more important, especially in emerging markets (Bhattacharya et al. 2016).

Availability and cost of financing are influenced by the risks involved in infrastructure investment. Several factors determine the risks – real and perceived - associated with infrastructure investment: these investments are typically of long-term nature, involve high upfront costs, differ from project to project and thus cannot reach economies of scale, and usually involve different stakeholders and non-standardised financing structures (OECD 2015a). These risks are exacerbated in the case of low-carbon and climate resilient infrastructure with specific constraints in developing countries.

The key functions that the financial system performs in the real economy include mobilising capital and allocating resources, managing and transferring risks, and price discovery. Capital markets can be an efficient way to allocate risks to those investors that are most willing to bear them at an agreeable rate of compensation. Financial markets support the infrastructure sector through a variety of investors (e.g. utilities, banks or institutional investors) and asset classes (such as debt, equity or mezzanine).

The OECD has developed a taxonomy of financial instruments to clarify the role of market-based financing for infrastructure across the spectrum of investors and risks. Each instrument has its unique set of characteristics and therefore implications for lending or investment portfolios (OECD 2015a). The taxonomy details variety and also their suitability to different asset categories In the taxonomy infrastructure risks are be classified by their main source – namely political and regulatory, macroeconomic and business, and

technical and grouped according to the project development phases from development to construction, operation and termination phase. (See ANNEX 1)

Building on this work empirical mapping has been conducted on investments in the low carbon sector by the OECD and the IEA. This work on investment trends analysis draws on both project-based and mergers and acquisitions (M&A) data from commercial databases to provide evidence of finance trends in low carbon infrastructure sectors at disaggregated levels (See ANNEX 2)

There are different dimensions to the supply of financing for infrastructure and its composition, understanding the relationship between traditional sources of finance and capital markets is critical. Infrastructure is ultimately funded by taxpayers or direct users and can be financed by public sources (ie. national/subnational governments22 or development institutions) or private sources (i.e. corporate or project finance).

Private infrastructure financing is influenced by the potential revenues earned by the project. Projects with clear revenue streams (e.g. renewable energy) have a strong potential for private financing, while those where a revenue stream is not available (e.g. financing climate proofing of existing infrastructure, or certain climate-resiliency assets such as flood protection), or predictable (e.g. financing of basic infrastructure projects in developing countries with weak regulatory frameworks), will be financed by the public sector.

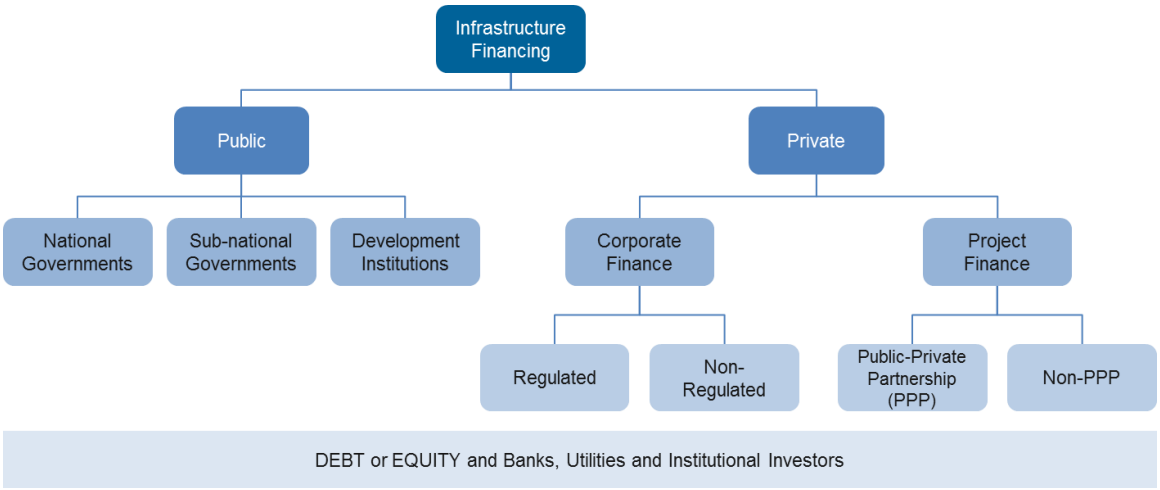
Following IEA and OECD, this analysis covers the investment and financing activity for low carbon infrastructure, from the private sector point of view, at different levels:

- ***Financial structures****:* private capital is provided is two main forms, corporate finance (financed on 'balance sheet') and project finance (external finance).
- ***Delivery models:*** including different forms of regulation from SOEs to fully privatized companies to PPPs and concessions.

22 With the focus on the development of local currency markets and the successful issuance of infrastructure bonds, sub-national and local governments have grown in significance

- ***Financing phase****:* investment activity can be split across the value chain in *primary financing* associated with new activity in mature assets (e.g. greenfield projects, asset finance); *secondary market finance* relating to existing assets, including refinancing and M&A

Figure 2 Infrastructure Financing Structure



Source: Adapted from Inderst 2016

3.3.1 Financial structure

Energy (power) investments are made mainly on company balance sheets however project finance has grown in particular for renewables investments. According to the IEA in 2018 utilities, independent power producers, and consumers (for distributed generation) represented about 85% of power investments (IEA 2019).

Corporate finance is the dominant channel in private infrastructure finance. For instance, private investment in regulated entities such as utilities has a relatively long track record, most often on the balance sheets of these companies. The same is true for developers in other sectors, such as waste removal, ports, and also traditionally in electricity generation. Companies listed on public exchanges are sizeable owners of infrastructure assets, providers of infrastructure services and investors in infrastructure projects. They range from specialist businesses to diversified conglomerates.

In recent years infrastructure projects have been able to expand access to more diversified pools of financing, reflecting general trends in financial markets, specific policy measures and sector characteristics (OECD 2017). Project finance structures for renewable energy projects have been growing as a total share of finance flows reflecting a preference for utility-scale term loans structures in developing countries such as China and South Africa, as well as constrained cash flows which have reduced the ability of utilities in some markets, such as Europe, to self-finance projects. Also, recent developments in the wind energy sector show how banks, private equity funds, pension funds, state-backed "green" banks and insurance companies have all invested in these projects in the last years.

At the same time climate change has moved rapidly up the political and societal agenda posing new challenges to traditional providers of finance and opening new opportunities for partnerships and collaboration among institutions. More in particular:

- Utility business models in developed markets are challenged by a more competitive environment driven by changes in electricity demand, the growth of low marginal cost sources of energy, such as renewables, which tend to displace high variable cost energy generation, and the rising share of decentralised generation in the electricity generation mix.
- Corporate direct participation in the low-carbon infrastructure by high technology companies and traditional oil and gas companies is becoming more mainstream. Corporations have provided finance in the renewables sector as off-takers through direct investments, power purchase agreements (PPAs), pure equity investments and partnership models. Behind this flow of finance is a trend among large corporations to lower the emissions profile of their core business operations, or to promote renewable energy deployment more generally.
- Bank loans remain a critical source of finance for investment in new infrastructure projects and for the refinancing of operational assets, in both advanced and developing countries. At the same time the general upward trend of the volume and value of bond issuances in the infrastructure sector in recent years can be viewed as a reflection of growing institutional investor interest in the sector.

3.3.2 Delivery model

Delivery models –including policies and contracts- have a key role in managing market risks. In 2018, companies operating under fully regulated revenues or long-term contractual mechanisms represented over 95% of power sector investment (IEA 2019). Short-term price signals in competitive wholesale markets are too low to incentivise investments in the most capital intensive assets (IEA, 2018).

The delivery model and contractual schemes influence the risks the private sector will face and the responsibility for provision of financing among different stakeholders. There are a number of delivery models involving the public and/or private sector taking responsibility and different levels of control over the infrastructure asset including (i) public ownership and procurement (ii) concessions and public private partnerships (iii) SOEs and fully privately-owned companies.

Among concessions and PPPs, a range of contractual schemes will entail allocation of risks and financing from private sector institutions. As described by Gatti (2014) at one extreme, we find simple O&M services (the O&M, DB and TK schemes) provided by the private sector where the ownership of the facilities remains with the public sector. The only risk shifted to the private party is the operational risk, given the construction/investment and commercial risks are retained by the public sector. At the other extreme of the spectrum, the full exit of the public sector from the management of businesses through asset sales/divestitures or privatisation processes. The private sector gains full control of the assets and is assuming all risks involved in the deal.

Regulation plays a big role in managing market risk in the energy and transport sector. Demand risk based on different funding models (feed-in-tariffs, premium tarrifs, quotas, tenders) and quality of support schemes have a major impact on attracting private sector and the cost of capital.

Comparing to the onshore wind sector in Denmark, Sweden, and Finland, which all have low levels of country risk, Sweden has a WACC significantly higher than Denmark and Finland. This is, according to Swedish investors, due to the higher investment risk resulting from shortcomings of the funding model which does not offset existing price risks (Diacore 2016).

There seems to be reduced appetite of private sector for demand risk. This trend reflects problems faced by investors in recovering investments in capital-intensive assets only through user fees collected or the market price of the electricity generated. In transport, following the crisis, in the biggest OECD PPP markets, emerging evidence seems to suggest a significant shift in the risk profile of projects reaching financial closure, with almost solely availability-payment projects succeeding in obtaining financing (Makovsek, 2016). At the same time due to the increased in polical and regulatory risk investor interest is moving away from PPPs toward independent projects[23].

For renewables market risks are increasingly set by competitive mechanism. In 2018, contractual remuneration by competitive mechanisms represented 45% of utility-scale renewables (IEA 2019). These includes largely government schemes - such as auctions, but include also growing rapidly corporate procurement.

3.3.3 Financing phase

Overall there are significant differences in project risk phases based on the the maturity of the project and the available project specific experience, which is significantly less in the case of greenfield projects. This may lead to a considerably higher degree of uncertainty and risk.

Early stages of infrastructure projects are associated with higher challenges to financing as there are greater uncertainties and risks regarding future revenue streams. Greenfield or primary projects may be in planning, development, financing or construction stage. They are considered to be riskier given the construction risk involved, the lack of revenues during the construction period, and uncertainty about revenue levels once it is operational (Weber and Alfen 2010).

Once a project reaches completion and there is greater certainty about investment costs and future revenues, its risk profile is lower. In fact in contrast to the overall drop in primary financing, as seen in

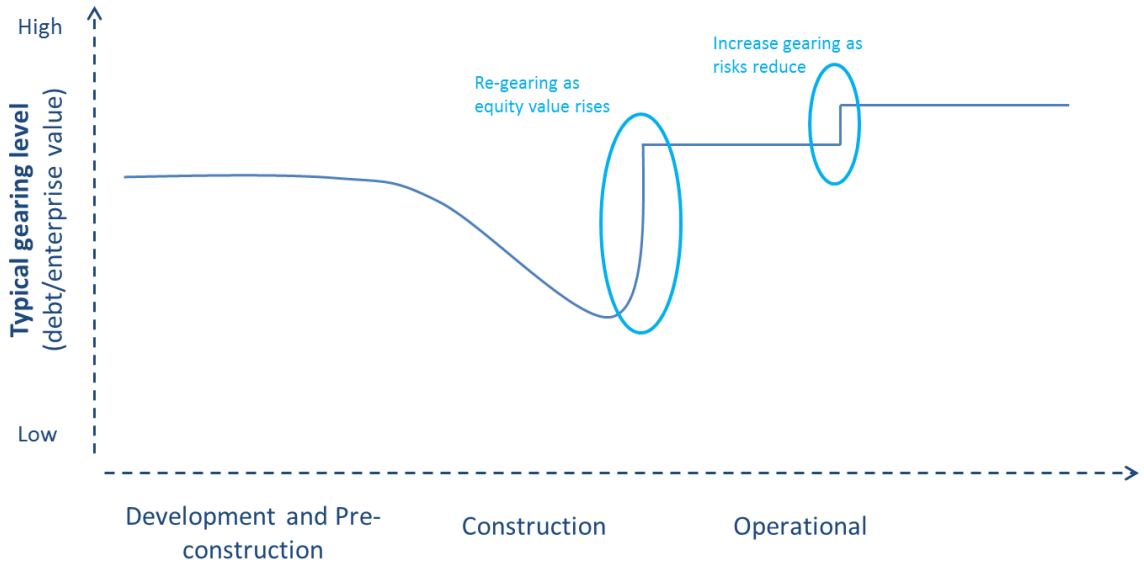
[23] Difficulties in executing requests for proposals, blowback on certain previous projects, and political infighting in various jurisdictions, have made it more challenging to execute PPPs. As a result, investors are becoming more interested in independent projects (source Probitas 2019).

OECD (2017) a large secondary market for infrastructure is developing, boosted by mergers and acquisitions (M&A) and refinancing activity[24]. In contrast, brownfield or secondary projects are already operational and/or have a predecessor of some description at the same location. These projects may involve the reconstruction, renovation or expansion of existing assets.

As risks involved in infrastructure investment vary considerably during the infrastructure project lifecycle, the capital structure and level of gearing change as well. Figure 2 displays a typical development cycle of an infrastructure asset from early stages to operational stages. Early periods are characterised by higher risks and lower gearing, underscoring the importance of equity finance or transitional government or MDB financing. Increased gearing in the operational stages allows the use of debt instruments such as bonds.

[24] Global infrastructure M&A activity doubled from a low of USD 83 billion in 2012 to a record USD 179 billion in 2016, with the United States and China leading in terms of volumes see OECD (2017)

Figure 3 Infrastructure project development cycle



Source: OECD based on RREEF

Refinancing frequently takes place after the project has overcome construction phase without any major issue and difference from the expected budgeted capital expenditures and subsequently after a first few years of operation to validate traffic estimates ("the ramp up period). In this situation with the project derisking project sponsors can lower the cost of financing reduce cover rations and increase the term of the debt.

3.4 THE ROLE OF INSTITUTIONAL INVESTORS IN LOW CARBON FINANCING

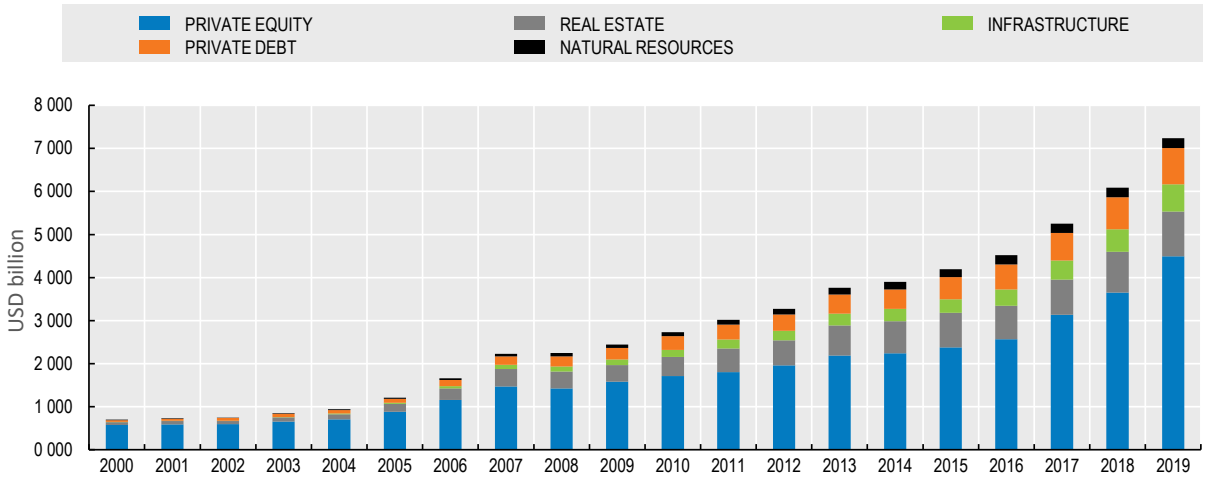
Recent OECD work has provided a first-of its kind comprehensive empirical mapping of current holdings (i.e. stock, not flows) of infrastructure investment by institutional investors, from OECD and G20 countries (OECD 2020). Together with Preqin data, OECD granular data allows in this section a targeted examination of how different types of institutional investors invest, or could invest, in infrastructure[25] (See ANNEX 2).

The infrastructure financing market has gone through a radical transformation in the last twenty years. The global financial crisis accelerated the move towards disintermediation and alternative models to invest in infrastructure. A number of factors, such as a changed macroeconomic environment, more stringent regulations on financial intermediaries, and a modified appetite for long-term asset investments, have led to a reallocation of flows from the banking sector to the institutional investors sector. In recent years, the push to ESG investment also contributed to increased investors interest in low carbon infrastructure.

The infrastructure market has grown from low levels of USD 129 billion in 2009 to over USD 0.5 trillion in 2019 and is expected to reach USD 1 trillion by 2022. As of December 2019, the infrastructure fund industry holds USD 631 billion in unlisted equity infrastructure assets, up from just USD 129 billion at the end of 2009 (Preqin 2020 and Figure 3). Totals in 2018 and 2019 both approached USD 100 billion – a substantial increase compared with full-year fundraising of USD 17 billion back in 2009. If this rate of expansion continues, then infrastructure assets will breach USD 1 trillion by the end of 2022.

[25] This section presents results of an empirical mapping of current infrastructure holdings by institutional investors domiciled in OECD and G20 countries. For the purposes of the report, the term institutional investor includes pension funds, insurance companies, sovereign wealth funds and asset managers. Given the lack of a widely accepted definition of green infrastructure, the adopted definition is based on a comparative analysis of multiple regulatory approaches, including the EU sustainable finance taxonomy.

Figure 4 Private capital assets under management by asset class, 2009 - 2019



Source Preqin (2020).

However, there is a major mismatch between investors and governments expectations. Demand from private investors is high but concentrated on some types of assets that do not necessarily match governments' priorities. As a result, infrastructure investment funds have had trouble investing the private capital they have raised, with a record surplus of "dry powder" reaching $212 billion as of December 2019 double the amount at the start of 2015 (Preqin 2020).

Investors with a long-term horizons such as pension are interested in core infrastructure assets with inflation-linked returns and long-term stable cash flows, to match asset/liability risk. **Core infrastructure** opportunities are represented by – privately-held infrastructure debt or equity as opposed to public stocks or bonds; and – "Brownfield" (existing) and "contracted" infrastructure, as well as brownfield regulated utilities rather than "greenfield" (new) projects. (WEF 2017). Investors are focused on developed markets targeting North America and Europe and have relatively little interest in emerging markets.

The market is adapting in different ways to the current environment, reducing the targeted returns of the funds, looking to move into higher-risk strategies and new markets (e.g. value-added funds and emerging markets in Asia) or middle-market projects with less competition.

Investor's preference in relation to the financing phase are related to their appetite for risk. In the traditional investment style classifications, secondary market investments would suit income-style investors while primary would suit growth-style investors. In fact, investors in greenfield projects do not generally turn a profit in the first years of the development and construction phase, but instead are merely required to make payments. Initial capital is only returned when the respective facility is operative (making for a J curve which is typical of cash flows from private equity investments). Investors accept the higher risk associated because of the growth potential of an asset in its start –up phase, and the value growth expected. On the other hand, in the secondary market, investors' main interest is in high and stable dividends. This resembles the regular income streams from real estate or bonds.

The empirical mapping conducted by the OECD shows that institutional investors hold a total of USD 3.34 trillion in infrastructure assets as of February 2020 with total holdings in green infrastructure amounting to USD 314 billion (OECD 2020). Among key takeaways:

- **Financial structure - corporate vs project**: Unlisted and direct exposure to green infrastructure is significant but corporate exposure is much higher. The total USD 3.34 trillion includes listed corporate and asset level investment. USD 1.04 trillion is allocated through direct investment and unlisted funds while USD 2.3 trillion is held in listed stocks of companies developing, managing and/or operating infrastructure assets (listed infrastructure).
- **Financing phase - primary vs secondary**: most of the current positions through unlisted funds and direct project-level equity investment are established through secondary stage investment, i.e. acquisition of operational projects representing 65% and 87% of the total financing.
- **Financing mix - asset manager vs asset owners**: there are major differences between investment decisions taken by asset managers and asset owners (pension funds, insurance companies and sovereign wealth funds). The mapping shows asset managers' preference for liquid assets.

3.5 CHOICE OF THE DELIVERY AND FINANCING MODE

Designing effective energy policies, attracting large scale investment requires an understanding of the dynamics of infrastructure and renewable investment risk. Governments have a fundamental role in setting the policies and regulations that influence who invests and the risks and returns that shape the allocation of energy capital. Different types of private funding models imply different capital structures for infrastructure and the specific role for investors. The forms of the privatisation process - with varying degrees of private participation will influence the governance and control of infrastructure, as well as the way investors make their investment decisions.

From a government point of view, the decision to provide the infrastructure by itself or in partnership with the private sector - the choice of the **delivery mode** - will be informed by a range of factors. Political sensitivity and the nature of the market failure are important factors determining the structure of infrastructure supply [market structure] and private sector involvement. For example where supply entails a natural monopoly, the private sector will usually be willing to provide the service, though normally at a level that is below, and a price that is above, the social optimum. This will often result in some type of arm's length regulation.

Despite having important implications for public sector discretionary control, value-for-money and affordability, in many countries, the choice of modality is often based on habit and lacks specific criteria both for traditional infrastructure and private finance options (Burger and Hawkesworth, 2011).

Decisions on financing should aim to minimise costs, including contingent liabilities and transaction costs, ensure the affordability and robustness of the financing structure as well as the sustainability of the financing over the long term, making sure that incentives are aligned among the stakeholders.

A critical factor is the cost of capital. Private finance initiative (PFI) projects have turned out to have relatively high costs of capital, whereas price-capped, regulated asset based (RAB) networks have had much lower costs of capital. As there is a significant difference between the costs of capital under different

regulatory regimes, reducing the cost of capital by reducing the level of risk transfer to the private sector has the potential to achieve considerable cost savings.

Beside the cost of capital, the financing viability of a project is affected by the robustness of the financing structure. To take advantage of the leverage effect and because of the large project volumes, debt is prevalent in private infrastructure financing. Important considerations relate to the appropriate use of leverage, the risk taken by the owners/operators and fixed or variable nature of costs. High level of revenue uncertainty (i.e. toll roads) do not encourage high level of debt given the fixed nature of repayments

Given the infrastructure long-term horizon, the sustainability of financing should be considered.. Private equity models with an investment horizon of 5 to 7 years are also not matching the longer term of infrastructure concessions.

Additional factors have an influence **on the funding and financing models** such as corporate, project finance or bond structures. Possible drivers and parameters may include:

- ***The financing profile of the investment*****:** a large initial investment followed by significant operating and maintenance costs could for instance indicate advantages from bundling the construction, operation, and maintenance of the assets in a single contract. In the wind- and solar-power sectors, most of the costs are incurred upfront, so concessions are often used by governments to procure projects. Project finance structures matching the long-term nature of the concessions, relying on the cash flows during the operation period, become the preferred route for financing renewable projects.
- ***The level of uncertainty, especially within broader enabling conditions, and attractiveness of domestic policy frameworks****:* projects may face significant speculative risks that are difficult for the private sector to quantify and mitigate, linked notably to unstable and unpredictable legal and regulatory frameworks, high political risk and construction risk. In the offshore wind-power sector for example, as projects scale up and move into deeper water, newer technologies also add to construction risk, which may discourage some investors from participating. The political and

regulatory regime, and the likelihood that policy support will erode over time, are key risk considerations for investors when investing in renewable electricity projects.

- ***Financial market conditions,*** such as difficulties in securing project finance debt, development of capital markets and market-imposed corporate constraints (i.e. deleveraging, impact of oil prices), high costs of capital, as well as the general volatility in capital markets can influence the ability to raise capital.
- In developing and emerging economies, infrastructure investments are often unable to attract long-term financing, as financing conditions such as shorter maturities and higher margins increase refinancing risks and make projects unviable. These barriers often present a larger impediment to investment and include a relatively small tax base, limited expertise, corruption, unstable political environments, and relatively high sovereign risk.

3.6 CONCLUSIONS AND IMPLICATIONS

There is a major mismatch between investors and governments expectations. Demand from institutional investors is high but concentrated on some types of less risky "core" low carbon infrastructure assets that do not necessarily match governments' priorities. As a result, infrastructure investment funds have had trouble investing the private capital they have raised, with a record surplus of "dry powder" reaching $212 billion as of December 2019 double the amount at the start of 2015 (Preqin 2020).

Investors with a long-term horizons such as pension are interested in core infrastructure assets with inflation-linked returns and long-term stable cash flows, to match asset/liability risk[26]. Core infrastructure opportunities are represented by – privately-held infrastructure debt or equity as opposed to public stocks or bonds; and – "Brownfield" (existing) and "contracted" infrastructure, as well as brownfield regulated utilities rather than "greenfield" (new) projects. (WEF & Chapter 4-5) Investors are focused on developed markets targeting North America and Europe and have relatively little interest in emerging markets.

High demand for "core" infrastructure is expected to continue. In 2020, over 250 infrastructure funds are collectively seeking more than $200bn from investors. This demand contrasted by little investment is causing major challenges highlighting structural issues in the market, including competition for limited quality assets and overconcentration and influence of the largest infrastructure funds.

Investors seek stability and certainty in the political and regulatory regime. Attracting increased investment can therefore be achieved through the provision of greater long term policy certainty. Targeted interventions are also one part of the contribution that the Government can make to promoting private sector investment. Governments can attract and encourage new sources of capital by maintaining a strong,

[26] As seen in Chapter 6 while a number of funds are expressing greater interest in investing in **greenfield assets,** few funds reported exposures to such assets with a preference for **brownfield-type investments,** which they see as less risky and more aligned with a long investment horizon. Most of the overseas projects they invest in are in other OECD countries - showing strong **'home bias'** -with most of the funds surveyed remaining opportunistic in their emerging market interest in infrastructure

active and coordinated dialogue with private sector investors to ensure that infrastructure is an attractive asset class.

Developing infrastructure as an investible asset class for institutional investors can also help recycling capital for banks. The COVID crisis makes the macroeconomic outlook uncertain with a potential weak recovery and a significant build-up of bad loans for banks. The European Central Bank estimates that in a severe but plausible scenario non-performing loans at euro area banks could reach €1.4tn, well above the levels of the 2008 financial and 2011 EU sovereign debt crises.[27]The absence of an efficient capital market for infrastructure would represent a barrier to the financing of new projects (e.g. impeding recycling of capital).

The financial market and asset management industry have a crucial role in providing sustainable solutions matching the evolution in the nature of risks over the project lifecycle with different types of financing. The development of a secondary market for infrastructure will facilitate the recycling of capital. Efficient secondary markets could optimise risk pricing and reduce the overall cost of capital for infrastructure projects. The creation of a secondary market would help then to reinforce partnership models and engage with institutional investors who may prefer to invest in operational assets, while using traditional sources of finance (such as utility balance sheets and bank loans) during the construction phase.

This highlights the potential of securitised structures such as YieldCos, INVITs and infrastructure REITs to scale-up real economy infrastructure investment. Instruments such as exchange traded funds, green bonds and YieldCos use familiar financial instruments to enhance capital flows to sustainable infrastructure. Exchange-traded funds provide a vehicle for institutional and retail investors to access green investments.

[27] A European asset management company could be an effective solution to recycle non-performing loans sitting on bank's balance sheets .Source Financial Times 27 October 2020: The EU needs its own 'bad bank' Andrea Enria (chairman of the supervisory board of the European Central Bank)

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ANNEX 1 - OECD TAXONOMY

In 2015 the OECD produced for the G20 a Taxonomy of Instruments and Vehicles for Infrastructure. Building on this work the G20/OECD Guidance Note on Diversifying Sources of Finance for Infrastructure and SMEs was endorsed by G20 Leaders in September 2016. Leveraging this framework several other research and data analyis have been produced in the last years (see next ANNEX).

The table below sorts instruments of the Taxonomy based on several dimensions. **The left hand margin describes modes of investment**, recognizing that there are broad asset categories (fixed income, mixed, equity), followed by principal instruments. Besides the fact that investors can be creditors or equity-holders, some investments, particularly PPP contracts and concessions, may have debt-like characteristics due to contracted cash flows. Thus for consistency, categories are defined by their nature, with the distinction drawn from whether an investor receives priority claims in corporate or project cash flows (creditor), mixed (creditor with equity participation rights), or residual claims to cash flows (equity). Further along the top of Table 6 are the **finance instruments** followed **by market channels including project, corporates and capital pools based structures.**

Table 4 Instruments and vehicles for infrastructure financing: a Taxonomy Part I

Modes		Infrastructure Finance Instruments		Market Channels
Asset Category	**Instrument**	**Infrastructure Project**	**Corporate Balance Sheet / Broader Entities**	**Capital Pool**
Fixed Income	Bonds	Project bonds	Corporate bonds, Green bonds	Bond indices, Bond funds, ETFs
		Municipal, Sub-sovereign bonds		
		Green bonds, Sukuk	Subordinate bonds	
	Loans	Direct/Co-investment lending to Infrastructure project, Syndicated project loans	Direct/Co-investment lending to infrastructure corporate	Debt funds (GPs)
			Syndicated loans, Securitized loans (ABS), CLOs	Loan indices, Loan funds
Mixed	Hybrid	Subordinated loans/bonds, Mezzanine finance	Subordinated bonds, Convertible bonds, Preferred stock	Mezzanine debt funds (GPs), Hyrbid debt funds
Equity	Listed	YieldCos, Closed-end funds	Listed infrastructure & utilities stocks, Closed-end funds, REITs, IITs, MLPs	Listed infrastructure equity funds, Indices, Trusts, ETFs
	Unlisted	Direct/Co-investment in infrastructure project equity, PPP	Direct/Co-investment in infrastructure corporate equity	Unlisted infrastructure funds (GPs)

In the Taxonomy infrastructure risks are classified by their main source – namely political and regulatory, macroeconomic and business, and technical (OECD (2012); OECD (2015a), OECD and World Bank (2015), CPI (2013) and **grouped according to the project development phases** from development to construction, operation and termination phase.

Table 5 Risks Linked to Infrastructure Assets over the project lifecycle: a Taxonomy Part II

Risk Categories	Development Phase	Construction Phase	Operation Phase	Termination Phase
Political and regulatory	Environmental review, land acquisition	Cancellation of permits	Change in tarriff regulation	Contract duration
	Rise in pre-construction costs (longer permitting process)	Contract renegotiation		Decommission
				Asset transfer
			Currency convertibility	
	Change in taxation			
	Social acceptance			
	Change in regulatory or legal environment			
	Changes in climate change policy and support schemes			
	Enforceability of contracts, collateral and security			
Macroeconomic and business	Prefunding	Default of counterparty		
	Financing availability		Refinancing risk	
			Liquidity	
			Volatility of demand/market risk	
			Liability risks - compensation from victims of climate change	
	Inflation			
	Real interest rates			
	Exchange rate fluctuation			
	Long pay-back period for climate change mitigation investment			
Technical	Governance of the project			Termination value different from expected / stranded assets
	Environmental			
	Project feasibility and inclusion in investments plan*	Reliability of forecasts for construction costs and delivery time	Qualitative deficit of the physical structure/ service	
	Archaeological			
	obsolescence			
	Force Majeure			

ANNEX 2 - DATA & METHODOLOGY

OECD (2017) Investment in Climate, Investing in Growth

Trends analysis draws on both project-based and mergers and acquisitions (M&A) data from commercial databases to provide evidence of finance trends in low carbon infrastructure sectors at disaggregated levels. The terms "investment" and "finance" of infrastructure are used interchangeably to reflect total capital value (stocks) of the projects and, thus, do not reflect proper investment flows (as per gross fixed capital formation). This said, some interesting observations emerge on the basis of this information.

In order to capture the size of the infrastructure market, data from existing databases providing information at infrastructure project level is used. Databases includes Dealogic, Thomson Reuters, IJ Journal, Infra-News, Bloomberg New Energy finance.

Figure 5 Categories included in the financing types for each database

	IJGlobal Transactions	Bloomberg New Energy Finance
Primary Financing	Project Finance – Primary Financing Corporate Finance– Primary Financing	New Built
Refinancing	Project Finance – Primary Financing Corporate Finance– Primary Financing	Refinancing
M&A	Project Finance – Asset Acquisition / Corporate Acquisition Corporate Finance – Asset Acquisition / Corporate Acquisition	Corporate M&A Asset Finance - Acquisition

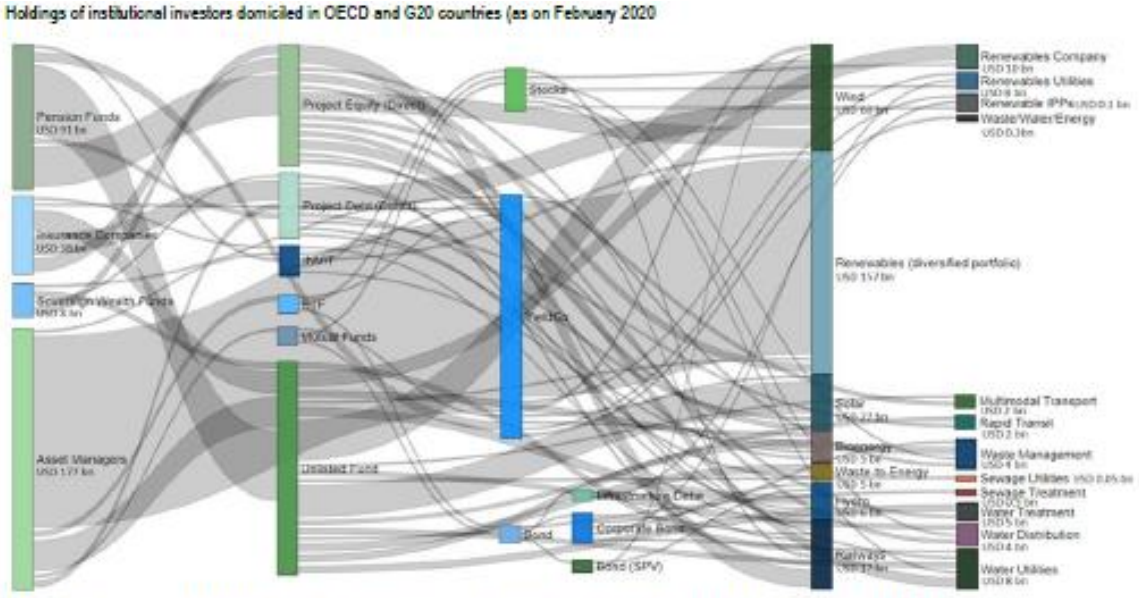
OECD (2020), Green Infrastructure in the Decade for Delivery: Assessing Institutional Investment, Green Finance and Investment

Data for the mapping exercise is sourced from multiple commercial databases. Commercial data is supplemented by primary data collection and econometric techniques to fill gaps. The main databases used for data gathering are Thomson-Reuters (2020), Preqin (2020) and IJGlobal (2019). The aggregation avoids double-counting and other overlaps by collecting data at a disaggregated level, at which distinctions are easily made, and then aggregating to the level presented here. For details on data treatment, the

merging of databases as well as statistical and econometric techniques used to fill data gaps, see Annex 2.A to the report

It is an analytical construction to highlight the diversity of the investment landscape. The main results of the quantitative mapping are presented as Sankey charts. These charts provide a snapshot of current infrastructure investment by institutional investors. In other words, the charts below provide information on the current stock of investments, i.e. infrastructure holdings, and should not be misread as flows (i.e. time series data).

Figure 6 Institutional investment in green infrastructure (excl. direct investment in stocks) - USD 314 billion



Note: The figure excludes direct stock holdings. Further, while some nodes appear to have unequal left and right sides, this is just a visual effect and they are always balanced.
Source: Authors

CHAPTER 4 : COUNTRY SURVEY - PENSION FUNDS INVESTMENT IN INFRASTRUCTURE, THE DEMAND FOR LONG TERM INVESTMENT IN INFRASTRUCTURE

4.1 INTRODUCTION

Institutional investors such as pension funds, life insurers and mutual funds that operate in retirement savings systems - have been seen as sources of long-term capital and financial market development. The exemplary case are pension funds, which start collecting contributions when individuals enter the workforce and only start paying benefits with the assets accumulated thirty to forty years later.

Long-term investment horizon in principle allows these investors to take advantage of any above average returns which alternative investments such as infrastructure and venture capital can deliver (Chapter 2). However, there are also major challenges potentially constraining investors to higher allocations to such assets and their capability of being long term investors. Demographic and financial pressure with regulation are major factors defining the profile of pension liabilities and ultimately asset allocation.

Infrastructure theoretically matches the long-term appetite of investors such as pension funds, benefitting the economy more broadly. While the low-risk, geographically varied returns associated with infrastructure match the diversification objectives of pension fund portfolios, involvement of long-term investors can also improve the quality of public investment programs (Torrance 2009 and Gelb 2014).

Academic literature in relation to long term investing has been focusing on risk appetite and whether long-term investors should pursue a higher level of risk in their portfolio because of their longer investment horizon. Normative studies on long term investments have been focusing on SWFs, endowments and alternative investment. There is a complete lack of research on pension funds in infrastructure framing the discussion from a pension policy design point of view.

The profile of liabilities and the asset-liability link are major drivers of pension fund asset allocation. For pension funds based on the predictability of liabilities there may be the need to match the profile of investment with more or less liquid assets. Illiquid investments may be unsuitable for an investor with a short time horizon because the investor may not have time to recover from investment losses for example.

To better understand the role of pension funds as long-term investors in infrastructure further analysis is needed on the future evolution of pension policies and regulation, constraints on the liabilities side, consequences for investment allocations and infrastructure sectors. Framing this analysis at country level and considering also infrastructure policies will results in policy implications in the pension fund and infrastructure areas.

Aim of Chapter 4 is to analyse the evolution and drivers of growth of pension fund investment in infrastructure in a context of changing retirement landscape. This chapter allows an understanding of structural, financial and demographic pressures pensiond funds are currently subject to and that are set to increase over the coming decades. These will have major impact on future portfolio strategies and investment in long term assets. Different levels of development, country and sector specifics will imply different sets of products and viable solutions. Governments need to create the conditions to respond to this long-term investment demand, aligning policies in the infrastructure, pension and financial markets areas.

A country dimension has been adopted to better understand specific problems encountered and solutions proposed by responsible institutions. While infrastructure investments are considered globally, opportunities depend on the availability of specialist information in the region of investment (Torrance, M. 2009). For policy makers looking to attract long-term financing in infrastructure, the composition of local pension markets, regulations and openness to foreign investment can influence how capital is invested.

Findings are mainly based on interviews with industry professionals as the existing data sources are limited, particularly with regard to infrastructure investment policy and risk management. The information acquired in interviews complements that obtained from a literature review, selected pension fund annual reports, and an analysis of the available data sources.

This analysis is building on national account statistics on pension funds gathered by the OECD and qualitative country surveys within the framework of the OECD Long Term Investment Project and G20

work[28]. A first survey part of the Transcontinental Infrastructure 2030-2050 project focused on pension funds in Canada, Australia, the United States, South Korea and a number of funds in Europe (see Annex 2 and 3 for interviewees and steering committee). Subsequent studies have been looking even more in details at the comparison between Australia, Canada and G20 countries experiences (G20/OECD 2016) and Inderst and Della Croce 2012).

This chapter first looks at pension fund asset growth and allocation and over other last decade, including structural challenges to long term investing (and infrastructure investing), allowing to assess future perspectives. It then compares and contrasts the experience of pension funds in infrastructure in several countries focusing in particular on Canada, Australia, the United States, South Korea and Europe[29].

[28] The OECD Global Institutional Investors Database also benefits from the joint OECD, IOPS and World Bank Global Pension Statistics exercise.

[29] The choice of countries is based on the importance of asset under management and availability of information for the analysis

4.2 LITERATURE REVIEW

4.2.1 Pension Funds as Long-Term Investors

There are several factors affecting long term investors including investor's objective and constraints and risk returns considerations based on asset management and modern portfolio theory. Academic literature in relation to long term investing has been focusing on risk appetite and whether long-term investors should pursue a higher level of risk in their portfolio because of their longer investment horizon.

Asset management theory related to equity risk premium makes time horizon a key driver linked to risk appetite: the longer the holding period, the higher the risk tolerance (Siegel 1998; Damodaran (2010; and Goetzmann and Ibbotson 2006). Mercer (2008) link investment horizon and risk tolerance in definition of SWFs in addition to institutional objectives: while central banks may buy more stocks, stabilization funds focus on government bonds or other liquid financial instruments, in line with their short-term orientation and their goal of protecting public budgets from excessive volatility in commodity prices.

There are key constraints on long-term investors defining how much long-term capital is available to invest. In addition to risk appetite, the following are also key constraints: investment beliefs. (i.e. superior returns), decision making structure (investment team and trustee), liabilities profiles (WEF 2011).

These constraints will affect the nature of investments used in the portfolio. Typically, the SAA for risk averse investors will have a large weight in governments bonds and cash, while those with more willingness and ability to take risk have more of their assets in risky asset classes such as equities and alternatives investments looking for illiquity premia. (Khandani & Lo, 2009).

To assess long term performance risk-adjusted rate of return my not be sufficient. Clark and Monk (2019) provide an alternative principles-based model of investment management relevant to all long- term investors, appropriate for even new and innovative investment processes. Clark and Monk (2018)

identified a set of metrics of performance consistent with superior long-term investment performance relevant to a range of asset owners large and small.

Social security system old-age insurance systems are devices for the sharing of income risks of elderly people with others. Risks can be shared intergenerationally (with the young of the same country), intragenerationally (with other elderly of the same country), or internationally (with foreigners) (Shiller 1999). Pension funds facilitate intergenerational risk-sharing smoothing shocks on asset returns, improving risk allocation through time diversification, and allowing fund to gain equity premium (Gollier 2007).

Retirement is the major aim behind private saving. Bodie (2011) focuses on institutional forms of private retirement savings, how they have shaped and will impact capital markets.The search by pension funds for an improved risk-reward trade-off has spawned a new branch of the financial services industry - professional asset management including advising pension funds about asset allocation, security selection, and portfolio management.

The underfunding of many pension systems has major consequence on society. The current situation is one in which beneficiaries view their benefits as secure promises and taxpayers do not perceive that they will be held accountable for guaranteeing those promises. The underfunding of pension funds needs to be borne by some party: taxpayers or public employees be they the past, current or future (Novy-Marx & Rauh, 2011).

The profile of liabilities for DB funds, is a major driver of pension fund asset allocation. The predictability of liabilities will require to match the profile of investment with more or less liquid assets. Illiquid investments may be unsuitable for an investor with a short time horizon because the investor may not have time to recover from investment losses for example. The asset-liability link could translate in focusing on greater risks (i.e., invest in stocks) or avoid uncertainty (i.e., invest conservatively in fixed-income securities). exacerbating the conflicts between generations of participants.

Pension fund regulation is a major factor defining the profile of pension liabilities and ultimately asset allocation. The asset-liability link for DB pension funds ((asset allocation policies and lifetime productivity of the workers) is reflected in how to measure funds' liabilities and the role of regulation (Sundaresan & Zapatero, 1997). As projected liabilities are discounted at the expected return on assets, accounting rules for public pensions push investors into equity to gain a higher allowed discount rate for the liabilities (Lucas and Zeldes, 2009).

In the USA, investment in riskier portfolios is incentivised by DB public pension fund regulation (Government Accounting Standards Board - GASB) in order to justify a higher discount rate and report a lower funding gap (Brown and Wilcox 2009, Novy-Marx and Rauh 2009, Pennacchi and Rastad 2011 and Mohan and Zhang 2014). Andonov Bauer, and Cremers (2017) comparing U.S. public funds with public Canadian and European public funds and U.S. public funds with U.S. private funds show that regulation rather than country effects and fund type (public vs. private) is the key determinant of the differences in liability discount rates and strategic asset allocation.

With defined contribution (DC) pension plans increasing their role in retirement income systems in many countries, academic research has been looking at implications for investment strategies. Farrel Shoag (2014) found that there is little difference between the DB and non-DB plans in terms of asset mix, returns, and fees, except that DB plan have greater access and allocations to alternative investments. Antolin, Payet Yermo (2010) found that for DC plans, life cycle strategies that maintain a constant exposure to risky assets during most of the accumulation period, switching swiftly to bonds in the last decade before retirement seem to produce adequate results. Campbell , Viceira (2009) observe that in defined-contribution (DC) pension plans, there is no conflict on who controls the asset allocation decision as in DB plans because the same individuals are plan sponsors and beneficiaries.

4.2.2 Alternative Investment

Long-term investment horizon in principle allows such investors to take advantage of any above average returns which alternative investments such as infrastructure and venture capital should deliver. Normative studies on long term investments have been focusing on SWFs, endowments and alternative investment.

Harvard and Yale began investing in venture capital in the early 1970s, but most corporate and public pensions did not follow until the 1980s and 1990s, respectively. Many sovereign wealth funds decided to emulate Yale's allocation when shifting their investment strategy to reach the same performance (Sender, 2007). Fernandez and Eschweiler (2008) assess the impact of SWFs asset allocation on bond and equity markets to remain low while predicted SWFs share in total alternatives to rise fast. In fact, Brown, Garlappi and Tiu's (2007) suggests that university endowments have a comparative advantage in assuming the tail and illiquidity risks inherent in alternative assets.

There are different views on the opportunity of SWFs pursuing risky investments. Aizenman and Glick's (2008) paper on sovereign wealth funds argues that the utility of funds can be maximized if a sovereign wealth fund pursues riskier investments. Aglietta (2009) based on a review of the investment strategies of Norway's Government Pension Fund, Singapore's Temasek and China's CIC, concludes that sovereign wealth funds should focus on pursuing safe investments because their primary purpose is national wealth preservation.

Evidence on SWFs asset allocation is scarce. SWFs invest actively (with control rights) in both public and private sectors and their allocations are balanced across risky asset classes and biased toward home-region and certain industries (finances and transportation, energy and telecommunication) (Dyck and Morse 2010). But Balding (2008) finds that sovereign wealth funds act as rational, economically driven investors, diversifying their portfolio by asset class and geographic region.

Looking at infrastructure, according to Gelb (2014) SWFs can improve the quality of the public investment programs, without duplicating government institutions or national development bank, with the

condition of having a sound mandate and professional management and staffing. Torrance (2009) investigates how institutional investors as owners of infrastructure assets are focusing beyond their traditional financial and geographic borders. Results show that the low-risk, geographically diversify returns match the allocation diversification objectives of investors.

4.3. PENSION FUNDS LANDSCAPE

4.3.1 Assets under Management and Investment Allocation[30]

Traditionally, pension systems have combined two distinct components: one public, the other private. Public pensions were mandatory, financed on a pay-as-you-go (PAYG) basis, and managed by public sector institutions. Private pensions, on the other hand, were voluntary, employment-based (occupational) pension plans, or individual retirement arrangements (personal pension plans) based on the principle of asset accumulation (funding) or book reserve financing.

As described in several OECD Pensions Outlooks 31 the pensions landscape has changed over the past decades across countries. Governments, through pension reforms, have begun to emphasize contributory pension schemes to build assets in order to finance future retirement income, as opposed to retirement benefits provided through fiscal expenditures. This has enabled much of the growth observed in pension fund assets under management.

Overall pension assets exceeded USD 40 trillion worldwide in 2018[32] Pension assets were overwhelmingly accumulated through pension funds, gathering alone over USD 28 trillion of assets at the end of 2018. Some countries also use other vehicles to save for retirement such as pension insurance contracts sold by insurance companies (e.g. Denmark, France) or products offered and managed by banks and investment companies (e.g. individual retirement accounts, IRAs, in the United States). There is a large variety of pension arrangements and mix of public and private pensions varied across countries [see Box 1].

[30] Main sources of information are OECD Pension Markets in Focus 2019, 2018

[31] Refer to OECD Pensions Outlook 2016

[32] This estimate for 2018 is based on data collected through the joint OECD, IOPS and World Bank Global Pension Statistics exercise. This statistical exercise collects the total amount of investments related to funded and private pension plans source: OECD Pension Market in Focus 2019

The ratio of assets to GDP has increased in 68 out of 71 reporting countries over the last decade. The OECD average ratio of assets to GDP, weighted according to the pension assets in each country, was 126% in 2018, compared to 49.7% in 2008.

This development has been driven by several factors including financial performance and the transition of pension systems from pay-as-you-go to funded pension plans, leading to growth of both privately and publicly managed pension funds (De La Cruz and others 2019). The increase in the proportion of working-age people covered by a pension plan was especially strong in countries with relatively recent mandatory systems (e.g. Israel, Latvia, Bulgaria, Colombia, North Macedonia) or auto-enrolment (e.g. New Zealand) programmes.

The shift towards funding and private sector management has been especially strong in Latin America and East Europe, where mandatory personal accounts systems have been introduced to replace part of social security benefits. Reforms were partly due to governments' objectives of reducing the fiscal liabilities of public pension systems by scaling back benefit promises, and partly due to the advantages of financial markets in providing old-age support via better diversification of risks and positive macroeconomic repercussions, such as capital market development.

However, in recent years some European countries backtracked on their policy reforms. The size of pension assets was lower in 2018 than in 2008 in Hungary, following a major overhaul of the funded and private pension system in 2011. Some other European countries also transferred some pension assets back to the public system (e.g. Poland in 2014). The Czech Republic also terminated and wound up retirement funds with savings from the second pension pillar by the end of 2016.

Relative mature pension fund market in Latin America are Brazil and Chile. Brazil accumulated the largest amount of pension assets in absolute terms in the continent following the approval in 1977 of regulation on closed pension funds – sponsored by employers, trade unions and association. In Chile the Latin American

country with the largest amount relative to the size of its economy the funded pension system was introduced in 1981.

This growth in assets is likely to continue in OECD countries**,** especially in countries where mandatory retirement systems or where private pensions and insurance markets are still small in relation to the size of their economies. For example, in Korea, pension fund assets grew from USD 76.2 billion in 2007 to 485.9 billion in 2017.[33]

In developing countries, governments are establishing mandatory and/or contributory retirement systems. They generally face an even greater opportunity to develop their institutional investor sectors as, with few exceptions, their financial systems are largely bank-based. Nigeria's pension market grew from USD 6.9 billion in 2007 to USD 24.6 billion in 2017; China's from USD 20.8 billion to USD 197.8 billion over the same time period. Whether such growth materialises will depend on some key policy decisions, such as the establishment of a national pension system with a funded component which is nowadays a common feature in most OECD countries.

Box 1: Private pension plan: The OECD classification

The OECD defines as "private pension systems" all funded and book reserved[34] pension systems. Following that definition, the special, funded regimes for public sector workers that exist in some countries are also classified as private by the OECD (e.g. CalPERS, OTPP etc.).

There is a large variety of pension arrangements across OECD countries. Pension provision through private pension arrangements can take the form of *mandatory* or *voluntary* arrangements. They could be linked to an employment relationship, making them *occupational pension plans*, or they may be based on contracts between individuals and private pension providers, making them *personal pension plans*.

[33] For country level statistics, see Pension Markets in Focus 2018, http://www.oecd.org/daf/fin/private-pensions/pensionmarketsinfocus.htm

[34] Book reserves are balance sheet provisions made by companies that sponsor pension plans for their employees.

Moreover, pension provision can be achieved through either *defined contribution* or *defined benefit* arrangements.

Defined benefit (DB) and defined contribution (DC) are the two basic types of benefit formulas. Occupational pension plans can take either form, while personal pensions are exclusively of the DC type. Approximately 60% of OECD pension assets are in DB plans. Occupational DB and DC plans are defined in the official OECD classification as:

Defined contribution (DC) occupational pension plan: occupational pension plans under which the plan sponsor pays fixed contributions and has no legal or constructive obligation to pay further contributions to an ongoing plan in the event of unfavourable plan experience.

Defined benefit (DB) occupational pension plan: occupational plans other than defined contributions plans. DB plans generally can be classified into one of three main types – traditional, mixed and hybrid plans.

DB pension funds bear longevity and investment risk, being required to pay a set amount to their beneficiaries at a point of time in the future. In DC plans these risks are assumed by participants, retail investors who predominantly invest via mutual funds.

Occupational pension plans in OECD countries have traditionally been DB. However, in recent years there has been a shift to DC plans, in particular in the United Kingdom and the United States.

In almost all OECD countries the main type of private pension arrangement remains occupational or employer-based. Occupational pensions are overwhelmingly funded through pension funds in most OECD countries, the main exception being countries such as Denmark, Norway and Sweden where pension insurance contracts play a larger role and Germany where book reserves are the main type of financing vehicle.

Within pension funds, we can further distinguish between public sector and corporate pension funds, covering public and private sector employees respectively, which implies different regulation,

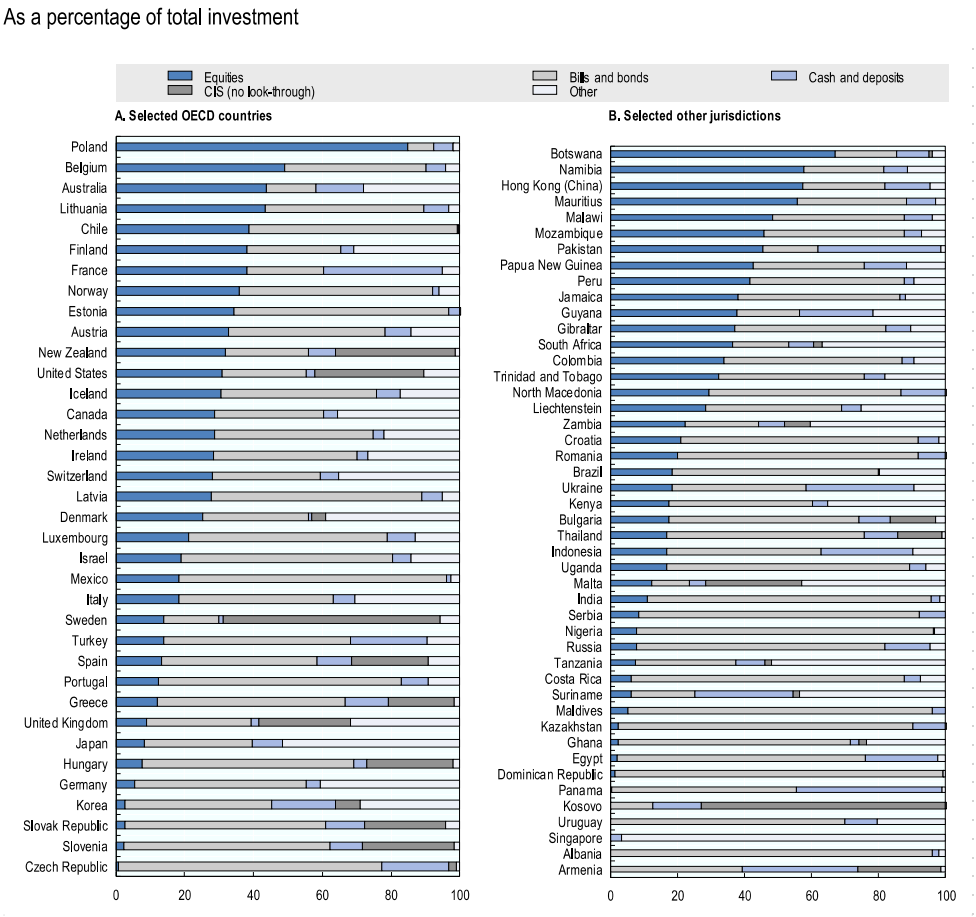
accounting, and incentive structures. Corporate pension funds generally have more restrictive accounting and regulatory guidelines and are more likely to receive pressure from stakeholders to minimise fund volatility. Public sector pension funds are unfunded in some countries so that taxpayers ultimately bear the cost of public pension deficits.

Asset Allocation

Pension funds' asset allocation differs significantly across countries. Asset allocation is influenced by a variety of factors, such as country specific regulation, sponsor strength and liability considerations for DB plans (e.g. open versus closed plans), cultural factors, governance structures, tax issues and ultimately domestically available assets.

According to the OECD, in most countries, bonds and equities are the two main asset classes in which pension assets were invested at the end of 2018, accounting for more than half of investments in 32 out of 36 OECD countries, and 39 out of 46 other reporting jurisdictions (Figure 1).

Figure 7 Allocation of assets in funded and private pension plans in selected asset classes and investment vehicles, 2018 or latest year available



Source: OECD Global Pension Statistics.

In the majority of countries, fixed income remains the dominant asset class, accounting for over 40 per cent of total assets in thirteen OECD countries out of twenty-one for which such information was available. Equity allocation outweighed bonds in 7 OECD countries and 12 other jurisdictions, by 43.7% to 14.6% in Australia, by 57.5% to 24.3% in Hong Kong (China), and by 57.8% to 23.7% in Namibia for instance.

There is an increasing use of passive investment strategies among instititutional investors.(De La Cruz and others 2019) Passive investors benchmark their returns against a pre-defined market index not selecting individual investments. Difficult to estimates total size of passively managed funds with Blackrock (2017) finding passive investments accounting for 17.5% in global equity market investments in 2017 and BIS

showing that the share of passive equity funds in equity funds globally was around 36.7% in 2017 up from 15% in 2007. In particular the share of passive equity funds in the United States, increased from 18% in 2007 to 43% in 2017 of total US equity fund assets and in Japan, passive equity funds' share increased from 32.5% in 2007 to 66.7% in 2017 (BIS 2018).

At the same time pension funds exposure to alternative assets continues to grow, extending a long-established trend and reflecting pension funds' growing appetite for diversification. In recent years investors have been considering changes in the policy asset mix to reduce exposure to the volatility of returns on publicly traded equities. However, due to low yields on fixed-income securities, they have been implementing the change through an increased allocation to alternative assets, including real estate, private equity and infrastructure.

4.3.2 Challenges to Long Term Investing

Most pension funds are subject to structural, financial and demographic pressures that are set to increase over the coming decades. These will have major impact on future portfolio strategies and investment in long term assets. These historical trends expected to continue in the future have underlined liquidity issues and at the same time a lower risk appetite for many investors.

Pension funds are under financial pressure due to a combination of the low return environment, and aging populations in advanced countries reflected in the gradual maturing of their demographic profiles. In addition, the underfunding of Defined Benefit plans (accounting for more than 60% of OECD pension assets) has been further affected by the low yield environment. The DB-DC shift and the impact of regulation on long term Investment may lead to a different asset allocation in infrastructure.

Pension funds are under financial pressure to ensure Long-term solvency

Funding ratios measure the amount of liabilities that assets available cover. When the value of assets in DB plans is less than the value of liabilities arising from the pension promise, or in other words, when the funding ratio is below 100%, the plan is underfunded. DB plan sponsors are usually responsible for guaranteeing the funding of the plan.

Falling interest rates and narrowing credit spreads have increased pension liabilities, putting additional financial pressures on the funding position of several DB pension funds in many regions[35]. For defined

[35] The funding position of DB plans is assessed here as the ratio between the investments and the technical provisions (net of reinsurance) of DB plans. Calculations are based on data provided by national authorities participating in the joint OECD, IOPS and World Bank Global Pension Statistics exercise. Investments of DB plans may be a low estimate of assets of DB plans as they would not include receivables and claims against the plan sponsor to cover the funding shortfall. Technical provisions represent the amount that needs to be held to pay the actuarial valuation of benefits that members are entitled to. This is the minimum obligation (liability) for all DB pension plans.

contribution schemes, the effect on returns is similar, while low interest rates can increase annuity prices for retirees.[36]

Low interest rates affect both sides of the defined benefit balance sheet, not only by making it more difficult to earn a return to meet future obligations, but also increasing pension liabilities to DB funds. In recent years, many DB pension plans have become underfunded, driving a re-assessment of investment and risk-management practices.

Several major countries were underfunded in 2018 (i.e. assets in DB plans were not be able to cover the pension liabilities), with the following funding levels: Iceland (32%), Mexico (67%), the United Kingdom (96%), the United States (57%) and Indonesia (96%). Over the last decade, this level of underfunding remained more or less the same in United Kingdom and the United States or deteriorated further in Iceland, Mexico and the Netherlands among OECD countries.

Structural demographic pressure in advanced countries

Populations in OECD countries are getting older. This increased longevity has lengthened the period over which payments need to be paid in addition, with the first wave of the baby-boomers generation approaching retirement, the ratio of active workers to retirees is projected to fall in the next years. As a result, a declining proportion of pension members will carry an increased responsibility for meeting the plan's funding requirements.

Relatively mature demographic profiles result in a lower risk tolerance in the investment strategies of pension funds reflected in a moderate equity allocation within the asset mix. For those investors that decide to de-risk, the typical approach is to allocate a larger proportion of their portfolio to liquid, high- grade debt instruments and, sometimes, to use derivatives to protect their portfolio from interest rate and inflation

[36] See Pension Markets in Focus 2015 for an overview of financial issues facing global retirement schemes

changes. For example, in life-cycle investment policies in Chile and Mexico, assets of plan members are more exposed to more conservative and less risky investments as they age.

On the other hand, young pension systems with funds that are still growing thanks to new entrants, are likely to have a more aggressive investment focus on growth and asset accumulation (there will be many years before there is net cash flow out). In Hong Kong (China), the Mandatory Provident Fund Schemes Authority noted a preference of members for growth fund likely accounting for the relatively high proportion of assets invested in equities in 2018, 12 percentage points higher than in 2008 (OECD 2019)

In DB pension funds a greater focus on plan liabilities is likely to affect pension investment and risk management. Better appreciation of the interest rate sensitivity of plan liabilities and the risks of large mismatch in the characteristics of a plan assets and liabilities, translates in an increased interest in asset/liability matching.[37]

Historically, pension fund investment has tended to focus on asset returns. Investment tended to be asset driven with performance measured on a relative basis by comparing returns with those of the appropriate asset class benchmark. An acceptable return for the overall pension fund was typically defined by comparing the plan's performance against the median of a universe of pension plan returns.[38]Many European pension funds do not assess the adequacy of their asset-liability management and do not hedge asset and liability management risks – accounting risk and sponsor risk are not properly addressed.

This approach matches future asset sales and income streams against the timing of expected future expenses, also known as growth and withdrawal scenarios, to minimize liquidation risk. Liability matching is valuable

[37]Pension funds liabilities are sensitive over time to emerging inflation since the benefits of active employees are typically linked to their wages and retiree benefits are increased in line with some portion of price inflation by many plan sponsors.

[38] Some pension funds, such as ATP, have adopted a risk-budgeting framework that applies techniques of financial risk management to pension funds.

in situations where amount and timing of payments is known in advance and where limited financial backing is available to support a liability[39]

The nature of long-term savings is changing (Defined Benefit – Defined Contribution shift)

In the early 1980s, the assets set aside to finance retirement income resided mostly in DB arrangements in the United States, at around 60% of total retirement assets This share has steadily declined to 33% of total retirement assets in 2015 and is likely to continue to decline. This trend is also observable in other countries, such as Mexico. Denmark's retirement system, also shown in is dominated by savings in DC arrangements. Canada, by contrast, is still mostly dominated by large public DB plans, though DC arrangements constitute a sizeable portion of total assets.

Across OECD countries, only Canada, Finland, Ireland, Israel, Portugal, and Turkey reported DB assets greater than 50% of total assets for funded pension plans in 2015. In emerging countries where in the past few decades new legislation has established mandatory or voluntary pension arrangements, it is more likely that these systems were created as DC or hybrid arrangements.

The DB-DC shift may lead to a different asset allocation. Defined benefit fund may not always compare to that of a defined contribution plan, even if members of both plans have similar investment horizons, as the management of investment decisions resides with different individuals (DB plans are professionally managed, DC plan investment choices reside with individual members). Additionally, sponsor type (corporate, multiemployer, public), who may be subject to different regulatory environments, may influence the operating environment and characteristics of funds.

[39] There are two main approaches to liability matching: pure matching describes the construction of a portfolio replicating exactly all outgoing liabilities (thus only possible for fixed liabilities) and with the aim to be held until redemption. Duration/Convexity matching on the other hand can be applied to nominal or real liabilities, where the duration mirrors the payments stream sensitivity to changes in interest rates and convexity is the durations sensitivity to interest rate movements, thus resulting in a dynamic portfolio.

The design of default investment options in defined contribution (DC) pension plans has major implications on asset allocations.There is increasing consensus that some type of life-cycle strategy is desirable for default options, with decreasing risk exposure as the individual ages, shifting the asset allocation from publicly traded equities to fixed income or bond like products. However, the specific allocation to risky assets (such as equities) at different ages is a matter of much debate, both in academic and policy circles[40].

Impact of Regulation on Long Term Investment

Quantitative limits may constrain investment in long term assets. In fact, with the exception of a few large markets, most countries put regulatory ceilings on pension funds' exposure to alternative assets. In general, minimum levels of creditworthiness for allowable investments –often based on the investment grade rating assigned by rating agencies – limit the choice of investment opportunities for pension funds. Limits can be on unlisted or direct investments or other quantitative constraints on foreign investment that can prevent investment in emerging markets.

At the end of 2018 the majority of OECD countries – twenty-five- have quantitative limits on the investments of pension funds[41]. Only nine countries do not impose any ceiling to pension fund investment for the asset classes. Whilst highly country specific, investment restrictions can be grouped into three broad categories: limits on pension fund investment in selected assets, limits in foreign assets and other quantitative regulations.

In addition to quantitative investment limits, the move to market-consistent valuations and risk-based solvency standards is also indirectly affecting the ability of pension funds and insurers to act as long-term investors, investing in longer-term, less liquid assets such as infrastructure and other alternative asset classes

[40] There is also an on-going debate on the relative merits of deterministic investment strategies with a fixed glide-path over the life-cycle and dynamic strategies that take into account some supposedly long-term features of asset returns, such as mean-reversion See Antolin P., Payet S., Yermo J. (2010)

[41] See OECD Surveys on Investment Regulations of Pension Funds and the online database compiling all the information from December 2001 (http://www.oecd.org/pensions/privatepensions/annualsurveyofinvestmentregulationofpensionfunds.htm).

Severinson and Yermo (2012). Specifically, when discount rates are based on market interest rates and bonds have a low risk weighting in the solvency regulatory framework, there is a strong incentive to use bonds and interest rate hedging instruments to reduce volatility in solvency levels, as has been observed in the insurance and pension fund sectors in some Scandinavian countries.

The lack of clarity about regulatory treatment of ESG factors may also affect long term investment. Pension funds in common law jurisdiction, have a legally binding fiduciary duty towards their beneficiaries in addition to being held to the prudential standards common to all investors. Fiduciaries have additional obligations of loyalty and care that may affect their interpretation of prudential standards and of how ESG integration can help or hinder them in discharging their duties. Such standards can include: investing prudently, acting in the best/sole interests of beneficiaries, taking a long-term view, avoiding conflicts of interest, and diversifying portfolio investments (OECD 2017).

4.4 PENSION FUND INVESTMENT IN INFRASTRUCTURE - COUNTRY ANALYSIS

4.4.1 Drivers of growth

Clearly, different countries are at different stages in the evolution of pension fund investment in infrastructure. OECD surveys have focussed on Canada, Australia, the United States, South Korea and Europe (OECD 2011, 2012 and Inderst and Della Croce 2012). The choice of countries is based on the importance of asset under management and availability of information for the analysis.

Australia and Canada pension fund investment volumes in infrastructure have risen strongly in the last decades. Australia has the longest history in (dedicated) infrastructure investing, going back to the 1990s with the first funds having built up since then a significant allocation to the sector with portfolio allocation to equity infrastructure of 10% or more. In Canada, the experience is somewhat shorter, with most (large) pension funds starting during the 2000s.

United States pension funds have been investing little in infrastructure, acquiring an early exposure mainly to the energy sector, through a few active funds active in the country. Recent developments in the infrastructure market have increased investors' attention to this asset class; however, investors are taking different approaches towards investment in infrastructure.

In Europe, despite the maturity of the infrastructure market, especially in countries such as the United Kingdom, France, Spain investors have started building up their allocation to infrastructure, treating it as a separate allocation, only in recent times. Allocations to such assets are still limited (e.g. 1 to 3% equity of total portfolio) even if targets have been slowly increasing in recent years.

In Asia, Korea has been a pioneer in pension funds investment in infrastructure, through the large public retirement plans. Japan - the largest retirement market in the region - has invested little in the past but is now moving swiftly in the infrastructure sector following the leadership of the Government Pension Investment Fund.

Active investors who have made several investments are more likely to have separate allocations, showing that most place infrastructure in separate allocations as programmes mature: infrastructure is commonly treated as a separate allocation in the overall portfolio in Canada and Australia while it is in most cases a subsector of real estate or private equity for European and American investors.

Several key factors account for the growth of pension fund infrastructure investment.

The first factor is the number of investable infrastructure transactions developed domestically i.e. the availability of investment opportunities for private finance and for pension funds. Private finance through PPPs and project finance has taken different routes in different countries.

Following privatisations growth in industrialised countries across regions over the last 30 years, private sector delivery and operation of infrastructure has rapidly increased.

The United States and Canada for example have historically relied on public financing of infrastructure such as highways, bridges, ports, canals. Federal and provincial governments in fact invested directly in infrastructure projects rather than rely on private sector financing. The Australian and European transport sectors on the other hand, have experienced higher private sector participation, over the last three decades.

In Australia as the number of infrastructure transactions grew, so did the availability of financial instruments, predominantly infrastructure funds, providing investors with access to infrastructure investment opportunities. This led to the development of investor understanding of infrastructure investment and investor demand for suitable infrastructure assets ultimately outstripping local supply of investable projects. The scale of the programme has been such that it has formed a base from which Australian investors have been able to play an active role in the development and ownership of infrastructure projects and assets elsewhere in the world.

In Korea the traditional view of infrastructure was as an investment of strategic importance, a major public good where there may have been difficulties in raising funds. Investment in infrastructure was therefore considered a government responsibility. With the involvement of private capital since the end of the 90s,

new investment opportunities in the infrastructure sector were offered to investors in Korea. More recently Korean public pension funds have been aggressively investing in infrastructure in foreign countries.

In some sectors full privatisation is not always possible, or politically viable. Therefore, governments have increasingly proposed new forms of cooperation between public and private sector in infrastructure called Public Private Partnerships (PPPs or P3). For reasons of history as well as public policy, public-private partnerships are more widely developed in some countries than in others.

Australia and the UK have been early adopters of PPPs since the early 1990s. In Australia, a vast proportion consisted of large transport items, in particular urban toll roads and tunnels. In comparison, despite closing some high-profile projects in the early 1990s, the USA Canada and Europe generally have lagged behind in the use of PPPs.

In Canada, the PPP pipeline has been steadily growing since the mid-2000s in the healthcare, road and justice systems sectors which are now considered mature and benefiting from strong competition from equity and debt participants in addition, there is a growing pipeline of transport and water projects.

After the financial crisis and with the failure of several projects it started a reconsideration of efficiency of delivery models for infrastructure. In Australia and UK, a reform process is underway to identify weaknesses and to 'retune' the PPP model.

Debt availability is paramount given the high leverage of infrastructure projects. In Europe, the shortage of bank debt has been a major issue during the financial crisis, with other factors being the past Euro crisis and subsequent constraining regulation on banks such Basel III. In contrast, both in Canada and Australia, bank debt has been more easily available for infrastructure projects, both from domestic and international (e.g. Asian) banks. Canadian banks provide infrastructure loans relatively short term, up to a maximum of 7 years or so. Life insurance companies also provide longer term debt.

A major difference between Europe, Canada and Australia is the infrastructure bond market. Europe and Canada have one of the most developed project bond markets while it is rather underdeveloped in Australia. Canadian infrastructure bonds tend to be investment grade while after the demise of Monoline insurers

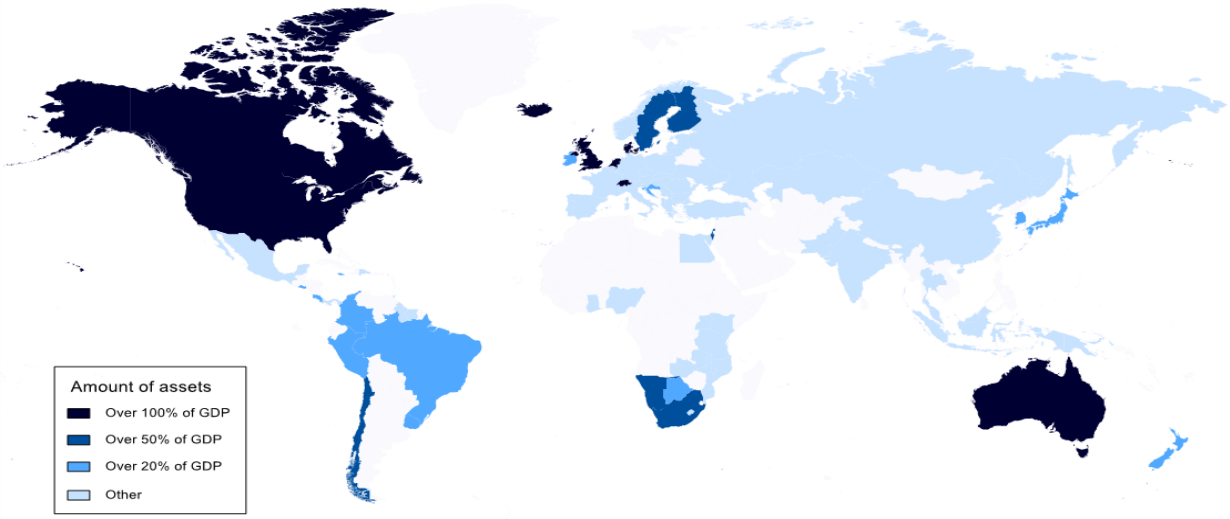
external guarantees play a role in Europe. In the U.S. there is a traditionally strong municipal bond market for infrastructure at the State level, although little financing of private bonds linked to project specific issuances.

The second factor driving the growth of investment in infrastructure is the maturity and size of the pension fund market i.e. the institutional capital available for investment. Although the aggregate OECD pension market is large, the size of domestic markets varies considerably, reflecting the mix of public and private pensions, whether participation is mandatory or voluntary, and investment policies.

There are major differences among pension systems. The growth of Australia's investment industry has been a consequence of the introduction in 1992 of the compulsory Superannuation systems as part of a major reform package addressing Australia's retirement income policies. The largest European investors in infrastructure are in countries such as the United Kingdom, the Netherlands, Sweden, Denmark and Finland with well-developed pension markets. On the other hand, the state-run pay-as-you-go (i.e. unfunded) public pension tier in countries like Greece, Italy, Spain and Turkey still plays a major role in the old-age retirement system, limiting the growth of private pensions and the potential for investment in infrastructure.

The size of pension markets varies among countries and regions. Within the OECD area, 8 out of 36 countries had pension assets at the end of 2018 above 100% of their economy (Figure 2). The largest pension markets are in the USA with assets worth USD 27.5 trillion, representing 64.8% of the OECD total; second the UK with USD 2.8 trillion, followed by Canada USD 2.5 trillion and Australia USD 1.9 trillion. By contrast, the amount of pension assets was lower than 20% of GDP in 54 out of 87 reporting jurisdictions, including some fast-developing countries (e.g. China, India). Among non-OECD countries, South Africa actually has one of the largest pension fund industries both in absolute terms and in relation to its economy, at over 50% of GDP, which puts it at the level of the top OECD countries.

Figure 8 Size of assets in funded and private pension plans in reporting jurisdictions, 2018 or latest year available. As a percentage of GDP



There are also differences among pension fund structures. The occupational retirement system in Canada, UK, USA and Korea is predominately DB, the one in Australia, East Europe and Latin America, predominately DC. This has a direct impact on the way investment decisions are made, on the asset allocation of pension funds, and on the way decision-makers can and do invest in infrastructure. In a DC system, the ultimate investment decision is not with pension boards and executives but remains with the individual members. However, they can somehow be 'steered' by the availability of investment options and default funds.

In a DB system, solvency and funding regulation can make long-term investing more difficult, as requirements for illiquid assets are typically tighter than for liquid assets. In a DC system, investment in illiquid asset classes, such as unlisted infrastructure, can be difficult, especially when individuals have the option to switch funds easily. This creates issues with the interim valuation of illiquid assets and potential liquidity bottlenecks. The drive towards low-cost, default DC funds can also be a detriment to investing in more complex asset classes such as infrastructure. Some of these issues have emerged in Australia during the financial crisis but the effects there were very limited and compensated by new cash flows into the system.

The size of pension funds is also positively correlated with investment in infrastructure. Similar to the UK, Canada's pension system looks fragmented, with thousands of pension schemes governed independently by a Board of Trustees. In Canada, roughly half of pension assets are managed by public funds, with about 20 'super-large' funds (i.e. with assets over US$10bn). Canadian pension funds are often said to be of much larger scale than those in other countries, and therefore more suitable to in-house fund management and direct infrastructure investing. In fact, Canada's pension assets are quite heavily concentrated in bigger funds.

Australia pension system, too, has a broad range of funds, but in a different way. Excluding the hundreds of thousands of super-small funds, there are still over 300 superannuation funds spread over four other categories: industry, corporate, public sector and retail. It should be noted, however, that a number of Australian pension funds are experiencing strong growth rates, and that Australia's number of funds in the 'super league' of the global 300 has doubled only in the last years.

A consolidation process is underway in the pensions industry. Regulation forcing funds to tackle solvency issues coupled with the drive of diversification in private markets through active investment are driving a trend to increasing concentration and ongoing consolidation of the highly fragmented pension fund industry (e.g. the Netherlands, Australia) resulting in growth in the average size of funds. In an increasingly global and competitive world, governments and sponsors need to face the question of scale and resources of pension funds as a matter of priority.

The third factor accounting for the growth of infrastructure investment is pension fund regulation, one of the major drivers of investment strategies.

Pension funds in fact, due to their fiduciary responsibility, tend to be heavily regulated, particularly with regard to their risk profiles and how risky assets are treated in their accounts. Most countries set up limits or completely forbid direct investment in real estate, private investment funds or loans. Over time, most of the legislative changes regarding investment regulation of pension funds led to a softening of the limits and allowed more discretion to pension funds.

Regulation is one of the major drivers of pension funds investment strategies. Pension funds in fact, due to their fiduciary responsibility, tend to be heavily regulated, particularly with regard to their risk profiles and how risky assets are treated in their accounts. In many countries, different quantitative restrictions have traditionally been applied, normally stipulating upper limits on investment in specific asset classes, including alternative investment and infrastructure.

In general, Anglo-Saxon countries adopt the prudent person rule (PPR) in pension fund investment which requires only that funds be invested "prudently" rather than limited according to category. Australia, Ireland, New Zealand, the United Kingdom, the United States, the Netherlands and Luxembourg for example do not impose any specific limit on pension funds' asset allocation and have higher exposure to equity investments. On the other hand, quantitative local investment rules have traditionally favoured highly rated and liquid debt instruments. Eastern Europe and Latin America, being new funded pension systems for example exhibit a high degree of regulation and higher exposure to fixed income assets[42].

[42] Countries with civil law institutions use quantitative limites while anglo-saxon countries with common law use the prudent person. However this is not always true. Canada is an example of a country that had substantial quantitative limitations in addition to its prudent person rule. Similarly, there are countries that are less associated with Anglo-American law that have adopted a prudent person approach to regulation, such as the Netherlands, Japan and

At the end of 2018 the majority of OECD countries – twenty-five- had quantitative limits on the investments of pension funds[43]. Only nine countries did not impose any ceiling to pension fund investment for the asset classes. Whilst highly country specific, investment restrictions can be grouped into three broad categories: limits on pension fund investment in selected assets, limits in foreign assets and other quantitative regulations. See Table below

Table 6 Investment Regulations

Quantitative Regulations	**Examples**
1. Portfolio limits on pension fund investment in selected assets	
Equity Investment	Investments in equities, in particular in unlisted equities, are capped in most countries regulating investments of pension funds. There is an upper limit on equities in 20 OECD countries and 34 non-OECD jurisdictions that are part of the survey. Investment limits are less stringent for listed equities than for unlisted equities, like in Finland where there is only a limit of 10% for investments in unlisted equities and a 50% limit for listed equities for company pension funds and industry-wide pension funds.
Private Investment Funds	Direct investment in real estate is not allowed in Italy, Japan, Mexico, Poland, Turkey, Albania, Armenia, Colombia, Costa Rica, Croatia, the Former Yugoslav Republic of Macedonia,

[43] See OECD Surveys on Investment Regulations of Pension Funds and the online database compiling all the information from December 2001 (http://www.oecd.org/pensions/privatepensions/annualsurveyofinvestmentregulationofpensionfunds.htm).

	Hong Kong (China), India, Kosovo, Lithuania, the Maldives, Nigeria, Pakistan, Peru, Romania, Thailand and Uruguay.
2. Portfolio limits on pension fund investment in foreign assets	
Global investment limits in foreign assets	Two main types of limit on foreign investments can be observed in the surveyed countries: I) specific limits by type of asset class; ii) restriction on the overall share of foreign assets. For example, North Macedonia sets up specific limits on foreign investments by asset class. For instance, pension funds of this country cannot hold more than 30% of their portfolio in debt securities of non-state foreign companies or banks of selected countries, nor more than 50% in bonds and other securities issued by foreign governments and central banks of EU and OECD members. In Chile, while each type of fund has a specific limit for investment abroad (from 35% for fund E to 100% for fund A), the share of assets of the aggregated five types of fund must not exceed 80%of the combined total assets.

Source OECD – Survey of Investment Regulations of Pension Funds 2019

Most countries set up limits or completely forbid direct investment in real estate, private investment funds or loans. Investment abroad may also only be allowed in selected geographical areas, such as the OECD, the European Union regulated markets, or the European Economic Area (EEA). Two main types of limit on foreign investments can be observed I) specific limits by type of asset class; ii) restriction on the overall share of foreign assets.

Over time, most of the legislative changes regarding investment regulation of pension funds led to a softening of the limits and allowed more discretion to pension funds[44]. For example, Canada eliminated the limit on foreign investments (30% of the portfolio) in 2005, and investment limits became less stringent for example: in Mexico (allowing investments in more categories, raising investment limits or expanding the list of eligible countries for foreign investments like in 2017), or in Peru which raised progressively the limit for foreign investments. In 2018, rules were further loosened in a number of countries, such as Israel (increase of the investment ceiling for commercial loans not rated or rated below BBB-), Korea (investments in REITS listed on regulated markets allowed for occupational DB plans), Portugal (withdrawal of the 55% investment limit in equities for personal retirement saving schemes (PPR) financed through pension funds).

The final key factor to take into account is financial intermediation playing a key role in letting investors access opportunities. Infrastructure investment involves a steep learning curve given the unique nature of each investment

The past decades have seen a trend of significance in the financing of infrastructure – the provision of investment vehicles such as private equity and infrastructure funds targeting mainly opportunities in equity markets. These new investment vehicles allow a broader range of smaller pension funds to also get involved.

Investing in the asset either directly or through an infrastructure fund, requires a long lead time to complete due diligence, educate plan sponsors and set up the appropriate structure for investment and risk management the capacity of pensions funds is needed at all levels: governance, management, operational resources.

This is not only a question of numbers but also of skills and experience with new asset classes. Indirect investors may outsource the operations but still face demanding tasks of governance and overseeing of

[44] European regulation of pension fund investment prior to the introduction of the euro was by asset classes, regulated investment overseas, and in some cases fixed rates of return. In some cases, governments required pension funds to invest solely in government debt.

illiquid assets. For smaller and medium-sized pension funds, it is still difficult to find suitable investment vehicles.

The focus of infrastructure investing has been traditionally on the equity side, public or private, in all developed countries. Institutional investors such as insurance companies are increasingly interested in infrastructure debt for a number of reasons that have to do both with ‘debt’ and ‘infrastructure’ characteristics.

It should be noted that infrastructure bond investing is not necessarily a new thing. For example, the fixed income departments of many pension funds would have invested in bonds of (privatized) utility or transport companies for a long time. Furthermore, the more than US$ 3tr US municipal bond market is a core ingredient of US bond portfolios. PPP bonds are a part of mainstream Canadian bond indices.

New-style infrastructure debt investing tends to involve either specialist debt funds (with a mix of infrastructure bonds, loans or mezzanine debt), or direct investment in infrastructure loans, e.g. of new greenfield projects or by taking over an existing loan portfolio from a bank.

4.5 CONCLUSIONS AND IMPLICATIONS

The pensions landscape has changed over the past decades across countries.

Overall pension assets exceeded USD 40 trillion worldwide in 201845 with pension funds, gathering alone over USD 28 trillion of assets. The OECD average ratio of assets to GDP, weighted according to the pension assets in each country, was 126% in 2018, compared to 49.7% in 2008. There has been a marked shift towards funding and private sector management in pension systems, driven largely by the introduction of mandatory private pensions. Funding has also become increasingly important within publicly managed pension systems.

This growth in assets is likely to continue in OECD countries, especially in countries where mandatory retirement systems or where private pensions and insurance markets are still small in relation to the size of their economies. In developing countries, governments are establishing mandatory and/or contributory retirement systems. They generally face an even greater opportunity to develop their institutional investor sectors as, with few exceptions, their financial systems are largely bank-based.

Pension funds' asset allocation differs significantly across countries. The rise of institutional investors has been accompanied by the increasing use of passive investment strategies. At the same time pension funds exposure to alternative assets continues to grow, extending a long- established trend and reflecting pension funds' growing appetite for diversification

The nature of long-term savings is changing

[45] This estimate for 2018 is based on data collected through the joint OECD, IOPS and World Bank Global Pension Statistics exercise. This statistical exercise collects the total amount of investments related to funded and private pension plans source: OECD Pension Market in Focus 2019

Most pension funds are subject to structural, financial and demographic pressures that are set to increase over the coming decades. These will have major impact on future portfolio strategies and investment in long term assets. More in particular:

- Falling interest rates and narrowing credit spreads have increased pension liabilities, putting additional financial pressures on the funding position of several pension funds in many regions. In recent years, many DB pension plans have become underfunded, driving a re-assessment of investment and risk-management practices.
- Relatively mature demographic profiles result in a lower risk tolerance in the investment strategies of pension funds reflected in a moderate equity allocation within the asset mix. In DB pension funds a greater focus on plan liabilities is likely to affect pension investment and risk management.
- The shift towards defined contribution arrangements - observed across OECD and non-OECD countries - with individuals bearing the risks of retirement, compared to DB arrangements, has important implications for long term and infrastructure investment.
- Quantitative investment limits, the move to market-consistent valuations and risk-based solvency standards are affecting the ability of pension funds and insurers to act as long-term investors, investing in longer-term, less liquid assets such as infrastructure and other alternative asset classes. The lack of clarity about regulatory treatment of ESG factors may also affect long term investment going forward.

Drivers of Pension Fund Investment in Infrastructure: country evolution

Clearly, different countries are at different stages in the evolution of pension fund investment in infrastructure. Several key factors account for the growth of pension fund infrastructure investment.

The first factor is the number of investable infrastructure transactions developed domestically i.e. the availability of investment opportunities for private finance and for pension funds.

Following the wave of privatisation that has swept mainly the industrialised countries of the world over the last 30 years, the involvement of the private sector in the provision and operation of infrastructure has rapidly increased. Governments have also increasingly proposed new forms of cooperation between public and private sector in infrastructure called Public Private Partnerships (PPPs or P3).

The second factor driving the growth of investment in infrastructure is the maturity and size of the pension fund market i.e. the institutional capital available for investment.

Although the aggregate OECD pension market is large, the size of domestic markets varies considerably, reflecting the mix of public and private pensions, whether participation is mandatory or voluntary, and investment policies. The size of pension funds is also positively correlated with investment in infrastructure. The majority of pension systems looks fragmented, with thousands of pension schemes governed independently by a board of trustees not able to benefit from scale and management expertise needed for infrastructure investment.

The third factor accounting for the growth of infrastructure investment is pension fund regulation, one of the major drivers of investment strategies.

Pension funds in fact, due to their fiduciary responsibility, tend to be heavily regulated, particularly with regard to their risk profiles and how risky assets are treated in their accounts. Over time, most of the legislative changes regarding investment regulation of pension funds led to a softening of the limits and allowed more discretion to pension funds. However, most countries set up limits or completely forbid direct investment in real estate, private investment funds or loans.

The final key factor to take into account is financial intermediation playing a key role in letting investors access opportunities.

Infrastructure investment involves a steep learning curve given the unique nature of each investment, not all pension funds are able to access the asset class. The past decades have seen a trend of significance in the financing of infrastructure – the provision of investment vehicles such as private equity and infrastructure

funds targeting mainly opportunities in equity markets. These new investment vehicles allow a broader range of smaller pension funds to access infrastructure.

Demographic and financial pressure are having an impact on infrastructure investment

The changing nature of long-term savings is shaping the current and future demand for long-term infrastructure investment: demographic and financial pressure are having (and will have) an impact on infrastructure investment.

Given the low interest rate environment and volatile stock markets of recent years, institutional investors are increasingly looking for new sources of long-term, inflation protected returns. Investments in real, productive assets, such as infrastructure could potentially provide the type of income which these investors require supporting investment and driving growth.

Pension funds are under financial pressure due to a combination of the low return environment, and aging populations in advanced countries reflected in the gradual maturing of their demographic profiles. These historical trends expected to continue in the future have underlined liquidity issues and at the same time a lower risk appetite for many investors.

There is among investors a reconsideration of liabilities constraints. Better appreciation of the interest rate sensitivity of plan liabilities and the risks of large mismatch in the characteristics of a plan assets and liabilities, translates in an increased interest in asset/liability matching, ultimately fuelling pension fund's demand for good quality – income oriented –, inflation linked investments that can match their liabilities

As plans' risk tolerance decreases, infrastructure - as an inflation sensitive asset- can play a role facilitating the shift of funds toward a conservative preservation focus. However, for mature funds facing negative cash flow, it is difficult to justify the introduction of additional illiquid assets to the portfolio given ongoing

liquidity needs. Therefore, any allocation to infrastructure investment would likely come from a corresponding reduction to the real estate or private equity programmes.

Liquidity will be a major issue for many pension funds when allocating to infrastructure. Funding deficits have highlighted the challenges of managing the financial risks of older DB pension plans that have a high ratio of retired to active employees. For pension funds suffering from poor funding ratios and insufficient future contributions the need to provide liquidity to pay benefits over the next decades, mean they can't increase or maintain existing allocations to alternative assets such as infrastructure

Also, for DC plans, investment in illiquid asset classes, such as unlisted infrastructure, can be difficult, especially when individuals have the option to switch funds easily. This creates issues with the interim valuation of illiquid assets and potential liquidity bottlenecks.

Pension and regulatory reforms for long term investing

Governments need to create the conditions to respond to this long term investement demand, aligning policies in the infrastructure, pension and financial markets areas. The financial market and asset managemtent have a crucial role in providing sustainable targeted solutions to cater this demand. Different level of development, country and sector specifics will imply different sets of products and viable solutions. Several developments can support policy action in matching this appetite from pension fund investors for infrastructure.

A consolidation process is underway in the pensions industry. Regulation forcing funds to tackle solvency issues coupled with the drive of diversification in private markets through active investment are driving a trend to increasing concentration and ongoing consolidation of the highly fragmented pension fund industry (e.g. the Netherlands, Australia) resulting in growth in the average size of funds.

Consolidation of small funds is a positive outcome in terms of long-term sustainability and infrastructure investment. It appears in fact that the most active investors in infrastructure are also the largest funds. The

size of such funds allows them to invest in this sector and still maintain the liquidity necessary to meet the required prudential requirements. Larger funds tend to have an advantage over their smaller counterparts, particularly in their ability to reduce management fees. In addition, the largest funds have the resources and skills to evaluate investments directly and perform due diligence on alternative assets such as infrastructure.

As regulation is a major driver of investment, it will be paramount to continue softening quantitative limits and ensuring no hindering effect on LTIs from market and risk-based valuations. Several initiatives are reviewing the impact of regulation on long term investment and sustainable infrastructure (i.e. FSB, EIOPA, NGFS).

The global financial crisis and its subsequent severe impact on growth and employment have led to several proposals and actions to strengthen prudential regulation frameworks. While enhancing stability of the system these proposals may at the same time raise the long-term cost of capital and affect the capability of pension funds to invest long term in assets such as infrastructure.

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ANNEX 1 - ABOUT THE QUALITATIVE COUNTRY SURVEY - METHODOLOGY

The OECD Project on Infrastructure to 2030, published in 2006/7, already recognized the growing importance of investment needs to 2030 for infrastructure in telecommunication, electricity, water and transport, while highlighting at the same time, the notion of an emerging "infrastructure gap". To bridge this "infrastructure gap" institutional investors were identified as one of the most promising candidates and it was decided to further review opportunities and barriers to investment in infrastructure from the standpoint of pension funds.

A qualitative survey of a sample of the most significant actors was then launched by the OECD within the framework of the OECD Project on Transcontinental Infrastructure 2030-2050. The focus of the survey was mainly on (unlisted) equity investment given the different dynamics and drivers underlying pension fund investment in debt infrastructure and different subjects involved in the investment decision.

The selection of interviewees was biased towards large-sized defined-benefit, occupational pension funds, since these funds represent a large share of overall infrastructure investment and in some cases have developed investment policies specific to infrastructure. Interviews were held with managers of institutional investors holding assets that collectively totalled over US$4tn at the end of 2010.

Besides pension funds themselves, a number of investors from the insurance sector, and prominent financial consultants, infrastructure funds, multilaterals, academics, advisors to treasury and infrastructure departments, were also consulted.

The inputs to the present report also incorporate advice and guidance from participants in the Steering Group of the OECD Project, as well as work and publications of line Directorates of the OECD.

ANNEX 2 STEERING COMMITTEE

European Investment Bank

Overseas Infrastructure Alliance – India

Ministry of Transport – Turkey

Ministère de l'écologie, de l'énergie, du développement durable et de la mer – France

Institut National de Recherche sur les Transports et leur Sécurité (INRETS) – France

Department of Mobility and Public Works – Flemish Government Belgium

Swedish Road Administration Sweden

State Planning Organization – Turkey

Macquarie Capital – Australia

Ministry of Transport and Communications – Finland

Federal Ministry of Transport, Innovation and Technology (BMVIT) – Austria

Ministry of Transport – Denmark

Ministry of Transport, Public Works and Water Management – The Netherlands

CDC Infrastructure – France

Federal Department for Environment, Transport, Energy and Communications – Switzerland

Oliver Wyman – United States

Invited Experts and Guests

ATP – Denmark

Von Dewfall Advisory & Management – Netherlands

Global Infrastructure Fund Research Foundation – Japan

ANNEX 3 - LIST OF INTERVIEWEES[46]

Institutional Investors

California Public Employees Retirement System (CalPERS) – USA

California State Teachers Retirement System (CalSTRS) – USA

Los Angeles County Employees Retirement (LACERA) – USA

Illinois State Retirement System (SURS) – USA

Teacher Retirement System of Texas (TRS) – USA

New Jersey State Investment Council – USA

University of Texas Investment Management Company – USA

Union Labor Life Insurance Company (ULLICO) – USA

John Hancock – USA

Ontario Municipal Employees' Retirement System (OMERS) – Canada

Canada Pension Plan Investment Board (CPPIB) – Canada

Ontario Teachers Pension Plan (OTPP) – Canada

OPTrust – Canada

PGGM – the Netherlands

APG – the Netherlands

ATP – Denmark

University Superannuation Scheme (USS) – United Kingdom

Varma Mutual Pension Insurance Company – Finland

[46]Over sixty interviews were conducted through mainly face to face meetings or if not possible through conference calls between May and December 2010. Additional comments were also provided during the drafting of the document.

London Pension Fund Authority (LPFA) – United Kingdom

Prudential (M&G) – United Kingdom

Aviva Investors – United Kingdom

Zurich Insurance – Switzerland

National Pension Service – South Korea

Public Employees Pension Service – South Korea

Korea Teachers Pension (KTP) – South Korea

AustralianSuper – Australia

Queensland Investment Corporation (QIC) – Australia

Industry Funds Management (IFM) – Australia

Fonds de Réserve pour les Retraites – France

Caisse de Dépôts Infrastructure (CDC) – France

Cassa Depositi e Prestiti (CdP) – Italy

Fondazione Cariplo – Italy

Other interviewees

Infrastructure Australia (IA)

Infrastructure Partnerships Australia

Macquarie Korea

Hewitt Associates

Pension Consulting Alliance

Cambridge Associates

Townsendgroup

Ennis & Knupp

Probitas Partners

IFC – World Bank

CP2 – Australia

European Investment Bank (EIB)

Marguerite Fund

Hewitt Associates

Tower Watson

Mercer

Macquarie Group

Morgan Stanley Private Equity – USA

Axa Private Equity

F2i

Prometeia

RREEF

Barclays Private Equity

Meridiam

Campbell Lutyens

Bfinance

UBS

Goldman Sachs

Infrastructure UK

Dexia Bank

Société Générale

JP Morgan

Deutsche Bank

Moody’s Investors Services

Infrastructure Journal

Infrastructure Investors

Infra-News

Global Pensions

Stanford University

Harvard University

APPENDIX 4

List of organizations and companies interviewed for the report (~~Inderst Della~~ Croce, 2012).

AUSTRALIA: • Association of Superannuation Funds of Australia • Challenger Ltd • Colonial First State Global Asset Management • Industry Fund Management • Infrastructure Australia • Infrastructure Partnerships Australia • Macquarie Capital Limited • Plenary Group • SunSuper • UniSuper Management Pty Ltd

CANADA: • Alberta Investment Management Corp. • Aquila Infrastructure Management • Association of Canadian Pension Management (ACPM) • CAAT Pension Plan • Canada Pension Plan Investment (CPPIB) • Infrastructure Canada • Kindle Capital • Ontario Teachers‟ Pension Plan • Pension Investment Association of Canada (PIAC) • PPP Canada • Stonebridge Infrastructure Debt Fund • Teachers' Retirement Allowances Fund

CHAPTER 5: ESG, PRIVATE MARKETS IMPACTS ON INSTITUTIONAL INVESTMENT IN INFRASTRUCTURE

5.1 INTRODUCTION

A growing number of investors are integrating environmental, social, and governance (ESG) considerations in their investment programs due the potential impact of sustainability on their long-term financial performance and as a tool for managing ESG-related risks (OECD 2020)[47]. As investors with a typically long-term horizon, institutional investors have a particular incentive to consider ESG risks in unlisted infrastructure, which may materialise in the medium to long-term. This is having an impact on asset allocation decisions reflected for example in an interest for active investing and a variety of ESG integration approaches for infrastructure.

In the last decades, in a context of aging of populations and constraints on public budgets Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) have gained importance within the financial system as effective investment vehicles for realizing future liabilities and achieving some balance between generations (Blundell-Wignall et al. 2008) and (Clark and Monk 2011 and 2017)[48]. These so called universal owners that invest long-term and have large and diversified portfolios should be better placed to shape and benefit from ESG policies.

However, these supposedly long-term institutional investors are also recurrently being labelled as "short-termist", of feeding asset price bubbles with a herd-like mentality and of being "asleep at the wheel" as company managers abuse their power to the detriment of shareholders (OECD 2011). These concerns have

[47] Environmental, social and governance (ESG) investment, sustainable investment, socially responsible investment, impact investment, moral investment and other terms are being used more or less synonymously to define the practice of incorporating ESG factors in investment decisions. For more on this see Chapter 4 and 7 of the OECD 2020 Business and Finance Oulook

[48] Although there is no single widely accepted definition, Sovereign and Public Pension Reserve Funds (PPRFs) could be defined as funds set up by governments or social security institutions with the objective of contributing to finance the relevant pay-as-you-go pension plans Blundell-Wignall et al., (2008) . It is not utilised a strict definition of Large Pension Funds LPFs, following OECD practice is intended here to capture the largest investors in the world, compared on an absolute basis, followed by the largest investors within specific countries (See Chapter 2).

led to calls for more "responsible" and longer-term investment among institutional investors, often associated with sustainable infrastructure investment.

Aim of this chapter is to identify the flows and better capture the underlying trends in asset allocation and investment strategies of pension funds on alternative assets (i.e. private markets) and sustainable/ESG investment. The focus of this analysis is on the channels and ultimate impact on low carbon infrastructure, looking more in depth at green strategies - part of ESG thematic investement - having an impact on the energy transition. Unique access to OECD microeconomic data of two distinct pools of long-term savings – LPFs and PPRFs - allow deep insights of the general trends observed at national level in chapter 4 – Country Survey: Pension Fund Investment in Infrastructure.

Despite the increasing interest in long term investors, only a limited amount of information has historically been available regarding the investment strategies actually implemented by pension funds, sovereign wealth funds or PPRFs. Granular statistical data is scarce at asset or sector level forcing the literature to focus on the use of case studies of selected investors or more normative studies on asset allocation. This has led to considerable uncertainty about the exact nature of the strategies of the broader market and their evolution over time.

The OECD in 2011 launched the first annual quantitative survey covering Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) among the largest in their respective economies, and comparatively, amongst the largest in the world. In 2019, the survey reviewed the trends in assets and asset allocation of 125 LPFs and PPRFs, which in total managed USD 12.4 trillion in assets in 2017, approximately one third of the total worldwide assets held by this class of institutional investor (See Chapter 2).

This chapter leverages the first part of the survey using when possible comparable samples of different publications to draw conclusions valid for the last decade. It first looks at trends on sustainable investment relevant for infrastructure. It then examines ESG integration considering asset allocation and alternative

investment evolution in the last years. It ultimately looks at sustainability investment and thematic strategies including green aspects.

5.2 INDUSTRY PRACTICE AND LITERATURE REVIEW

5.2.1 ESG and long term value

While there is increased investor interest in adopting ESG approaches, the linkage between ESG factors in infrastructure and infrastructure investment risks and returns is not well understood, and the literature is nascent. Beyond infrastructure, the impact of ESG factors on financial performance is a central issue in the debate around long term investors and sustainable investment. Amel-Zadeh, Amir and Serafeim, George (2017) find that relevance to investment performance is the most frequent motivation for use of ESG data followed by client demand and product strategy, bringing change in companies, and then ethical considerations.

Some studies suggest ESG approaches tend to reduce risks and generate higher returns through an 'ESG factor' driving the performance of companies (Amundi, 2019). For example, Fuerst (2015) regressed Global Real Estate Sustainability Benchmark (GRESB) scores on various REIT financial indicators such as ROA and ROE in order to test the link between sustainability and financial performance. The study found that there was a positive relationship between sustainability score and the profitability of real estate companies. The study attributed these results through gains in operating performance, efficiency, and lowering risk exposures.

Academic literature had been focusing on the relation between ESG and corporate financial performance. Friede, Gunnar and Busch, Timo and Bassen, Alexander (2015) look at more than 2000 studies on the relation between ESG and corporate financial performance with roughly 90% of studies showing a non-negative ESG-CFP relation and the large majority of studies reports positive findings. Clark , Feiner and Viehs M.

(2015) find positive correlation between diligent sustainability business practices and economic performance demonstrating that responsibility and profitability are complementary.

Long term investors may gain excess returns in integrating ESG factor in their investment process. Cai and He (2014) find a positive correlation between corporate environmental responsibility and long-term stock performance. They argue that environmental responsibility is an intangible asset, likely to be undervalued by the market, especially in the long horizon, thereby causing environmentally responsible companies to exhibit long-horizon excess returns. Khan, Mozaffar and others (2015) findings indicate that investments in sustainability issues are shareholder-value enhancing

However in a recent assessment of the overall literature on ESG, the OECD concluded that broadly there is mixed evidence on the impact of ESG performance on financial performance (OECD 2020). In fact not all academic research points to such positive relationships between ESG factors and long-term returns. Eccles and Seraphim (2013) suggest that there is a negative relationship between a firm's ESG performance and its financial performance because of the costs of taking action such as voluntarily reducing emissions.

For infrastructure, the long asset life cycles and investor timelines may expose infrastructure assets to particular ESG risks which are material to investors. However, data on infrastructure is often lacking and not comparable as it not being reported in a standardised format or audited by companies' auditors. Also, the same company can receive divergent ESG ratings, due to problems of inconsistency of criteria and misrepresentation through one single metric of the impact of multiple ESG factors (OECD 2020).

As reporting is still immature, scoring has focused on firm's management approach and transparency of performance rather than direct performance. A recent study by EDHEC cross-references for the first time the ESG scores computed by GRESB Infrastructure and the financial metrics of the EDHEC infra universe, showing that ESG ratings are not positively or negatively correlated with returns, suggesting that the adoption of ESG investment approaches should not harm returns (no trade-offs) but also challenging the notion that ESG is a risk factor (EDHEC, 2020).

5.2.2 Long Term Investors and Asset Allocation

Due to the long-term nature of their investments, institutional investors may be better placed to shape and benefit from ESG policies. Insurance companies and pension funds are so called universal owners that invest long-term and have large and diversified portfolios. This gives them access to long-term opportunities, and the need to assess long-term risks when making their portfolio choices. Investors that do not require short-term liquidity may be in a better position to influence the management of companies they invest in or finance, so that corporate directors focus on long-term firm value (Busch, Bauer and Orlitzky, 2016).

Long term asset allocations decisions affecting sustainable and ESG investing are based on type of institution, specific objectives and mandates. Strategic asset allocation results from combining investor's constraints and objectives, it includes long term capital market expectations and is mainly based on modern portfolio theory (Markowitz 1952; Sharpe 1964, Lintner 1965). Asset allocation of SWFs and PPRFs varies widely depending on their specific objectives and mandates while pension funds are constrained by the nature of their liabilities. Kunzel et al. (2011) find notable differences in strategic asset allocation (SAA) exist even amongst SWFs of similar types.

There are several definitions of sovereign wealth funds and public pension reserve funds in academic literature, often overlapping. Chwieroth (2014) and Alhashel, (2015) and Griffith-Jones & Ocampo (2010) define SWFs as public institutional investors which originate from productive and financial imbalances across countries and invest domestically or internationally to seek commercial profits. Kunzel et al., (2011) divide SWFs into four categories: (1) stabilization funds, aiming at isolating state budgets from the excessive volatility of commodity prices, (2) savings funds, ensuring intergenerational transfers of national wealth, (3) sovereign pension reserve funds (SPRFs), covering potential future pension deficits, and (4) reserve investment corporations, dealing with currency reserves in excess of those managed by the central bank. Blundell-Wignall, Hu, and Yermo (2008) conclude that SWFs and public pension reserve funds (PPRFs)

differ significantly with respect to objectives, investment strategies, sources of financing, and transparency requirements.

Constraints and objectives affect portfolio composition and risk appetite. Risk averse investors are expected to have a larger allocation to fixed income and cash, while investors taking more risk – being able to manage it - have more risky investments such as equities and alternatives. Dreassi, Miani, Paltrinieri (2017) comparing the largest sovereign pension reserve funds (SPRFs) and social security reserve funds (SSRFs) find that SSRFs allocate their assets less aggressively, with a preponderance of fixed-income securities, consistently with the influence and scrutiny of private citizens. Conversely, SPRFs exhibit a preponderance of equity and alternative investments, indicating that they pursue equity and illiquidity premiums while fulfilling their strategic goals in managing public resources. Fotak, Gao and Megginson (2016) show a "shift to domestic investment" pattern for SWFs and also an industry preference change from the financial to the real estate sector.

Among major factors influencing risk appetite are benefit guarantess and past investment performance. Pennacchi and Rastad (2011) find evidence that pension funds chose greater overall asset –liability portfolio risk – with higher discount rates for their liabilities- following periods of relatively poor investment performance.Crossley and Jametti (2013) looking at canadian pension funds find that insured plans will invest more heavily in risky assets than do similar plans without benefit guarantees.

Country macroeconomic conditions and institutional environment have an impact on asset allocation. In general SWFs seem to favour investment in advanced countries in terms of more liquid financial markets, better protection of legal rights, and more stable macroeconomic context (Ciarlone and Miceli 2016)). On the other hand, some studies point to SWFs preference for weak legal country institutions. Johan, Knill, and Mauck (2013), examining investments of 19 SWFs during the period 1991–2010, show that SWFs are more likely to invest in private equity compared with public equity in target nations where investor protection is low. Boubakri, Cosset, and Grira (2016) find that SWFs, in comparison to pension funds, are

more likely to invest in firms operating in strategic industries and in countries with sustainable economic growth and weak legal and institutional environment

Large and active investors are attracted to private markets (such as private equity or infrastructure) by potential abnormal returns exceeding public markets. CEM Benchmarking (2015 and 2019) finds that pension funds through active investing have been able to beat the market. Gross of investment costs, the value added by Large Institutional Investors (pension funds) between 1992-2013 over their policy return averaged 58 basis points.

Contrary to the efficient market hypothesis assuming that all available information is incorporated in stock prices several studies find evidence of abnormal returns in alternative asset and private markets. Jegadeesh, Kräussl, Pollet (2009) looking at private equity investments indicate abnormal returns of approximately 1% per year. Fang,Ivashina and Lerner (2014) find that direct private equity investments have performed better than public market indices, in the last 20 years. Harris, Jenkinson,, Kaplan (2014) studying the performance of nearly 1,400 U.S. buyout and venture capital funds find buyout fund performance has consistently exceeded that of public markets.

5.2.3 Limits of Research

Infrastructure investors often use these factors as a tool for managing ESG-related risks, in particular to obtain downside protection. As investors with a typically long-term horizon, institutional investors have a particular incentive to consider ESG risks in infrastructure, which may materialise in the medium to long-term.

While there is increased investor interest in adopting ESG approaches, the linkage between ESG factors in infrastructure and infrastructure investment risks and returns is not well understood, and the literature is nascent. Academic literature had been focusing on the relation between ESG and corporate financial performance recognizing that long term investors may gain excess returns in integrating ESG factor in their

investment process. For infrastructure as reporting is still immature, scoring has focused on firm's management approach and transparency of performance rather than direct performance

Long term asset allocations decisions affecting sustainable and ESG investing are based on the type of institution. Asset allocation of SWFs and PPRFs varies widely depending on their specific objectives and mandates while pension funds are constrained by the nature of their liabilities. Risk averse investors are expected to have a larger allocation to fixed income and cash, while investors taking more risk – being able to manage it - have more risky investments such as equities and alternatives. Large and active investors are attracted to private markets (such as private equity or infrastructure) by potential abnormal returns exceeding public markets.

Evidence on asset allocation and ESG investment is often based on partial information - small samples of investors – or target allocation data sources - not at investor level - making difficult to compare portfolio strategies across sectors and countries. Further academic research is needed on asset allocation trends, approaches investors are taking to ESG and alternative investment and on asset class performances. This would benefit pension funds facing difficult choices on investment allocation in their fiduciary roles and regulators called to supervise the overall pension system risk.

5.3 ESG INVESTMENT AND INFRASTRUCTURE

5.3.1 Sustainable investing strategies

Investors are placing sustainability at the centre of their investment approach, making it a major force across global financial markets. The integration of ESG factors into investment decision-making and risk management, including for infrastructure investment, is part of a broader trend among institutional investors to adopt sustainable investment strategies, which also include divestment, corporate engagement, sustainability themed investment, and impact investing, among others. Sustainable investing assets stood at USD 30.7 trillion at the start of 2018, a 34% increase in two years, in certain regions it accounts for a sizeable share of professionally managed assets, from 18% in Japan to 63% in Australia and New Zealand (GSIA 2018). For example asset managers are putting pressure on companies not taking action on climate change, with measures including existing investments in coal producers, to using votes at annual meetings to signal dissatisfaction.[49]

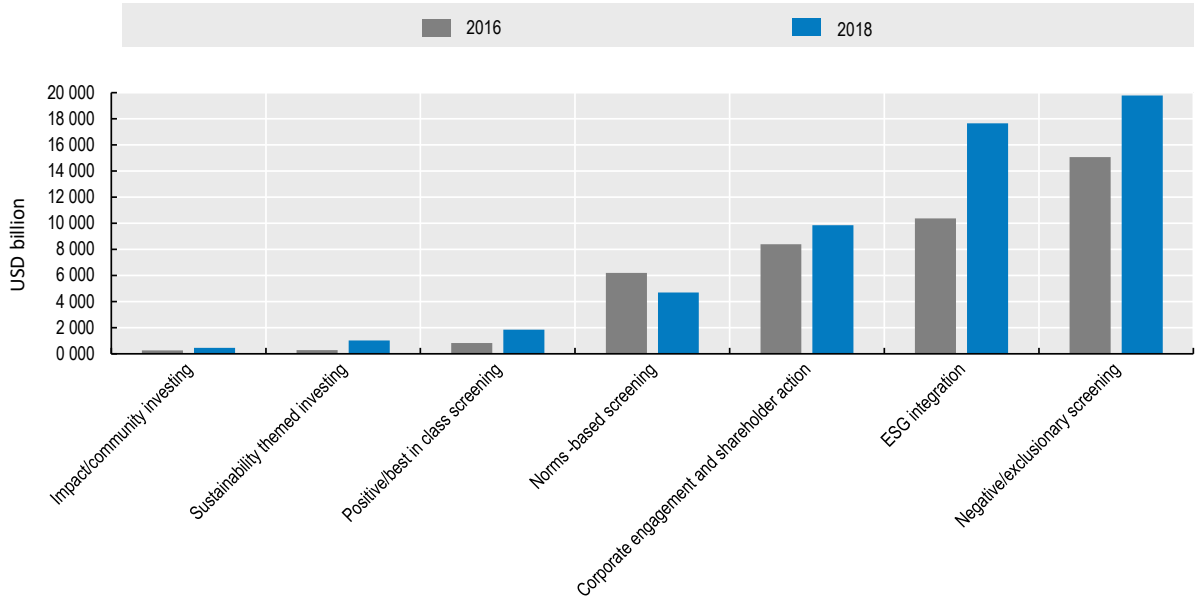
Sustainable investments extend across the range of public and private asset classes commonly found in diversified investment portfolios. The latest Global Sustainable Investment Alliance (GSIA) report on sustainable assets shows that in 2018, 51% of total USD 31 trillion assets were allocated to public equities and 36% to fixed income with the remaining 13% in private markets in alternative asset classes such as real estate, private equity and infrastructure (Figure 1 and GSIA, 2018).[50] There are a variety of investors in sustainable investment with different objectives and mandates among the most active institutional investors such a pension funds and insurers. As OECD (2020) concludes, some investors examine ESG factors mainly via the risk management lens as an opportunity for higher financial returns, while others perceive ESG factors

[49] In July 2020 Blackrock placed 244 companies "on watch" for insufficient progress on climate issues and it took voting action at the annual meetings of 53 companies (22 %) over climate issues in 2020, largely through voting against the re-elections of directors. Companies punished included German carmaker Daimler, US coal-miner Peabody Energy and Fortum, the Finnish electricity company. Source: Financial Times 14 July 2020 Blackrock punishes 53 companies over climate inaction

[50] The GSIA survey shows asset class allocation in Europe, the United States, Japan and Canada in 2018. Sustainable investments can also be found in hedge funds, cash or depository vehicles, commodities.

as non-financial objectives such as carbon emissions or other sustainability-performance targets that they wish to promote.

Figure 9 Global growth of sustainable investing strategies, 2016–2018



Source: GSIA (2018)

Corporate engagement and shareholder action is a popular and growing strategy among infrastructure investors in private markets. Infrastructure equity investors often have controlling stakes in the business, allowing significant scope in corporate engagement – limited though by the contractual nature of the services provided. Although a debt investor has less control over the operations of its assets compared to an equity investor, there are several ways debt can support equity to be more sustainable, including through setting conditions prior to funding and/or covenants related to the remediation of ESG risks. Projects may also need specific covenants related to environmental considerations, construction permitting, and post-closing remediation monitoring.

Relevant for infrastructure, the range of active strategies focused on sustainability as an investment outcome includes thematic and impact investing. Although starting from a low base they have known a huge growth in recent years with thematic investing accounting for USD 1 trillion in 2018, up from less than USD 280

billion in 2016 (GSIA 2018). As noted in OECD (2020), environmental factor integration achieved via impact and thematic investing is relevant for infrastructure as it may include social infrastructure or renewable energy projects, green bonds and companies addressing environmental issues.

In some cases, institutional investors are evolving their investment frameworks to align their investment strategies with broader environmental or development objectives such as the United Nations Sustainable Development Goals (SDGs), or environmental issues more broadly as part of their investment framework and/or thematic investment strategy. Other initiatives such as those emerging from the Paris Agreement on Climate have placed pressure on signatories to enforce policy and regulations that curb emissions, a movement that has broad implications for infrastructure, particularly in the energy and transportation sectors which are major emitters of CO2.

5.4 ASSET ALLOCATION TRENDS IN PRIVATE MARKETS

5.4.1 Growth in Assets under Management

Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) have become major players in international financial markets in the last two decades. In 2017 the weighted average of LPFs and PPRFs assets accounted for respectively 21.2% and 18.9% of the national GDP in the countries covered in the survey publication. Fourteen of the twenty-seven pension reserve funds surveyed had established their funds after 2000.

The total amount of assets under management for the large pension funds (LPFs) covered by the survey was approximately USD 4.9 trillion at the end of 2017 (Table 1). Total assets under management, measured in local currency, increased by a robust 10.3% (nominal) on average between 2016 and 2017 (through investment returns and/or fund flows). In terms of total assets relative to the national economy, Singapore's Central Provident Fund had the highest ratio at 80.2% of GDP, followed by ABP at 61.6% (which with PFZW represented 88.3% of the Dutch GDP), Malaysia's Employees' Provident Fund at 59.9%, South Africa's GEPF at 40.5%, and Denmark's ATP at 35.3%.

The total amount of public pension reserve fund (PPRFs) assets at the end of 2017 was equivalent to USD 7.5 trillion within the countries for which data was received or obtained (Table 2). The reserves put aside by PPRFs increased by 6.9% (nominal) on average between 2016 and 2017 (based on local currency values and weighted by assets). In terms of total assets relative to the national economy, Korea had the highest ratio at 33.9% of GDP, followed by Luxembourg at 32.7%, Jordan at 32.2%, Japan at 29.8%, and Sweden at 28.6% (aggregate AP funds).

Large reserves are also accumulated in sovereign wealth funds that have a pension focus. The Government Pension Fund Global in Norway has two main goals: to facilitate government savings necessary to meet the rapid rise in public pension expenditures in coming years, and to support long-term management of petroleum revenues. At the end of 2017, the fund held USD 1.1 trillion in assets, accounting for 266.3% of

Norway's GDP. The fund is considered to be the largest sovereign wealth fund in the world. The Russia Federation's National Wealth Fund is dedicated to supporting the pension system to guarantee long-term functioning of the system

Emerging economies are also home to some of the largest LPFs and PPRFs in the world. For example, the survey included large pension funds in six major non-OECD countries: Argentina, Brazil, Malaysia, Nigeria, the Russian Federation, and South Africa. South Africa's GEPF at USD 152.8 billion and Brazil's Previn at USD 56.7 billion stood out as the largest funds in their respective continents. Malaysia's Employees' Provident Fund, with assets under management of USD 199.5 billion is amongst the largest investors in the world.

Box 1 – OECD Definitions

According to the OECD (2019) Pension Markets in Focus 2019 there are two types of PPRFs. Although both have the same ultimate objective (i.e. meeting the potential financial liabilities relating to the social security system), they vary in terms of funding sources, investment strategies, and payout phases, among others.

- One is the fund that is part of the overall social security system, where the inflows are mainly surpluses of employee and/or employer contributions over current pay-outs, as well as top-up contributions from the government via fiscal transfers and other sources. Among others, Denmark's Social Security Fund, Japan's Government Pension Investment Fund, and USA's Social Security Trust Fund fall within this category. These funds may be managed by the social security institution itself or an independent -often public sector- fund management entity.
- The other type refers to those funds which are established directly by the government (completely separated from the social security system), and whose financial inflows are mainly from direct fiscal transfers from the government. Unlike the first type of PPRFs, those within this category have been set up by governments to meet future deficits of the social security

system. Some are not allowed to make any pay-outs for decades. All of these funds are under autonomous management entities. Examples include the Australia Future Fund, the New Zealand Superannuation Fund, the Norwegian Government Pension Fund, and the French "Fond de Réserve pour les Retraites". These funds are also sometimes classified as sovereign wealth funds (SWFs). Though they do not all have high foreign investment allocations.

As noted in the IOPS 'Good Practices in the Risk Management of Alternative Investments by Pension Funds'2 (IOPS Good Practices), there is no precise definition of alternative investments. The nature of alternative investments is dynamic and ever-evolving, and closely linked to the development of financial markets. While there is no official definition of alternative assets, the term is usually applied to instruments other than listed equities, bonds, and cash. For the purposes of this survey, "alternative" investments comprise the following types of investments: hedge funds, private equity, real estate, infrastructure, commodities and "other" (other includes timber and currency/interest rate overlays).

Emerging markets are defined in the OECD surveys as countries in the following regions: Latin America and Caribbean, European countries (excluding the European Union) and Russia, Middle East, Africa, and Asian countries excluding Japan, Korea, Australia and New Zealand.

5.4.2 Asset allocation LPFs and PPRFs

The survey has been monitoring since 2011 the asset allocation of both large pension funds (defined benefit and defined contribution) and PPRFs in OECD and non-OECD countries. A spectrum of fund profiles exists, from portfolios invested in predominately safer assets such as fixed income and cash, to portfolios with higher amounts of equities and investments in alternative asset classes.

The investment strategies of institutional investors differ significantly across countries and type of investors. As seen, the academic literature has been focusing on several factors influencing optimal allocation for pension funds and PPRFs including market trends, investment beliefs, regulation, risk

appetite, liability considerations, cultural factors, governance structures, tax issues and ultimately domestically available assets.

The asset allocation of PPRFs varies widely depending on their specific objectives and mandates. Compared to other institutional investors, many PPRFs have a relative certainty of the asset base as well as amount and timing of future cash flows. For example, the Canada Pension Plan Investment Board ("CPPIB") is not expected to use any investment income to help pay benefits until 2021. Hence, PPRFs are not forced, in theory, to seek the short-term returns that many other market participants must achieve due to their investment objectives, yield requirements or business models, nor are they driven by short-horizon market dynamics. On the other hand, some PPRFs may be subject to political pressure, directly influencing their asset allocation decisions, as the divestment of assets in 2015, following fiscal pressure in some countries.

Alternative investments were much more prevalent amongst pension funds based in OECD countries than non-OECD countries. In 2017 the simple average portfolio for the LPFs based in the OECD shows that 45.6% of total assets were invested in fixed income and cash, 35.6% in equity, and 18.8% in alternatives/other investments . For LPFs in non-OECD countries, the simple average portfolio held 69.5% in fixed income and cash, 23.9% in equities, and 6.6% in alternatives/other investments.

Alternative investments for LPFs include hedge funds, real estate, unlisted infrastructure, private equity, and other categories such as natural resources, loans, or commodities. As part of the alternative asset allocation, a number of funds also invested in infrastructure.

In 2017, the simple average portfolio for the PPRFs included in the survey shows that 54.0% of total assets were invested in fixed income and cash, 30.5% in listed equities, and 15.5% in alternative/other investments. Norway's GPFN had the highest allocation to listed equity at 64.6% of total assets. Alternative investments in PPRFS portfolios include hedge funds, real estate, unlisted infrastructure, private equity, and other categories such as natural resources.

A spectrum of mandates and limits on investment leads to varying investment profiles. Some funds, such as those in Spain and the United States, have statutory limits requiring them to invest only in government bonds (in the case of the United States, special issues of the United States Treasury). In Australia, Canada and New Zealand, long-term mandates lead to a profile more similar to a funded pension scheme (defined benefit fund) with lower allocations to fixed income and higher allocations to return seeking assets, such as alternative investments and equity.

5.4.3 Asset Allocation Evolution

Looking at historical asset allocation the survey reveals that LPFs across regions have been reducing equity and fixed income exposure in favor of larger alternative investment allocations[51]. In fact, data on asset allocation for a group of 35 LPFs over the four years 2014- 2017 shows that allocations to alternatives (including infrastructure) increased from 14.8% of total assets in 2014 to 16.4% in 2017[52]. Over this same time period, allocations to fixed income and cash decreased by 1.1 percentage points, and equity decreased by 0.5 percentage points.

Underlying trends within alternatives over the same period 2014-2017 show that LPFs have on average decreased allocations to land and buildings and increased allocations to infrastructure and hedge funds. Allocations to private equity have been relatively flat, while loans have increased.

While the increasing trends in alternatives have been observed in many regions, it is not uniform across OECD and G20 countries with funds citing regulatory barriers to investing in alternative asset classes. Pension funds in Brazil, for instance, reduced exposure to alternatives and increased fixed income and cash with Previ reducing its target to alternative investments and equities and increasing target allocations to fixed income. On the other hand for Canadian OTPP, total alternatives grew to 50.6% of the total portfolio at the

[51] Shifting market values factor into changing asset allocation, however, given that equity markets have advanced through most of this time period

[52] Thirty-five LPFs reported asset allocation over the period 2014-2017 for this historical analysis, which is a subset of the 2017 total survey population.

end of 2017 and total allocation to alternatives for Australia's Hostplus increased from 32.4% in 2014 to 39.0% in 2017.

General trends in asset allocation over the period 2014-2017 confirm that PPRFs are on average shifting investment from fixed income to equities and alternatives Looking at a sample of 20 funds, on average, allocations to alternatives (including infrastructure) increased from 12.7% of the total portfolio in 2014 to 13.5% in 2017; a slower pace than what was observed amongst LPFs[53] Funds also on average increased allocations to equities by 1.8 percentage points, and decreased fixed income and cash by 2.7 percentage points.

Trends within alternatives show that funds have on average increased allocations to land and buildings, infrastructure, and hedge funds. Private equity, which occupied the largest slice of alternatives portfolios, decreased compared to 2014. CPPIB (Canada) increased allocations to alternatives from 29.5% of the total portfolio in 2014 to 43.5% in 2017.

A few funds within the PPRF group are just beginning to ramp up new allocations, which is partly driving the trends observed. For example, the GPIF in Japan is currently making some of its first investments in private equity and other alternatives after the migration of its portfolio to a new policy allocation of 50% equity and 50% fixed income, with up to 5% of the total portfolio invested in alternatives. In order to do so the GPIF has ramped up its alternative investment capabilities through new internal resources and the establishment of a Private Market Investment Department in March 2016. The GIPF is following the model adopted by the Norwegian Government Pension Fund – with a real estate allocation to 4.5% of the total portfolio in 2017 out of 5% target.

[53] Twenty PPRFs reported asset allocation over the past four years for this historical analysis, which is a subset of the 2017 total survey population.

5.5 ESG INTEGRATION AND GREEN STRATEGIES

5.5.1. ESG investment integration

The integration of ESG considerations in investment decisions is becoming a more common practice among institutional investors. However, not all institutional investors integrate ESG factors in their investment decision-making process at the moment. A recent OECD ESG survey (see chapter 4 OECD (2020)) confirms that:

- Although many insurance companies and pension funds do make ESG considerations when selecting investment opportunities, a significant number do not.

- A majority of respondents declared that they integrate some ESG considerations into their investment decision process: 20 pension funds (out of 25 respondents) and 30 insurance companies (out of 51) considered at least some environmental, social or governance factors on new investments.

- Eighteen insurance companies and four pension funds responded that they do not take any ESG factors into account in their investment decision-making process.

- A small number of institutional investors – three insurance companies and one pension fund – which have not yet started integrating ESG factors -- responded that they were planning to do so in the future. These respondents indicated that the main reasons for not yet integrating ESG factors were a lack of resources, internal knowledge and guidance from policy makers on how to take ESG considerations into account.

According to the OECD ESG survey , most institutional investors that choose to integrate ESG factors in their investment decisions implement this through their general investment procedure. However there is an increasing number of sustainability themed funds structured in a way that the investments meet an environmental or social needs, or focus on long-term and strategic trends.

Thematic investment and ESG impact investments are frequently applied via investing in designated funds.Some investors direct their thematic investments towards assets that promise secure investment returns as well as positive sustainability impact, such as green, sustainable and social bonds and microfinance funds.

The fact that infrastructure investment is often undertaken through private markets makes the adoption of ESG decision-making more challenging, as private markets do not have the same disclosure requirements as public markets. Given the often indirect nature of their infrastructure investments, through funds or managed separate accounts, institutional investors must rely significantly more on their asset managers and other service providers to track their exposure and performance. Hence asset managers play a key role in implementing and measuring ESG criteria in institutional investors' portfolios.

Regulatory requirements related to ESG have increased the adoption of ESG considerations in infrastructure investment. Funds are also adjusting to new regulations in some markets that seek to clarify the role of ESG in a fund's investment process. This is part of a broader policy and regulatory push to clarify and disclose climate-related risks in the financial sector, which provides an indirect push for asset owners (and asset managers, who may manage their investments) to consider climate and other ESG-related risk factors, given potential exposures through their investments.

Previous OECD work on the regulatory frameworks that apply to institutional investors in different jurisdictions concluded that integrating ESG factors in investment decisions is generally permitted if consistent with the financial obligations of insurance companies and pension funds towards their beneficiaries and members (OECD, 2017).

These regulations and policy initiatives have put added pressure on the investment community to improve ESG reporting and have also forced investors to consider long-term risks associated with ESG factors, including future regulations or policies that might impact their infrastructure assets. A growing number of investors concerned with the potential impact of sustainability on their long-term financial performance are involved in initiatives on voluntary disclosure of ESG practices.

A number of countries have put into place reporting requirements on disclosure of ESG practices by institutional investors, which may have implications for the application of ESG practices to infrastructure investments held within portfolios. For instance, Australia requires pension funds, insurance companies, and asset managers to disclose their ESG practices. France has introduced the most far-reaching requirements in

terms of ESG reporting by institutional investors. Under Article 173-VI of the *Energy Transition Act*, asset managers, pension funds and insurance companies must provide information not only on how they integrate ESG factors in their investment and voting decisions but also on the climate risks they face and how their portfolio construction contributes to the transition to a low-carbon economy.

Furthermore, the adoption of ESG factors in infrastructure investment is enabling institutional investors with an impact orientation to screen and select projects, funds, and companies, and *align their infrastructure investments with sustainability objectives*, consistent with return objectives. This alignment may be one of principle but it may also be motivated by a view on sectoral growth opportunities or as a way to avoid or manage certain types of risks, such asset stranding.

5.5.2 Green investment [54]

The range of active strategies focused on sustainability as an investment outcome, includes impact investing aiming at environmental problems such the global energy transition.The OECD has gathered for the fourth year in 2017 data on green investments by LPFs and PPRFs, provided in Tables 3-4 (see Annex 2)55. This

[54] Twenty-six and thirty-seven funds responded to this section on green investment in 2015 and 2017 respectively.

[55] This section benefits from data collected by the OECD for the period 2015-2017 and quantitative analysis. The focus is on two distinct pools of long-term savings: large pension funds (LPFs) and public pension reserve funds (PPRFs). In 2017, the OECD gathered, for the fourth year in a row, data on green and social investments by LPFs and PPRFs. Twenty-six and thirty-seven funds provided information about their green investments in the OECD surveys covering the period 2015- 2017. These data included information on investments that funds have made in specific products, debt/equity instruments, or through specific mandates for social impact and/or green investment. Not all funds included in the survey reported that they actively implement ESG frameworks in their investment processes as In 2017, twenty-six LPFs stated that they were not active in green finance. The sample although subject to bias towards more active investors is still significant in terms in assets under management and provides unique insights on current trends and market evolution in recent years.

part of the survey was seeking information on investments that funds have made in specific products, debt/equity instruments or through ad-hoc investment mandates designed for green investment. Green investment includes low-carbon infrastructure investment, which is also discussed in the next chapter of the thesis. Beyond quantitative data this section provides insights as to how investors define sustainable and green investment, their different approaches and policy or investors initiatives.

Based on data gathered through the survey, it becomes evident that there are neither uniform interpretations underlying sustainability including green and social investment, nor standardized implementation strategies amongst the funds. In addition, not all funds have reported actively implementing ESG frameworks in their investment processes. In 2017, twenty-six LPFs stated that they are not active in green finance with funds reporting barriers to incorporate green strategies due to the institutional structure of the funds or regulatory framework conditions.

There are a variety of definitions of green investments, depending on investor standards. For the OECD survey of LPFs and PPRFs, examples of such investments include green equity indexes such as FTSE4Good, the S&P Global Eco Index, and the S&P Global Water Index; green bonds such as European Investment Bank climate awareness bonds, SEB Green Bonds, and Credit Suisse – World Bank/IFC Green Bonds; and alternative investments in real estate that are environmentally acceptable such as those that improve energy efficiency, reduce CO_2 emissions, or involve recycling (OECD, 2019a).

Funds have different approaches to green investments. For instance, while AIMCo (Canada) has no pre-determined target allocation for green investment, it tracks the percentage of its investments in renewable energy, its overall renewables exposure, and the climate change related impact of its investments. FFR (France) considers several green factors in its allocation decisions for both listed and non-listed investments, such as low-carbon indexes, environmental technology, infrastructure, clean technology, and the management of environmental issues. Furthermore, FRR targets a CO_2 emissions reduction of 50% in its listed equities mandates.

Sustainable debt issuance was approx.. USD 450 billion in 2019, higher than the year before at around USD 250 billion, but still a fraction of overall debt issuance at over 5% (IEA, 2020). New types of debt instruments are also linking financial performance to environmental outcomes. For example, interest rates for a USD 2.5 billion Enel bond issued in 2019 are tied to goals for renewables capacity and emissions levels. This overall growth was accompanied by an increase in the number of pension funds investing in green bonds and in the relative size of their allocations in, particular in Sweden, Belgium, and France.

Funds based in Austria, France, the Netherlands and Sweden reported sizeable allocations to green equities. PMT (the Netherlands) reported that approximately 30% of its portfolio in 2017 was green equities. The categorisation of its entire listed equity portfolio as "green" is the result of how it considers ESG factors in all of its investment decisions, including new investment strategies, product mandates, and investment proposals. France's ERAFP applies an ESG best-in-class approach to all equity mandates in 27.5% of its total portfolio. AP4 reported that 9.1% of its total portfolio was held in green equities, labelling this allocation as 'low-carbon' and 'ESG' strategies. For BCIMC, green equity refers to global equity securities whose ESG rating is high relative to sector peers.

Beyond green bonds and green equity, some funds also reported holding alternative green investments, such as renewable energy and cleantech projects. AP2 (Sweden) reported a sizeable allocation to green investments, at 12.1% of its total portfolio, part of which included private equity investment in renewable energy/climate solutions. AP7 (Sweden) reported a small allocation to cleantech, which it defined as new

environmentally improved business models and technical innovations that make it possible to use natural resources more efficiently and responsibly. The fund also reported that it was looking to increase its allocation to cleantech over the next couple of years.

Funds are paying increasing attention to European Union (EU) initiatives in relation to green investment. The EU taxonomy adopted in June 2020 aims to define which economic activities are sustainable, including socially and environmentally (OECD, 2020b). In addition, an EU regulation that entered into force in April 2020 defines two types of low-carbon benchmarks, the EU Paris Aligned and the EU Climate Transition, requiring ESG disclosures for benchmarks sold in the European Union.

5.6 CONCLUSIONS AND IMPLICATIONS

Investors are placing sustainability at the centre of their infrastructure investment approach

The integration of ESG factors into investment decision-making and risk management, including for infrastructure investment, is part of a broader trend among institutional investors to adopt sustainable investment strategies, which also include divestment, corporate engagement, sustainability themed investment, and impact investing, among others. Sustainable or ESG investments extend across a variety of investors and the range of public and private asset classes commonly found in diversified investment portfolios including alternative asset classes such as real estate, private equity and infrastructure.

Corporate engagement and shareholder action is a popular and growing strategy among infrastructure investors in private markets. Relevant for infrastructure, the range of active strategies focused on sustainability as an investment outcome includes thematic and impact investing. In some cases, institutional investors are evolving their investment frameworks to align their investment strategies with broader environmental or development objectives such as the United Nations Sustainable Development Goals (SDGs), or environmental issues more broadly as part of their investment framework and/or thematic investment.

Despite broad recognition of the importance of ESG criteria and interest in incorporating these factors into infrastructure investment decision-making, the implementation of these criteria in asset valuation remains at an early stage. Several international standards and tools have been developed to integrate sustainability and resilience aspects into infrastructure development and support ESG infrastructure asset analysis. Current methods for ESG measurement and ESG-related analysis vary among stakeholders at different phases in the infrastructure process.

As part of the alternative asset allocation, an increasing number of funds are also investing in unlisted infrastructure

In recent years diversification benefits and higher expectations of investment returns are increasingly driving investors to alternative investments, such as hedge funds, real estate, private equity, and other categories (i.e. natural resources, loans, or commodities). Looking at historical asset allocation chapter 5, reveals that Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs are on average shifting investment from fixed income to equities and alternative. As part of the alternative asset allocation, an increasing number of funds are also investing in unlisted infrastructure.

However not all investors are able to access long term illiquid assets such as infrastructure. A spectrum of mandates and limits on investment leads to varying investment profiles and exposure to alternatives. In Australia, Canada and New Zealand, PPRFs long-term mandates lead to a profile more similar to a funded pension scheme (defined benefit fund) with lower allocations to fixed income and higher allocations to return seeking assets, such as alternative investments and equity. On the other hand, GPIF in Japan, following the Norwegian investment model is slowly transitioning its traditional portfolio allocation to alternative asset classes with its recent first investments in private equity out of its 5% target allocation to alternatives.

ESG and green strategies for low carbon infrastructure

Despite broad recognition of the importance of ESG criteria and interest in incorporating these factors into infrastructure investment decision-making, the implementation of these criteria in asset valuation remains at an early stage. The integration of ESG factors into investment decision-making and risk management, including for infrastructure investment, is part of a broader trend among institutional investors to adopt sustainable investment strategies, which also include divestment, corporate engagement, sustainability themed investment, and impact investing, among others. Sustainable or ESG investments extend across a variety of investors and the range of public and private asset classes commonly found in diversified investment portfolios including alternative asset classes such as real estate, private equity and infrastructure.

There is an increasing number of sustainability themed funds focusing on green investment and the energy transition. Thematic investment and ESG impact investments are frequently applied via investing in designated funds. The range of active strategies focused on sustainability as an investment outcome, includes

impact investing aiming at social or environmental problems such as affordable housing and the global energy transition. Based on data gathered through the OECD survey, it becomes evident that there are uniform interpretations neither underlying sustainability including green and social investment, nor standardized implementation strategies amongst the funds.

Investor's involvement in private markets is challenging the risk management and governance models of pension funds (i.e. insourcing asset management) with implications for policy makers and regulators

As seen, there is increased belief among investors that long- term investment approaches including active management based on fundamental analysis exploiting market inefficiencies in private markets and sustainable investments might be better able to pursue long-term value. However, the increase in allocations to higher risk investments will have a profound impact on risk management and governance of pension funds.

Many alternative assets for example create their own distinct risk modelling, forcing pension fund managers to change the way they plan and track their risk budgets. Pension funds need to quantify their tolerance for risk at a total fund level but also understand how that risk budget is allocated across an increasingly varied mix of assets and investments. Alternative investments generally have lower liquidity, use unconventional strategies (hedge funds), sell in less efficient markets, have the ability to use financial leverage, and require a longer investment horizon than public bonds and equities (often due to illiquidity).

The adoption of more complex investment strategies including alternatives is challenging the traditional governance models of pension funds. Asset and risk management skills will be necessary at pension board level and insourcing asset management will allow to reduce costs and agency risks. Still the risks of being different – by adopting unconventional asset allocation techniques or investments – are a challenge or even a barrier for investors. This is particularly true when communicating changes to stakeholders such as beneficiaries, trustees, or even the public, when such matters can be complex and technical.

From a regulatory perspective, monitoring of trends in asset allocation is needed to identify more clearly any emerging risks to financial stability. As assets grow and the systemic importance of the pension schemes increases, prudential surveillance, regulation and oversight along with sound fund governance will become increasingly important.

Increasing investor's involvement in ESG and infrastructure: better data, analysis and disclosure

ESG trends are affecting the investment landscape in infrastructure, as investors are demanding greater transparency and information regarding investment impact and sustainable infrastructure. Given the large amount of variation in investor action, there is therefore a need to convene and to align initiatives and to collaborate where possible in order to reduce redundancies and to achieve global standards regarding ESG practices, and disclosure of risks.

The fact that infrastructure investment is often undertaken through private markets makes the adoption of ESG decision-making more challenging, as private markets do not have the same disclosure requirements as public markets. Given the often indirect nature of their infrastructure investments, through funds or managed separate accounts, institutional investors must rely significantly more on their asset managers and other service providers to track their exposure and performance. Hence asset managers play a key role in implementing and measuring ESG criteria in institutional investors' portfolios.

Governments and regulators could, where appropriate and needed, strengthen formal requirements to provide consistent information on investments by pension funds on ESG factors, following internationally agreed standards. This would allow for future monitoring on an international basis. Regulatory requirements related to ESG have increased the adoption of ESG considerations in infrastructure investment. Funds are also adjusting to new regulations in some markets that seek to clarify the role of ESG in a fund's investment process. This is part of a broader policy and regulatory push to clarify and disclose climate-related risks in the financial sector, which provides an indirect push for asset owners (and asset managers, who may manage their investments) to consider climate and other ESG-related risk factors, given potential exposures through their investments.

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ANNEX 1 - TABLES

Table 7 Total assets of selected Large Pension Funds in 2017

Country head office	Name of the fund or institution	Total investments or assets		
		USD bn.	% of GDP	% increase (compared to the previous year)
Australia	AustralianSuper	101.2	7.2	19.5
Australia	CBUS	33.9	2.4	18.4
Australia	Health Employees Superannuation Trust Australia (2,3)	31.1	2.3	15.5
Australia	Hostplus Superannuation fund	22.6	1.6	31.4
Australia	Qsuper (2,3)	72.3	5.3	7.2
Australia	UniSuper Management Pty Ltd	48.7	3.5	11.7
Austria	APK Pensionskasse	5.6	1.3	7.1
Austria	Valida Pension	6.7	1.5	7.0
Austria	VBV Pensionskasse	7.9	1.8	12.7
Botswana	Botswana Public Officers Pension Fund	5.9	32.5	6.4
Brazil	Banesprev	5.0	0.3	7.4
Brazil	FAPES - BNDES	3.2	0.2	9.2
Brazil	FORLUZ	4.6	0.2	4.1
Brazil	Fundação CESP	8.3	0.4	5.6
Brazil	Fundação Petrobras de Seguridade Social	21.7	1.1	4.1
Brazil	Fundação Sistel de Seguridade Social	5.1	0.3	3.1
Brazil	Previ	56.7	2.9	11.9
Brazil	Real Grendaza	4.6	0.2	6.2
Brazil	Valia	6.7	0.3	5.2
Canada	Alberta Investment Management Company (AIMCO)	82.6	4.8	8.2
Canada	British Columbia Investment Management Corporation (2,4)	101.9	6.6	11.2
Canada	Local Authorities Pension Plan (LAPP)	34.0	2.0	13.2
Canada	OMERS (2)	76.8	4.5	11.6
Canada	OTPP	147.7	8.6	7.7
Chile	AFP Cuprum	41.1	14.0	6.3
Croatia	Allianz ZB Obligatory Pension Fund	5.4	9.2	6.2
Croatia	Erste Plavi	2.2	3.8	17.0
Croatia	PBZ CO	2.3	4.0	8.3
Croatia	Raiffeisen Mandatory Pension Funds	4.5	7.8	10.5
Denmark	ATP (2)	123.8	35.3	1.2
Denmark	PensionDanmark	34.4	9.8	10.8
Denmark	PFA Pension	76.9	20.5	7.1
Finland	KEVA	62.2	23.2	6.9
Finland	Varma Mutual Pension Insurance Company	54.3	20.2	7.2
France	ERAFP (2)	28.3	1.0	9.8
Germany	BASF Pensionskasse	11.4	0.3	10.1
Germany	Bayer-Pensionskasse (2)	10.3	0.3	2.8
Hong Kong, PRC	Mandatory Pension Fund Schemes (5)	107.9	31.7	30.5
Iceland	Birta	3.1	12.5	8.7
Iceland	Gildi Pension Fund	4.9	19.7	9.5
Iceland	Lifeyrissjodur Starfsmanna Rikisins	7.9	31.4	10.7
Iceland	Pension Fund of Commerce	6.4	25.4	10.4
Ireland	Bank of Ireland	6.3	1.8	-2.1
Ireland	ESB	4.5	1.3	16.0
Indonesia	BPJS Ketenagakerjaan (2)	22.3	2.2	15.6
Italy	Cometa	13.1	0.6	6.0
Italy	FONCHIM	7.4	0.4	9.7
Italy	Fonte	4.4	0.2	9.3
Japan	Pension Fund Association	109.1	2.3	4.1
Korea	Samsung Life	13.7	0.8	8.9
Lithuania	Swedbank Pensija 2	0.3	0.6	7.6
Lithuania	Swedbank Pensija 3	0.5	1.0	16.2
Lithuania	Swedbank Pensija 4	0.2	0.5	21.8
Malaysia	Employees' Provident Fund	199.5	59.9	9.6

Netherlands	PFZW	236.5	26.7	6.4
Netherlands	PMT	83.4	9.4	1.9
Netherlands	Stichting Pensioenfonds ABP	545.5	61.6	8.3
Netherlands	Stichting Pensioenfonds van de Metalektro (PME)	55.9	6.3	4.2
Nigeria	AES Fund (6)	1.0	0.3	41.0
Nigeria	CPFA Fund (6)	1.8	0.5	27.5
Nigeria	RSA Fund (6)	6.8	1.8	..
Peru	AFP Integra (2)	19.0	8.8	12.9
Portugal	Banco BPI Pension Fund	1.8	0.8	16.2
Portugal	CGD Pensões (7)	3.2	1.4	6.1
Romania	Azt Viitorul Tau (8)	2.2	1.0	25.7
Romania	Raiffeisen Acumulare	0.0	0.0	12.3
Russian Federation	Future ("Buduschee")	4.9	0.3	11.0
Russian Federation	Lukoil - Garant	4.4	0.3	1.1
Russian Federation	Sberbank	8.6	0.5	33.6
Singapore	Central Provident Fund (2)	268.4	80.2	9.3
South Africa	GEPF	152.8	40.5	12.4
South Africa	Sentinel Retirement Fund (9)	3.6	0.9	1.9
Spain	Endesa	2.1	0.2	2.9
Spain	Fonditel (10)	3.9	0.3	-3.3
Spain	Santander	0.3	0.0	9.9
Sweden	Alecta	101.1	16.7	7.7
Sweden	AP7	51.1	7.4	22.2
Switzerland	Pensionskasse Post	17.4	2.4	6.6
Switzerland	Publica	40.4	5.6	5.2
Turkey	OYAK (2)	19.6	2.4	7.1
United Kingdom	BBC Pension Scheme(2,4)	19.7	0.8	22.7
United Kingdom	BT Pension Scheme (2,3)	64.0	2.5	7.0
United Kingdom	Railways Pension Scheme (2)	37.2	1.3	7.7
United Kingdom	RBS Group Pension Fund (2)	60.5	2.2	2.2
United Kingdom	USS (11)	87.1	3.0	6.5
United States	CalPERS (2,3)	326.5	1.7	9.3
United States	CalSTRS (2,3)	208.7	1.1	10.6
United States	Florida Retirement System Pension Plan (2,3)	154.4	0.8	8.7
United States	Los Angeles County Employees Retirement Association	55.6	0.3	12.2
United States	Massachusetts PRIM Board (2,3)	66.9	0.3	10.1
United States	New York State and Local Retirement System (2,4)	197.6	1.0	7.6
United States	State of Wisconsin Investment Board (2)	104.6	0.5	24.7
	EuroControl Pension Fund	1.9	n.d.	13.0
Total		**4,884.0**	**21.2**	**10.3**

".." means not available

(1) Data correspond to all forms of investment with a value associated with a pension fund/plan. (2) Data for 2017 has been gathered from publicly available sources. (3) Data is as of June 30, 2017. (4) Data is as of March 31, 2017. (5) Assets reported by the Mandatory Pension Fund are aggregated from 36 member schemes. (6) In Nigeria, there are three types of pension schemes, namely, the Retirement Savings Account (RSA), which is contributory; the Closed Pension Funds; and the Approved Existing Schemes (AES). The largest pension fund from each of these three schemes has been selected. (7) Data cover the CGD Staff's Pension Fund. (8) Data refer to the largest pension plan managed by Azt Viitorul Tau. (9) Data refer only to the Pensioner Portfolio. (10) Data refer to Fonditel's biggest pension plan: Empleados de Telefónica de España. (11) Data is as of March 31, 2018.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs and publicly available reports.

Table 8 Total assets of selected Public Pension Reserve Funds in 2017

Country head office	Name of the fund or institution	Year of establishment	Total investments or assets (1)		
			USD bn.	% of GDP	% increase (compared to the previous year)
Argentina	Sustainability Guarantee Fund	2007	64.7	11.4	37.4
Australia	Future Fund (2)	2006	108.3	7.7	8.8
Belgium	Zilverfonds (6)	2001	0.0	0.0	-100.0
Bosnia and Herzegovina	Pension Reserve Fund Of Republic of Srpska	2011	0.1	0.7	4.3
Bulgaria	State Fund for Guaranteeing the Stability of the State Pension System	2007	1.7	2.8	4.8
Canada	Canada Pension Plan Investment Board	1997	268.8	15.7	13.1
Canada	Quebec Pension Plan	2006	55.2	3.2	11.3
Chile	Pension Reserve Fund	2006	10.9	3.7	13.0
China (People's Republic of)	National Social Security Fund (2)	2001	341.4	2.7	10.0
Finland	Valtion Eläkerahasto	1997	23.5	8.7	4.3
France	AGIRC - ARRCO (2) and FRR (5)	n.d.	115.0	4.2	-0.8
Germany	Sustainability Fund (Nachhaltigkeitsrücklage) (2)	1972	40.1	1.0	3.3
India	Employees' Provident Fund Organisation (2,4)	1952	131.7	5.1	15.5
Japan	Government Pension Investment Fund	2006	1,440.9	29.8	12.3
Jordan	Social Security Investment Fund (2)	n.d.	12.9	32.2	10.0
Korea	National Pension Fund (2)	1988	580.7	33.9	11.3
Luxembourg	Fonds de Compensation Commun au Régime Générale de Pension (2)	2004	21.7	32.7	6.1
Mexico	IMSS Reserve (7)	n.d.	1.6	0.1	9.5
New Zealand	New Zealand Superannuation Fund	1989	26.8	14.0	17.8
Norway	Government Pension Fund - Norway (GPFN)	2001	29.3	7.3	13.2
Poland	Demographic Reserve Fund	2002	7.2	1.3	14.9
Portugal	Social Security Financial Stabilisation Fund	1977	18.9	8.1	10.7
Spain	Social Security Reserve Fund	1997	9.7	0.7	-46.1
Sweden	National Pension Funds (AP1-AP4 and AP6)	2000	171.8	28.6	6.8
United States	Social Security Trust Fund	1940	2,891.8	14.8	1.5
Total selected countries (8)			**6,374.6**	**18.9**	**6.9**
Memo item: Sovereign Wealth Funds with a pension focus (9)					
Norway	Government Pension Fund - Global (GPFG)	1990	1,068.8	266.3	13.1
Russian Federation	National Wealth Fund (2)	2008	65.2	4.1	-13.9
Total memo items			**1,133.9**		
Total PPRFs and SWFs with a pension focus			**7,508.5**		

(1) Data correspond to all forms of investment with a value associated to a pension fund/plan. 2017 valuations are for year-end, unless otherwise noted. (2) Data have been gathered from publicly available sources. (3) Total investments are the sum of assets of AP1, AP2, AP3, AP4, and AP6. (4) Data refer to the end of March 2017, and include the Employees' Provident Fund, the Employees' Pension Fund and the Employees' Deposit Linked Insurance Fund. (5) Data refer to two funds: AGIRC-ARRCO which announced its intention to merge both plans in 2015, and FRR. (6) Belgium's Zilverfonds was liquidated in 2017. (7) Data only refer to reserves used to pay early retirement due to invalidity or work-related injuries. (8) Weighted average for assets as a % of GDP and % increase. (9) Norway's Government Pension Fund - Global and Russia's National Wealth Fund are sovereign wealth funds and not public pension reserve funds; their mandate goes beyond financing pension expenditures.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs and publicly available reports.

Table 9 Detailed green investments of selected LPFs and PPRFs in 2017

As a percentage of total investment

Country head office	Name of the fund or institution	Total investments in 2017 (in USD m.)	Green investments (as a % of total investments)				
			Green equity	Green bonds	Alternative green asset classes (1)	Other green investments	Total Green Investments
Australia	UniSuper Management Pty Ltd	48,694	4.2	0.3	0.7	..	5.2
Australia	Hostplus Superannuation Fund	22,640	..	..	..	1.5	1.5
Austria	VBV Pensionskasse AG	7,879	14.5	..	..	0.2	14.6
Belgium	EuroControl	1,888	4.3	4.7	..	..	9.0
Brazil	Banesprev	4,993	0.2	..	..	..	0.2
Brazil	Fundação Petrobras	21,681	..	..	..	0.3	0.3
Brazil	Previ	56,687			0.0	..	0.0
Brazil	Valia	6,701	3.7		0.2	..	4.0
Canada	AIMCo	82,613	0.4	0.0	..	..	0.5
Canada	Local Authorities Pension Plan	34,019	0.5	..	..	..	0.5
Canada	OTPP	147,750	..	..	0.9	..	0.9
Denmark	PFA Pension	76,949	0.5	..	1.1	..	1.6
Finland	Varma Mutual Pension Insurance Company (2)	54,347	17.0	0.7	..	..	17.7
France	FRR	43,724	18.1	0.6	0.2	..	18.9
Germany	BASF Pensionskasse	11,408	2.6	..	..	..	2.6
Iceland	Gildi Pension Fund	4,923	..	0.9	0.4	..	1.3
Iceland	Lifeyrissjodur Starfsmanna Rikisins	7,869	0.2	1.8	..	..	1.9
Japan	Pension Fund Association	109,053	..	0.1	..	..	0.1
Netherlands	PFZW	236,479	3.5	0.9	2.1	..	6.5
Netherlands	PME	55,887	36.2	0.4	0.9	..	37.5
Netherlands	PMT	83,377	33.0	0.3	0.2	..	33.6
Netherlands	Stichting Pensioenfonds ABP	545,464	1.1	1.0	1.2	4.4	7.7
New Zealand	New Zealand Superannuation Fund	26,837	..	..	..	6.2	6.2
Nigeria	RSA Fund	6,850	..	0.1	..	..	0.1
Norway	Government Pension Fund - Global	1,068,774	0.8	0.1	..	..	0.9
Romania	Azt Viitorul Tau	2,216	..	..	..	0.2	0.2
South Africa	GEPF	152,812	..	0.3	..	..	0.3
Spain	Endesa	2,092	..	0.6	..	..	0.6
Spain	Fonditel (3)	3,931	1.5	1.3	0.1	..	2.9
Spain	Santander	313	..	1.2	..	..	1.2
Sweden	Alecta	101,095	43.5	2.1	..	21.5	67.1
Sweden	AP1	40,511	..	0.5	..	..	0.5
Sweden	AP2	42,000	1.6	1.5	5.8	3.4	12.5
Sweden	AP3	42,055	..	3.9	0.1	0.0	4.0
Sweden	AP4	43,453	13.4	1.3	..	..	14.7
Sweden	AP7	51,061	..	0.1	0.2	..	0.4
United Kingdom	USS (4)	87,060	..	..	0.1	..	0.1

".." means not available, or zero.

(1) The alternative green asset classes can include hedge funds, natural resources, private equity, infrastructure, and inflation-linked bonds. (2) All direct equity investments are "green", since invests are made under Varma's climate policy. (3) Data refer to Fonditel's largest pension plan: Empleados de Telefónica de España. (4) Data are as of March 2018.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

Table 10 Detailed green investments of selected LPFs and PPRFs in 2015

As a percentage of total investment

Country head office	Name of the fund or institution	Total investments in 2015 (in USD m.)	Green investments (as a % of total investments)				
			Green equity	Green bonds	Alternative green asset classes (1)	Other green investments	Total Green Investments
Australia	Health Employees Superannuation Trust Australia (2)	24,683	2.2	..	3.4	..	5.6
Australia	UniSuper Management Pty Ltd	36,538	3.9	0.3	0.8	..	4.9
Australia	Hostplus Superannuation fund	13,947	..	0.5	0.4	..	0.9
Brazil	FUNCEF	13,909	0.6	..	..	..	0.6
Brazil	Previ (3)	39,372	..	..	..	0.0	0.0
Canada	British Columbia Investment Management Corporation	74,111	2.6	..	..	..	2.6
Canada	OTPP	121,565	..	..	0.5	..	0.5
Denmark	PFA Pension	56,574	0.2	..	0.3	..	0.5
Denmark	Pension Denmark (4)	25,726	..	..	..	12.2	12.2
Finland	Valtion Eläkerahasto (5)	20,416	..	..	0.3	..	0.3
France	ERAFP (6)	25,572	27.5	0.0	..	..	27.5
Netherlands	PMT (7)	65,937	29.0	..	0.0	..	29.0
Netherlands	Stichting Pensioenfonds ABP (8)	429,916	1.2	0.5	0.8	5.1	7.7
New Zealand	New Zealand Superannuation Fund (9)	19,974	..	..	0.0	7.2	7.2
Norway	Government Pension Fund - Global	869,034	..	..	..	0.7	0.7
Romania	Azt Viitorul Tau	1,305	..	..	..	0.1	0.1
Spain	Endesa	1,784	..	0.3	..	..	0.3
Spain	Fonditel (10)	3,731	1.2	..	0.1	..	1.3
Spain	Santander	238	..	1.0	..	..	1.0
Sweden	AP7	33,546	..	..	0.3	..	0.3
Sweden	Alecta	86,668	..	0.5	..	..	0.5
Sweden	AP2	35,387	1.6	1.5	6.1	3.0	12.1
Sweden	AP3 (5)	36,970	..	1.2	0.0	0.0	1.3
Sweden	AP4	36,367	9.1	1.2	..	..	10.3
United Kingdom	USS (11)	70,602	..	..	0.2	0.1	0.3
:h as stocks, exchange-trac	United Nations Joint Staff Pension Fund (5)	53,574	0.4	0.3	..	..	0.7

Note: Some funds have green investments (in "green" indices for instance) but cannot separate these investments from other portfolio investments, as is the case for Keva in Finland, and Illinois SURS in the United States (green private equity).

".." means not available.

(1) The alternative green asset classes include hedge funds, natural resources, private equity, infrastructure and inflation-linked bonds. (2) Includes investment in private equity clean technology. (3) Green investments are defined by Previ as assets (such as stocks, exchange-traded funds, and mutual funds) in which the underlying business(es) are somehow involved in operations aimed at improving the environment. (4) Other investments include renewable energy. (5) Reported values are as of June 30, 2015. (6) If investments based on the FTSE4Good or similar methodologies are considered as green investments, all the investments in equity by ERAFP could be seen as green, since ERAFP applied an ESG best-in-class approach to all equity mandates. (7) PMT reported its entire listed equity allocation as green investment, as their investment processes uses ESG criteria for its selection and monitoring of asset managers. (8) Other investments include green real estate, which are defined as properties with a GreenStar label in the GRESB Index, and that have an above average performance on sustainability. (9) Other investments include forestry. (10) Data refer to Fonditel's biggest pension plan: Empleados de Telefónica de España. (11) Other green investments include renewable energy and low-carbon infrastructure, cleantech private equity, and a listed environmental technology fund.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

CHAPTER 6: LOW CARBON INFRASTRUCTURE INVESTMENT

6.1 INTRODUCTION

In the aftermath of the COVID crisis with investors focusing on portfolio resilience, low carbon infrastructure and in particular renewables are considered an alternative return sources that can provide income and diversification. At the same time, looking to the future demand for electricity higher renewables investment will be needed. In the IEA Sustainable Development Scenario, spending on renewable power would need to double by the late 2030s (IEA 2020).

Infrastructure as a new asset class is considered to have several distinct and attractive investment characteristics including the low-risk, geographically varied returns matching the diversification objectives of pension fund portfolios (Torrance 2009). Similarly, a narrative has been emerging about the renewable power investment offering improved diversification, better liability-matching, and less volatility. However there is little evidence on performance, actual investment and institutional investor's approaches to low carbon infrastructure in portfolio allocation.

Aim of this chapter is to describe with strong empirical evidence the role of low carbon infrastructure investments in the asset allocation process looking at different portfolio approaches taken by major investors and measuring investment evolution over the last decade. Unique access to OECD microeconomic data of two distinct pools of long-term savings – Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) - will allow to complement trends observed at portfolios level as strategic asset allocation in chapter 5 – ESG and Institutional Investors in Infrastructure

An understanding of what are the channels and where carbon infrastructure fit in the total portfolio allocation low is relevant for the private sector in general and for policy makers in particular, trying to mobilize

investment, designing financial instrument matching investor's specific objectives and risk appetites. However for alternative investments and infrastructure, official data on pension fund flows is scarce as national statistical agencies do not currently collect separate data on these investments. The different forms available to investors to gain exposure to these asset classes means that information is often buried under different headings.[56] This makes difficult to draw comparison even when data is actually available.

While norms and conventions summarize the state of play at any point in time the functional effectiveness of intermediation is the true test of the relevance of history and geography (Merton and Bodie, 1995, 2005). Following this approach we look at practice of investment management and the functional role of infrastructure, for the definition of infrastructure as an asset class. This analysis offers insights on the development of investment in infrastructure in the past as well as direct implications for its future evolution.

The OECD in 2011 launched the first annual quantitative survey covering Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) among the largest in their respective economies, and comparatively, amongst the largest in the world. In 2019, the survey reviewed the trends in assets and asset allocation of 125 LPFs and PPRFs, which in total managed USD 12.4 trillion in assets in 2017, approximately one third of the total worldwide assets held by this class of institutional investor (See Annex 1).

This chapter leverages the second part of this survey – for several years of publication - looking at different approaches taken by institutional investors to low carbon infrastructure investment its allocation in the total portfolio. It reports on the market for low carbon infrastructure and future perspectives, to then focus on allocation to infrastructure investments and low carbon infrastructure in particular, either in the form of

[56] For example, infrastructure investment may not occupy a separate allocation, appearing instead as part of private equity or reaestate allocations. Pension fund investment in listed infrastructure vehicles is reported by national statistics agencies as national or foreign equities and infrastructure lending is reported as fixed income, while direct investment or participation in private equity vehicles is sometimes reported within the category "other".

unlisted infrastructure equity, listed equity, or debt, measuring infrastructure investment and monitoring its evolution over the last years across regions and countries.

6.2 LITERATURE REVIEW

6.2.1 Low Carbon Infrastructure as an Asset Class?

The notion of asset class is related to a number of criteria. Greer (1997) and Fabozzi and Markowitz (2011) define an asset class as a set of homogeneous investments, that bear some fundamental economic similarities to each other including a common legal or regulatory structure. For Kritzman (1999) in statistical terms risk and returns expectations should be similar and paired correlations of assets should be relatively high within an asset class but should be lower versus assets in other asset classes. Idzorek and Armstrong (2009) emphasize that asset classes should be non-overlapping and mutually adding up to a sufficient approximation of the relevant investable universe. Ilmanen and Kizer (2012) however also signal how the notion of asset class has been losing its relevance in investment management after the 2008 financial crisis, given the failure of asset-class based allocation to provide diversification.

New research is trying to demonstrate how the inclusion of infrastructure is able to provide better diversification and shift the efficient frontier, allowing better risk-return combinations of investment portfolios (Litterman, B. 2004, Blanc-Brude, 2013). The eventual goal would be to apply standard methods for quantifying market risk factors using well-established asset pricing models such as those used in Fama, E. and French, K. (2012).

In relation to infrastructure there are different views on the nature of the asset class and its investment characteristics. Inderst (2010) states that there is no such thing as a ‘‘standard infrastructure asset’’ with universally low investment risk, rather its heterogeneous nature and relative short history make it more “like a sub-asset class or sectors within the conventional finance vehicles such as listed equities, private

equities, and bonds” . Therefore the actual risk characteristics depend on a large variety of factors such as the sector, the regulatory regime, asset maturity, and geography. Political risk and leverage also are important factors.

The “infrastructure investment narrative” are commonly held investor’s views on the investment characteristics of infrastructure assets, including low exposure to business cycle due to low price elasticity of infrastructure services, value mostly determined by long term income streams (see Blanc-Brude (2013) and EDHEC 2018)). This implies low return covariance for infrastructure hence diversification benefits. Blanc-Brude, F. Della Croce R. & others (2016) building on this narrative propose a template for collecting and reporting infrastructure investment data for the purpose of building investment benchmarks corresponding to reference debt or equity portfolios of privately-held infrastructure.

Not all academics support this infrastructure investment narrative. Ansar A. and Pohlers M. (2014) challenge common propositions about infrastructure such as natural tendency towards monopoly owing to technical economies of scale; that infrastructure outputs (such as cubic metres of water or kilowatt–hours of electricity) and end-users of these outputs are essentially homogenous. Ultimately that future demand of infrastructure is predictable only with some degree of certainty given current economic downturn and the speed of technological innovation in infrastructure systems.

Merton and Bodie (1995 and 2005) adopt a functional approach to financial system design with a key role of financial functions rather than of institutions. According to the authors this approach helps to understand driving changes in the institutional structures of financial systems over time and across regions also showing the growth in the asset management industry.

Following this approach infrastructure could be defined by virtue of its functional role in an investment portfolio. By this measure, it is normally an asset class although the managers of other asset classes often like a share of infrastructure assets. For example, fixed income managers believe that infrastructure provided or at least promised a predictable flow of income which could be monetised. At the same time, infrastructure depends upon managers' skills and expertise which tend not to overlap with other asset

classes. Indeed, in many cases, infrastructure investing requires long-term commitment and with that different skills and expertise than simply trading securities.

Similar to infrastructure a narrative has been emerging about the renewable power investment (solar PV, wind, and other clean power technologies) offering improved diversification, better liability-matching, and less volatility. In fact according to Imperial IEA (2020) renewable generation assets, when backed by remuneration based on long-term contracts and policies, offer financial performance that is less correlated with the economic cycle, predictable and stable free cash flows, cash yields over long durations and hedges against conventional commodity price risks.

Yet this idealized hypothesis about renewables has not received universal support from quantitative assessments and academic literature is scarce or non-existent. Early experience in Spain with governments retroactive reductions in renewable energy tariffs, caused losses for investors. Other investments associated with clean energy also performed badly including the losses in companies like Solyndra (promising technology replaced by solar PV) and sectors like biofuels that were subject to substantial commodity price exposure.

In recent years, more investment performance data has become available, showing that clean energy investments are delivering attractive returns. Academic findings indicate that renewables shares over the past decade offered higher total returns relative to fossil fuels, with lower annualized volatility (a measure of investment risk). IEA & Imperial (2020) study focuses on historical financial performance of fossil fuels versus renewable power in listed equity markets of select advanced economies: the United States, the United Kingdom, and Germany and France. As already proved in the past, this report has demonstrated existing limitations to academic research including definition of "pure-play" renewable power sector based only on listed market data (Donovan, Núñez 2012).

6.2.2 Empirical Evidence

Empirical evidence on infrastructure as an asset class has been focusing mainly on listed indices or stock infrastructure (and some combinations of unlisted). Some studies examine stocks that are classified under a set list of infrastructure *activities* and derive a certain proportion of their income from these activities. Others look at indices such as MSCI, FTSE, DowJones MSCI, S&P, Brookfield, Macquarie, and UBS.

Using listed indices, several studies look at infrastructure performance reporting potential diversification benefits (Peng and Newell 2007; Finkenzeller et al. 2010; Dechant and Finkenzeller 2013; and Oyedele et al. 2014). Bird et al. (2013) and Bianchi et al. (2014) find that infrastructure exhibits returns, correlation, and tail risk similar to that of the stock market, with a marginally higher Sharpe ratio. However, there is no examination of statistical or economic significance. Finkenzeller et al. (2010) and Peng and Newell (2007)57 studied listed infrastructure equities and found high returns and higher volatility than equity markets. Sharpe ratios were also higher than market average equities and correlations of listed infrastructure were not significant with average equities.

Evidence that infrastructure is a defensive investment (downside protection) has been challenged, as not all sectors of infrastructure conform to the low-risk hypothesis. Rothballer and Kaserer (2011) 58 found that listed infrastructure companies exhibited lower systematic market risk (beta) than average equities, but that idiosyncratic risk was higher for infrastructure companies, citing high operating leverage, construction risk and regulatory risk as key factors that influence risk and return.

Australian listed infrastructure funds performed poorly during the GFC with some funds managed by Macquarie Infrastructure, Babcock and Brown forced to liquidate or restructure due to high leverage. Bird

[57] The authors hand-picked 32 listed stocks to analyse over the period 1995-2007, attempting to most closely match purported portfolio benefits of infrastructure. It is noteworthy that this study ended before the GFC.

[58] A study which included 1,400 firms worldwide. They report significant heterogeneity in the risk profiles of different infrastructure sectors, with an average beta of 0.68, but with variation between sectors. For the utility, transport, and telecom companies, the average betas were 0.50, 0.73, and 1.09, respectively

et al. (2012) 59 for assets in Australia found that controlling for the Fama-French factors60, higher volatility and a higher beta to equity markets than listed utilities. The authors did find evidence of excess returns which they attribute to a "regulatory risk premium".

Looking at inflation hedging characteristics of infrastructure, Bird et al. (2012) find that their sample of US infrastructure does have some ability based on its sensitivities to inflation linked bonds. However, they also find that non-utility infrastructure sectors do not provide inflation hedging. Rödel and Rothballer (2012) find that infrastructure hedges inflation just as well as other equities, except for those firms with high pricing power.

The role of listed infrastructure in a portfolio context has been rarely undertaken. Idzorek and Armstrong (2009) create an infrastructure index by combining existing industry indices and using three versions of their composite index (low, medium, and high utilities), they report that over the 1990–2007 period, infrastructure returns were similar to those of US equities but with slightly less risk. Finally, using the capital asset pricing model (CAPM) to create a forward-looking model of expected returns including an infrastructure allocation, the authors find that adding infrastructure does not lead to a meaningful improvement in the efficient frontier.

The question of whether listed infrastructure as an asset class a good proxy for a broader universe of is privately held infrastructure equity has been discussed in previous research. Donovan , Jiajun (2018) find evidence of diversification benefits from a UK Yieldco portfolio, suggesting the potential for sustainable energy infrastructure to be classified as a unique asset class. However Blanc- Bride F., Whittaker T., Wilde S. (2017) find no *persistent* evidence to support the claims that listed infrastructure provides diversification benefits. They show that listed infrastructure, as it is traditionally defined (by SIC code and industrial sector), is not an asset class or a unique combination of market factors.

[59] Over the period 1995-2009

[60] Size and value anomalies

The COVID crisis offers a unique opportunity for the development of private infrastructure as a global asset class with a reconsideration of the underlying risk to the performance of the asset. The crisis impact on infrastructure companies shows that this asset class is correlated to the market. In line with the wider equity market in the first quarter of 2020, listed infrastructure indices show a drop of 18 to 22% with Global Listed Infrastructure Organisation (-17.7%) and EDHECinfra listed infrastructure managers proxy (-22.5%). Recent findings (IEA Imperial 2020) indicate that over January- April 2020 renewable power companies held up better than fossil fuel companies during a period of severe stress and volatility.

However further distinction is needed among different risk profiles. Merchant companies exposed to the business cycles were hit the hardest both by lower expected cash flows and higher risk premia. Amongst these firms, the transport sector especially airports, roads and ports were even more impacted (Amenc, Blanc-Brude, Gupta , Lum 2020). In the unlisted markets, the EDHECinfra300 equity index was down - 6.37% for the quarter, and the most impacted sectors exhibited returns more than twice as negative (EDHEC 2020).

6.2.3 Limitations of existing research

Taken together, these studies are useful to understand the potential characteristics, but conclusions cannot be drawn that affirm the infrastructure and renewable investment narrative. The literature review provided finds heterogeneous results often not statistically robust. Hence the empirical explanation of infrastructure performance is incomplete and many of these characteristics need to be affirmed or refuted in order to better define infrastructure asset class parameters. There are still problems with sampling biases (region, diversification, and time period) along with issues with comparability to private markets and unlisted infrastructure. Renewable power portfolio presente different characteristics than fossi fuel ones such as average market capitalization, dividend pay-out ratio, firm capital structure, and liquidity.

The COVID crisis offers a unique opportunity for the development of private infrastructure as a global asset class with a reconsideration of the underlying risk to the performance of the asset. With additional performance data it will be possible to demonstrate the merit of infrastructure as a traditionally defined

separate asset class or a new combination of investment factor exposure and whether investing in infrastructure (listed or unlisted) can create additional diversification benefits for investors,

Further understanding on investors approaches to infrastructure and low carbon infrastructure in particular is needed. However, there is little evidence on actual investment ultimately flowing to low carbon infrastructure sector. For alternative investments and infrastructure, official data on pension fund flows, is scarce as national statistical agencies do not currently collect separate data on these investments. The different forms available to investors to gain exposure to these asset classes means that information is often buried under different headings.[61] This makes difficult to draw comparison even when data is actually available.

[61] For example, infrastructure investment may not occupy a separate allocation, appearing instead as part of private equity or reaestate allocations. Pension fund investment in listed infrastructure vehicles is reported by national statistics agencies as national or foreign equities and infrastructure lending is reported as fixed income, while direct investment or participation in private equity vehicles is sometimes reported within the category "other".

6.3 INVESTING IN LOW CARBON INFRASTRUCTURE

6.3.1 Net Zero Emissions and Low Carbon Infrastructure

Achieving net zero emissions will require an unprecedented transformation of our infrastructure system. Different economies will face varying challenges, but the transformation of the global economy to be environmentally sustainable and resilient includes decarbonising industry and transport, building smart energy systems, and increasing access to affordable, clean energy.

Looking to the future demand the global picture is a future of greater reliance on electricity, and greater use of renewables to produce that electricity. Debate as to which pathways society should take to meet the 1.5°C targets[62] required to minimise the effects of climate change is ongoing. As it is impossible to predict the exact mix of technologies and behaviours that will best meet the challenge of reaching net-zero greenhouse gas emissions, the use of scenario analysis gives an improved understanding of what a sensible mix might look like (Bardalai, Della Croce 2019).

In the IEA Sustainable Development Scenario, spending on renewable power would need to double by the late 2030s (IEA Imperial (2020). A study by McKinsey (2018) estimated that roughly USD 1.6 trillion of renewable power investments will be made available to institutional investors by 2030. Roughly 70% of that investment opportunity will be composed of unlisted assets that do not trade publicly.

Scenarios recently considered by the EU and the UK include lower demand for energy across the economy driven by more resource efficiency and energy efficiency; clean mobility, circular economy (which refers to the use of closed systems encouraging reuse, recycling, refurbishment, etc); and tackling remaining emissions with carbon capture and storage. Extensive electrification is expected, particularly of transport

[62]UN Intergovernmental Panel on Climate Change, 'Special Report: Global warming of 1.5°C', October 2018, available at: https://www.ipcc.ch/sr15/

and heating. In Europe, approximately 80% of electricity is to be supplied by renewable energy sources[63], while in the UK the doubling of electricity demand will be supported in full by low-carbon sources (compared to 50% of electricity demand met by low-carbon sources today[64])

In Europe, in order to reach these goals investment in energy systems and infrastructure will require an increase of 2% of GDP to 2.8% of GDP (€520–575m per year), equivalent to additional investments of €175-€290 billion a year. In the UK, the extra investment required is equivalent to around 1% of GDP in 2050[65]. To meet these investment needs, the European Commission has proposed having 25% of the next EU budget (2021-2027) contributing to climate objectives, and has established a dedicated channel for financial support for sustainable infrastructure investments through the "InvestEU" programme.

Evolution of Investment in Renewables

Since 2010, global clean energy investment averaged USD $300 billion per year - almost five times the level of 2004 - and renewables represented 50% of global infrastructure deal flow in 2019[66]. At the same time, many renewable technologies are less expensive than fossil fuel, and the clear trend is costs will fall further. Solar PV capital costs have fallen by 85% and onshore wind costs by 49% since 2010, according to *Bloomberg New Energy Finance*. Offshore wind has experienced a 32% cost decline in the last two years alone.

As part of the overall trend to diversify investment portfolios, institutional investors – including pension funds and insurance companies – have been increasingly interested in renewable infrastructure investments. For example they are among the largest sources of capital for EU renewable energy projects as institutional investors moved from accounting for less than 2% of all EU project investment – both debt and equity – in

[63] European Commission, 'A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy', November 2018, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0773

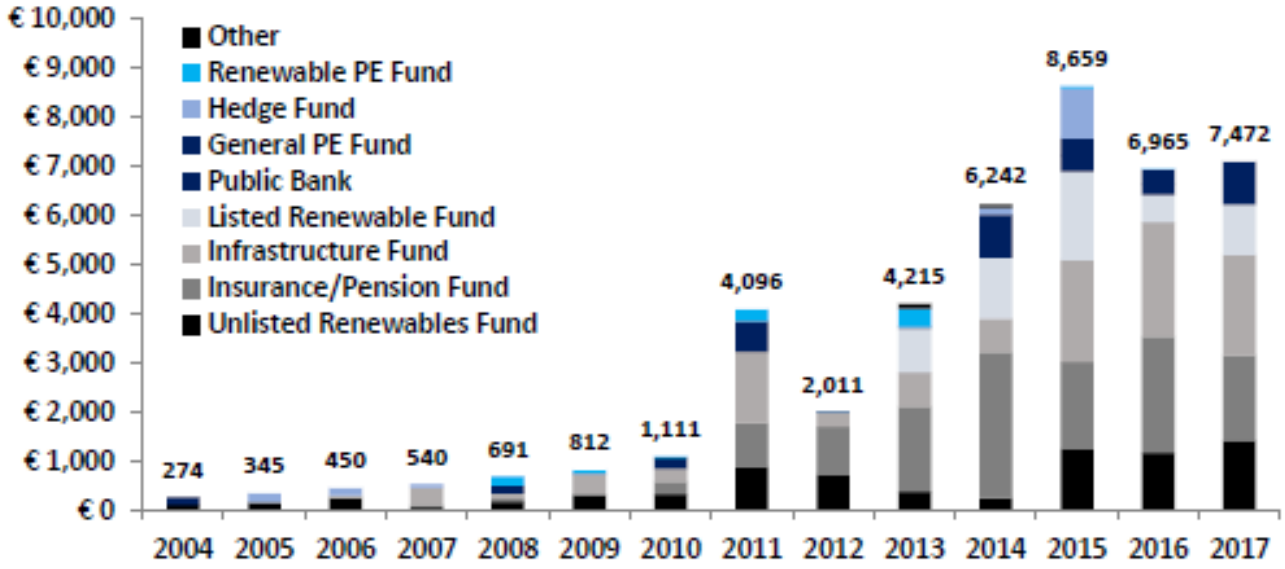
[64] Committee on Climate Change, 'Net Zero - The UK's contribution to stopping global warming', May 2019, available at: https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

[65] European Commission, 'A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy', November 2018, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0773

66 Source:Bloomberg New Energy Finance and IJGlobal, 2019 Deal Statistics Based on number of deals

2004 to 14% in 2017[67] (see Figure below) New fund structures try to align asset owners' long-term horizon with asset managers, to achieve specific ESG goals, including energy transition and renewables.

Figure 10 Institutional Investor Equity Investment in EU Renewable Energy Projects 2004-2017 - By Investor Type (€ Millions)



Source: Two Lights Energy Advisors LCC (2019)

Renewables markets offer different investment opportunities depending on the respective regional cyclical phases. Low yielding bonds in Europe and US are increasing investor's competition for renewables assets in advanced countries. In the UK, 343 onshore wind farms were commissioned in 2017, versus only 23 in 2019[68]. At the same time over half of the world's electricity is expected to be generated in the Asian region by 2030 due to growing populations, economic growth and a smaller installed base of renewables capacity. For example South Korea has targets to add a 42GW in renewables capacity over the next decade – equivalent to the UK's entire installed renewables capacity today.

Trends transforming traditional power and energy infrastructure systems are reshaping customer expectations and opening up new business models. As renewables markets mature, support mechanisms are

67 Most of these projects were also financed with bank project financing, which means that the total investment supported by that equity was, on average, 100-150% greater than the equity invested.

68 Source Renewable UK, 2019

naturally being scaled back with innovating new sources of contracted revenues including corporate power purchase agreements and investors looking for contracted opportunities globally. In 2019 and 2020 three new funds have been launched to focus exclusively on renewable assets at a global level, following a similar trend seen in other sectors (i.e. digital sector)69.

The growth of renewable energy has significant technical implications in this area, particularly the need to adapt to intermittency. Funds active in the energy sector are trying to capture as much of the value chain as possible – as buying renewable energy assets together with storage and distribution. Energy transition funds are adapting to these trends, focusing on the resiliency of the electricity system including the networks, biogas and the circular economy and energy efficiency. For example SUSI Partners was aiming in 2019 to first close on its EUR 1 billion SUSI Global Energy Transition Fund. An evergreen structure, this fund aims to invest in a diversified portfolio of around 20 construction and development-stage assets with a focus on infrastructure relevant for the energy transition.

6.3.2 Investing in Low Carbon Infrastructure

For investors, decisions to allocate capital towards infrastructure depends on financial performance, taking into account risk-adjusted returns. This requires a clear and robust classification of the individual infrastructure companies that equity investors can acquire or to which debt investors can lend to. These definitions building on financial economics of infrastructure companies have been used by financial regulators to qualify infrastructure assets under various prudential frameworks. For example qualifying infrastructure companies based on criteria-definitions were used Basel-II and III Accord, the Solvency-II Directive, and the CRR-2 Regulation of European banks.

[69] Blackrock third renewable only vehicle – Global Renewables Power Fund III targeting USD 2.5 billion and seeking gross returns between 12/13 %. Next II 50 Macquarie launched a USD 1.5 billion as Green Investment Group (after USD 1.2 billion offhosre wind fund in 2017). Stonepeak fund aiming at USD 1.2 billion fund. Source Infrastructure Investors

Low carbon infrastructure include renewable energy projects especially utility-scale renewables (i.e. wind farms and solar parks), and related infrastructure such as transmission lines and distribution grids. More broadly economic infrastructure refers to utilities (electricity, telecommunications, and water) and transport (ports, airports, rail and road). Infrastructure investments are direct or indirect stakes in entities that own or operate these assets. Where commodity risk is more present, the infrastructure label is less likely to be applied (Moody's 2015)70.

In addition to the physical characteristics there are other elements that further define the investment opportunity such as the contractual approach, the phase of asset development (e.g. Greenfield vs Brownfield) and stage of development of the market infrastructure (World Economic Forum 2010). Overall the definition of an individual infrastructure opportunity needs to draw on the different elements in order to give a meaningful description. For example, a new social project in a developed market is very different from the privatization of an established economic project in an undeveloped market.

EDHECinfra (2018) has established eight global indices and several more sub-indices based on the analysis of 15 years of data and survey responses of more than 200 asset owners, managers and other stakeholders. Analysis of this data resulted in identification of the main factors explaining the market price evolution of unlisted infrastructure and the main price influencing risk factors. Furthermore, these indices are based on The Infrastructure Company Classification Standard – a taxonomy based on four pillars that ought to define the main types of risks and risk exposure characteristics.

From an investor perspective depending on the investment characteristics of the specific project, infrastructure will be classified according to its risk/return profile. Diversification, liquidity, capital requirements, pricing frequency, and amount of control over the investment can all vary through the

[70] Natural resource extraction (such as oil or gas) is not vital to the functioning of an economy; a country can import such commodities. Yet energy distribution networks are fixed and essential (Moody's 2015).

different methods of investing in infrastructure and can serve differing investment objectives in a fund's long-term strategic asset allocation.

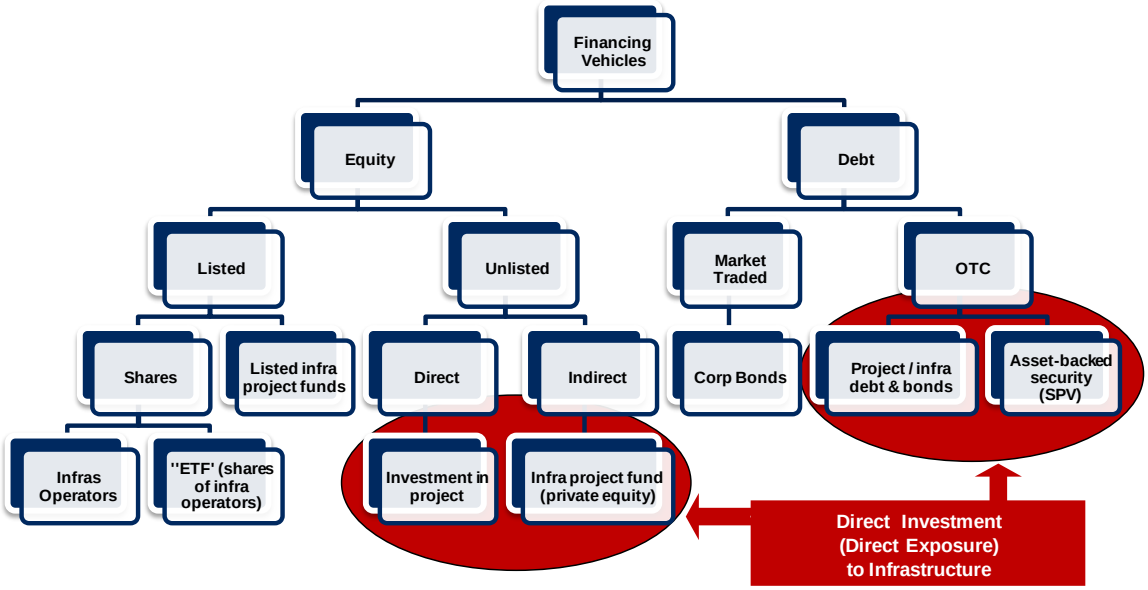
Low carbon infrastructure match long-term buy-and-hold strategies aiming to generate stable, low risk and low volatility cash yields for the full operating asset lives of 25 to 30 years or longer. These investments in fact are made in real assets that typically provide essential services, employ proven technology and are supported by long-term contracts or tariffs (which are often linked to inflation) that provide an assured revenue stream.

Investors with a separate allocation to infrastructure aim to gain direct exposure to the characteristics of the infrastructure asset (i.e. long term, stable, often inflation linked etc.). Direct exposure is gained mainly through unlisted equity instruments (direct investment in projects and infrastructure funds) and project bonds while indirect exposure is normally associated with listed equity and corporate debt (Figure 1). Some funds consider investing in infrastructure projects (i.e. a toll road) as a direct exposure to infrastructure and investing in infrastructure corporate (i.e. a utility) as a way to gain indirect exposure to the characteristics of infrastructure

Figures may be understated given that for fixed income the majority of the funds do not report such details on their allocation and unlisted infrastructure equity is often included in other asset classes. Some funds also report their allocation to infrastructure through listed equity (i.e. infrastructure corporates), which for this survey, we have considered as indirect exposure.

From a policy perspective one way to identifying how much finance from institutional investors is reaching infrastructure is by tracking the capital that institutional investors can provide via direct investment in these projects as highlighted in red below based on the main financing vehicles for infrastructure investment:

Figure 11 Direct Investment and Exposure to Infrastructure



Source: Della Croce, R. and J. Yermo (2013)

Barriers to Low Carbon Infrastructure as an Asset Class

There are challenges particular to 'market structure': reasons for institutional investor hesitancy to invest directly in green infrastructure range from energy and environment regulatory and policy uncertainty to risks specific to new technology related projects making it difficult for rating agencies to give sufficient investment grade ratings. Capital along the clean energy project cycle is highly fragmented across equity and debt, and smaller scale deals or energy efficiency projects lack aggregation mechanisms. These issues are compounded by a lack of suitable investment vehicles (such as green bonds or funds) providing the liquidity and risk/return profile that institutional investors need.

In addition to the lack of large and deep local markets in developing countries, there are often restrictions on investment (for domestic investors, and sometimes for foreign investors), such as heavy bureaucracy and controls, and weak financial infrastructure. Infrastructure, in particular, is considered to be vulnerable to high

political, regulatory and execution risk, especially in developing countries. In addition to the policy environment, other factors preventing foreign investments are inflation and currency risk[71], potentially restrictive investment requirements, and lack of local capacity and expertise.

Low carbon infrastructure investing exhibits different characteristics from other asset classes, which could represent barriers to entry to potential investors. High up-front costs, lack of liquidity and long asset life of the projects require significant scale and dedicated resources both to understand the risks involved and to manage them, resources that many investors are lacking. These characteristics imply that infrastructure investment – at least in the forms in which it is currently offered – may not be a suitable proposition for all investors.

In addition, the lack of a clear benchmark for measuring investment performance is also seen by many investors as one of the main barriers to invest in infrastructure. Only limited empirical analysis has been done to assess the risk-adjusted performance and portfolio diversification benefits of listed infrastructure in a portfolio, with only a few studies on unlisted infrastructure performance.

Ultimately the primary concern for investors is the investment performance in the context of their specific objectives (such as paying pensions and annuities). Low carbon infrastructure can become an alternative asset class for private investors provided that investors can access bankable projects and an acceptable risk/return profile is offered.

A related issue is that, whilst some countries collect data which matches the needs of the relevant authorities, there is no international, official, accurate data on the asset allocation of pension funds in alternative asset classes, which include, inter alia, hedge funds, private equity, real estate, infrastructure, and commodities.

[71] Currency risk - particularly relevant for developing countries with volatile financial markets - arises from the change in price of one currency against another. Whenever investors or companies have assets or business operations across national borders, they face currency risk if their positions are not hedged.

6.4 PORTFOLIO ALLOCATION TO LOW CARBON INFRASTRUCTURE

6.4.1 Analysis of infrastructure allocation in the total portfolio: Infrastructure as an Asset Class

Over the last decade, investors have started to recognize infrastructure as a distinct asset class. Several funds indicated that they would consider moving infrastructure investments to a dedicated allocation as investments mature, or as they see opportunities arise. Target allocations amongst the funds with dedicated exposure ranged on the low end from 1% to up to 20% of total assets

Although the majority of funds surveyed stated they are actively investing in infrastructure, total allocations are not comparable. They relate to different forms of investment reported an allocation to infrastructure investments, either in the form of unlisted infrastructure equity, listed equity, or debt. Further analysis of infrastructure portfolios is needed to understand past trends in investment and future perspectives.

Since 2011, the OECD Annual Survey of Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs) has collected data on the infrastructure investments of some of the world's largest and most influential funds. We have considered for this part data covering the period 2010 -2017. More in depth analysis is building on the following years:

- In 2015 a total of 49 funds, accounting for USD 2.5 trillion in AUM (see Annex 2 - Table 1).
- In 2017, a total of 49 funds, accounting for USD 2.8 trillion in AUM (see Annex 2 - Table 2).

In 2015, of the 49 funds that indicated investment in infrastructure assets, 37 reported exposure to unlisted infrastructure assets, and 18 had dedicated target allocations to the asset category (see Annex 2 - Table 3).

In 2017, of the 49 funds that indicated investment in infrastructure assets, 44 reported exposure to unlisted infrastructure assets, and 20 had dedicated target allocations to the asset category (see Annex 2 - Table 4).

Pension funds with a dedicated allocation are more likely to have a target allocation to the asset class as part of their long-term strategic asset allocation and are more likely to invest through unlisted equity instruments (infrastructure funds or direct investment). For funds without a separate allocation to infrastructure, investment in such assets may be included in real estate or private markets categories, or in

the event that the fund invests in listed instruments, infrastructure investments may be categorized in listed equities or fixed income as a result of passive investments in public securities, or part of active portfolios.

Institutional investors are drawn to the long-term nature, stability, and predictability of cash flows that low carbon infrastructure assets can offer, making them suitable to diversify pension fund asset-liability management objectives. Since listed infrastructure tends to move in line with broader market trends, it is a common held view that investing in alternative investment and unlisted infrastructure in particular although illiquid, can be beneficial to ensure proper diversification. For example ERAFP based in France, included infrastructure investments in its "diversification pocket", together with private equity, amongst others. The British Columbia Investment Management Corporation, one of Canada's largest institutional investors, has built its infrastructure investment portfolio around what it calls "core infrastructure assets", which typically operate in stable regulatory environments and provide reliable cash flows.

In the survey population over the period taken under consideration for unlisted equity infrastructure, there is an even split between direct investment and unlisted funds. Direct investment is a common method for funds to gain exposure to infrastructure, especially amongst large funds that have the size and expertise to manage assets directly. Infrastructure funds (GPs) that invest on behalf of pension funds were the second most popular choice amongst the survey population. In fact, knowing that the overall pension market is large and highly fragmented, many smaller funds do not possess the staff or expertise to directly manage assets. Hiring external consultants and asset managers to manage infrastructure investment is the preferred route to access this asset class.

Despite the difficulties of measuring debt investment in infrastructure, often reported in other asset classes by investors, the survey clearly outlines high activity and some interesting new trends in this category which can include publicly traded debt instruments or direct project loans, senior and/or mezzanine loans, and bonds. Some funds also reported green bonds as part this allocation.

Debt exposure to infrastructure was USD 11.4 billion or 0.4% of total assets in 2015 (Annex 2 - Table 5) and USD 10.4 billion or 0.4% of total assets in 2017 (Annex 2 - Table 6). Of the funds surveyed, 14

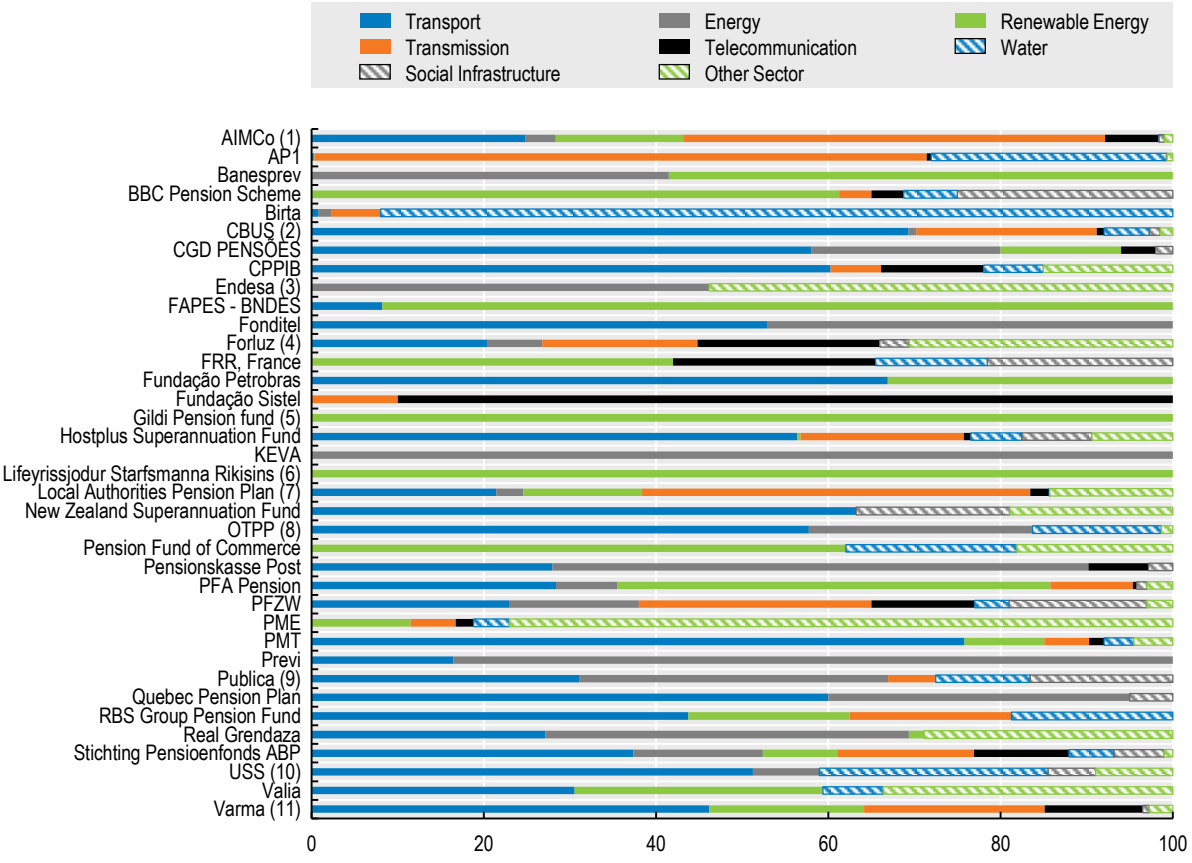
reported exposure to direct loans and bonds in 2015 and 13 funds in 2017. Infrastructure loan investments were included in UK's USS reporting 0.6% of the total portfolio and the Swiss fund Publican reporting 0.9% allocated to infrastructure debt, diversified across transportation, energy, and social infrastructure.

Some green bonds may also be included as infrastructure investment. Investment in green bonds increased in 2014 and 2015 due to expanded issuer volumes. Some of these debt instruments back clean water and energy projects which could fall under the category of infrastructure. Two funds based in Brazil, FAPES-BNDES and Valia reported exposure to infrastructure debt; FAPES-BNDES had previously reported that its exposure was through debentures of companies in the infrastructure sector, telecommunications, and energy.

6.4.2 Analysis of infrastructure portfolios: Low-carbon infrastructure investment

As the renewable energy market continues to expand, a growing number of institutional investors are increasing their portfolio allocation. For example, in April 2019, Norway's NOK 9 trillion (EUR 932 billion) sovereign wealth fund decided to invest up to 2% of the fund's value in unlisted renewable energy infrastructure.

Figure 12 Infrastructure investment by sector, 2017[72]



[72] (1) AIMCo reported allocations for only a portion of the total portfolio.
(2) Includes land titles.
(3) Other includes multi-sector infrastructure.
(4) Other includes healthcare related investments; includes public and private infrastructure.
(5) Hydro and geothermal energy.
(6) Geothermal heat.
(7) Other includes timberlands, waste management.
(8) Energy includes generation and transmission.
(9) Allocations are for a loan portfolio.
(10) Data are as of March 2018.
(11) Allocations are as of December 2016.

Source: OECD calculations based on responses to the OECD Survey of large pension funds and public pension reserve funds.

Transportation and energy are the largest sectors in which the funds surveyed have made infrastructure allocations (see Figure 3). This indicates investor preference and the availability of opportunities. While there are differences across funds, corporate information suggests that pension funds are often attracted by the long-term tariff agreements in the transport and regulated utilities sector. Renewable energy and social infrastructure are relatively new, although increasingly important sectors in the portfolio of certain investors. While the majority of funds were not investing in renewables in 2015, the same sector represented 20% of the total infrastructure portfolio in 2017. Unlisted equity is only one medium through which funds may invest in renewables – it is likely that actual allocations to renewables are higher through investments in listed equity instruments and other channels.[73]

In 2017, the average fund that reported the sectoral allocations of its unlisted infrastructure equity portfolio invested 28.6% of its portfolio in transportation, making this the largest sector. This was followed by renewable energy, with an average of 20% of the unlisted infrastructure equity portfolio. Two funds based in Iceland allocated 100% of their infrastructure allocation in geothermal energy and heat. Funds in the United Kingdom, including the BBC Pension Scheme and RBS Group Pension Fund, allocated sizeable allocations to renewables: RBS has financed onshore wind energy, while BBC has financed solar, onshore, and offshore wind investments. A number of Brazilian pension funds, including Banesprev, FAPES-BNDES, Petrobras, and Valia, also reported sizeable allocations to renewables.

Among the largest investors in renewables are the Dutch, Danish and Canadian pension funds. Dutch Pension Fund APG has committed direct investments in more than $1 billion of EU renewable energy projects; Danish pension funds PKA Pension and PensionDanmark have invested over $1 billion in EU offshore wind

[73] In the OECD survey, infrastructure investment is calculated as a % of total assets of funds investing in infrastructure. Infrastructure investment is calculated as a % of total assets of all funds in the survey, excluding the ones stemming from publicly available reports.

and biomass projects ; Canadian Pension Funds CDPQ, PSP, OMERS and several others have collectively invested more than $1 billion in investments in US and EU renewable projects.

Investors have a strong preference for brownfield (operational) assets that have proven abilities to generate cash flows. Prospective risk and return are perceived as higher in new greenfield assets and may require more due diligence on the part of the investor. However greenfield risks in renewables are lower compared to other infrastructure sectors with more project complexity and longer construction timelines. Beyond "core" infrastructure there is increasing interest among investors in what are considered to be value-added brownfield opportunities. These investments are focused on assets that need to be refurbished - either addressing operational or structural issues - or funding expansion. Expected returns on such projects already generating cash flows for the investors are higher than core projects.

That being said, increased return appetite in relation to construction risk is pushing investors to acquire the expertise to be able to provide creditor oversight on new-build construction. For example PGGM has been investing in new projects through its partnership with Royal BAM in Holland. Lifeyrissjodur Starfsmanna Rikisins, based in Iceland, reported that 100% of its unlisted equity was invested in greenfield assets, likely linked to geothermal heat. Publica, based in Switzerland, reported allocating 93.1% in greenfield investment, which consisted of infrastructure loans, likely at construction stage.

With a few exceptions, funds are not investing in infrastructure in emerging markets

Most funds in the survey did not report this level of detail, but the results from this group of investors, which is fairly representative of large and sophisticated investors, shows low or no investment in emerging markets by most funds, which indicates that further policy work may be necessary in order to facilitate north-south investment.

This sample reveals low levels of investment in emerging markets, in general with no funds reporting exposure in Africa, the Middle East, or in Eastern Europe. In 2015, twelve funds reported the geographical distribution of their unlisted infrastructure equity portfolio while in 2017 twenty-two funds reported the geographical distribution of their unlisted infrastructure equity portfolio. Emerging Asia Infrastructure was

popular with the New Zealand Superannuation Fund and two funds based in the Netherlands: ABP and PFZW while Latin America was a common investment recipient for Canadian funds.

Some funds also had a strong home-market bias. Funds based in Australia had high allocations to the domestic market, with some diversifying foreign exposure in North America and the European Union. Two funds invested only domestically: AFP Integra in Peru, Previ in Brazil, and Pensionskasse Post in Switzerland.

Twelve funds reported domestic and foreign allocations in their unlisted infrastructure equity portfolio – this group consists mostly of large funds based in OECD countries that have an established track record and institutional knowledge regarding infrastructure investment. Most of these twelve funds invested a significant portion of their infrastructure portfolio outside of their domestic market, with the exception of funds based in Australia, which were biased towards Australian assets, and one fund in Peru which invested all assets in the domestic market. For those funds that reported large foreign exposures, it was mostly in other OECD countries, particularly in the European Union and North America.

It is also noteworthy that the majority of funds based in non-OECD countries do not invest in unlisted infrastructure equity. Of the 24 funds in non-OECD countries that reported their asset allocations, only three reported an allocation to unlisted infrastructure equity.

An exception amongst survey respondents was the Canada Pension Plan Investment Board. CPPIB opened offices in New York and São Paulo, putting investment professionals closer to key markets, and expanded its activities in Latin America, India and other selected Asian markets over 2014. The fund has five offices across four continents, and its foreign allocations are relatively balanced amongst developed and emerging markets.

6.4.3 Analysis of infrastructure investment levels: Historical Evolution

Since 2011, the survey population has changed, making it difficult to draw conclusions from direct comparison over this full time period covering the years 2010-2017. In order to do so, subgroups of funds reporting on their allocation through the years have been considered. Some general trends can be analyzed.

Historical analysis of the total survey population confirms that allocations have been growing at a slow pace, amongst both LPFs and PPRFs from approximately 2% to 4% total portfolio. Indeed, funds in this group exhibit varied experience with some having well established investment programmes in infrastructure others just starting.

The pace of this increase has been slow these years, indicating that infrastructure allocations, on average, have not been growing compared to the rest of the portfolio. 18 funds reported their infrastructure allocation in the survey over the period 2010-2015 (Annex 3 - Figure 4). The average of these funds increased from 2.0% of total assets in 2010 to 2.9% in 2015.

Changes in infrastructure allocations were not uniform across the survey population – despite the slow increase on average, some funds have made dramatic changes to their infrastructure portfolios. Four of the 18 funds in Figure 4 had established new allocations to infrastructure in the period under consideration. PFZW, based in the Netherlands, reported 1.5% of the total portfolio was invested in infrastructure in 2010, compared to 3.4% in 2015. The allocation for USS, based in the United Kingdom, increased from 3.1% to 4.5% over the same time period. For the Québec Pension Plan, allocations to infrastructure increased from 2.1% to 4.9%. Sweden's AP3 reported a decrease in infrastructure investment from 2.1% to 1.6%.

Looking more in detail at the 49 funds taken into consideration in 2015, total investment in infrastructure at the end of 2015, considered as direct exposure (USD 91.7 billion), represented 3.6% of total assets of these 49 funds (Annex 2 - Table 5). In 2014, 41 funds reported exposure to unlisted equity totaling USD 74.3 billion, or 3.0% of assets.

Total investment in infrastructure at the end of 2017, considered as direct exposure (USD 120.8 billion), represented 4.3% of total assets (Annex 2 - Table 6). Unlisted equity (i.e. infrastructure funds or direct investments in projects) is the largest category of infrastructure investment in 2015 at USD 80.3 billion, and 3.2% of total assets. It accounts for USD 110.5 billion, and 3.9% of total assets in 2016.

Survey results show that overall investment levels – including funds not investing in infrastructure- are low compared to total investment capital in institutional investor portfolios. In fact, the largest pension funds

have invested approximately one percent of their assets in infrastructure, excluding indirect investment via the equity of listed utility companies and infrastructure companies.

In 2015, when total assets under management are considered for the funds that returned questionnaires (i.e. 95 funds, USD 8.4 trillion), infrastructure investment in the form of unlisted equity and debt was USD 91.7 billion in 2015, representing 1.1% of the total assets under management.[74]

In 2017 survey when total assets under management are considered for the funds that returned questionnaires (i.e. 99 funds, USD 9.0 trillion), infrastructure investment in the form of unlisted equity and debt was USD 120.8 billion in 2017, representing 1.3% of the total assets under management.[75]

Canada, Australia, UK and the Netherlands have well established capital markets for infrastructure finance. Superannuation funds based in Australia, all reported high allocations to unlisted infrastructure equity like CBUS and Hostplus with allocations respectively of 10.5%, and 11.6%, in 2017 and 8.9% and 10% in 2015. OTPP, based in Canada, also reported a large allocation to infrastructure at 7.7% in 2015 and 10.1% in 2017 of the total portfolio. PFZW in the Netherlands reported in 2015 3.4% of the portfolio allocated to unlisted infrastructure equity and 3.8% in 2017; USS in the United Kingdom reported 4.5%. in 2015 and 8.7% in 2017.

Investment levels in other parts of Europe, North America, and Latin America are on average much lower. Previ, based in Brazil, is a notable exception. Funds in Iceland, responding to the survey for the first time, reported investment levels in infrastructure under one percent.

[74] Figures may be understated given that for fixed income the majority of the funds do not report such details on their allocation and unlisted infrastructure equity is often included in other asset classes. Some funds also report their allocation to infrastructure through listed equity (i.e. infrastructure corporates), which for this survey, we have considered as indirect exposure.

[75] Figures may be understated given that for fixed income the majority of the funds do not report such details on their allocation and unlisted infrastructure equity is often included in other asset classes. Some funds also report their allocation to infrastructure through listed equity (i.e. infrastructure corporates), which for this survey, we have considered as indirect exposure.

Potential unmet demand for infrastructure assets

As seen in the survey there seems to be a large amount of potential capacity to expand institutional investment in infrastructure, taking into account the target allocations of the funds that already have established allocations and those that are considering opening new allocations. Target allocations amongst the funds with dedicated exposure ranged on the low end from 1% to up to 20% of total assets. Pension funds surveyed typically commit around 3% of their total assets to infrastructure while targeting on average 5% of total portfolio

Almost all funds that reported a separate target allocation to infrastructure were below targets at the end of 2017 which implies capacity in these funds to make additional commitments. Several funds indicated that they planned to increase target allocations to infrastructure in the next years.

In 2017, a number of funds indicated that they planned to add a new allocation to infrastructure within the next two years, including three funds in Romania, one fund in Italy, one fund in Mozambique, one fund in Nigeria, and one fund in Bosnia-Herzegovina. Five funds including Russia's VTB, Chile's AFP Provide, ERAFP in France, Spain's Endesa, and Indonesia's BPJS Ketenagakerjaan, planned to add new allocations to infrastructure in the near future.

Nineteen funds not investing in infrastructure indicated that they planned to open allocations in the future, including funds based in Croatia, Lithuania, Sweden, and the United States. LACERA, based in the United States, began investing in infrastructure for the first time in 2018, opening a 3% target allocation. Three funds based in Lithuania also opened new allocations after 2017.

6.5 CONCLUSIONS AND IMPLICATIONS

Renewable energy investment is growing, being part of infrastructure asset allocations

Renewables is becoming the largest opportunity in private infrastructure for institutional investors following strong low carbon investment growth (including solar PV, wind, and other clean power technologies) and maturing technologies. As part of the overall trend to diversify investment portfolios and driven also by ESG considerations seen in chapter 4 and 5 , institutional investors – including pension funds and insurance companies – have been increasingly interested in renewable infrastructure investment.

This chapter provides evidence that pension funds are significant investors in renewable energy and that they have actively been financing the energy transition. Green investment in the form of low carbon infrastructure and clean energy has experienced a steady rise in investor infrastructure allocation over the past decade. Renewable energy and social infrastructure are relatively new sectors in the portfolio of certain investors although increasing. While the majority of funds were not investing in renewables in 2015 the same sector represented 20% of total infrastructure portfolio in 2017 and Norway's sovereign wealth fund doubled its maximum allocation to renewable energy infrastructure in 2019.

Over the last decade, investors have started to recognize infrastructure as a distinct asset class. Historical analysis confirms that infrastructure allocations have been growing at a slow pace, amongst active LPFs and PPRFs surveyed from approximately 2% to 4% total portfolio. Since listed infrastructure tends to move in line with broader market trends, it is a common held view that investing in alternative investment and unlisted infrastructure in particular although illiquid, can be beneficial to ensure proper diversification.

Renewables is included in the infrastructure portfolio allocation. Low-carbon infrastructure in general is not a distinct category of investment including a variety of different risk-return opportunities. Pension funds with a dedicated allocation are more likely to have a target allocation to the asset class as part of their long-term strategic asset allocation and are more likely to invest through unlisted equity instruments (infrastructure funds or direct investment). However only a few funds have been launched in unlisted equity markets, by

investors that focus exclusively on renewable energy. For funds without a separate allocation to infrastructure, investment in such assets may be included in real estate or private markets categories, or in the event that the fund invests in listed instruments, infrastructure investments may be categorized in listed equities or fixed income as a result of passive investments in public securities, or part of active portfolios.

Reasons for institutional investor hesitancy to invest in green infrastructure range from policy uncertainty in relation to energy and to risks specific to related projects (new technology in energy, low returns in social infrastructure) making it difficult for rating agencies to give sufficient investment grade ratings. Capital along the clean energy project cycle is highly fragmented across equity and debt, and smaller scale deals or energy efficiency projects lack aggregation mechanisms.

There is a major mismatch between investors and governments expectations

Isues related to green assets, are compounded by a lack of suitable investment vehicles (such as green, social impact bonds or funds) providing the liquidity and risk/return profile that several institutional investors need.

Despite growing interest, institutional investors have, in aggregate, invested very little in infrastructure - approximately one percent of their assets in infrastructure - even in advanced economies. The overall low levels of investment observed in the total survey population are more likely in-line with the broader pension fund market as not all investors have established infrastructure investment allocations. Demand from institutional investors is high but concentrated on some types of less risky “core” low carbon infrastructure assets that do not necessarily match governments’ priorities.

As a result, infrastructure investment funds have had trouble investing the private capital they have raised, with many funds reporting that they were below their investment targets for infrastructure. In fact, there seems to be a large amount of potential capacity to expand institutional investment in infrastructure, taking into account also funds that are considering opening new allocations. Funds targeting on average 5% of total portfolio have capacity to increase their investment in unlisted infrastructure equity, including in climate-relevant sectors.

Renewable energy could become a global asset class, diversifying investor's exposure across regions and phase

Low carbon infrastructure and in particular, renewables are considered an alternative return sources that can provide income and diversification. While power price markets are interconnected across regions and even countries, they remain idiosyncratic, providing additional diversification. Different project lifecycle phases, exposure to different regions and regulatory regimes also add to the diversification potential.

Renewables markets offer different investment opportunities depending on the respective regional cyclical phases. Low yielding bonds in Europe and US are increasing investor's competition for renewables assets in advanced countries. Africa, Asia, India and Latin America are now seeing substantial institutional investment, especially equity. In particular, over half of the world's electricity is expected to be generated in the Asian region by 2030 due to growing populations, economic growth and a smaller installed base of renewables capacity.

While a number of funds are expressing greater interest in investing in greenfield assets, few funds reported exposures to such assets with a preference for brownfield-type investments, which they see as less risky and more aligned with a long investment horizon. This indicate that policies targeted at attracting investment in new projects are needed, along with improving business and financing models to cope with construction risk.

However pension funds are also investing in renewables greenfield risk considered lower compared to other infrastructure sectors with more project complexity and longer construction timelines. Developments in the wind energy sector in Europe are illustrative with pension funds, insurance companies, private equity and infrastructure funds now major equity investors in the European wind sector and utilities reducing their exposure.

The low investment in emerging markets by most funds, indicates that further policy work may be necessary in order to facilitate north-south investment including leveraging further the role of multilateral agencies. Some leading funds invest around one-third of their total portfolios in foreign markets.

However, their infrastructure investment shows an even greater 'home bias'. Most of the overseas projects they invest in are in other OECD countries – with only select markets (such as Brazil, Chile, in some cases India) outside of the OECD. Most of the funds surveyed remain opportunistic in their emerging market interest in infrastructure, focusing more on developed countries (defined as North America, European Union and Japan, Korea, Australia and New Zealand).

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ANNEX 1 - TABLES

Table 11 Infrastructure investment of selected LPFs and PPRFs, in 2015

As a percentage of total assets

Country head office	Name of the fund or institution	Total investments in 2015 (in USD m.)	Infrastructure investment (as a % of total investments)		
			Unlisted equity	Listed equity	Debt
LPFs					
Australia	Construction & Building Unions Superannuation Fund	23,664	10.5	..	..
Australia	Health Employees Superannuation Trust Australia	24,683	10.9	..	0.5
Australia	Hostplus Superannuation fund	13,947	11.6	..	..
Australia	QSuper	45,891	9.5	..	..
Australia	Sunsuper (1,2)	16,732	5.8	..	0.3
Australia	Telstra Superannuation Scheme (3)	13,306	1.5	1.9	..
Australia	UniSuper Management Pty Ltd	36,538	3.4	..	..
Brazil	FAPES - BNDES (3)	2,799	0.0	3.6	4.2
Brazil	FUNCEF	13,909	5.9	1.0	1.9
Brazil	Previ	39,372	6.2	4.6	..
Canada	British Columbia Investment Management Corporation	74,111	5.4	..	..
Canada	OTPP	121,565	7.7	..	..
Chile	AFP Provida (4)	42,634	0.0	0.2	0.7
Croatia	Allianz ZB obligatory pension fund	4,070	0.0	4.6	..
Denmark	PensionDanmark	25,726	10.7	0.0	0.0
Denmark	PFA Pension	56,574	0.6	..	..
Finland	Ilmarinen	39,020	1.5	..	..
Finland	Keva	48,136	0.7	0.3	0.5
Finland	Varma Mutual Pension Insurance Company	44,655	1.6	..	..
Israel	Makefet	12,398	0.3	..	..
Israel	Menora-Mivtachim	19,620	0.8	..	..
Japan	Pension Fund Association	101,993	0.4	..	..
Malaysia	Employees Provident Fund	159,489	0.0	3.2	..
Mexico	Afore XXI Banorte (1)	36,645	0.0	2.2	0.9
Netherlands	PFZW	178,118	3.4	0.0	0.0
Netherlands	PMT	65,937	0.8	1.1	2.8
Netherlands	Stichting Pensioenfonds ABP	429,916	1.9	..	..
Peru	AFP Integra	10,272	1.1	..	1.1
Portugal	Banco BPI Pension Fund	1,441	0.0	16.8	17.3
Portugal	Pension funds managed by CGD (5)	2,724	1.5	1.5	..
Romania	Azt Viitorul Tau	1,305	0.0	9.7	0.0
Russia	VTB (3)	1,903	0.0	7.2	0.0
South Africa	GEPF	109,203	0.7	..	0.0
Spain	Endesa	1,784	0.0	6.4	6.6
Spain	Fonditel ()	3,731	0.3	..	..
Switzerland	Pensionskasse Post	15,788	2.0	..	..
United Kingdom	USS	70,602	4.5	0.4	0.9
United States	State Universities Retirement System of Illinois	17,351	0.4	..	..
	United Nations Joint Staff Pension Fund (3)	59,944	0.2	..	..
PPRFs					
Argentina	Sustainability Guarantee Fund	50,689	0.0	..	12.9
Australia	Future Fund (3)	90,026	7.5	..	..
Canada	Canada Pension Plan Investment Board	204,228	7.3	..	..
Canada	Quebec Pension Plan (3)	44,988	4.9	..	..
Chile	Pension Reserve Fund	8,112	0.0	2.9	5.3
Finland	Valtion Eläkerahasto (3)	20,416	2.0	..	..
New Zealand	New Zealand Superannuation Fund	19,974	1.5	1.8	..
Sweden	AP1 (3)	36,030	1.0	..	..
Sweden	AP3 (3)	36,970	1.6	0.6	..
Sweden	AP4	36,735	0.0	4.6	..

".." means not available. (1) Data is as of August 31, 2015. (2) Data refer to the balanced option only. (3) Data s as of June 30, 2015. (4) Data is as of September 30, 2015. (5) Data cover the CGD Staff's Pension Fund, and the pension funds of Fidelidade, Galp Energia, Império-Bonança, and Mundial Confiança. (6) Data refer to Fonditel's biggest pension plan: Empleados de Telefónica de España.Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

Table 12 Infrastructure investment of selected LPFs and PPRFs, 2017

As a percentage of total assets

Country head office	Name of the fund or institution	Total investments in 2017 (in USD m.)	Infrastructure investment (as a % of total investments)		
			Unlisted equity	Listed equity	Debt
LPFs					
Australia	AustralianSuper	101,162	9.9	..	0.6
Australia	CBUS	33,910	8.9	0.4	..
Australia	Hostplus Superannuation fund	22,640	10.0	..	..
Australia	Unisuper	48,694	3.5	..	..
Brazil	Banesprev	4,993	0.3	..	..
Brazil	FAPES - BNDES	3,232	0.8	..	3.6
Brazil	FORLUZ	4,558	1.6	0.2	..
Brazil	Fundação Petrobras	21,681	3.0	..	..
Brazil	Fundação Sistel	5,111	0.3	..	..
Brazil	Previ	56,687	5.1	..	..
Brazil	Real Grandeza	4,565	1.3	..	..
Brazil	Valia	6,701	0.3	..	1.1
Canada	Alberta Investment Management Company (AIMCo)	82,613	7.6	..	..
Canada	Local Authorities Pension Plan	34,019	8.4	..	..
Canada	OTPP	147,750	10.1	..	..
Denmark	PensionDanmark	34,354	9.7	..	..
Denmark	PFA Pension	76,949	1.2	..	..
Finland	Keva	62,209	0.8	0.2	0.3
Finland	Varma Mutual Pension Insurance Company	54,347	0.6	..	..
Germany	BASF Pensionskasse	11,408	4.7	..	2.6
Iceland	Gildi Pension fund	4,923	0.4	..	..
Iceland	Lifeyrissjodur Starfsmanna Rikisins	7,869	0.2	0.6	1.8
Iceland	Pension Fund of Commerce	6,366	0.8	3.7	2.6
Ireland	Bank of Ireland	6,320	1.0	6.0	..
Ireland	ESB	4,542	4.8	..	..
Japan	Pension Fund Association	109,053	0.5	..	..
Netherlands	PFZW	236,479	3.8	..	..
Netherlands	PMT	83,377	0.7	..	..
Netherlands	Stichting Pensioenfonds ABP	545,464	2.4	..	..
Netherlands	Stichting Pensioenfonds van de Metalektro (PME)	55,887	0.8	..	2.2
Portugal	CGD Pensões (1)	3,179	1.7	2.0	..
Romania	Azt Viitorul Tau	2,216	..	10.7	..
South Africa	GEPF	152,812	1.2	..	..
Spain	Endesa	2,092	0.3	5.8	6.1
Spain	Fonditel (2)	3,931	0.7	..	..
Switzerland	Pensionskasse Post	17,361	2.5	..	..
Switzerland	Publica	40,427	..	..	0.9
United Kingdom	USS (3)	87,060	8.7	0.4	1.7
	Eurocontrol	1,888	5.2	..	..
PPRFs					
Argentina	Sustainability Guarantee Fund	64,655	..	..	7.8
Canada	Canada Pension Plan Investment Board	268,763	7.5	..	..
Canada	Quebec Pension Plan	55,227	5.5	..	..
Chile	Pension Reserve Fund	10,858	..	3.0	4.4
Finland	Valtion Eläkerahasto	23,479	1.2	..	..
France	FRR	43,724	0.1	..	..
New Zealand	New Zealand Superannuation Fund	26,837	1.7	0.7	..
Sweden	AP1	40,511	1.4	..	..
Sweden	AP3	42,055	3.3	0.7	..
Sweden	AP4	43,453	..	4.7	..

".." means not available.

(1) Data cover the CGD Staff's Pension Fund. (2) Data refer to Fonditel's biggest pension plan: Empleados de Telefónica de España. (3) Data are as of March 2018.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

Table 13 Infrastructure investment in 2015 – portfolio allocation

As a percentage of total assets

Country head office	Name of fund	Infrastructure allocation	Where does it fit in the portfolio allocation	Invest in greenfield projects	Actual allocation to unlisted infrastructure (2015) (% of total assets)	Most recent reported target asset allocation to unlisted infrastructure (if separate) (% of total assets)
LPFs						
Australia	Health Employees Superannuation Trust Australia	Separate	Infastructure, unlisted debt	Yes	10.9	12.5
Australia	UniSuper Management Pty Ltd	Non-separate	..	Yes	3.4	..
Australia	Sunsuper (1)	Separate	Infastructure	..	5.8	7.0
Australia	Telstra Superannuation Scheme (2,3)	Separate	Infrastructure	No	1.5	3.0-5.0
Australia	Hostplus Superannuation Fund	Separate	Infrastructure	Yes	11.6	10.0
Australia	QSuper	Separate	Infrastructure	No	9.5	10.0
Australia	Construction & Building Unions Superannuation Fund	Separate	Infrastructure	Considering	10.5	11.0
Brazil	FAPES - BNDES	Non-separate	..	No	0.0	..
Brazil	FUNCEF	Non-separate	Private equity, equity, fixed income	No	5.9	..
Brazil	Previ (2)	Non-separate	Equity	Yes	6.2	..
Canada	British Columbia Investment Management Corporation	Non-separate	Infrastructure, infrastructure & renewables	No	5.4	..
Canada	OTPP (2)	Separate	Infrastructure	..	7.7	..
Croatia	Allianz ZB obligatory pension fund	Not separate	Equity	Considering	0.0	..
Denmark	PFA Pension (2,4)	Non-separate	Equity, private equity, fixed income	..	0.6	..
Denmark	PensionDanmark	Separate	..	Yes	10.7	..
Finland	Ilmarinen (2)	Non-separate	..	..	1.5	..
Finland	Keva	Non-separate	Private equity, equity, fixed income	No	0.7	..
France	ERAFP (2)	Separate	Infrastructure and private equity	To be defined	0.0	1.0
Israel	Makefet	Non-separate	..	..	0.3	..
Israel	Menora-Mivtachim	Non-separate	..	..	0.8	..
Mexico	Afore XXI Banorte (2)	Separate	Listed infrastructure equity, fixed income	Yes	0.0	..
Netherlands	PFZW	Separate	Infrastructure	Yes	3.4	5.0
Netherlands	PMT	Separate	Equities, fixed income	No	0.8	To be decided
Netherlands	Stichting Pensioenfonds ABP	Separate	Infrastructure	Yes	1.9	3.0
Peru	AFP Integra	Separate	Infrastructure	Yes	1.1	..
Portugal	Banco BPI Pension Fund	Non-separate	Equity and fixed income	..	0.0	..
Portugal	CGD PENSÕES	Separate	..	No	1.6	1.0
Portugal	Fidelidade	Non-separate	..	No	0.8	..
South Africa	GEPF (2)	Non-separate	Private equity, developmental investments	Yes	0.7	..
Spain	Endesa (2)	Non-separate	Equity and fixed income	..	0.0	..
Spain	Fonditel (2,5)	Non-separate	Private equity	Yes	0.3	4.0
Japan	Pension Fund Association	Non-separate	Fixed income	No	0.4	2.0
Romania	Azt Viitorul Tau	Non-separate	Equity	No	0.0	..
Switzerland	Pensionskasse Post	Separate	Infrastructure	Yes	2.0	2.0
United Kingdom	USS (2)	Separate	Infrastructure	Considering	4.5	5.0
United States	State Universities Retirement System of Illininois	Non-separate	Other (opportunity fund)	..	0.4	..
	United Nations Joint Staff Pension Fund	Non-separate	Real estate	..	0.2	..
PPRFs						
Argentina	Sustainability Guarantee Fund (6)	Separate	Infrastructure	Considering	..	5.0-20.0
Australia	Future Fund	..	Infrastructure and timberland holdings	..	7.5	..
Canada	Canada Pension Plan Investment Board (3,7)	..	Infastructure	..	7.3	..
Canada	Quebec Pension Plan	Separate	Infrastructure	..	4.9	7.5
Chile	Pension Reserve Fund	Non-separate	Equity, fixed income	..	0.0	..
Finland	Valtion Eläkerahasto	Separate	..	Yes	2.0	..
Japan	Government Pension Investment Fund (2)	Non-separate	..	No	..	..
New Zealand	New Zealand Superannuation Fund	Non-separate	Infrastructure, private equity	..	1.5	..
Sweden	AP1	Separate	Infrastructure	..	1.0	5.0
Sweden	AP3	Separate	Real estate, other	..	1.6	..

".." means not available.

(1) Sunsuper target allocation is based on the balanced option. (2) Data partially based on previous year's questionnaire. (3) Target allocation is based on three pre-mixed options for plan participants. (4) PFA Pension is a defined contribution scheme, thus a target allocation does not exist at the fund level. (5) Data refer to Fonditel's largest pension plan: Empleados de Telefónica de España. Although Fonditel did not indicate a separate category for infrastructure, the fund reported in 2015 a 4% target and categorises infrastructure as private equity. (6) Argentina's Sustainability Guarantee Fund invests in infrastructure through private debt instruments. (7) CPPIB does not have a separate allocation to infrastructure because CPPIB has a "Total Portfolio Approach" and therefore no specific allocations to any asset class. The Total Portfolio Approach ensures that CPIB can maintain - or deliberately change - targeted risk exposures across the entire portfolio as individual investments enter, leave or change in value.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

Table 14 Infrastructure investment in 2017 – portfolio allocation

As a percentage of total assets

Country head office	Name of fund	Infrastructure allocation	Where does it fit in the portfolio allocation	Invest in greenfield projects	Actual allocation to unlisted infrastructure (2017) (% of total assets)	Most recent reported target asset allocation to unlisted infrastructure (if separate) (% of total
LPFs						
Australia	AustralianSuper	Separate	Infrastructure	No	9.9	..
Australia	CBUS	Separate	Infrastructure	Considering	8.9	..
Australia	Hostplus Superannuation fund	Separate	Infrastructure	Yes	10.0	..
Australia	Unisuper	Non-separate	..	Yes	3.5	..
Brazil	Banesprev	Non-separate	..	No	0.3	..
Brazil	FAPES - BNDES	Non-separate	Private equity, equity	No	0.8	..
Brazil	FORLUZ	Non-separate	Private equity, equity	No	1.6	..
Brazil	Fundação Petrobras	Non-separate	Equity	No	3.0	..
Brazil	Fundação Sistel	Non-separate	..	No	0.3	..
Brazil	Previ	Non-separate	Equity	Yes	5.1	..
Brazil	Real Grandeza	Non-separate	Private equity	No	1.3	..
Brazil	Valia	Non-separate	Private equity	Yes	0.3	..
Canada	Alberta Investment Management Company (AIMCo)	Separate	Infrastructure	..	7.6	8.4
Canada	Local Authorities Pension Plan	Separate	Infrastructure	..	8.4	15.0
Canada	OTPP (1)	Non-separate	Real assets - Infrastructure	Yes	10.1	..
Denmark	PensionDanmark (2)	Separate	Infrastructure	Yes	9.7	10.0
Denmark	PFA Pension (2,3)	Non-separate	Private equity, equity, fixed income	No	1.2	..
Finland	Keva	Non-separate	Private equity	No	0.8	..
Finland	Varma Mutual Pension Insurance Company (2)	Non-separate	..	No	0.6	..
Germany	BASF Pensionskasse	Separate	Alternative assets, infrastructure	Yes	4.7	6.0
Iceland	Gildi Pension fund	Non-separate	Private equity	..	0.4	..
Iceland	Lifeyrissjodur Starfsmanna Rikisins	Non-separate	Equity	No	0.2	..
Iceland	Pension Fund of Commerce	Non-separate	..	No	0.8	..
Ireland	Bank of Ireland	Separate	Infrastructure	No	1.0	3.0
Ireland	ESB	Separate	Infrastructure	No	4.8	4.0
Japan	Pension Fund Association	Separate	Infrastructure	No	0.5	1.0
Netherlands	PFZW	Separate	Infrastructure	Yes	3.8	4.2
Netherlands	PMT	Separate	Real estate	No	0.7	1.0
Netherlands	Stichting Pensioenfonds ABP	Separate	Infrastructure	Yes	2.4	3.0
Netherlands	Stichting Pensioenfonds van de Metalektro (PME)	Separate	Infrastructure	Yes	0.8	..
Portugal	CGD Pensões (2,4)	Non-separate	..	No	1.7	..
South Africa	GEPF	Non-separate	Private equity	Yes	1.2	..
Spain	Endesa	Separate	Infrastructure	No	0.3	..
Spain	Fonditel (2,5)	Non-separate	Private equity	Yes	0.7	..
Spain	Santander	Separate	Infrastructure	..	0.2	2.0
Switzerland	Pensionskasse Post	Separate	Infrastructure	Yes	2.5	4.0
Switzerland	Publica	Separate	Infrastructure debt	Yes	0.9	3.5
United Kingdom	USS (2,6)	Separate	Infrastructure	Yes	8.7	5.0
	Eurocontrol	Separate	Infrastructure	No	5.2	7.5
PPRFs						
Argentina	Sustainability Guarantee Fund (2,7)	Separate	Infrastructure	No	..	5.0-20.0
Bosnia and Herzegovina	Pension Reserve Fund Of Republic of Srpska	Non-separate	Infrastructure / Real estate	..	0.0	5.0
Canada	Canada Pension Plan Investment Board (8)	Separate	Infrastructure	Yes	7.5	..
Canada	Quebec Pension Plan	Separate	Infrastructure	..	5.5	8.0
Finland	Valtion Eläkerahasto (2)	Separate	Infrastructure	Yes	1.2	2.0
France	FRR	Non-separate	..	..	0.1	..
New Zealand	New Zealand Superannuation Fund	Non-separate	Infrastructure, private equity	..	1.7	..
Sweden	AP1 (2)	Separate	Infrastructure	..	1.4	5.0
Sweden	AP3 (2)	Non-separate	Real estate, other	Considering	3.3	..

".." means not available.

(1) Separate allocation to infrastructure was reclassified to real assets in 2016. (2) Data partially based on previous years' questionnaires. (3) PFA Pension is a defined contribution scheme, thus a target allocation does not exist at the fund level. (4) Data cover the CGD Staff's Pension Fund. (5) Data refer to Fonditel's biggest pension plan: Empleados de Telefónica de España. (6) Data are as of March 2018. (7) Argentina's Sustainability Guarantee Fund invests in infrastructure through private debt instruments. (8) CPPIB has a

target infrastructure allocation at a total fund level; however, there is no specific target allocation within the different infrastructure security types.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

Table 15 Infrastructure investment in 2015

	Total assets, in USD millions	As a % of total assets of funds in Part B of the report	As a % of total assets for all funds (2)
Unlisted Equity	80,275	3.2	1.0
Debt	11,408	0.4	0.1

(1) Infrastructure investment is calculated as a percentage of total assets of funds investing in infrastructure. (2) Infrastructure investment is calculated as a percentage of total assets of all funds in the survey, excluding the ones stemming from publicly available reports.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

Table 16 Infrastructure investment in 2017

	Total assets, in USD millions	As a % of total assets of funds in Part B of the report (1)	As a % of total assets for all funds (2)
Unlisted Equity	110,466	3.9	1.2
Debt	10,368	0.4	0.1

(1) Infrastructure investment is calculated as a percentage of total assets of funds investing in infrastructure. (2) Infrastructure investment is calculated as a percentage of total assets of all funds in the survey, excluding the ones stemming from publicly available reports.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs

Table 17 Infrastructure investment vehicles of selected LPFs and PPRFs, 2015

As a percentage of total unlisted infrastructure equity investment

Country head office	Name of the fund or institution	Total unlisted infrastructure equity in 2015 (in USD m.)	Unlisted infrastructure investment breakdown (as a % of total unlisted infrastructure investments)		
			Unlisted infastructure funds	Direct and co-investment infrastructure equity	Other unlisted infrastructure equity
LPFs					
Australia	CBUS	2,494	84.5	10.5	5.0
Australia	HESTA	2,697	92.1	5.2	2.6
Australia	Hostplus Superannuation fund	1,614	89.8	10.2	0.0
Australia	QSuper	4,362	9.2	90.8	0.0
Australia	Sunsuper (2,3)	972	11.0	89.0	0.0
Australia	Telstra Superannuation Scheme (4)	199	61.4	38.6	0.0
Brazil	FUNCEF	827	100.0	0.0	0.0
Brazil	Previ	2,449	0.0	100.0	0.0
Canada	British Columbia IMC	4,003	23.0	77.0	0.0
Canada	OTPP	11,316	0.0	100.0	0.0
Denmark	PFA Pension	362	100.0	0.0	0.0
Finland	Keva	337	32.9	67.1	0.0
Finland	Varma Mutual Pension Insurance Company	707	100.0	0.0	0.0
Japan	Pension Fund Association	387	0.0	100.0	0.0
Netherlands	PFZW	6,025	32.0	68.0	0.0
Netherlands	PMT	499	100.0	0.0	0.0
Netherlands	Stichting Pensioenfonds ABP	8,147	66.0	34.0	0.0
Peru	AFP Integra	110	100.0	0.0	0.0
South Africa	GEPF	712	100.0	0.0	0.0
Spain	Fonditel (5)	11	100.0	0.0	0.0
Switzerland	Pensionskasse Post	310	100.0	0.0	0.0
United Kingdom	USS	3,153	23.1	76.9	0.0
United States	State Universities Retirement System of Illinois	78	100.0	0.0	0.0
	United Nations Joint Staff Pension Fund (4)	98	100.0	0.0	0.0
PPRFs					
Canada	Canada Pension Plan Investment Board	14,896	0.2	99.8	0.0
Finland	Valtion Eläkerahasto (4)	407	51.7	48.4	0.0
New Zealand	New Zealand Superannuation Fund	292	27.9	72.1	0.0
Sweden	AP1 (4)	373	0.0	100.0	0.0
Sweden	AP3 (4)	603	100.0	0.0	0.0

(1) Totals may not add up to 100 due to rounding. (2) Data is as of August 31, 2015. (3) Data refer to the balanced option only. (4) Data s as of June 30, 2015. (5) Data refer to Fonditel's largest pension plan: Empleados de Telefónica de España.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPRFs.

Table 18 Infrastructure investment vehicles of selected LPFs and PPRFs, 2017

As a percentage of total unlisted infrastructure equity investment

Country head office	Name of the fund or institution	Total unlisted infrastructure equity in 2017 (in USD m.)	Unlisted infrastructure investment breakdown (as a % of total unlisted infrastructure investments) (1)		
			Unlisted infastructure funds	Direct and co-investment infrastructure equity	Other unlisted infrastructure equity
LPFs					
Australia	CBUS	3,026	89.4	10.6	0.0
Australia	AustralianSuper	10,051	51.6	48.3	0.1
Australia	Hostplus Superannuation fund	2,258	77.4	22.6	0.0
Australia	UniSuper	1,688	100.0	0.0	0.0
Brazil	Banesprev	13	100.0	0.0	0.0
Brazil	FAPES - BNDES	27	88.3	11.7	0.0
Brazil	Forluz	73	100.0	0.0	0.0
Brazil	Fundação Petrobras	661	0.0	100.0	0.0
Brazil	Fundação Sistel	16	100.0	0.0	0.0
Brazil	Previ	2,904	0.0	100.0	0.0
Brazil	Real Grandeza	57	100.0	0.0	0.0
Brazil	Valia	21	100.0	0.0	0.0
Canada	Local Authorities Pension Plan	2,848	10.5	89.5	0.0
Canada	OTPP	14,934	0.0	100.0	0.0
Denmark	PFA Pension	957	100.0	0.0	0.0
Finland	KEVA	512	41.9	58.1	0.0
Finland	Varma Mutual Pension Insurance Company	311	100.0	0.0	0.0
Germany	BASF Pensionskasse	535	89.6	10.4	0.0
Iceland	Gildi Pension fund	22	0.0	100.0	0.0
Iceland	Lifeyrissjodur Starfsmanna Rikisins	13	0.0	100.0	0.0
Iceland	Pension Fund of Commerce	52	0.0	100.0	0.0
Ireland	Bank of Ireland	61	100.0	0.0	0.0
Ireland	ESB	218	100.0	0.0	0.0
Japan	Pension Fund Association	529	0.0	100.0	0.0
Netherlands	PFZW	8,911	24.9	75.1	0.0
Netherlands	PMT	564	100.0	0.0	0.0
Netherlands	ABP	13,096	39.8	60.2	0.0
Netherlands	PME	461	100.0	0.0	0.0
South Africa	GEPF	1,813	100.0	0.0	0.0
Spain	Endesa	5	100.0	0.0	0.0
Spain	Fonditel (2)	26	100.0	0.0	0.0
Switzerland	Pensionskasse Post	440	100.0	0.0	0.0
United Kingdom	BBC Pension Scheme	1,081	100.0	0.0	0.0
United Kingdom	RBS Group Pension Fund	1,081	0.0	100.0	0.0
United Kingdom	USS (3)	7,602	6.0	94.0	0.0
	EuroControl	98	100.0	0.0	0.0
PPRFs					
Canada	CPPIB	20,192	0.2	99.8	0.0
Canada	Quebec Pension Plan	3,051	0.0	100.0	0.0
Finland	Valtion Eläkerahasto	293	100.0	0.0	0.0
France	FRR	48	100.0	0.0	0.0
New Zealand	New Zealand Superannuation Fund	461	36.8	63.2	0.0
Sweden	AP1	583	2.8	97.2	0.0
Sweden	AP3	1,387	100.0	0.0	0.0

(1) Totals may not add to 100 due to rounding. (2) Data refer to Fonditel's largest pension plan: Empleados de Telefónica de España. (3) Data are as of March 2018.

Source: OECD calculations based on responses to the OECD Survey of LPFs and PPR

CHAPTER 7: PARTNERING WITH INSTITUTIONAL INVESTORS AND RECYCLING CAPITAL FOR LOW CARBON INFRASTRUCTURE

7.1 INTRODUCTION

As governments seek greater levels of private finance in low carbon infrastructure and in particular, pension fund investment, efforts are underway to develop new models and financial instruments for infrastructure procurement and create infrastructure as an asset class. Research has been focusing on greater alignment in terms of the investment horizon, investment philosophy, and cost of capital, risk profile and governance views (Ambachtsheer, 2017; Monk and Sharma, 2018).

Despite growing interest, institutional investors have, in aggregate, invested very little in low carbon infrastructure, in fact as seen in Chapter 6 there is a major mismatch between investors and governments expectations. There are challenges particular to the sector including policy uncertainty and risks specific to related projects such as new technology in energy. Capital along the clean energy project cycle is highly fragmented across equity and debt, and smaller scale deals or energy efficiency projects lack aggregation mechanisms. These issues are compounded by a lack of suitable investment channels and vehicles providing the liquidity and risk/return profile for a changing institutional investors landscape (Chapter 4).

Alternative risk and profit sharing approaches may diversify risks and lower the cost of capital, attracting investors and sponsors with risk preferences and return expectations not accommodated by commonly used models. Partnerships between asset owners, in particular pension funds and life insurance companies can be an effective way to develop specialised capabilities and unlock long-term patient capital. By pooling assets and creating a secondary market for infrastructure, securitisation, yieldcos and new listed vehicles could widen infrastructure investment access and improve transparency.

This chapter covers an examination of new models and instruments for private sector and institutional investors financing of low carbon infrastructure. With climate change posing new challenges to traditional providers of finance and opening new opportunities for partnership, focus of this chapter is on institutional

investors' role as 'recyclers of capital', taking operational assets off balance sheets of short-term financiers, thereby freeing up capital for new investment.

This chapter aims to offer an assessment of current and perspective models, from a long-term investors point of view, in particular pension funds and insurers. Following Clark (2018) and building on previous chapters, the focus is upon the allocation of risk and uncertainty between infrastructure investors and between investors and the public. Overcoming limitations in the literature and scarce evidence this chapter takes into account institutional investors' risk preferences and return expectations not accommodated by commonly used models for low carbon infrastructure. Defining expected contribution and limitations of institutional investors will also clarify the role of governments in delivering low carbon infrastructure and developing infrastructure as an asset class.

Findings are mainly based on interviews with industry professionals, as the existing data sources are limited. The information acquired in interviews complements that obtained from a literature review, selected pension fund annual reports, and an analysis of the available data sources. This chapter leverages and updates case studies first presented by Della Croce and Sharma (2014) and a wide recent consultation process with asset managers and asset owners conducted by the OECD for the G20/OECD Report on the Collaboration with Institutional Investors and Asset Managers on Infrastructure (OECD 2020 see Appendix 1)).

The chapter first looks at the evolution of infrastructure financing market and current and future challenges for institutional investors as key sources of low carbon infrastructure. The second part of the chapter introduces the new initiatives to pool institutional investors capital, that have developed in response to the drawbacks and early inefficiencies, highlighting specific case studies of co-investment platforms, government-led initiatives and revised unlisted infrastructure funds. The last section focuses on the creation of a secondary market for infrastructure looking at initiatives conducted by green investment banks and multilaterals, the creation of listed equity instruments and the role of securitization.

7.2 LITERATURE REVIEW

7.2.1 New models for infrastructure delivery through partnerships

Since the 1990s, new delivery models with private sector participation, variants of public-private partnership models (PPPs) – often using project finance technique – have been increasingly used particularly in OECD countries, offering further scope for unlocking private sector capital and expertise (EC 2011). For example, the Private Finance Initiative (PFI) has been the dominant form of large-scale buildings procurement used by the National Health Service (NHS) in the United Kingdom[76].

However, changes in financial sector regulation and concerns about the quality of assets held by banks restricted long-term lending. Government's policies tried to rely less on commercial banks in PPPs projects and attract funds from alternative financial institutions, primarily pension funds and insurance companies (Vecchi, Hallowell, Gatti 2013). This change in the model was likely to have a major impact on PPPs and delivery models in Europe more broadly.

The shift from a bank lending model for infrastructure delivery, to one that engages with a broader range of financial institutions implicates a re-allocation of project risks and profit to other contractual parties. With this aim, in December 2012, the UK government published the outcome of a year-long inquiry into the PFI – resulting in the introduction of a slightly amended model, called PF2. Buckberg; E. (2016) detailed new frameworks for PPP design- the risk- and profit-sharing approaches - expanding the options for sponsors and investors to consider in PPP negotiations, with the aim to increase the number of PPP deals and improve the odds of the projects' long-term success.

While support mechanisms for renewables are, being scaled back as markets mature, institutional investors are looking for long-term contracts and fixed prices. Innovating new sources of contracted revenues include

[76] Since 1993, 123 PFI projects for new hospital facilities had been agreed between NHS organisations and private sector 'special purpose vehicles' (SPVs) representing private sector investment of £16 billion and a projected long-term nominal cost to the NHS of £70.5 billion (Source HM Treasury 2012).

auctions for renewable - Contract for Differences (CfDs) delivering lower costs and used in offshore wind. In addition, corporate power purchase agreements (PPAs) are becoming more popular with 19GW of procured in 2019, a 44% rise year-on-year (Blackrock 2020). To mobilize long-term, substantial private investment in zero-carbon assets further assurances need to be given on profitability of longer-lived clean energy technologies.

Alternative risk and profit sharing approaches may create choices that are attractive to investors and sponsors with risk preferences and return expectations not accommodated by commonly used models. Regulators with an appropriate degree of political independence, with a politically specific mandate, can ensure that durable assets are financed at very low weighted costs of capital (WACCs), through various designs for long term contracts (Allan J. & others 2020).

In the Regulated Asset Base (RAB) model, the investment is guaranteed through the assets' revenue stream and the regulatory framework while risks are passed to the users. Makovšek D. (2018) Buckberg; E. (2016) look at whether the Regulated Asset Base model, used for example in the water and electricity sectors, could applied to other type of infrastructure financing models, such as concessions. According to Newbery, D. & others (2019) in the case of the Thames Tideway Tunnel in the UK, the application of an hybrid RAB model77 allowed to reduce risk lower the cost of capital by accessing infrastructure funds with limited project expertise and capabilities.

Furthermore, the public sector needs to put more emphasis on a life-cycle approach in order to be able to drive down the overall costs of projects including operations, maintenance and eventual replacement, building up appropriate capital reserves. Helm D. (2009) and Helm D., Tindall T. (2009) consider how the RABs can be developed to provide credible long-term contracts over a wide range of activities suggesting three solutions to the exhausted balance sheets are considered to finance future investment: rate-of-return

[77] with excess cost sharing and a cost cap

regulation; the split cost of capital; and a not-for-dividend, mutual or state ownership (Welsh Water and Network Rail).

Research has been focusing on institutional investors' role as 'recyclers of capital', taking operational assets off balance sheets of short-term financiers, thereby freeing up capital for new investment. The role that institutional investors can play in global infrastructure development and low carbon is well documented (Della Croce 2014; Röttgers, Tandon and Kaminker, 2018; Della Croce, 2011). Several organisations have identified and analysed the modalities to direct institutional capital towards low carbon infrastructure (OECD, 2015; Inderst, 2016; Nelson and Pierpont, 2013; Della Croce and Yermo, 2013; Youngman and Kaminker, 2016; Inderst, 2016; Kaminker, 2016; G20/OECD, 2013).

Asset owners investment partnerin allow to share risks, lower cost of capital, develop specialised capabilities and unlock long-term patient capital (Bachher, Jagdeep, Dixon 2016). Beyond distributing risks, partnerships can facilitate access to investment providing a mechanism through which investors can sell to one-another a portion of their holdings (Clark 2018). While the low-risk, geographically varied returns associated with infrastructure match the diversification objectives of pension fund portfolios, involvement of long-term investors can also improve the quality of public investment programs (Torrance 2009 and Gelb 2014).

The OECD has recently presented a report to G20 with outcomes of a prolonged dialogue with private sector investors in infrastructure. This report looks at perspectives of asset owners and managers on ways to overcome the infrastructure investment gap providing proposals for G20 Finance Ministers and Central Bank Governors (OECD 2020). Within the full list of proposals expressed by investors, the report focuses on collaboration, engagement, and partnership as a mechanism to attract investment and manage risks.

7.2.2 Collaborative models for Institutional Investors

The failure of a number of investments during the global financial crisis exposed the lack of transparency of infrastructure vehicles and drawbacks of short-termism and principal agent issues of using certain

intermediaries. This coupled with a push to management cost reduction have been major drivers for alternative models of investment such as direct investment in infrastructure.

Recent literature has been looking at major issues and efficient ways for institutional investor to access infrastructure, focusing on collaborative models of institutional investment and relational investing. There is a growing trend amongst institutional investors towards more efficient ways of long-term capital deployment (Fang and others 2014; Monk and Sharma 2015; Della Croce, and Sharma,2014; Arezki, Bolton and others 2016).

Major constraints relate to the relatively high cost of financial intermediation and the pervasive misalignment of incentives in external asset management (Ambachtsheer 2017; Monk and Sharma, 2018). Clark Monk and others (2011) have looked at constraints preventing institutional investors to invest directly in infrastructure focusing on the time-inconsistency and principal-agent problems embedded in the third-party fund management model.

In particular, the direct or co-investment method of investing seems to provide more favorable terms compared with the fund model. Bachher and Monk (2013) and Monk et al., (2017) look at "the network effects" from working with like-minded peers to minimize the funds reliance on the for-profit financial services and asset management sector for deals and intelligence. Monk Sharma Feng (2015) drawing on social capital theory suggest a networking strategy for institutional investors that involves asset owners comparing, collaborating and ultimately co-investing in private market assets.

There is now empirical evidence that shows direct investing by long-term investors (LTIs) is a more economical and indeed higher-performing implementation style, especially for those LTIs considering private market investments. In fact, several investors believe that returns on core investments are attractive on a direct basis but are unattractive when burdened by the usual fee and carry of a fund structure (Probitas 2019).

Reduction of management fees seems to be a major driver of direct and co-investment for limited partners in private markets. The magnitude of the fees earned by general partners of buyout and venture funds has been analyzed by Metrick and Yasuda (2010). They estimate, based on 240 mid- and large-sized funds raised in the mid 2000s, the average net present value of the typical payment received per partner per fund. They find that for venture funds, the average is US$ 17 million; for buyout funds, US$ 33 million. Since private equity groups raise funds very frequently (18 months to 3 years during the period analyzed), these payments represent a huge wealth transfer from the limited to the general partners.

In fact, the literature suggests that there is a very substantial gap between gross and net returns from alternative investing. Gottschalg and Phalippou (2009) estimate that gross of fees and carry, buyout funds outperform the S&P 500 by 3% per year. Net of fees and carry, however, they underperform by 3% per year which implies an investment cost of 6% per year. A 6% annual return gap results in a 13-fold difference in end-of-horizon wealth after 50 years–the kind of difference that cannot be ignored by investors with long horizons.

Principal-agent issues between short-term private equity asset managers and long-term asset owners could also create disincentives for the adoption of ESG factors in the investment process. This is particularly relevant for the unlisted infrastructure equity market where a number of infrastructure funds have adopted the private equity incentive structure that usually only allows for an investment holding period of 4-5 years in order to make the most of the financial rewards of this vehicle (Clark and Monk 2017; Bennon and Sharma, 2018).

7.3 PARTNERING AND RECYCLING CAPITAL FOR LOW CARBON INFRASTRUCTURE

7.3.1 Re-conceptualization of intermediation: Looking for a new Era of Investing

The challenges to institutional investors represented by the underlying economy dynamics and the increasingly complex and challenging financial ecosystem, are highlighting the need to "reframe finance" (Clark and Monk 2017). This is becoming even more urgent with the rise in AI, big data and social networking, tech innovations transforming financial services.

Major constraints for institutional investors in infrastructure relate to the relatively high cost of financial intermediation and the pervasive **mis-alignment of interests embedded in their principal-agent based investment model** (Ambachtsheer, 2017; Monk and Sharma, 2018). Relevant in particular for infrastructure many funds recognize that the **long chain pf principal agent relationship** has allowed for a distortion of their overarching objectives (Ambachtsheer 2013). A re-conceptualization of intermediation, reframing finance will lead to a revitalization of infrastructure as an asset class and a new era of infrastructure investing **(**Clark, Monk, Orr, Scott 2011).

As seen in chapter 3 high demand for "core" infrastructure is expected to continue. In 2020, over 250 infrastructure funds are collectively seeking more than $200bn from investors. This demand contrasted by little investment is causing major challenges highlighting structural issues in the market, including competition for limited quality assets and overconcentration and influence of the largest infrastructure funds.

Large dry powder and sluggish global growth have meant more competition for attractive investment opportunities and concerns about sustainability of pricing and risk/return balance in developed markets and large projects. According to some commentator: "The infrastructure investing business appears to have

turned itself into a perpetual motion machine. The underlying assets — toll roads, pipelines and wind turbines — are teetering on a pyramid of thinner profits and higher risks"[78].

7.3.1.1 Models for Institutional Investment in Infrastructure

Clearly, different countries are at different stages in the evolution of pension fund investment in infrastructure (Chapter 4). Factors accounting for the growth of pension fund infrastructure investment include the availability of investment opportunities for private finance and for pension funds; the maturity and size of the pension fund market; pension fund regulation and financial intermediation playing a key role in letting investors access opportunities.

Australian and Canadian pension funds have been pioneers in infrastructure investing since the early 1990s. They also have the highest asset allocation to infrastructure around the globe today. The 'Canadian model' and the '(new) Australian model' of infrastructure pose a challenge to the 'private equity model', dominant in Europe and the USA (Inderst Della Croce 2013)

Australia has a tradition of listed infrastructure investing, both in individual companies (including privatized ones) and in listed funds ('the old Australian model'). However, after disappointments with listed infrastructure funds (performance, agency issues, etc.) the unlisted equity market for infrastructure has developed rapidly. Contrary to Europe and the USA, there is a clear preference for open-ended funds ('the new Australian model').

North America and Europe are dominated by the closed-end, private equity-style funds, managed by General Partners (GP), with pension funds playing the role as Limited Partners (LP). Despite direct investment of a few public pension funds, the large majority of United States pension investors invest in infrastructure

[78] Financial Times John Dizard January 24 2020, FTfm: Infrastructure funds have become a way around decarbonisation targets. "Despite weak earnings, the infrastructure funds have been able to trade those assets back and forth with each other for ever-higher prices. Then they use the mark-to-model results to raise more money from institutional investors and the public markets"

through funds. In Europe pension funds utilise the indirect market route to benefit from the experience and expertise offered by infrastructure fund managers. Only the largest pension funds have the right resources in place to invest directly in infrastructure.

Canadian infrastructure investing is primarily undertaken via unlisted closed-end funds, direct investments and co-investments. Typically, smaller pension funds concentrate on indirect routes into infrastructure. A number of large Canadian pension funds started off with indirect vehicles but have over time increasingly taken the direct route the 'Canadian model'. Not only they are able to co-invest but also to take leading roles in consortia, competing with other funds and financial sponsors when bidding for projects. This also means that these investors have in-house resources to produce their own research and risk assessment of infrastructure projects without being dependent on external consultants.

The standard, global fee model offered to most investors in private equity type funds used to be broadly '2+20', i.e. 2% management fee plus 20% performance above a certain hurdle of, e.g., 8%. Since the global financial crisis, some pension funds have negotiated somewhat lower fees. In Australia, the fee level of open-ended funds has fallen to much lower levels. Reasons may be the long-running heavy competition in that market place and the success of IFM. In Canada, fees were one of the reasons for large pension funds to go direct, and to seek co-investment opportunities. The investment costs are reported to be much lower with investors in other countries seeking to copy such attempts to reduce management costs (Inderst and Della Croce 2012; and Probitas 2019)

Despite the evolution, overall asset owners have shown a lack of institutional innovation, highlighting a stasis related to the reactive nature of these institutions and the entrenchment of common interests. As seen in Clark and Monk (2017) in the face of rapid transformation of the investment management industry, the current organization and management typically reflects their establishment, in many cases looking back over 50 to 70 years. Recent events such as the COVID and the global financial crisis though can fundamentally alter perceptions about the **desiderability of the status quo, offering an opportunity for change.**

7.3.1.2 The case for innovation through cooperation and collaboration

Investors are adopting different models for institutional investment in infrastructure. Among the drivers, the development of new mechanisms to overcome the barriers to long-term investment in private markets less resource intensive and more aligned (Clark., Monk Orr, Scott 2011)).**The disconnect between the old institutional investment model and development of global markets can be solved through innovation in organisational form and functions (**Clark and Monk 2017).

In this section following Clark and Monk (2013) and (2017) is introduced an analytical framework to interpret cooperation and collaboration in financial institutions like pension funds and sovereign wealth funds, its potential for infrastructure and limitations.

According to this framework, the key ingredient driving the long term success of institutional investors is its **governance**. **In their research** Clark and Monk (2017) **point to** four ways in which an organization can secure the resources it requires to be innovative. These are i) extra-financial objectives ii) fees and cost transparency iii) collaboration and cooperation and iv) competitive advantages. **Cooperation and collaboration among investment organizations facilitate innovation because they offer participants an action space in which to be informal and yet in some way committed to a project[79].** This is done by bringing like minded organizations and managers together around mutual problems with an aim to developing a common solution.

In practice there are different options to realise cooperation and collaboration including conferences and research clubs, seeding related ventures, partnerships, informal and formal, investment clubs and shared

[79] As specified in Clark and Monk (2013) " collaboration is likely to require a stronger legal framework than is the case with cooperation, specifying the respective shares of the benefits of collaboration, limits on actual and potential liabilities, and the boundaries of the collaborative agreement with respect to the operations of project partners. Furthermore, collaboration is likely to require a stronger governance framework than is the case with cooperation, specifying the mechanisms of objective-setting, decision-making, and conflict resolution"

equity (**Clark and Monk 2013).** They go from the simplest ways in which to facilitate senior managers' knowledge and understanding of the options available and move on to more complex strategies which require the mobilisation and application of institutional resources and capabilities.

As the majority of small pension funds do not have the capabilities and size to invest in infrastructure, partnerships can facilitate the pooling of numerous small resource commitments to invest in large projects. For small investors the other option is to use external portfolios managers on service contracts. Large investment management companies offer **pooled investment vehicles** for infrastructure by style of investment sector and geographic focus; the criticism made by the authors is that they they tend to manage the product rather than the long term relationships with clients.

However there are major issues to the development of the market and potential for collaboration. Cooperation and collaboration are likely to be only partial solutions to the costs and consequences of organizational inertia. Key elements in a long term partnership are the way entities are governed, the allocation of voting rights, and the degree to which services envisaged are innovative Clark and Monk (2013). There might be tensions between partners that are larger and those that are smaller; the former are always likely to consider the opportunity costs of remaining in such partnerships whereas the latter may have no real alternative. When partnering with governments, one key concern for investors is the potential cost of capture i.e.being held hostage by government – this seems to be especially important to those funds that undertake infrastructure investments in their own backyard (as opposed to other countries).

The majority of capital flowing into the industry is concentrated in a small group of the largest fund managers with outsized influence on the market. For example, half of the fundraising in 2019 went to just five funds. The mega size of these funds is a reflection of the larger size of commitments than in other asset classes and the skills and capabilities needed to access deals, information and due diligence 80. However, there is emerging evidence that most the rents (profits) from these skills go to the fund managers

[80] Due to the large size of infrastructure projects and the relative prevalence of large investors in the asset class – asset managers will make larger commitments than family offices in order to disburse their allocations across a similar number of vehicles

themselves, rather than to the limited partners. Amenc and Blanc-Brude & others (2020) using data for the actual investments of two key peer groups (large asset managers and large asset owners) find substantial market outperformance especially for large asset managers.

The pandemic also raises concerns about infrastructure risk management and vehicles in terms of how to insulate cash flow projections from major shocks and manage the liquidity provided by the equity buffer and available debt service reserve accounts/liquidity facilities. Already, some asset owners and infrastructure managers have taken write-downs.81

Despite the growth infrastructure remains a nascent asset class and represents a relatively small part of the private capital industry. For example the current 250 infrastructure funds seeking capital, compare with around 4,000 private equity vehicles. Over the last few years, the industry has consolidated to some extent and adjusted to address investor concerns. This is evidenced by fund managers offering tiered options for fees based on the amount of capital contributed and when, separate managed accounts for investors in funds as well as co-investment options for large investors in funds. Investor understanding of the asset class has also developed making them more sophisticated in manager assessment and selection. ESG is also increasingly included as a component of the incentive plans of executives of portfolio companies and in the compensation of the ESG team.82

7.3.2 Attracting Institutional Investors and Recycling Capital

To respond to the long-term investment demand and attract alternative sources of finance such as institutional investors, new financial instruments and forms of collaboration beyond traditional instruments are needed.

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[81] Valuations drop for AustralianSuper's unlisted assets IJ Journal Alexandra Dockreay 24 Mar 2020 - Australia's largest superannuation scheme has cut the valuation of its unlisted assets portfolio, having undertaken a revaluation in the "current unique circumstances"

[82] In September 2019, Meridiam adopted the new statute in French law of a mission-driven or Benefit organization, aiming to deliver financial dividends return and non-financial impact. The compensation package of its team members is partially indexed on impact as a performance indicator, as is the carried interest formula for the next funds, to be determined around a 'bonus/malus' system that tracks achievements of non-financial, social and environmental dividends in the investment portfolio. Source Infrastructure Investors , Sustainable Investing in Infrastructure 2019

This can make infrastructure as an asset class more accessible to a broader group of investors and help to diversify the large risks of infrastructure projects - currently shouldered largely by the banking sector and the public sector through guarantees - across many groups of investors through the capital markets.

The use of private capital is intended to transfer some risks from the public to the private sector and provide other commercial benefits to offset the higher cost of private capital. Several governments have introduced various mechanisms to support private capital funding public assets, changing the risk allocation between the private sector, taxpayer and consumer. To attract more private sector finance into infrastructure projects, policy makers will need to consider how material residual risks or other constraints can be mitigated so that potential transactions are seen as investable opportunities.

The financial market and asset management industry have a crucial role in providing sustainable solutions matching the evolution in the nature of risks over the project lifecycle with different types of financing. Once infrastructure projects reach, the operational phase there is potential to crowd-in institutional investors. This allows for a recycling of equity and bank finance and the recycling of public funds that can be used for new investments.

The development of a secondary market for infrastructure will facilitate the recycling of capital. Efficient secondary markets could optimise risk pricing and reduce the overall cost of capital for infrastructure projects. The creation of a secondary market would help then to reinforce partnership models and engage with institutional investors who may prefer to invest in operational assets, while using traditional sources of finance (such as utility balance sheets and bank loans) during the construction phase.

7.3.2.1 Alternative risk/profit sharing models (PPPs or other, new forms of PPPs)

Investors seek stability and certainty in the political and regulatory regime. Attracting increased investment can therefore be achieved through the provision of greater long term policy certainty. Targeted interventions are also one part of the contribution that the Government can make to promoting private sector investment.

Governments can attract and encourage new sources of capital by maintaining a strong, active and coordinated dialogue with private sector investors to ensure that infrastructure is an attractive asset class.

Incentive regulation in the network industries, such as setting price caps for infrastructure services, can help ensure that investment is cost reducing and mimics a competitive environment. Empirically, there is evidence that price-cap regulation when combined with regulatory independence boosts investment, especially in electricity grids and telecommunications networks. However, setting access prices for users of infrastructure is challenging for the regulator, with the possibility of too low a price leading to underinvestment and too high a price leading to inefficient bypass.

Research is currently trying to assess whether the Regulated Asset Base model, used for example in the water and electricity sectors, could be used for other type of infrastructure financing models, such as concessions. Furthermore, the public sector needs to put more emphasis on a life-cycle approach in order to be able to drive down the overall costs of projects including operations, maintenance and eventual replacement, building up appropriate capital reserves.

Under the regulatory asset base model an investment in an income generating regulated asset will be financed via a long-term borrowing. The investment is effectively guaranteed through the assets' revenue stream and the regulatory framework. Risk has been passed to the users through the price they have to pay (for example for water, electricity).

Alternative risk and profit sharing approaches represent new opportunities for investors. The US Department of the Treasury detailed new frameworks for PPP design aiming to attract more private investment to infrastructure. Adopting innovative financing approaches will assist with the provision of infrastructure and in effectively allocating the risks and returns from a project. A key aspect is flexibly determining the most effective capital structure and mix of private and public funding through the life cycle of the project from greenfield into the brownfield phase.

Innovative financing approaches involve the government adopting a flexible approach in deciding the form of its financing involvement to crowd in the private sector in funding major infrastructure projects. This can

include using means other than providing traditional government grant funding such as by using loans, loans that convert into an equity holding, equity, debt or credit enhancements. Other innovative sources of infrastructure funding such as land value capture, special assessment districts, tax increment financing, joint development, could be considered. Land value capture, in particular, has the potential to facilitate the financing of greenfield assets where returns are not yet provided through operations. Such a technique recognises the economic impact that infrastructure can have beyond the project itself, by raising property values of adjacent real estate, cost-free to those benefitting. Land value capture attempts to monetise some of the value creation of rising property values within the infrastructure financing scheme.

7.3.2.2 Innovative government approaches: Asset Recycling

Innovative government financing approaches such as Asset Recycling can enable institutional investors to be brought into a greenfield investment after the construction or other risks have been reduced. Asset recycling (AR) seeks to optimise the mix of private and public financing through the life cycle of infrastructure assets, enlarging the pool of capital available for infrastructure development. AR takes advantage of investor appetite for operational infrastructure assets, which typically have long-lived, and relatively stable, cash flows. Investors have continually stated that there is a lack of investment "pipeline" of investable projects.

AR could provide a means for clear signals to market participants of a government's commitment to maintain infrastructure investment engagement with the private sector. While refinancing does not lead to additional investments, it can lower overall costs for users and governments, potentially freeing up fiscal space. It thereby allows the government to recover some or all of its funds and create additional fiscal room to deploy (effectively recycling) these funds into other government activity, whether infrastructure or other services.

The Australian experience Asset (or capital) recycling, an approach initially established by the Australian government in 2014 under the aegis of its Asset Recycling Initiative (ARI), has gained increased attention

worldwide83. It seeks to leverage existing operational public infrastructure assets as a means to secure financing for new, often greenfield, public infrastructure investment, which is required to close the infrastructure investment gap. The AR process consists of two main steps, namely

1. Divesting, or partially divesting, existing operational infrastructure assets to private sector investors by selling debt or equity on secondary markets and
2. (a) re-directing the proceeds and (b) re-investing them into greenfield infrastructure.

The first step of divesting existing operational brownfield infrastructure is in essence a privatization of public infrastructure assets, which has been extensively performed by many economies, predominantly during the wave of privatization of public infrastructure starting in the 1990'. The second step of re-directing the proceeds from the private sector investments to re-investing them into new greenfield infrastructure assets is what makes **Asset Recycling (AR) an innovative approach** to not only liquidize capital, but also deploy it in a targeted manner to increase the stock of quality infrastructure available in an economy. To this end, by means of AR, a stream of investment potential is intended to be generated, achieved by governments repeatedly divesting existing infrastructure assets, investing the generated liquid capital into the construction of new infrastructure, and divesting again the newly built infrastructure.
To guarantee the use of the capital proceeds from divested assets is used for new infrastructure oftern is created a dedicated trust fund This fund helps to build support. clearly signalling commitment, accountability and transparency to the public.

[83] Australia has been a pioneer in the adoption of an AR scheme with its Asset Recycling Initiative (ARI), as part of its Infrastructure Growth Package (IGP). To promote the availability of brownfield infrastructure assets available for investment, the Commonwealth Government implemented the ARI which provided States and Territories with financial incentives if they sold assets and re-invested the capital into additional economic infrastructure. Under ARI, the Commonwealth Government would make an incentive payment equal to 15% of the proceeds from an asset divestment, if the State government reinvested the proceeds from the asset into additional productivity enhancing infrastructure. ARI recognised that private sector demand for brownfield infrastructure assets which have proven, stable revenues remains very high, so divestment of these brownfield assets was seen an effective way for State governments to fund greenfield infrastructure without reliance on taxes or debt. The ARI agreement concluded on 30 June 2019. Through the ARI, over $17 billion in infrastructure capital was re-invested in greenfield infrastructure projects.

7.4 PARTNERSHIPS WITH INSTITUTIONAL INVESTORS[84]

7.4.1 Market and Government initiatives in the Equity Market for Infrastructure

In light of the challenges, it is widely acknowledged that private institutional infrastructure investment is significantly needed but requires a collaborative effort by all parties; governments, investors and managers and existing models need to be enhanced and developed to ensure an alignment of interests. Some countries have promoted partnership models for equity investors, bringing together pension funds, corporate investors, insurance companies, or other sources of finance. Some participants viewed such models as an alternative to a traditional PPP arrangement and as a way to stimulate collaboration in a long-term sustainable manner.

Equity funds formed as partnerships to leverage institutional investors capital are examples of new investment models for public and private sectors to fund infrastructure projects in developed and also developing countries. They could become important sources of risk sharing finance as well as providers of organizational capacity and expertise in support of the financing of infrastructure projects.

There are solutions for private institutional infrastructure investment that can be categorised as both market-led and government-led initiatives.

- **Market-led initiatives** refer to the vehicles set up by private institutions and are being designed to address the conflicts of interest between investors and fund managers over time horizons and fees. The market-led initiatives are directed at different types of investors in the differentiated infrastructure investor universe.
- **Government-led initiatives** refer to vehicles set up by governments to encourage institutional investors to invest in infrastructure assets. These have included helping to set up an investment platform for investors and providing seed capital for infrastructure funds.

[84] This section is largely based on case studies first developed by Della Croce and Sharma (2014). Updates to original cases studies, new cases studies are provided in the section and appendices 2 and 3.

Infrastructure typical nature of long-term assets and often large size allow a wider diversity than private equity and real estate in vehicle structures (Chapter 6). In the latest Probates Partners' survey in 2019, the two most popular investing structures for respondents were closed-end infrastructure funds and co-investments with interest in open-end funds (Probitas 2019). Major structures in the market include:

1. utilities/construction companies and financial investors
2. co-investment platforms
3. infrastructure unlisted funds
4. government-led equity fund initiatives

The case studies highlighted in the section below provide examples of investment structures that have been created in response to the issues noted above. The cases provide examples of mechanisms used to facilitate institutional infrastructure investment in various locations around the world, including co-investment platforms, revised/investor-friendly unlisted funds, utilities and financial investor partnerships and government-led equity fund initiatives. This section includes a large set of recent and relevant examples drawn from industry practice and leverages updated case studies and analysis identified in Della Croce and Sharma (2014).

7.4.2 Pooling Investor Capital - Case Studies

7.4.2.1 Utilities and Financial Investors

In addition to market structural trends the implementation of COP 21 objectives is a major drivers for combining industry and finance for low carbon infrastructure. International objectives are in fact translated in national laws – for example in France through the French Energy Transition Act - aiming to reduce energy consumption and greenhouse gas emissions.

Utilities and financial investors (asset managers and asset owners) are increasing cooperation in the renewable sector, and in infrastructure investments. Where the ability to self-finance new investment is

limited, for example, utilities could act as construction companies, building projects through joint ventures or special purpose vehicles (SPVs) and project finance structures. For financial investors the aim is to strategically add exposure to certain industry sectors they favor.

For example, in July 2018 in partnership with Dalmore Capital, the UK Pension Infrastructure Platform (PiP), became a new partner in twenty-four of EDF Renewables UK wind farms (c.550MW) with the purchase of a 49% minority stake. In Italy, the utilities EDF and Edison and the infrastructure fund F2i established the third-largest operator in the Italian renewable energy sector in 2014; Google recently paired up with Eneco in the Netherlands and Duke Energy in the United States, both utilities; and Apple partnered with Goldwind in China, a maker of wind turbines.

Amundi Energy Transition (AET) is a joint venture between Amundi (largest asset manager in Europe with AUM of more than € 1 trillion) and EDF (industry player in green energy) launched in 2018, fundraised EUR 500 million in equity capital from institutional investors to finance projects for energy transition in France[85]. AET has partnered with Dalkia, active in energy services and heating networks, to finance 150 energy transition plants for industrial sites and local authorities including efficient energy co-generation plants (or Combined Heat Power – CHP).

7.4.2.2 Unlisted Equity Funds

As indicated above, institutional investors have raised concerns over the terms and conditions of infrastructure funds being offered in the early stages of the market. The conflicts of interest have arisen due to the perceived **short-term opportunistic approach of fund managers** compared with the long-term patient outlook of institutional investors such as pension funds, insurers and sovereign wealth funds.

From the fund manager's perspective, there seems to be a challenge in satisfying various conflicting objectives such as time horizon, liquidity, rate of return, while also generating income through fees. Early funds have typically been just 10-14 years with a limited investment period of 4 or 5 years. The shorter-

[85] Source March 2018: https://int.media.amundi.com/news/amundi-energy-transition-brings-together-fifteen-institutional-investors-with-the-european-investment-bank-to-finance-projects-for-energy-transition-e128-b6afb.html

term focus is more suited to turn-around or development deals and the mandatory exit is not consistent with the long-term hold philosophy of core infrastructure. Contributions, valuations and liquidity are all controlled at the manager's discretion and distributions are only made towards the end of the fund life (Preqin 2013).

The market has developed in the last years in the terms and structure of funds offered to investors. The 10-year closed-end maturity typical of private equity remains common, but there is an ongoing shift toward longer maturities: Funds with maturities of 12 to 15 years are becoming more popular, and there is some interest in funds with maturities up to 20 years (Probitas 2019).

Open-end funds or funds of length greater than 15 years seem to be more appropriately matched to the long-term liabilities of institutional investors. Open-end funds have an investment period that is ongoing and provides immediate exposure to income generating assets (rather than a blind pool fund). With open-end funds, there is greater ability to grow and diversify the fund over time and no rush to deploy capital. With regards to contributions, investors have more control, valuations are regular and independent, and liquidity is available from cash yield with the option of exits and redemption if appropriate. Investors also have control over reinvestment and distributions decisions (IFM 2013).

On the other hand, management of the fund during a downturn could prove challenging due to the potential simultaneous withdrawal of funds following liquidity constraints of several pension fund participants. The closed-end model is often seen as suitable for riskier ventures in smaller and greenfield projects or emerging markets with potential liquidity issues related to the open-end model causing concerns from a regulatory viewpoint.

The Meridiam funds, closed-end vehicles with a 25-year horizon, provide a good example of unlisted equity fund opportunities for institutional investors that have a time horizon and fee structure more aligned with the core economic infrastructure definition that has been sold to institutional investors. The funds also provide a good example of how institutional investment can be attracted into vehicles that take on development risk, an area of exposure that institutional investors have been reluctant to take on.

The Industry Funds Management (IFM) open-end vehicle model also seems to be able to achieve strong alignment of interests. IFM has $156 billion under management on behalf of 27 industry super funds and is a large investor in infrastructure around the world. IFM's fees are investor driven, not manager driven, and are therefore significantly lower than those charged by private equity funds, meaning assets with appropriate risk profiles are selected and liability matching is achieved[86]. However, more recently IFM has come under scrutiny in relation to its business model amid questions about conflicts of interest arising when superannuation funds invest in their own ventures and fierce competition to banks and bigger funds as Macquarie.

Following the COVID-19, industry super-owned IFM Investors offered a new infrastructure investment model – the Building Australia Model – based on a competitive public tender process.The model allows early entry for investors in the projects to long-term equity partner in order to ensure , better collaboration and risk allocation during the procurement and delivery process (see appendix for more details).

Return expectations for infrastructure funds are driven by perceived risk with major differences between closed, open, equity and debt funds. 75% of respondents to a recent Probitas Survey expect the net IRR on core brownfield funds to be less than 10%, while 60% expect infrastructure "light" funds to generate net IRRs of 17.5% or higher, much more like private equity87. Open-end funds can have more diverse strategies but most often they have high allocations to core projects. Consequently, their return expectations are most like core funds. Investors expect that debt funds will have the lowest returns, with 84% of investors expecting net IRRs of less than 10%.

[86] Financial Review: Superannuation wants to build infrastructure , John Kehoe Senior writer Jul 17, 2020: According to the new IMF CEO "The success of the infrastructure platform hasn't just been about generating strong returns for our investors and shareholders. Consistently over a long period of time, as the organization has grown and become more successful, it's created economies of scale that have been returned to investors in lower fees, forcing the rest of the industry to bring their fees down too"

[87] Source Probitas Partners' Infrastructure Institutional Investor Trends: 2019 Survey Results

Infrastructure Fund Fees

Management fees remain a contentious issue for infrastructure as in the alternative market passive asset managers as Vanguard are launching new cheapest products for pension funds. In a recent survey from 2019 PEI's Perspective Survey 45% of respondents pointed to management fees as the biggest point of contention from investors during the due diligence process with managers 88. 65% of investors surveyed asked their GPs for greater transparency and disclosure agreeing that fees charged by private equity funds are difficult to justify.

There is now greater appreciation of the diversity of risk/return profiles of infrastructure assets and this should be reflected in the fees charged to investors. It is understandable that a fund investing into greenfield assets in the emerging markets carrying greater risk and requiring appropriate management resources will charge a higher fee compared to a fund investing into brownfield assets in developed countries. There are various developments in fee structure that have taken place as a result of the market adjusting for differing opinions.

Fees on closed funds are on committed or drawn-down capital while fees on open-end funds are usually lower on a stated percentage basis and are calculated on the basis of Net Asset Value, increasing over time. Ultimately investors' return expectations drive what they are willing to pay in management and performance fees.

It is widely perceived that management fees should just cover the cost of running the fund on a day- to-day basis as opposed to providing a source of profit for the manager. Given the large size of funds, a level of 2 percent management fee, common for private equity funds is considered too high, particularly for brownfield core economic infrastructure assets in OECD countries (Watson Wyatt 2009).

In terms of performance fees, these are usually based on a hurdle rate and carried interest. Similarly, the hurdle rate will depend on the strategy employed and should be different for brownfield PPP/PFI assets in developed countries compared with development projects in emerging economies. Higher return strategies

[88] PEI's Perspective Survey 2019, https://www.infrastructureinvestor.com/management-fees-remain-sticking-point/

having higher expectations for hurdle rates, though on average around the 8% level. It is noted that managers should only earn a performance fee if it is adding value (or generating alpha) (Watson Wyatt 2009). One of the ongoing difficulties in determining an appropriate fee structure for infrastructure funds is the holding period for investments. Unlike private equity, where the typical holding period is 2 or 3 years, infrastructure investments may be held for 10 years or more, with many investors' preferences moving towards even longer holding periods. Measurement of the value added by a manager where there are long periods without a market event (i.e. divestment) is particularly challenging.

7.4.2.3 Co-investment platforms

At the UN Climate Action Summit in September 2019 the Danish pension industry has announced plans to invest more than Euro 46 billion in green transition towards 2030, through green stocks, green bonds and investments in energy efficient construction (UN 2019). Collaboration between Danish pension funds in the wind sector, helped by the government, allowed risk-sharing through partnerships, in the case of on-shore and off-shore[89].

Also Swedish funds are collaborating to invest in sustainable infrastructure. In 2019 the state controlled pension funds in Sweden - altogether known as the AP funds - found a new company whose purpose is to make broad investments in infrastructure. Each of the three funds has placed SEK 3bn in the new company, which has been named Polhem Infra. The fund was founded in order to spread the risk on different asset management strategies and comply with a new law entered in effect on January 2019 and requiring companies to make more sustainable investments[90].

Co-investment platforms have started to emerge in response to the dissatisfaction that many institutional investors shared with the infrastructure fund models being offered by financial intermediaries. In order to

[89] A notable example is the 2011 deal for the 400 MW Anholt offshore wind farm, in which PensionDanmark and PKA together acquired 50% at EUR 900 million (Clean Energy Pipeline, 2014).

[90] https://amwatch.dk/article11321416.ece

bypass the large fees associated with investing through unlisted equity funds, a number of large pension funds and sovereign wealth funds have looked at pooling their financial and internal resources to invest jointly in infrastructure projects. There have also been initiatives of partnering with other funds with more expertise (i.e. Canadian and Australian pension funds) on a deal-by-deal basis.

Large investors have opted to collaborate amongst themselves to benefit from a number of advantages: better alignment of interest with other pension funds, like-minded investment horizon, lower fees, better control of the characteristics of the investment, larger commitments, local knowledge, and a spreading of risk.

Pooled vehicles also face a number of challenges. Pension plans often have different strategies based on differences in strategic orientations, diversification targets, and exposure limits. Other potential challenges could result from issues such as governance, fees and compensation of investment professionals. In order to overcome these challenges, government support may be required to either help achieve co-ordination between the parties or provide access to attractive investment opportunities.

There are a number of useful insights that can be drawn from the co-investment platform analysed in this chapter. The Pensions Infrastructure Platform (PIP), in the UK received much media attention at the outset, as a novel way of attracting more pension funds to invest into infrastructure. Pensions Infrastructure Platform (PiP) was launched in 2012 - to focus on UK infrastructure - by pension schemes, to ensure better alignment, better value and better governance 91. A Multi-Strategy Infrastructure Limited Partnership was launched in 2016 to focus on direct investments into UK infrastructure assets .

While the benefits of the PIP structure seem clear, the implementation of the model has proved challenging. This has primarily revolved around the selection of an appropriate manager/administrator to drive the initiative forward without acting in a conflicted way and ensuring the interests of the pension

[91] https://www.pipfunds.co.uk/about-us/our-history/

fund members are transparently represented. Two years after the initial idea for the PIP was formulated, three of the initial founding member funds pulled out of the initiative[92].

The syndication model lead by CPPIB through its investment in the 407 toll road provides another example of an alternative, lower-cost model for pension funds looking to access infrastructure. The model provides benefits in that large investors are able to access investments with lower competition and lower costs. For the lead investor, scale is achieved with investment partners that have similarly aligned interests. However, despite the great attraction of the syndication model, it has been observed that the number of large, lead investors like CPPIB are limited and the deal flow for these opportunities may be scarce, making the repeatability of deals and their anticipatable nature difficult.

The Global Strategic Investment Alliance, initiated by OMERS, offers a co-investment infrastructure vehicle to other large institutional investors with lower fees and a longer hold attracting other like-minded investors. GSIA $12.5 billion co-investment programme investment period came to an end in April 2019. It has an institutional investor as its GP- OMERS (charging 50 basis points on invested capital, but no carry) and some of the world's largest investors as its LPs, including Japan's $1.4 trillion Government Pension Investment Fund, Pension Fund Association of Japan, and the Development Bank of Japan[93].

The vehicle focuses on very large projects - requiring a minimum enterprise value of $2 billion-plus – targeting funds that can make very large capital commitments. OMERS has invested over $3.8 billion through the Alliance, typically more than half of the capital required for every GSIA investment, ensuring long term alignment over the 15-year duration of the fund. A drawback of the GSIA is the restriction to large investors with not much scope for smaller investor involvement.

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[92] The BT and BAE Systems private sector funds and the London Pension Fund Authority (LPFA) Source: UK schemes abandon infrastructure platform over costs, returns – IPE By Taha Lokhandwala 26 February 2014

[93] What OMERS learnt managing third party capital? Source: 23 April 2019 Infrastructure Investor

7.4.2.4 Government-Led Initiatives

As indicated above, because of the politically sensitive nature of infrastructure assets, there are a number of initiatives instigated by governments that can facilitate institutional investment in this area. The government-led initiatives illustrated in this chapter including CDPQ Infra PINAI, Marguerite and PAIDF funds have entailed governments or development institutions directly contributing seed funds.

The Marguerite Fund, established by the EIB and a number of partners, is designed to support equity investments in new (greenfield) infrastructure projects in the areas of transport (TEN-T), energy (TEN-E) and renewables in European member states. The Marguerite Fund is an example of how a pooled investment vehicle can be set up for large institutional investors to invest in complex, idiosyncratic assets. The support of the European Investment Bank and European Commission has been crucial for reassuring institutional investor capital deployment into the fund. The fund has also had its challenges with the process taking in excess of 14 months to be set up. This was due mainly to negotiations over the terms and conditions of the manager of the fund. Investors have indicated that clear governance and transparency over fees and other terms was crucial to their involvement with the fund.

Marguerite, European Fund for Energy, Climate Change and Infrastructure ("Marguerite I"), was launched in 2010 with seed funding from six major European public financial institutions (National Promotion Banks and the EIB) and the European Commission. In 2020, the fund is fully invested with over EUR 700m equity and quasi-equity capital to 20 investments in 13 european countries. The second fund, Marguerite II has the goal to be a **catalyst for greenfield and brownfield infrastructure investments** in renewables, energy, transport and digital infrastructure. Marguerite Pantheon SCSp is an investment vehicle with a portfolio of renewable and concession-based assets in the secondary market, owned by a pool of investors

Both the **PINAI and PAIDF funds** provide examples of how public seed capital can be used to attract institutional infrastructure investment into the emerging economies. While the fees for both of these funds may be akin to private equity fees, the greater risk associated with investing into emerging economies has warranted the extra cost associated with these vehicles. Government assistance again provides assurance to

investors for investing in these slightly riskier assets and also helps provide access to deal flow in an off-market‟ way. The PAIDF however believes that the government could have provided their fund better regulatory support for catalysing foreign investment into infrastructure assets in Africa.

Collaboration models have been developed for greenfield investment where an institutional investor, such as a pension fund, plays a significant role in project development and management, in effect, throughout planning, construction, financing, and operating stages. In such instances, investors have expressed a strong desire for long dated investment and are willing to manage construction and development risks in partnership with public sector counterparts, while earning a commensurate return for taking on risks.

A new "one-stop-shop" model was develop by CDPQ Infra - wholly owned by Caisse de dépôt et placement du Québec - and the government of Quebec. Under this model, CDPQ Infra is responsible for developing and operating infrastructure projects, including the USD 6.3 billion Réseau express métropolitain (REM) scheduled for 2021. The REM is under construction according to the plan and CDPQ Infra is expecting to achieve a minimum return of 8%, threshold at which the two minority shareholders - Quebec and Ottawa – will receive royalties and that will allow to recover the initial capital investment ($2.6 billion). The new transportation system attract 160,000 users a day – will diminish congestion in Montreal's roads and subways. NZ Super Fund, the New Zealand equivalent of the Caisse de dépôt, has identified CDPQ Infra as a potential partner to develop a light rail system of about 60 kilometers in the city of Auckland, valued at around 5.3 billion[94]

[94] They submitted a proposal to the Government in November 2019, as part of a competitive bid process to fund, deliver and operate the light rail project. Ultimately, following delays to decision-making caused by the Covid crisis, and with the governing parties unable to agree on the way forward, the Government ended the bid process without selecting a preferred delivery partner for the project. Sources : http://pensionpulse.blogspot.com/2020/06/cdpq-infra-derailed-in-auckland.html https://www.nzsuperfund.nz/assets/Uploads/Guardians-Annual-Report-2020.pdf

7.5 DEVELOPING SECONDARY MARKETS FOR LOW CARBON INFRASTRUCTURE

The absence of an efficient capital market for infrastructure represent a barrier to the financing of new projects (e.g. impeding recycling of capital) and the development of infrastructure as an asset class. Providing the banking sector with recyclable liquidity will become increasingly important as demand for sustainable investments accelerates. The ability of banks to replenish sustainable capital crucially underpins economic growth and sustainable development in the 21st century and securitisations are a robust mechanism of achieving this (SEB & others 2018).

The role of governments goes much further than providing assistance in setting up infrastructure funds. To guarantee the success of these initiatives governments need to provide mechanisms to catalyse foreign investment, assist with more favourable regulatory conditions for investments and collaborate on all aspects of investment more transparently. Governments first priority is on the formation of primary markets for infrastructure creating a pipeline of low-carbon infrastructure assets to help investors assess investment opportunities and transparent bidding processes.

Considering the scale of financing that will be required to retrofit existing infrastructure and build new infrastructure over the next decade, particularly in developing countries, development banks and finance institutions will need to play a significant part in helping countries shift from 'billions to trillions', deliver on their Nationally Determined Contributions (NDCs) and transition to low-emission and climate-resilient infrastructure, both within and outside the G20.

The specific profiles of institutional investors highlight the need for expanded and diversified channels of financing for low carbon infrastructure, which can cater to long term investment horizons, risk appetites, liquidity needs, and capacities to invest in potentially complex and large-scale projects.

Different level of development, country and sector specifics will **imply different sets of products and viable solutions. As many investors perceive a lack of suitable financing structures increasing private**

capital into sustainable infrastructure will require the expansion of financial instruments available for LTI (e.g. bonds, equity, basic securitisation of loans).

Developing countries face difficulties in accessing both equity and debt finance in both the early and later stages of the project cycle, due to immature capital markets. IMF survey findings suggests funding and absorptive capacity constraints are a common impediment to scaling up infrastructure investment across low income countries (IMF, 2017). In the survey availability of external finance and administrative capacity were seen as key barriers in fragile states, while availability of domestic resources and concerns about debt accumulation were most important for low income economies.

7.5.1 Role of Green and Development Banks

Infrastructure state-owned banks, as well as development or green banks and finance institutions (NDBs, MDBs and bilateral DFIs and Export Agencies) are playing an increasing role accelerating private sector investment in green infrastructure and developing secondary markets for sustainable infrastructure. Through their interventions they aim to (i) use blended finance investing alongside the private sector to crowd-in investment (ii) improve liquidity in the secondary market; and (iii) signal to the investors community, national commitment and future opportunities for refinancing and acquisition.

The involvement of development banks (national, multilateral and bilateral) and state-owned banks in financing infrastructure is particularly evident in the primary financing of infrastructure, highlighting the importance of their role in de-risking investment for greenfield projects. Their expertise and capacity is key to finance feasibility studies and preparation of projects, including elements of commercial viability, in preparation for private sector investment at later stages. This is particularly true in developing countries which have poorer credit ratings or where the perception of risk is high and long-term finance remains constrained.

Development banks are also partnering with industry to help facilitate investment into low carbon markets. As an example of a pure equity investment, Google, along with the Public Investment Corp (PIC) and the

Development Bank of Southern Africa, financed the USD 230 million Jasper solar PV project in South Africa. A cooperation between the Development Bank of Japan and the Japan Wind Development Co., Ltd. has been set up as part of Japan's **first capital recycling model to expand the use of wind power in Japan**.

Blended finance for low carbon infrastructure is also increasing rapidly with enhancement instruments (foe example first loss positions), credit support, maturity and credit tranching, as some of the instruments that can help to reach long term investors with different preferences.

Furthermore, governments and MDBs can adopt **innovative approaches to financing early project phases,** such as the use of debt and debt instruments that convert into equity. Such a transfer of financial ownership to private investors provides a return to initial lenders which may be recycled into other infrastructure projects.

In recent years green investment banks have been created to act as a catalyst to accelerate private sector investment in clean energy. Launched in 2014 the NY Green Bank provides long-term refinancing to clean energy projects with merchant risk to facilitate their acquisition. The NY Green Bank targets operational projects that do not benefit from long-term offtake agreements and are exposed to market risk[95].
The Green Investment Bank in the UK had a funding of over £3.8 billion from the government, additional to private sector finance acting as a co-investor. Eighty percent of the investments were targeted towards the priority sectors of offshore wind, waste recycling, waste-to-energy, and non-domestic energy efficiency. UK government's sale of Green Investment Bank was completed in August 2017 with the new owner Macquarie committing to the GIB's target of leading £3 billion of investment in green energy projects over the next 3 years. However there are doubts about the opportunity of selling GIB and recent recommendations to the government include a re-institution of a green bank in the UK[96].

[95] https://greenbanknetwork.org/ny-green-bank/

[96] In an evaluation conducted for the UK house of commons this decision is criticised as the Government chose to sell GIB before fully assessing its impact, prioritising reducing public debt and how much money could be gained from the sale over the continued delivery of GIB's green objective (House of Commons (2018)) The committee of

The G20 called on MDBs to optimize their balance sheets in 2015 for additional infrastructure and development lending. Unfunded facilities as the risk mitigation scheme product used for the Elazig PPP in Turkey by MIGA and the EBRD address DFI's balance sheet constraints while leveraging the participation of private market funding from institutional investors[97]. Synthetic securitisations can help green and development banks to expand their lending capacity while engaging private sector investors.

MDBs and Export Credit Agencies (ECAs) could recycle infrastructure loans from their balance sheets into capital markets, insofar as the assets have been de-risked and have reached operational status and proved a good operational track-record. Some of these loans may be on terms that are overall in line with the current market, and thus could attract interest from investors, freeing up capacity for new projects.

However, MDBs and ECAs are not well equipped to work with securitisation models as their lending and guarantee platforms are designed principally for banking. For example transfer of ECA guarantees would need to be secured for the securitisation vehicle, implying ECAs education and capacity to build comfort with securitisations.

As the first synthetic securitisation between a DFI – the African Development Bank (AfDB) and private investors, Room2Run has created a framework that can be broadly applied across DFIs, allowing them to more aggressively work toward achieving the UN's 17 SDGs. Room2Run proved that private sector investors are interested in investing alongside DFIs at various places in the capital stack, not just in the most senior positions. In January 2020 AfDB's president announced that about $600 million has been

Public Accounts that conducted the evaluation asserted that the sale to Macquarie for GBP 1.6 billion was a misjudgement not having assurance over s future investment in the UK green sector and in emerging technologies (see https://publications.parliament.uk/pa/cm201719/cmselect/cmpubacc/468/468.pdf)

[97] In 2016 MIGA and EBRD collaborated to offer first liquidity-backed political risk insurance for greenfield project bond developed with infrastructure investment firm Meridiam.

invested by the African Development Bank (AfDB) in Africa for the development of renewable energy in the continent thanks to additional lending capacity.

7.5.2 Role of Listed Equity Instruments

New instruments can be helpful tools for bundling, scaling up and selling infrastructure investment. Given the cost, complexity, and risks of infrastructure investment, requiring specialised expertise and staff, not all investors are able to invest through private markets. A number of institutional and retail investors seeking to gain exposure to infrastructure assets prefer instead to invest through publicly listed securities.

Attracting investment through public equity markets may also be an attractive method for countries that lack significant scale or capacity in private markets investment, or that have growing retail investor bases, pension savings, or foreign investment in listed shares.

Infrastructure trusts can be established by governments as separate legal entities, which hold and manage multiple brownfield infrastructure assets. Private investors of all – even smaller – sizes can hold units of the trust, and receive distribution payments on a periodic basis. For instance, the government of India has created **Infrastructure Investment Trusts (InvITs) as part of its Brownfield Asset Recycling for Infrastructure Investment (BAR).** InvITs are **trust based structures that raise funds from long term institutional investors**. Investors have a claim on a dedicated revenue stream generated by mainly operating assets, which are governed under a strong regulatory structure. The infrastructure project's operation could remain with the current operator. **By raising capital from private investors, the BAR via the InvITs creates liquid capital for the construction of new infrastructure assets.**

Currently, India has five operational InvITs, of which three stem from the road sector, three from the power transmission sector and one from oil and gas pipelines. These InvITs have raised approx. USD 3.2 billion over last two years. Additional InvITs are in the offing in the telecom tower and optic fibre sectors

(Reliance Group), as well as in the renewable energy sector (CPPIB and Piramal)[98]. Foreign Institutional Investors such as Canadian Pension Funds (CPPIB, OMERS), Allianz Capital Partners, Singapore's GIC and a Brookfield Group subsidiary have invested in India's InvITs as well as Multilateral Development Banks and DFIs such as the AIIB, the IFC and the DEG (German DFI).

A number of countries have already established real estate investment trust (REIT) legislation that can act as a blueprint for a clearly defined purpose built infrastructure investment trust (IIT). As REITs are defined by clear rules in qualifying assets, income, taxation, and distribution, a similar approach to infrastructure using a listed fund structure could be considered (OECD 2020).

The Yieldco concept was modelled on listed real estate investment trusts (REITs) and Master Limited Partnerships, which are used in the United States to hold low risk infrastructure assets.[99] YieldCos are publicly traded companies created by a parent company that bundle operating infrastructure assets to generate predictable cash flows that are then paid out in dividends to shareholders.

Developments in the United States yieldco market have tested their structures and raised questions about their future (OECD 2016c). Since yieldcos were established to hold cash-flow generating assets and are committed to distribute all available cash to investors as dividends,[100] this would imply that much of the expected return to investors would be in the form of income instead of capital growth. Yet many yieldcos included aggressive dividend growth policies as part of their earnings guidance. A steep drop in yieldco equity prices in 2015, prompted by flaws in the business model and also contagion from falling fossil fuel prices, closed off access to capital markets and brought the yieldco machine to a halt. While falling stock prices lead to rising dividend yields, they made growth through new acquisitions unfeasible due to depressed stock prices. As a result, investors are re-evaluating the yieldco model.

[98] Source: OECD survey; EconomicTimes (2020)

[99] Master Limited Partnerships are a type of limited partnership that is publicly traded, and is representative of the midstream conventional energy sector. Since securities law in the United States does not currently include wind and solar projects as qualifying assets, yieldcos were launched starting in 2012 as an attempt to mimic the MLP model for renewable electricity assets.

[100] NRG Yield Inc., Prospectus, Form S-1 Registration Statement Under the Securities Act of 1933.

In the more conservative UK, which still has a strong Yieldco market, they were sold as very low risk, income producing investments; and they have delivered. Among the fifteen largest public market deals of 2019, six were secured by investment funds and yieldcos (UNEP 2020). Amon the largest deals several UK transactions including Greencoat UK Wind raising $488 million in a secondary offering, the Renewables Infrastructure Group raising a total of $370 million., Aquila European Renewables Income Fund, raising $173 million through an IPO.

To make viable the yieldco model stronger and more responsible corporate governance along with greater transparency of asset transactions (drop-downs from sponsor) is necessary. In addition, reforms such as higher carbon prices and stronger climate mitigation policies could make investment in renewable energy, through public equity markets, more attractive by making returns more competitive with conventional energy.

7.5.3 Role of Securitization

Securitised products targeted at green infrastructure could help to mobilise investment by pooling risks and diversifying across various countries and projects. Securitisation models may not always be a viable option for infrastructure. Challenges include: the heterogeneous nature of infrastructure assets, lack of standardisation, lack of viable collateral, high risk charges for securitisation products, and diversity of governing sectoral regulation. On the other hand, small-scale bank loans essential for investment in energy efficiency and renewable energy (such as small-scale solar) could offer good opportunities for securitization.

In particular, there is massive potential in achieving energy efficiency in buildings, infrastructure, and industry. However as investment is difficult to monetise, financing for energy efficiency may not be happening at the scale needed due to difficulties in capturing the financial value of the investment. Policy reforms that make energy efficiency profitable and create demand will scale up lending through such channels.

Securitisation could be a way to tap capital markets liquidity when projects need to refinance and provides capital relief for banks, allowing them to recycle lending capacity into new projects. A key advantage of securitisation, where it is based on the pooling of similar operational assets, would be the creation of a more liquid secondary market, with a much reduced need for a detailed review of assets and greater ability to benchmark different assets. Currently, secondary market transactions of project finance deals require an in-depth review given their specificities.

Collateralised loan obligations (CLOs) could help financing the energy transition. Energy infrastructure projects loans can be included into a CLO structure and transformed into a liquid asset class for the debt capital markets (SEB & others 2018). Renewables markets with long-term contracted power purchase agreements and availability-based projects, could be candidates to explore given their relatively straightforward structure and the ability to assess counterparties or final payers.

However only well-defined and proven high quality brownfield assets are viable as a basis for securitisation models, which may mean that such models may be more suitable for developed markets where much infrastructure has already been built (and where capital markets are deeper and more diverse).

In addition for investors regulation such as Solvency II could represent a major barrier to investment.

Several initiatives state driven attempt to attract institutional debt into infrastructure financing. For example in 2020, the Asian Infrastructure Investment Bank (AIIB) backed by the Singapore government has set up a **securitization platform w**ith Singapore-based Clifford Capital. Aim of this initiative is to help infrastructure lenders sell loans and recycle their capital into new projects offering long-term investors an asset class to invest their portfolios.

The first Asian infrastructure project finance securitisation was performed in 2018 by Clifford Capital. Among the investors, institutional investors across regions including insurance companies, pension funds, endowment funds. Accessing project and infrastructure loans in a credit enhanced structure.allowed capital recycling for banks channelling new capital for Asia's infrastructure financing, contributing to the creation of an investible asset class for institutional investors.

In 2018, the National Australia Bank (NAB) **bundled eight loans it had extended to seven renewable energy projects, into a portfolio worth AUD 200 million.** The bank packaged 75% of the portfolio into a close-ended investment vehicle that issued project bonds to private investors, including institutional investors. CEFC made an AUD 90 million cornerstone investment in the offering to catalyse institutional investors[101].

Insurance Australia Group, the largest insurance company in Australia, invested AUD 50 million alongside CEFC (OECD 2020). In a first for Australia, the NAB low-carbon shared portfolio provided institutional investors an opportunity to get exposure to clean energy infrastructure without investing in single projects directly. The loan repayments provided by underlying projects are passed-through to institutional investors and other bondholders. NAB retained 25% of the portfolio on its own balance sheet and absorbed the management costs. **The transaction allowed NAB to free-up capital to finance new projects by shifting assets to investors with commensurate risk appetite.**

[101] As reported in OECD (2020) with sources: https://www.cefc.com.au/case-studies/nab-low-carbon-shared-portfolio-opens-up-investment-opportunities/ https://www.iag.com.au/sites/default/files/Documents/Climate%20action/IAG_Climate_Action_Plan_October_2018_1.pdf; https://www.climatebonds.net/files/files/2018-06%20AU%20NAB%20Trust%20Services%20Limited.pdf; https://news.nab.com.au/more-investment-in-renewable-energy projects/;https://greenbank.ny.gov/Investments/Portfolio;

7.6 CONCLUSIONS AND IMPLICATIONS

Re-conceptualization of intermediation: Looking for a new Era of Investing

Major constraints for institutional investors in infrastructure relate to the relatively high cost of financial intermediation and the pervasive mis-alignment of interests embedded in their principal-agent based investment model (Ambachtsheer, 2017; Monk and Sharma, 2018). Relevant in particular for infrastructure many funds recognize that the long chain pf principal agent relationship has allowed for a distortion of their overarching objectives (Amabachsteerr 2013). A re-conceptualization of intermediation, reframing finance will lead to a revitalization of infrastructure as an asset class and a new era of infrastructure investing (Clark, Monk Orr Scott 2011).

Clearly, different countries are at different stages in the evolution of pension fund investment in infrastructure (Chapter 4). Factors accounting for the growth of pension fund infrastructure investment include the availability of investment opportunities for private finance and for pension funds; the maturity and size of the pension fund market; pension fund regulation and financial intermediation playing a key role in letting investors access opportunities.

Despite the evolution, overall asset owners have shown a lack of institutional innovation, highlighting a stasis related to the reactive nature of these institutions. The current organization and management typically reflects their establishment, in many cases looking back over 50 to 70 years. This stasis is remarkable given the transformation of the investment management industry over the past 25 years. At the limit the crisis facing the US state and local public pension fund sector is illustrative of the costs and consequences of institutional stasis. Recent event such as the COVID and the GFC crisis though can fundamentally alter perceptions about the desiderability of the status quo.

Investors are adopting different models for institutional investment in infrastructure. Among the drivers, the development of novel, and less resource intensive, mechanisms to overcome the barriers to efficient long-

term investment and aligned access to private markets (Clark, Monk Orr Scott 2011). Innovation in organisational form and functions are perceived to be solutions to the apparent disconnect between the dated institutional investment model and the new realities of global markets.

Matching the evolution in the nature of risks with different types of financing: attracting Institutional Investors and Recycling Capital

To respond to the long-term investment demand and attract alternative sources of finance such as institutional investors, new financial instruments and forms of collaboration beyond traditional instruments are needed. This can make infrastructure as an asset class more accessible to a broader group of investors and help to diversify the large risks of infrastructure projects - currently shouldered largely by the banking sector and the public sector through guarantees - across many groups of investors through the capital markets

The financial market and asset management industry have a crucial role in providing sustainable solutions matching the evolution in the nature of risks over the project lifecycle with different types of financing. Once infrastructure projects reach, the operational phase there is potential to crowd-in institutional investors. This allows for a recycling of equity and bank finance and the recycling of public funds that can be used for new investments.

The development of a secondary market for infrastructure will facilitate the recycling of capital. Efficient secondary markets could optimise risk pricing and reduce the overall cost of capital for infrastructure projects. The creation of a secondary market would help then to reinforce partnership models and engage with institutional investors who may prefer to invest in operational assets, while using traditional sources of finance (such as utility balance sheets and bank loans) during the construction phase.

The absence of an efficient capital market for infrastructure represent a barrier to the financing of new projects (e.g. impeding recycling of capital) and the development of infrastructure as an asset class. Providing the banking sector with recyclable liquidity will become increasingly important as demand for sustainable investments accelerates. The ability of banks to replenish sustainable capital crucially underpins

economic growth and sustainable development in the 21st century and securitisations are a robust mechanism of achieving this (SEB & others 2018).

Pooling Institutional Investors Capital for low carbon infrastructure

New partnerships have been launched to invest in low carbon infrastructure and financing models are emerging for energy efficiency and renewable energy projects. Partnership models emerge as a way to leverage traditional bank and utility finance in primary markets with trends in secondary markets, M&A, asset management, and institutional investment demand. There is increased co-operation between utilities, banks and financial investors in the renewable sector, and in infrastructure investments, in general.

Equity funds formed as partnerships to leverage institutional investors capital are examples of new investment models for public and private sectors to fund infrastructure projects in developed and also developing countries. They could become important sources of risk sharing finance as well as providers of organizational capacity and expertise in support of the financing of infrastructure projects. The example of the Danish pension and wind industry is instructive in this sense, in the case of on-shore and also recently off-shore.

Main drivers of these initiatives to pool institutional investors capital have been the recognition that each individual institutional investor might not have the resources and expertise necessary to make direct infrastructure investments and might also not have the scale and risk appetite to invest. Many investors also voiced concerns with the asset manager - asset owner relationship and the desire to partner with other like-minded investors. It was felt that asset managers (*i.e.* infrastructure funds), were not representing the long-term interests of asset owners (i.e. pension funds) and there seemed to be a significant governance gap. Finally, in emerging market economies additional solutions are needed to face the large gap between investment needs and investment supply.

With regard to unlisted infrastructure funds, it is recognised that a spectrum exists for the level of fees and terms and conditions of unlisted funds, similar to the spectrum of risk and return characteristics that exists for the different infrastructure investments. For example, funds investing in greenfield projects in emerging

economies, where risks are greater and the required expertise is greater, would be expected to charge higher fees than funds that invest in brownfield core economic infrastructure assets in developed countries. As a result of growing investor dissatisfaction, investment managers have had to make adjustments to the terms and conditions of their funds.

Recent initiatives have seen governments or development institutions providing assistance by setting up infrastructure funds and contributing directly through seed funds. Initiatives such as the establishment of CDPQ Infra, Pan African Infrastructure Development fund, the Philippine Investment Alliance for Infrastructure fund and the Marguerite fund in Europe provide examples of how funds can be set up with government involvement to help attract institutional investment in the much needed investment areas of the emerging economies and greenfield infrastructure. Examples of national and multilateral development banks actively involved include the African Development Bank, Asian Development Bank and the newly created Asian Infrastructure Investment Bank.

Developing Secondary markets for low carbon infrastructure

By pooling assets, securitisation, yieldcos and new listed vehicles could widen the access to and transparency of infrastructure investment while diversifying risk and lowering the cost of capital. Aggregating portfolios of loans from the balance sheet of banks, these products are well suited to refinance small scale assets such as distributed solar PV or efficiency projects. The creation of a more liquid secondary market, with a much reduced need for a detailed review of assets and greater ability to benchmark different assets.

The importance of capital market intermediation is crucial when considering private sector participation in long-term investment financing. Well-functioning and deep capital markets are needed to offer a wider range of instruments to channel long-term finance. The variety of liability profiles of institutional investors highlight the need for expanded and diversified channels of financing for low carbon infrastructure which

can cater to different investment horizons, risk appetites, liquidity needs, and capacities to invest in potentially complex and large-scale projects.

Infrastructure state-owned banks, as well as development or green banks and finance institutions (NDBs, MDBs and bilateral DFIs and Export Agencies) are playing an increasing role accelerating private sector investment in green infrastructure and developing secondary markets for sustainable infrastructure. Through their interventions they aim to (i) use blended finance investing alongside the private sector to crowd-in investment (ii) improve liquidity in the secondary market; and (iii) signal to the investors community, national commitment and future opportunities for refinancing and acquisition.

The G20 called on MDBs to optimize their balance sheets for additional infrastructure and development lending. Unfunded facilities as risk mitigation scheme products and synthetic securitisations can help development banks to expand their lending capacity, engage private sector investors, maintain or even improve their rating, and reduce reliance on limited public-sector resources.

Attracting investment through public equity markets may also be an attractive method for countries that lack significant scale or capacity in private markets investment, or that have growing retail investor bases, pension savings, or foreign investment in listed shares. Infrastructure trusts can be established by governments as separate legal entities as part of their Asset Recycling programs. By raising capital from private investors, these programs via investment trusts create liquid capital for the construction of new infrastructure assets. Contrary to the US better structuring and marketing of Yieldcos products in the UK has proven their viability.

Collateralised loan obligations (CLOs) and other securitised and structured financial products could play a critical role in financing global sustainable infrastructure investments at scale and pace. Loans for sustainable energy infrastructure projects can be incorporated into a CLO structure and thus be converted to a liquid asset class designed for the global debt capital markets SEB & others (2018). Renewables markets with long-term contracted power purchase agreements and also availability-based projects, could

be candidates to explore given their relatively straightforward structure and the ability to assess counterparties or final payers. Small-scale bank loans essential for investment in energy efficiency and renewable energy (such as small-scale solar) could offer good opportunities for securitization.

Catalyse institutional investors for low carbon infrastructure

As many fiscally constrained governments seek greater levels of private finance in infrastructure, there is a growing need to leverage private financing and "blend" scarce public money with private resources through various instruments (investment grants, interest subsidies, and first-loss guarantees). Governments focalise there effort on being more innovative in the way they fund projects, using new financial instruments and techniques, and optimising risk allocation amongst the respective stakeholders. This is particularly important in developing economies where investment is sometimes further hindered by weak policy frameworks and governance.

Despite the positive net contributions of certain investments to economic welfare, market failures and differing incentives can prevent investors from taking certain risks and/or making certain investment decisions. A key role for the public sector is to leverage the government balance sheet through risk mitigation instruments for infrastructure projects and attract private sector capital. Financial instruments create a multiplier effect for public funding by facilitating and attracting other public and private financing for projects. The use of innovative instruments can be expanded in order to stimulate knowledge-sharing, critical mass, economies of scale, standardisation and risk sharing among project stakeholders.

Infrastructure state-owned banks, as well as development or green banks and finance institutions (NDBs, MDBs and bilateral DFIs and Export Agencies) are playing an increasing role accelerating private sector investment in green infrastructure and developing secondary markets for sustainable infrastructure. Through their interventions they aim to (i) use blended finance investing alongside the private sector to crowd-in investment (ii) improve liquidity in the secondary market; and (iii) signal to the investors community, national commitment and future opportunities for refinancing and acquisition.

Financial and energy reforms to create a Secondary Markets for low carbon infrastructure

The financial market and asset management have a crucial role in providing sustainable-targeted solutions to cater long-term demand from investors, matching their appetite for risk with opportunities in low carbon infrastructure.

The absence of an efficient capital market for infrastructure represent a barrier to the financing of new projects (e.g. impeding recycling of capital) and the development of infrastructure as an asset class. Providing the banking sector with recyclable liquidity will become increasingly important as demand for sustainable investments accelerates and the impact of the COVID induced crisis has an impact. The ability of banks to replenish sustainable capital crucially underpins economic growth and sustainable development in the 21st century and securitisations are a robust mechanism of achieving this (SEB & others 2018).

As shown in chapter 7, governments around the world are trying to bring more institutional debt into infrastructure financing setting up securitization platform as the one launched in 2020 by the Asian Infrastructure Investment Bank (AIIB) and backed by the Singapore government. In order to build confidence in the yieldco model, greater transparency of asset transactions (drop-downs from sponsor) is necessary, along with stronger and more responsible corporate governance. In addition, for investors regulation such as Solvency II could represent a major barrier to investment.

Ultimately, financial market developments need to be accompanied by major energy reforms. There is massive potential in achieving energy efficiency in buildings, infrastructure, and industry. However financing for energy efficiency may not be happening at the scale needed due to difficulties in capturing the financial value of the investment. Policy reforms that make energy efficiency profitable and create demand will scale up lending through such channels. Additionally, reforms such as higher carbon prices and stronger climate mitigation policies could make investment in renewable energy, through public equity markets, more attractive by making returns more competitive with conventional energy.

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ANNEX - 1 G20/OECD REPORT ON THE COLLABORATION WITH INSTITUTIONAL INVESTORS AND ASSET MANAGERS ON INFRASTRUCTURE

This report presents the outcomes of a prolonged dialogue with private sector investors in infrastructure, as part of a collaboration facilitated at the initiative of the G20 Infrastructure Working Group (IWG) under the Saudi G20 Presidency in 2020, supported by the OECD. It seeks to convey the perspectives of asset owners and managers on ways to overcome the infrastructure investment gap, by identifying selected key issues and challenges, providing proposals for G20 Finance Ministers and Central Bank Governors.

This initiative aims to promote an enhanced and sustained dialogue and collaboration with institutional investors and asset managers which is necessary to address, systematically and progressively, the challenges and issues that are impeding increased investment in quality and sustainable infrastructure. As such, the initiative fits within the G20 IWG effort in recent years to promote infrastructure as an asset class, which have been guided by the G20 Roadmap to Infrastructure as an Asset Class (2018) that draws together, in a holistic and forward looking way, the critical steps needed to develop infrastructure as an asset class and promote investible projects. The initiative also focusses especially on the quality and sustainability aspects of infrastructure, included in the Roadmap and extended widely in the new G20 Principles for Quality Infrastructure Investment (2019).

The report reflects discussions held over four seminars/symposia: a conference held in September 2019 in Riyadh on the margins of the G20 IWG meeting under the Japanese Presidency; a workshop held in October 2019 back to back with the meetings of the G20/OECD Task Force on Long-term Investment; a Symposium held in December 2019 in Riyadh, back to back with the meetings of the G20 IWG; and a seminar was held at the OECD in February 2020. Furthermore, it reflects numerous conference calls and interviews held with investors from March to June 2020, as well as written inputs, as the dialogue was adapted in light of the evolving covid-19 outbreak.

The report was developed in consultation with G20 IWG and G20/OECD Task Force members and observers, who provided numerous comments on the report at the meetings and in written form, reflecting

a dialogue and collaboration on the issues covered in the report. Over 100 investors participated in events, delivered input, or feedback for the report, reflecting assets under management of over USD 20 trillion across a wide geography, including investors based in 28 countries.

ANNEX - 2 CASE STUDIES/ADDITIONAL INFORMATION USED IN CHAPTER 7

Name	AUM (mn)	Geography	Launch Date
Meridiam Infrastructure Sicar	Eur 750	OECD	2006
Queensland Investment Corporation Global Infrastructure (QIC)	$8,300	North America	2006
Industry Fund Management	A$13,000	Australia	1995
Pension Infrastructure Platform	GBP 500	UK	2011
Global strategic Alliance	$7500	Global	2012
Philippines Investment Alliance for Infrastructure Fund (PINAI)	$625	South Asia	2012
Pan African Infrastructure Development PAIDF	$1200	Africa	2007
Margueritre Fund	$710	Europe	2012
Marguerite Pantheon SCSp		Europe (secondary market)	2020
CDPQ Infra (REM project)	$6,300	Canada	2020
Building Australia Model, new IFM Procurement Model	n.a.	Australia	2020
AIIB sets up securitization platform with Singapore-based Clifford Capital	US$ 458	Singapore, South East Asia	2020
African Development Bank Room2Run synthetic securitisation	US$ 1,000	Africa	2020
APG Sustainable CLO Case Study – Hypothetical Evaluation Approach	n.a.	Europe	2020

ANNEX - 3 CASE STUDIES/ADDITIONAL INFORMATION FOR SECTION 4

The Building Australia Model, new IFM proposed Procurement Model [102]

Following the COVID-19, industry super-owned IFM Investors is proposing a new infrastructure investment model – the Building Australia Model - to better meet the needs of governments and the public.

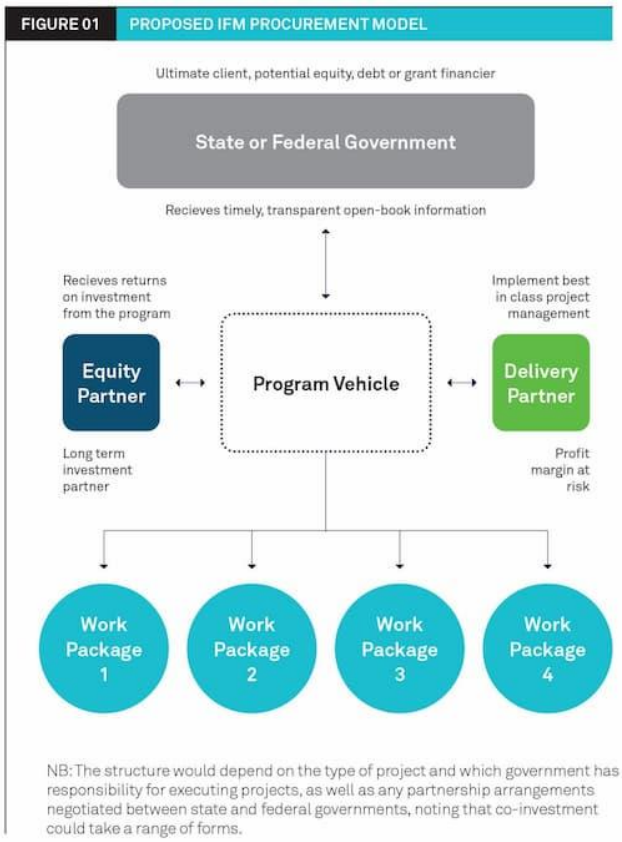
Current issues Disputes and cost blow-outs

In Australia, the current procurement model for large infrastructure projects is not working as well as it could be. This is because it relies on attracting large constructors whilst limiting the role for local medium-sized constructors and long-term equity owners. When things go wrong with construction, equity providers are passive. This effectively transfers construction and budget risk back to governments, and is resulting in substantial delays and cost overruns in some large projects. Furthermore, bidding consortia tend to be dominated by participants that exit and earn their profits shortly after construction is complete. They have little if any interest in the infrastructure asset's long-term operational performance and outcomes for the public.

As reported by Financial Review, big and complex government-backed infrastructure projects have been plagued by cost blow-outs and delays, leading to costly legal disputes between state governments and construction contractors.For example the Spanish group building a light rail line in Sydney, Acciona, pursued a $1.1 billion lawsuit against the NSW government and $1.5 billion of financial claims. The dispute was settled after the state government agreed to spend an extra $576 million to help Acciona finish the project. The total cost of the project almost doubled from $1.6 billion, when contracts were signed at the end of 2014, to $2.9 billion last year. In Victoria, the $6.7 billion West Gate Tunnel was delayed after the state government, Transurban and the project's builders, John Holland and CPB Contractors, disputed who should pay the extra costs for contaminated soil.

[102] Source: IFM website, Interview with new IFM CEO: Bring on the projects and get things moving, September 10, 2020 in Insights, Investment, Interviews; Financial Review: Superannuation wants to build infrastructure , John Kehoe Senior writer Jul 17, 2020

Figure 13 Proposed IFM procurement model: Building Australia



Source : IFM website

The Building Australia Model

The Building Australia Model is based on the idea of governments bringing in a well-capitalised, aligned long-term equity partner early on in a project selected through a competitive public tender process.

The long-term equity partner would help governments deliver better value for money, as well as improved collaboration on design and engineering, better risk allocation and more transparency during the procurement and delivery process. By working together sooner, this could lead to:

■ breaking major projects up into smaller packages, **enabling projects to be shovel-ready faster** and allowing midtier contractors to compete in bidding processes, stimulating job creation and construction

■ less risk for taxpayers, with **more active management of projects** by the longterm equity partner, enabling issues to be identified earlier and dealt with quickly

■ more **transparency and greater cooperation** by jointly developing project scope, delivery milestones and project costings, and

■ **more effective risk transfer to the private sector**, as equity partners have an incentive to ensure the project delivers a quality service to the community at a reasonable price over the long term.

There are issues though to governments implementation related to current market conditions. According to the new IFM CEO interviewed by Insights, Investment, Interviews in September 2020: "What stops it happening is government's entrenched views as to the best way of doing things. To be fair, they'll also look at their own cost of funds at the moment and say, 'well, that's really cheap. Maybe we don't need to pay the appropriate return that a long-term equity owner needs'.

CDPQ and Montréal light rail project[103]

A new "one-stop-shop" model including development, construction and operation was developed for the Montréal light rail project. The government of the province Quebec, Canada, announced in January 2015 a long-term agreement with Caisse de depot et de placement du Quebec (CDPQ), a long-term institutional investor managing primarily funds for public and parapublic pension and insurance plans. CDPQ has considerable experience in infrastructure investment. The agreement is designed to span multiple major infrastructure projects, each defined separately. The government may entrust Caisse with planning, construction and operation of a project, thus financing it off-balance sheet, while Caisse seeks commercial returns for its stakeholders. This direct agreement between a (regional) government and an institutional investor is a novel approach to collaboration.

CDPQ Infra is a wholly owned subsidiary of Caisse de dépôt et placement du Québec and is responsible for developing and operating infrastructure projects, including the Réseau express métropolitain (REM). The REM is a new, integrated 67-km public transit network intended to link downtown Montréal, the South Shore, the West Island (Sainte-Anne-de-Bellevue), the North Shore (Laval and Deux-Montagnes) and the airport through an entirely automated and electric light rail transit (LRT) system.

CDPQ Infra suggested building a single automated network of 26 stations spread over 67 km, which would connect several sectors of the metropolitan area. A project of 6.3 billion with a commissioning scheduled for 2021.

[103] Sources : Presentation of ProjetRem, November 2016, CDPQ Infra
http://pensionpulse.blogspot.com/2020/06/cdpq-infra-derailed-in-auckland.html

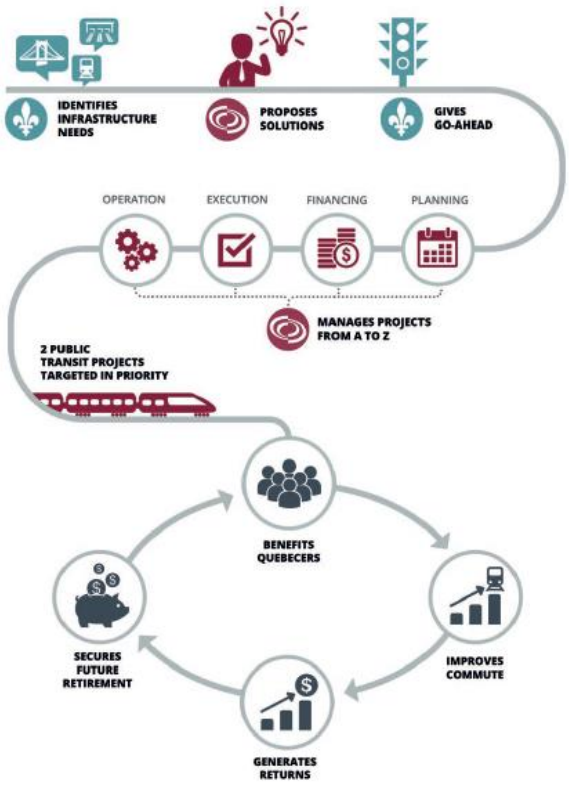
https://www.nzsuperfund.nz/assets/Uploads/Guardians-Annual-Report-2020.pdf

https://www.lapresse.ca/affaires/economie/transports/201807/30/01-5191257-rem-montreal-dabord-le-monde-ensuite.php?utm_categorieinterne=trafficdrivers&utm_contenuinterne=cyberpresse_les-plus-populaires-affaires_article_ECRAN1POS1

The REM is under construction, according to the plan. CDPQ Infra believes it can generate a minimum return of 8% on its investment, threshold at which the two minority shareholders - Quebec and Ottawa – can expect to receive royalties. Both levels of government should ultimately recover their capital investment ($ 1.3 billion each), as well as the financing costs incurred. Montréal, for its part, will inherit a state-of-the-art transportation system that could attract 160,000 users a day - and relieve some of its oversaturated roads and subways.

NZ Super Fund, the New Zealand equivalent of the Caisse de dépôt, has identified CDPQ Infra as a potential partner to develop a light rail system of about 60 kilometers in the city of Auckland, valued at around 5.3 billion. They submitted a proposal to the Government in November 2019, as part of a competitive bid process to fund, deliver and operate the light rail project. Ultimately, following delays to decision-making caused by the Covid crisis, and with the governing parties unable to agree on the way forward, the Government ended the bid process without selecting a preferred delivery partner for the project.

Figure 14 CDPQ and Montréal light rail project



Source: CDPQ Infra website

The Pensions Infrastructure Platform[104]

The Pensions Infrastructure Platform (PIP), in the UK received much media attention at the outset, as a novel way of attracting more pension funds to invest into infrastructure. Founded in 2012, Pensions Infrastructure Platform (PiP) is the infrastructure investment platform developed to facilitate long-term investment into UK infrastructure. It has been set up by pension schemes, to ensure better alignment, better value and better governance. In July 2018 in partnership with Dalmore Capital, PiP, became a new partner in twenty four of EDF Renewables UK wind farms (c.550MW) with the purchase of a 49% minority stake.

PiP launched the Multi-Strategy Infrastructure Limited Partnership in 2016, and is focused on direct investments into UK infrastructure assets through this vehicle. Other key features are:

- Target investment of £600 million, which was exceeded in December 2017
- Focused on a buy-and-hold strategy to avoid any churn
- Invests to deliver long-term index-linked cash flows of RPI + 0-5%
- Fees reflect the true cost of operation and the benefits of increasing scale will continue to accrue to investors

While the benefits of the PIP structure seem clear, the implementation of the model has proved challenging. This has primarily revolved around the selection of an appropriate manager/administrator to drive the initiative forward without acting in a conflicted way and ensuring the interests of the pension fund members are transparently represented. It has been over two years since the initial idea for the PIP was formulated and the stumbling blocks encountered were highlighted when three of the initial founding member funds pulled out of the initiative[105]

[104] https://www.pipfunds.co.uk/about-us/our-history/

[105] The BT and BAE Systems private sector funds and the London Pension Fund Authority (LPFA) Source: UK schemes abandon infrastructure platform over costs, returns – IPE By Taha Lokhandwala 26 February 201

ANNEX 4 - CASE STUDIES/ADDITIONAL INFORMATION FOR SECTION 5

AIIB sets up securitization platform with Singapore-based Clifford Capital[106]

Governments around the world are trying to bring more institutional debt into infrastructure financing. The Asian Infrastructure Investment Bank (AIIB) backed by the Singapore government has set up a securitization platform with Singapore-based Clifford Capital, with the aim of helping infrastructure lenders sell down loans and recycle their capital into new projects. Bayfront Infrastructure Management Pte (BIM) will be 30% owned by the AIIB and 70% by Clifford Capital – a Singapore-based project finance lending firm part-owned by Temasek Holdings, one of the country's sovereign wealth funds.

The loan warehousing facility – to be in operation in 2020 - will act as an intermediary between banks and institutional investors. The platform will be able to spend $1.98 billion on US dollar-denominated performing infrastructure loans made by banks across Asia. It plans to combine portfolios of loans from more than 20 international banks into diversified pools. Debt instruments issued by BIM to acquire and warehouse loans from banks are expected to benefit from a guarantee provided by the Government of Singapore.

BIM will acquire predominantly brownfield project and infrastructure loans from financial institutions, and warehouse and manage them, with the objective of distributing securitized notes to institutional investors in the public markets. BIM will also sponsor, structure and manage such distribution issuances and invest in the equity tranches or vertical slices of its securitization issuances to demonstrate alignment of interest with investors.

This platform will benefit existing bank lenders as it relieves their capital constraints by purchasing on balance sheet exposures. It also provides global institutional investors with access to a diversified project and infrastructure loan portfolio through a new investable asset class.

Despite the current the small size , there is potential to scale up the market for emerging market infrastructure-backed securities. The big infrastructure financing banks currently provide most of this private

[106] Source : Asia Connect, Infrastructure Investor

debt, but are being held back by higher capital charges for loans on their balance sheets, put in place to make the banking sector safer in the wake of the 2008 financial crisis. At the same time Institutional investors are facing major risks in Asian infrastructure, including off-take risk, political and currency mismatch risk making public-private partnership structures to be riskier in Asia-Pacific than in other regions.

The establishment of BIM builds on the successful issuance of Asia's first securitization of project finance and infrastructure loans through Bayfront Infrastructure Capital (BIC), launched in Singapore in 2018 (See below).

First infrastructure project finance securitisation in Asia [107]

On 25 July 2018, Clifford Capital successfully priced the first infrastructure project finance securitisation in Asia. Four classes of notes were issued by Bayfront Infrastructure Capital, which is sponsored by Clifford Capital, a Singapore-based specialist arranger and provider of project and structured finance solutions.

Strong demand was seen from global institutional investors including insurance companies, pension funds, endowment funds, family offices, specialised asset managers as well as individual sophisticated investors.

Also known as the Infrastructure Take-Out Facility (TOF), this landmark transaction was designed to unlock additional capital for Asia's infrastructure financing needs by facilitating capital recycling for banks and creating an investible asset class for institutional investors to access project and infrastructure loans in a credit enhanced structure.

Clifford Capital is the sponsor and manager of the TOF. As sponsor, Clifford Capital is responsible for the sourcing of the portfolio, including initial screening, credit analysis, due diligence and documentation. As manager, Clifford Capital will be providing certain investment management, administrative and advisory functions on behalf of Bayfront Infrastructure Capital.

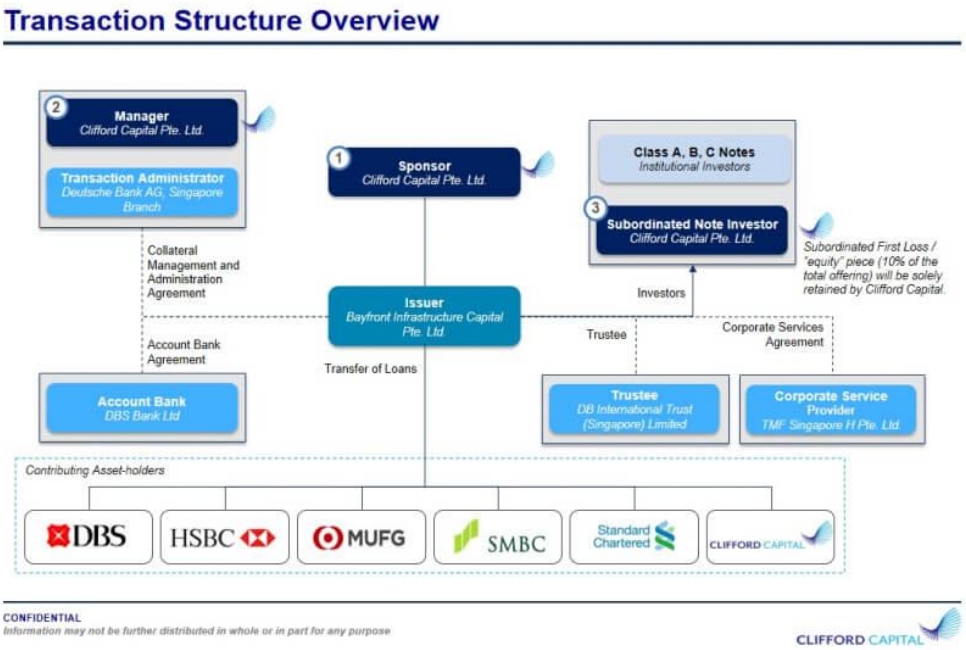
The TOF's US$458 million portfolio is diversified across 37 project finance and infrastructure loans, spread among 8 industry sub-sectors and 16 countries across Asia-Pacific and the Middle East. The

[107] Source: Clifford Capital

portfolio was sourced from leading international and regional banks with a significant presence in Singapore, including DBS, HSBC, MUFG, SMBC, Standard Chartered Bank as well as Clifford Capital. As of the issue date, **75.6% of the portfolio relates to operational projects** with stable and predictable long-term cash flows, including through offtake agreements entered into with reputable and credit-worthy counter-parties including major global corporations, state-owned enterprises and government or government-linked sponsors. The remaining 24.4% of the portfolio is in advanced stages of construction and benefits from external credit support provided by export credit agencies, insurers or multilateral financial institutions. The underlying debt service cash flows from the portfolio are generally denominated in U.S. dollars, which match the debt service cash flows with respect to the notes.

Three classes of investment grade rated notes (class A, B and C notes) were offered to institutional investors and are listed on the SGX-ST. The subordinated notes, which are not rated or listed, were retained by Clifford Capital. A diagrammatic representation of the transaction is set out below.

Figure 15 First infrastructure project finance securitisation in Asia

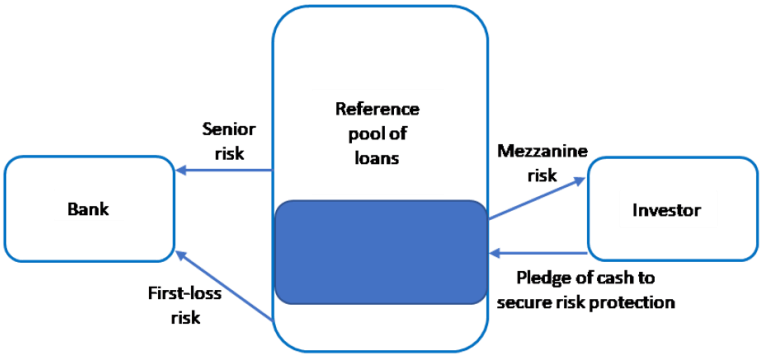


African Development Bank Room2Run synthetic securitisation [108]

Room2Run is a synthetic securitisation that helps development banks to expand their lending capacity, engage private sector investors, maintain or even improve their rating, and reduce reliance on limited public-sector resources.

Mariner Investment Group, through its IIFC Strategy, served as the anchor investor for Room2Run, alongside the Africa50 infrastructure fund, and spent four years working with the African Development Bank (AfDB) to develop the transaction[109]. **The primary objective of Room2Run was to help AfDB manage its existing balance sheet, giving the bank additional headroom for lending in socially and environmentally critical areas.**

Figure 16 African Development Bank Room2Run synthetic securitisation



Source: bhakti mirchandan

The transaction shifts mezzanine risk on a US$1bn portfolio of pan-African loans to private investors. By absorbing losses on the mezzanine tranche of the portfolio, the transaction meaningfully reduces the risk weight on the bank-retained senior portion of the structure, and hence the risk capital that the bank must

108108 Sources UNPRI, Forbes Forbes Bhakti Mirchandani, Nov 19, 2019: "How An Asset Manager And A Bank Revolutionized Impact Investing With Sustainability-Linked Credit Risk Transfer"

[109] Hedge fund Mariner began with a synthetic securitization of French bank Credit Agricole's $3bn infrastructure loan portfolio that created $2bn in incremental capacity to be used for green lending. This was the first credit risk transfer transaction with a private investor to utilize impact-focused requirements for released capital.

hold. **AfDB is then able to recycle this released capital, enabling $650 million of new development lending in Africa.**

Another key objective was for AfDB to maintain its relationship with the borrowers and remain the lender of record. By structuring the transaction as a synthetic securitization, investors can cover future losses on the portfolio through a contractual structure, rather than buying the loans. AfDB therefore retains the relationships and continues to service the loans just as it otherwise would have done.

A bank adds loans to a reference portfolio, which is split into senior, mezzanine, and first-loss pieces. Mezzanine is the middle layer that falls between the senior and first loss pieces. The bank retains risk on the senior and first-loss pieces and sells the mezzanine risk via a credit-linked note or other contract to an investor. The performance of the loans in the reference portfolio drives the performance of the structure as a whole. Any losses on the portfolio first hit the bank-retained first loss tranche, then the investor tranche, and finally a bank-retained senior tranche.

The reason that the transaction is described as synthetic is that the loans are not actually sold. Instead, the credit risk protection is provided on a contractual basis.

Under a credit risk transfer, the investor posts cash or cash equivalent collateral, which covers any losses in the underlying reference portfolio that may hit the investor tranche. In return, the bank pays the investor a periodic margin payment, which is based on the size of the investor tranche.

By buying credit protection, the bank is able to manage capital requirements around the reference portfolio by transferring a significant portion of the credit risk to investors. With certain reference pools, risk-based capital relief may also be available. This sharing of the risk with the investor frees up capital from the bank’s balance sheet to expand lending activities.

Financial scale of the project and impact

Room2Run's US$1bn reference portfolio consists of 45 loans from AfDB's non-sovereign lending book, spread among 16 African nations and 13 different MSCI Global Industry Classifications.

About half of the loans are to infrastructure project finance assets, with the other half split among development and commercial financial institutions, many of which are earmarked for particular development objectives.

In exchange for mezzanine risk protection on the 2% to 17.25% tranche of the reference portfolio (totalling US$152.5m), AfDB will pay investors a floating rate, plus a spread. The transaction creates a risk capital reduction for AfDB, which is equivalent to additional lending headroom of US$650m.

In addition to the immediate impact of new capacity for AfDB, the Room2Run transaction has set a precedent for other DFIs to follow. Mariner, Africa50, AfDB, and Mizuho (which served as an advisor to AfDB) have all engaged heavily with other DFIs to educate them on the structure, the process, and the benefits of such a transaction.

Room2Run created about 65% more headroom from the initial reference portfolio. Assuming no additional efficiencies in future deals, the structure could in theory take the US$1.95trn of DFI balance sheet rated by S&P and create US$1.25trn of new development lending capacity.

Project delivery and challenges overcome

The biggest challenge was the rating agency process. Development banks do not have a regulatory body, so rating agencies serve as de-facto regulators because they rate the banks' debt. S&P has the most quantitative approach to its DFI model, so a core question was how S&P would quantify and incorporate the transaction's benefit to AfDB. Ultimately, S&P calculated the impact of the transaction through its Risk Adjusted Capital Framework, reducing the risk-weighted assets of the portfolio.

Additionally, education was needed on all sides. Mariner spent a great deal of time conducting due diligence into understanding the assets and AfDB's lending processes. This included site visits across Africa and several weeks of meetings with bank employees. Furthermore, because one of the goals was to engage private sector investors in development, it was also important to educate institutional investors on the robust lending track record of DFIs.

It was unusual for the AfDB to share loan-level information to the extent that the investors required, and internal education was needed on the benefits of risk sharing transactions.

All parties showed exceptional determination through these challenges, buoyed by the knowledge that Room2Run would pave the road for others, not just at AfDB but also across other DFIs globally. Despite many difficulties associated with a first-of-its-kind deal, the transaction successfully closed in autumn 2018.

Measuring success and lessons learned

As the first synthetic securitisation between a DFI and private investors, Room2Run has created a framework that can be broadly applied across DFIs, allowing them to more aggressively work toward achieving the UN's 17 SDGs. Success can be measured in two ways:

- The first is the direct impact on AfDB's lending capacity, which has increased by US$650m. The social and environmental impact of this capacity will be demonstrated as the bank continues to finance solar fields, roads, and water projects across Africa.
- The second, and larger, impact is in creating a new market. Now that Room2Run has successfully closed, other DFIs that had been watching its progress are now advancing their own programmes.
  The impact of Room2Run as a catalyst could easily be in the trillions of dollars, all directed towards the socially- and environmentally-critical projects to which DFIs were established to lend.

Room2Run proved the concept and established the framework, and now it serves as a learning tool for others. Finally, Room2Run confirms private investor interest in amplifying development efforts, and has built channels between some of the largest international institutional investors and AfDB.

APG Sustainable CLO Case Study – Hypothetical Evaluation Approach[110]

Background

APG is one of the largest pension fiduciary asset managers globally. As a long-term, responsible investor, APG has been an advocate for growing the sustainable finance market and is an active participant in discussions on standards and regulatory considerations for new sustainability-linked investment products.

Investment Process

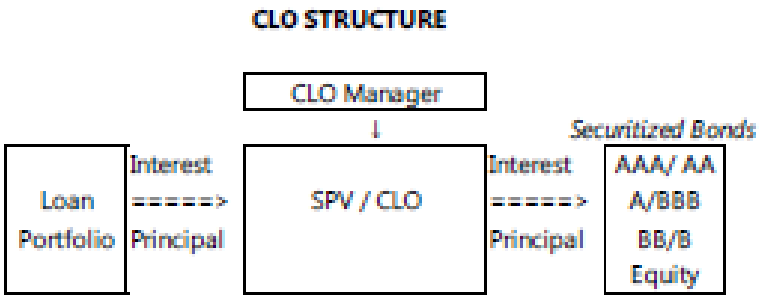
APG conducts financial analysis as the starting point for determining the soundness and safety of all potential investments. Accordingly, we would evaluate the investment merits of a sustainable CLO with the same approach for assessing any new product – with careful consideration of its relative attractiveness and overall fit within our portfolio. Independent of sustainability considerations, the investment team would first review the underlying assets to determine their income generating capabilities, followed by an assessment of the securitization process and CLO structure.

If a particular sustainable CLO meets our requirements from a relative value and structure perspective, we would then evaluate its sustainability features – including the use of proceeds language and impact reporting policies. Further analysis helps us confirm whether the proceeds are properly ring-fenced for the approved green/social expenditures and that there are no other negative externalities associated with the eligible projects that might offset the positive impact. APG could also potentially have a higher standard when it comes to evaluating sustainability impact compared to other market participants. Even if a

[110] source SEB & others 2018. This White Paper has been commissioned by the Co-Chairs of the G20 Sustainable Finance Study Group to provide important financial market content to support the Group's research under the G20 Argentinian Presidency.

regulatory-driven taxonomy of green classifications emerges, it's possible that other investors will also continue to rely on internal requirements around project eligibility and impact thresholds.

Figure 17 APG Sustainable CLO Case Study



Source: SEB & others 2018.

Risk/Return Analysis

APG invests in CLOs as part of a larger credit portfolio rather than a pure ALM strategy. Therefore, understanding the risk/return characteristics of a sustainable CLO in a benchmark- relative context is paramount since this product would represent an out-of-benchmark position, potentially with longer duration. If we were to consider a CLO of infrastructure loans, the long-dated maturities and often limited yield offered may make it a less attractive asset class in which to invest. In order to have greater appeal to benchmark sensitive investors in addition to ALM strategies, we would suggest considering opportunities to add shorter-dated projects in these CLOs as well.

Additionally, there are several key components of a sustainable CLO that we would consider as part of our risk/return analysis. First we would seek to better understand the diversification profile of the underlying pool of assets. CLOs are typically structured with a diversification requirement, with the diversity of loans serving as one of the main benefits of investing in CLOs. If sustainable CLOs receive a lower diversification score from rating agencies, further credit enhancement might be necessary. Compounded with a lack of performance history, investors may initially require even greater compensation for potential concentration risk.

Next, we would examine the structural features of a sustainable CLO. The objective here is to ascertain how new sustainable energy infrastructure loans are selected, assess the reinvestment process, and understand the overall mechanics of the active management process – focusing on the origination and servicing capability of the involved entities. Lastly, we would evaluate the capabilities of the sustainable CLO manager, which is an important consideration when investing in any CLO. Perceived differences in managers' level of skill, degree of experience, and track record can translate into meaningful impacts on pricing. For sustainability CLOs there will also be the added challenge of ensuring managers possess credible sustainability expertise in addition to their ability to successfully manage the CLO structure. This may result in investors seeking a complexity premium until some degree of performance history is established.

It is important to note that we do not view these issues as roadblocks to the eventual success of the sustainable CLO market. Highlighting a hypothetical approach to evaluation should help sustainable CLOs evolve over time to address institutional investor concerns and provide a pathway for increased investor demand and market growth over the long-term.

Regulatory Considerations

The regulatory environment, particularly Solvency II, makes it difficult to reduce capital requirements for sustainable CLOs. This particular regulation views CLOs as a riskier instrument because CLOs are generally viewed as an asset type with higher risk premium than Agency MBS due to their complex and actively managed structures. Applicable EU risk retention rules also need to be a requirement to ensure global investor appeal since this is still necessary to allow participation by European investors.

Ongoing Investor Outreach

In order to achieve the greatest success, we believe a broader assessment of institutional investor demand for the underlying assets should be undertaken as a necessary first step. It is our experience that securitizing assets does not necessarily change their relative attractiveness. Important topics would include: how a sustainable CLO fits within overall credit portfolios and how large an allocation for real infrastructure, sustainable or not, makes sense from a strategic point of view. Collaboration with potential

sustainable CLO managers will also be crucial in establishing guidelines for the type of sustainability support/resources existing CLO managers may need to appropriately manage this product structure.

CHAPTER 8: CONCLUSIONS

8.1 INTRODUCTION: PURPOSE AND SIGNIFICANCE OF THE THESIS

The general objective of the thesis is to examine the role institutional investors and in particular pension funds can play in meeting the infrastructure investment needs, as well as identifying the policies that will facilitate the mobilisation of financing at the necessary scale. Principle aim is to propose a framework for attracting pension fund investment in sutainable and low-carbon infrastructure, diversifying sources of finance and fostering the development of infrastructure as an asset class. A secondary goal of the thesis is to illustrate how long term investors can promote a more inclusive and sustainable financial system while contributing to the real economy.

This thesis is a contribution to current research found in different disciplines such as economic and finance, fields of study such as infrastructure, pension fund and public policy and analytical logics that include institutional, relational and intermediation analysis. This thesis is also about the geography of finance – a world in which global financial markets increasingly price national institutions and economic structures whatever their geography and history (Clark and Wojcik 2007). The world of finance is analyzed using the perspectives and skills of economic geographers, using techniques aimed at better understanding the evolving economic map of the world and its people (Clark and Wojcik 2007).

In this chapter, I present the major conclusions of the thesis, further areas of work borne out of the research process and policy implications of this research.

8.2 OVERVIEW OF MAIN CONCLUSIONS AND IMPLICATIONS OF THESIS CHAPTERS

The starting point of this thesis are some widely cited hypotheses in policy areas, academia and the investment community about i) the huge investment opportunities in the infrastructure market for private financing and ii) the important role that institutional investors are expected to play as long term investors looking for low market risk and stable and predictable cash flows properties attached to infrastructure as an asset class. These hypotheses though are supported by very limited empirical evidence. The thesis employs a four-paper approach to explore top-level questions. Here below major conclusions and takeaways.

The insights of this analysis are relevant for various infrastructure stakeholders and have implications for both investment management and public policy. They can be divided in two main group of considerations and policy actions: i) the need to understand and manage long term demand from institutional investors ii) the opportunity to develop infrastructure and renewables as an asset class. Main takeaways and implications are summarized in the table below

Table – Thesis relevance for key- stakeholders

Constituency	Topic Relevance	Key Takeaways
Chapter 4. Country Survey: Pension Fund Investment In Infrastructure – The Demand for long term investment in Infrastructure		
Policy makers and investors	The changing nature of long-term savings	Policy makers and investors need to understand future evolution of the market In fact the changing nature of long-term savings is shaping the current and future demand for long-term infrastructure investment: demographic and financial pressure are having (and will have) an impact on infrastructure investment.
Policy makers and Regulators	Pension and regulatory reforms for long term investing	Different level of development, country and sector specifics ~~will~~ imply different sets of products and viable solutions. For policy makers looking to attract long-term financing in infrastructure, the composition of local pension markets, regulations and openness to foreign investment can influence how capital is invested. Governments need to create the conditions to respond to this long-term investment demand, aligning policies in the infrastructure, pension and financial markets areas. There is a need to review the impact of regulation on long-term investment and sustainable infrastructure, ensuring no hindering effect on LTIs from market and risk-based valuations
Chapter 5. ESG, Private Markets impacts on Institutional Investment in Infrastructure		

Investors and Regulators	As part of the alternative asset allocation, an increasing number of funds are also investing in unlisted infrastructure	Looking at historical asset ~~allocation chapter 5, reveals~~, that Large Pension Funds (LPFs) and Public Pension Reserve Funds ~~(PPRFs~~, are on average shifting investment from fixed income to equities and alternative. Investor's involvement in private markets implies different risk management and governance models of pension funds (i.e. insourcing asset management~~)~~, From a regulatory perspective, monitoring of trends in asset allocation is needed to identify more clearly any emerging risks to financial stability. As assets grow and the systemic importance of the pension schemes increases, prudential surveillance, regulation and oversight along with sound fund governance will become increasingly important.
Investors and Regulators	ESG and green strategies for low carbon infrastructure	Increasing investor's involvement in ESG and infrastructure requires better data, analysis and disclosure The fact that infrastructure investment is often undertaken through private markets makes the adoption of ESG decision-making more challenging, as private markets do not have the same disclosure requirements as public markets. Given the often indirect nature of their infrastructure investments, through funds or managed separate accounts, institutional investors must rely significantly more on their asset managers and other service providers to track their exposure and performance. Hence asset managers play a key role in implementing and measuring ESG criteria in institutional investors' portfolios. Governments and regulators could, where appropriate and needed, strengthen formal requirements to provide consistent information on investments by pension funds on ESG factors, following internationally agreed standards.
Chapter 6. Low Carbon Infrastructure Investment		
Investors and Regulators	Renewable energy as a global asset class	Renewable energy investment is growing, being part of infrastructure asset allocations. Chapter 6 provides evidence that pension funds are significant investors in renewable energy and that they have actively been financing the energy transition. The vast majority of investors in the infrastructure portfolio allocation includes renewables. Low-carbon infrastructure in general is not a distinct category of investment including a variety of different risk-return opportunities. Renewable energy could become a global asset class, diversifying investor's exposure across regions and ~~phase Low~~ carbon infrastructure and in particular~~,~~ renewables are considered ~~an~~ alternative return sources that can provide income and diversification. While power price markets are interconnected across regions and even countries, they remain idiosyncratic, providing additional diversification. Different project lifecycle phases, exposure to different regions and regulatory regimes also add to the diversification potential.
Investors and Regulators	Renewable energy as a global asset class	There is a major mismatch between investors and governments expectations Despite growing interest, institutional investors have, in aggregate, invested very little in infrastructure - approximately one percent of their assets in infrastructure - even in advanced economies. Demand from institutional investors is high but concentrated on some types of less risky "core" low carbon infrastructure assets that do not necessarily match governments' priorities. As a result, infrastructure investment funds have had trouble investing the private capital they have raised, with many funds reporting that they were below their investment targets for infrastructure. In fact, there seems to be a large amount of potential capacity to expand institutional investment in infrastructure, taking into account also funds that are considering opening new allocations. Funds targeting

		on average 5% of total portfolio have capacity to increase their investment in unlisted infrastructure equity, including in climate-relevant sectors.
Chapter 7. Partnering with Instituional Investors and Recycling capital for low carbon infrastructure		
Investors/Asset Managers	Pooling Institutional Investors Capital for low carbon infrastructure	Equity funds formed as partnerships to leverage institutional investor's capital are examples of new investment models for public and private sectors to fund infrastructure projects in developed and developing countries. They could become important sources of risk sharing finance as well as providers of organizational capacity and expertise in support of the financing of infrastructure projects.
Investors/Asset Managers	Role of Financial Sector: Developing Secondary markets for low carbon infrastructure	The variety of liability profiles of institutional investors highlight the need for expanded and diversified channels of financing for low carbon infrastructure which can cater to different investment horizons, risk appetites, liquidity needs, and capacities to invest in potentially complex and large-scale projects. By pooling assets, securitisation, yieldcos and new listed vehicles could widen the access to and transparency of infrastructure investment while diversifying risk and lowering the cost of capital. The ability of banks to replenish sustainable capital crucially underpins economic growth and sustainable development in the 21st century and securitisations are a robust mechanism of achieving it.
Policy Makers/ Development Institutions	Role of Public Sector : Catalyse institutional investors for low carbon infrastructure	A key role for the public sector is to leverage the government balance sheet through risk mitigation instruments for infrastructure projects and attract private sector capital. As shown in chapter 7, governments around the world are trying to bring more institutional debt into infrastructure financing setting up securitization platforms Energy reforms that make energy efficiency profitable and create demand will scale up lending through such channels. Reforms such as higher carbon prices and stronger climate mitigation policies could make investment in renewable energy, through public equity markets, more attractive by making returns more competitive with conventional energy.

Chapter 4. Country Survey: Pension Fund Investment In Infrastructure – The Demand for long term investment in Infrastructure

Aim of Chapter 4 is to analyse the evolution and drivers of growth of pension fund investment in infrastructure in a context of changing retirement landscape. It responds to the following questions: what is the importance of pension funds in financial markets ? What are the major constraints to long term investment in the future? What are the factors of growth for pension fund investment in infrastructure at country level?

The changing nature of long-term savings is shaping the current and future demand for long-term infrastructure investment: demographic and financial pressure are having (and will have) an impact on infrastructure investment.

The first main conclusion of this chapter is that the pension's landscape has significantly evolved with assets under management increasing over the past decades across countries in different ways. There has been a marked shift towards funding and private sector management in pension systems, driven largely by the introduction of mandatory private pensions and funding becoming increasingly important within publicly managed pension systems.

At the same time, the changing nature of long-term savings is posing major challenges to long term investing. Most pension funds are subject to structural, financial and demographic pressures that are set to increase over the coming decades. These will have major impact on future portfolio strategies and investment in long-term assets. Major factors include financial pressure on the funding position of DB funds, relatively mature demographic profiles, and the shift towards defined contribution arrangements, the move to market-consistent valuations and risk-based solvency standards and the low interest rate environment

Given the low interest rate environment and volatile stock markets of recent years, institutional investors are increasingly looking for new sources of long-term, inflation protected returns. Investments in real, productive assets, such as infrastructure could potentially provide the type of income which these investors require supporting investment and driving growth.

Pension funds are under financial pressure due to a combination of the low return environment, and aging populations in advanced countries reflected in the gradual maturing of their demographic profiles. These historical trends expected to continue in the future have underlined liquidity issues and at the same time a lower risk appetite for many investors.

There is among investors a reconsideration of liabilities constraints. Better appreciation of the interest rate sensitivity of plan liabilities and the risks of large mismatch in the characteristics of a plan assets and liabilities, translates in an increased interest in asset/liability matching, ultimately fuelling pension fund's demand for good quality – income oriented –, inflation linked investments that can match their liabilities

As plans' risk tolerance decreases, infrastructure - as an inflation sensitive asset- can play a role facilitating the shift of funds toward a conservative preservation focus. However, for mature funds facing negative cash flow, it is difficult to justify the introduction of additional illiquid assets to the portfolio given ongoing liquidity needs. Therefore, any allocation to infrastructure investment would likely come from a corresponding reduction to the real estate or private equity programmes.

Liquidity will be a major issue for many pension funds when allocating to infrastructure. Funding deficits have highlighted the challenges of managing the financial risks of older DB pension plans that have a high ratio of retired to active employees. For pension funds suffering from poor funding ratios and insufficient future contributions the need to provide liquidity to pay benefits over the next decades, mean they can't increase or maintain existing allocations to alternative assets such as infrastructure

In addition, for DC plans, investment in illiquid asset classes, such as unlisted infrastructure, can be difficult, especially when individuals have the option to switch funds easily. This creates issues with the interim valuation of illiquid assets and potential liquidity bottlenecks.

Pension and regulatory reforms for long term investing are needed and have to be adapted to country different developments

Clearly, different countries are at different stages in the evolution of pension fund investment in infrastructure. Key factors accounting for the growth of pension fund infrastructure investment include: the number of investable infrastructure transactions developed domestically (i.e. the availability of investment opportunities for private finance and for pension funds), the maturity and size of the pension fund market (i.e. the institutional capital available for investment), pension fund regulation and development of financial markets and role of financial intermediation.

This growth in assets is likely to continue in OECD countries, especially in countries where mandatory retirement systems or where private pensions and insurance markets are still small in relation to the size of their economies. In developing countries, governments are establishing mandatory and/or contributory

retirement systems. They generally face an even greater opportunity to develop their institutional investor sectors, as, with few exceptions, their financial systems are largely bank-based.

Different level of development, country and sector specifics will imply different sets of products and viable solutions. For policy makers looking to attract long-term financing in infrastructure, the composition of local pension markets, regulations and openness to foreign investment can influence how capital is invested. Governments need to create the conditions to respond to this long-term investment demand, aligning policies in the infrastructure, pension and financial markets areas.

A consolidation process is underway in the pensions industry. Regulation forcing funds to tackle solvency issues coupled with the drive of diversification in private markets through active investment are driving a trend to increasing concentration and ongoing consolidation of the highly fragmented pension fund industry (e.g. the Netherlands, Australia) resulting in growth in the average size of funds.

Consolidation of small funds is a positive outcome in terms of long-term sustainability and infrastructure investment. It appears in fact that the most active investors in infrastructure are also the largest funds. The size of such funds allows them to invest in this sector and still maintain the liquidity necessary to meet the required prudential requirements. Larger funds tend to have an advantage over their smaller counterparts, particularly in their ability to reduce management fees. In addition, the largest funds have the resources and skills to evaluate investments directly and perform due diligence on alternative assets such as infrastructure.

In addition to developing the investor capability to invest long term, it is also essential to shape the regulatory framework to take into account long-term investment in an appropriate manner. Regulations sometimes exacerbate the focus on short-term performance, especially when assets and liabilities are valued referencing market prices. Given the positive externalities that infrastructure investment brings to the economic system, regulatory authorities should develop a dedicated regulatory approach for long-term investments, which takes into account their specific risks and their countercyclical economic role. Several

initiatives are reviewing the impact of regulation on long-term investment and sustainable infrastructure, ensuring no hindering effect on LTIs from market and risk-based valuations (i.e. FSB, EIOPA, NGFS).

Chapter 5. ESG, Private Markets impacts on Institutional Investment in Infrastructure

Aim of chapter 5 is to identify the flows and better capture the underlying trends in asset allocation and investment strategies of pension funds focusing on alternative assets (i.e. private markets) and sustainable investment. Unique access to OECD microeconomic data of two distinct pools of long-term savings – LPFs and PPRFs - allow deep insights of the general trends observed at national level in chapter 4 – Country Survey: Pension Fund Investment in Infrastructure. It responds to the following questions: what are the main asset allocation investment trends concerning long-term investment in alternative asset classes. How are sustainability and ESG taken into account in infrastructure portfolio allocations?

As part of the alternative asset allocation, an increasing number of funds are also investing in unlisted infrastructure. Investor's involvement in private markets is challenging the risk management and governance models of pension funds (i.e. insourcing asset management) with implications for policy makers and regulators

In recent years diversification benefits and higher expectations of investment returns are increasingly driving investors to alternative investments, such as hedge funds, real estate, private equity, and other categories (i.e. natural resources, loans, or commodities). Looking at historical asset allocation chapter 5, reveals that Large Pension Funds (LPFs) and Public Pension Reserve Funds (PPRFs are on average shifting investment from fixed income to equities and alternative. As part of the alternative asset allocation, an increasing number of funds are also investing in unlisted infrastructure.

However not all investors are able to access long term illiquid assets such as infrastructure. A spectrum of mandates and limits on investment leads to varying investment profiles and exposure to alternatives. In Australia, Canada and New Zealand, PPRFs long-term mandates lead to a profile more similar to a funded pension scheme (defined benefit fund) with lower allocations to fixed income and higher allocations to return

seeking assets, such as alternative investments and equity. On the other hand, GPIF in Japan, following the Norwegian investment model is slowly transitioning its traditional portfolio allocation to alternative asset classes with its recent first investments in private equity out of its 5% target allocation to alternatives.

As seen, there is increased belief among investors that long- term investment approaches including active management based on fundamental analysis exploiting market inefficiencies in private markets and sustainable investments might be better able to pursue long-term value. However, the increase in allocations to higher risk investments will have a profound impact on risk management and governance of pension funds.

Many alternative assets for example create their own distinct risk modelling, forcing pension fund managers to change the way they plan and track their risk budgets. Pension funds need to quantify their tolerance for risk at a total fund level but also understand how that risk budget is allocated across an increasingly varied mix of assets and investments. Alternative investments generally have lower liquidity, use unconventional strategies (hedge funds), sell in less efficient markets, have the ability to use financial leverage, and require a longer investment horizon than public bonds and equities (often due to illiquidity).

The adoption of more complex investment strategies including alternatives is challenging the traditional governance models of pension funds. For example, more expertise at the level of pension board members will be required perhaps including specialists that have appropriate asset and risk management skills. In order to reduce costs and agency risks many funds are also looking at insourcing asset management. Still the risks of being different – by adopting unconventional asset allocation techniques or investments – are a challenge or even a barrier for investors. This is particularly true when communicating changes to stakeholders such as beneficiaries, trustees, or even the public, when such matters can be complex and technical.

From a regulatory perspective, monitoring of trends in asset allocation is needed to identify more clearly any emerging risks to financial stability. As assets grow and the systemic importance of the pension

schemes increases, prudential surveillance, regulation and oversight along with sound fund governance will become increasingly important.

ESG and green strategies for low carbon infrastructure. Increasing investor's involvement in ESG and infrastructure: better data, analysis and disclosure

Despite broad recognition of the importance of ESG criteria and interest in incorporating these factors into infrastructure investment decision-making, the implementation of these criteria in asset valuation remains at an early stage. The integration of ESG factors into investment decision-making and risk management, including for infrastructure investment, is part of a broader trend among institutional investors to adopt sustainable investment strategies, which also include divestment, corporate engagement, sustainability themed investment, and impact investing, among others. Sustainable or ESG investments extend across a variety of investors and the range of public and private asset classes commonly found in diversified investment portfolios including alternative asset classes such as real estate, private equity and infrastructure.

There is an increasing number of sustainability themed funds focusing on green investment and the energy transition. Thematic investment and ESG impact investments are frequently applied via investing in designated funds. The range of active strategies focused on sustainability as an investment outcome, includes impact investing aiming at social or environmental problems such as affordable housing and the global energy transition. Based on data gathered through the OECD survey, it becomes evident that there are uniform interpretations neither underlying sustainability including green and social investment, nor standardized implementation strategies amongst the funds.

ESG trends are affecting the investment landscape in infrastructure, as investors are demanding greater transparency and information regarding investment impact and sustainable infrastructure. Given the large amount of variation in investor action, there is therefore a need to convene and to align initiatives and to collaborate where possible in order to reduce redundancies and to achieve global standards regarding ESG practices, and disclosure of risks.

The fact that infrastructure investment is often undertaken through private markets makes the adoption of ESG decision-making more challenging, as private markets do not have the same disclosure requirements as public markets. Given the often indirect nature of their infrastructure investments, through funds or managed separate accounts, institutional investors must rely significantly more on their asset managers and other service providers to track their exposure and performance. Hence asset managers play a key role in implementing and measuring ESG criteria in institutional investors' portfolios.

Governments and regulators could, where appropriate and needed, strengthen formal requirements to provide consistent information on investments by pension funds on ESG factors, following internationally agreed standards. This would allow for future monitoring on an international basis. Regulatory requirements related to ESG have increased the adoption of ESG considerations in infrastructure investment. Funds are also adjusting to new regulations in some markets that seek to clarify the role of ESG in a fund's investment process. This is part of a broader policy and regulatory push to clarify and disclose climate-related risks in the financial sector, which provides an indirect push for asset owners (and asset managers, who may manage their investments) to consider climate and other ESG-related risk factors, given potential exposures through their investments.

Chapter 6. Low Carbon Infrastructure Investment

Chapter 6 looks at the role of low carbon infrastructure in investor's portfolios. It responds to the following questions: how are investors approaching low carbon infrastructure investment? How much is invested in infrastructure and renewables and where does it fit in the portfolio allocation? What has been the evolution of pension fund investment in infrastructure over the years?

Renewable energy investment is growing, being part of infrastructure asset allocations. Renewable energy could become a global asset class, diversifying investor's exposure across regions and phase

Renewables is becoming the largest opportunity in private infrastructure for institutional investors following strong low carbon investment growth (including solar PV, wind, and other clean power technologies) and

maturing technologies. As part of the overall trend to diversify investment portfolios and driven also by ESG considerations seen in chapter 4 and 5 , institutional investors – including pension funds and insurance companies – have been increasingly interested in renewable infrastructure investment.

Chapter 6 provides evidence that pension funds are significant investors in renewable energy and that they have actively been financing the energy transition. Green investment in the form of low carbon infrastructure and clean energy has experienced a steady rise in investor infrastructure allocation over the past decade. Renewable energy is a relatively new sector in the portfolio of certain investors although increasing. While the majority of funds were not investing in renewables in 2015, the same sector represented 20% of total infrastructure portfolio in 2017 and Norway's sovereign wealth fund doubled its maximum allocation to renewable energy infrastructure in 2019.

The vast majority of investors in the infrastructure portfolio allocation includes Renewables. Low-carbon infrastructure in general is not a distinct category of investment including a variety of different risk-return opportunities. Pension funds with a dedicated allocation are more likely to have a target allocation to the asset class as part of their long-term strategic asset allocation and are more likely to invest through unlisted equity instruments (infrastructure funds or direct investment). However only a few funds have been launched in unlisted equity markets, by investors that focus exclusively on renewable energy.

Reasons for institutional investor hesitancy to invest in green infrastructure range from policy uncertainty in relation to energy and to risks specific to related projects (new technology in energy, low returns in social infrastructure) making it difficult for rating agencies to give sufficient investment grade ratings. Capital along the clean energy project cycle is highly fragmented across equity and debt, and smaller scale deals or energy efficiency projects lack aggregation mechanisms.

Low carbon infrastructure and in particular, renewables are considered an alternative return sources that can provide income and diversification. While power price markets are interconnected across regions and even countries, they remain idiosyncratic, providing additional diversification. Different project lifecycle phases, exposure to different regions and regulatory regimes also add to the diversification potential.

Renewables markets offer different investment opportunities depending on the respective regional cyclical phases. Low yielding bonds in Europe and US are increasing investor's competition for renewables assets in advanced countries. Africa, Asia, India and Latin America are now seeing substantial institutional investment, especially equity. In particular, over half of the world's electricity is expected to be generated in the Asian region by 2030 due to growing populations, economic growth and a smaller installed base of renewables capacity.

While a number of funds are expressing greater interest in investing in greenfield assets, few funds reported exposures to such assets with a preference for brownfield-type investments, which they see as less risky and more aligned with a long investment horizon. This indicate that policies targeted at attracting investment in new projects are needed, along with improving business and financing models to cope with construction risk.

The low investment in emerging markets by most funds, indicates that further policy work may be necessary in order to facilitate north-south investment including leveraging further the role of multilateral agencies. Some leading funds invest around one-third of their total portfolios in foreign markets.

However, their infrastructure investment shows an even greater 'home bias'. Most of the overseas projects they invest in are in other OECD countries – with only select markets (such as Brazil, Chile, in some cases India) outside of the OECD. Most of the funds surveyed remain opportunistic in their emerging market interest in infrastructure, focusing more on developed countries (defined as North America, European Union and Japan, Korea, Australia and New Zealand).

However there is a major mismatch between investors and governments expectations

Issues related to green assets, are compounded by a lack of suitable investment vehicles (such as green, social impact bonds or funds) providing the liquidity and risk/return profile that several institutional investors need.

Despite growing interest, institutional investors have, in aggregate, invested very little in infrastructure - approximately one percent of their assets in infrastructure - even in advanced

economies. The overall low levels of investment observed in the total survey population are more likely in-line with the broader pension fund market as not all investors have established infrastructure investment allocations. Demand from institutional investors is high but concentrated on some types of less risky "core" low carbon infrastructure assets that do not necessarily match governments' priorities.

As a result, infrastructure investment funds have had trouble investing the private capital they have raised, with many funds reporting that they were below their investment targets for infrastructure. In fact, there seems to be a large amount of potential capacity to expand institutional investment in infrastructure, taking into account also funds that are considering opening new allocations. **Funds targeting on average 5% of total portfolio have capacity to increase their investment in unlisted infrastructure equity, including in climate-relevant sectors.**

Chapter 7. Partnering with Instituional Investors and Recycling capital for low carbon infrastructure

As seen in Chapter 6 there is a major mismatch between investors and governments expectations. This demand contrasted by little investment is causing major challenges highlighting structural issues in the market, including competition for limited quality assets and overconcentration and influence of the largest infrastructure funds. Investors are looking at the development of novel, and less resource intensive, mechanisms to overcome the barriers to efficient long-term investment and aligned access to private markets.

This chapter covers an examination of new models and instruments for private sector and institutional investors financing of low carbon infrastructure. It responds to the following questions: how to align institutional investors to long term assets? What are the models used and the products and instruments needed for low carbon infrastructure?

Pooling Institutional Investors Capital for low carbon infrastructure. New partnerships have been launched to invest in low carbon infrastructure and financing models are emerging for energy efficiency and renewable energy projects.

Partnership models emerge as a way to leverage traditional bank and utility finance in primary markets with trends in secondary markets, M&A, asset management, and institutional investment demand. There is increased co-operation between utilities, banks and financial investors in the renewable sector, and in infrastructure investments, in general.

Equity funds formed as partnerships to leverage institutional investor's capital are examples of new investment models for public and private sectors to fund infrastructure projects in developed and developing countries. They could become important sources of risk sharing finance as well as providers of organizational capacity and expertise in support of the financing of infrastructure projects. The example of the Danish pension and wind industry is instructive in this sense, in the case of on-shore and recently offshore.

Role of financial markets: financial reforms are needed to create a Secondary Markets for low carbon infrastructure

The financial market and asset management have a crucial role in providing sustainable-targeted solutions to cater long-term demand from investors, matching their appetite for risk with opportunities in low carbon infrastructure.

The importance of capital market intermediation is crucial when considering private sector participation in long-term investment financing. Well-functioning and deep capital markets are needed to offer a wider range of instruments to channel long-term finance. The variety of liability profiles of institutional investors highlight the need for expanded and diversified channels of financing for low carbon infrastructure which can cater to different investment horizons, risk appetites, liquidity needs, and capacities to invest in potentially complex and large-scale projects.

The absence of an efficient capital market for infrastructure represent a barrier to the financing of new projects (e.g. impeding recycling of capital) and the development of infrastructure as an asset class. Providing the banking sector with recyclable liquidity will become increasingly important as demand for sustainable investments accelerates and the impact of the COVID induced crisis has an impact. The ability

of banks to replenish sustainable capital crucially underpins economic growth and sustainable development in the 21st century and securitisations are a robust mechanism of achieving this (SEB & others 2018).

By pooling assets, securitisation, yieldcos and new listed vehicles could widen the access to and transparency of infrastructure investment while diversifying risk and lowering the cost of capital. Aggregating portfolios of loans from the balance sheet of banks, these products are well suited to refinance small scale assets such as distributed solar PV or efficiency projects. The creation of a more liquid secondary market, will imply reduced expensive due diligence of assets and greater ability to benchmark different assets.

Public sector role in catalysing institutional investors for low carbon infrastructure

A key role for the public sector is to leverage the government balance sheet through risk mitigation instruments for infrastructure projects and attract private sector capital. Financial instruments create a multiplier effect for public funding by facilitating and attracting other public and private financing for projects. The use of innovative instruments can be expanded in order to stimulate knowledge-sharing, critical mass, economies of scale, standardisation and risk sharing among project stakeholders.

As shown in chapter 7, governments around the world are trying to bring more institutional debt into infrastructure financing setting up securitization platform as the one launched in 2020 by the Asian Infrastructure Investment Bank (AIIB) and backed by the Singapore government. In order to build confidence in the yieldco model, greater transparency of asset transactions (drop-downs from sponsor) is necessary, along with stronger and more responsible corporate governance. In addition, for investors regulation such as Solvency II could represent a major barrier to investment.

Infrastructure state-owned banks, as well as development or green banks and finance institutions (NDBs, MDBs and bilateral DFIs and Export Agencies) are playing an increasing role accelerating private sector investment in green infrastructure and developing secondary markets for sustainable infrastructure. Through their interventions they aim to (i) use blended finance investing alongside the private sector to

crowd-in investment (ii) improve liquidity in the secondary market; and (iii) signal to the investors community, national commitment and future opportunities for refinancing and acquisition.

Ultimately, financial market developments need to be accompanied by major energy reforms. There is massive potential in achieving energy efficiency in buildings, infrastructure, and industry. However financing for energy efficiency may not be happening at the scale needed due to difficulties in capturing the financial value of the investment. Policy reforms that make energy efficiency profitable and create demand will scale up lending through such channels. Additionally, reforms such as higher carbon prices and stronger climate mitigation policies could make investment in renewable energy, through public equity markets, more attractive by making returns more competitive with conventional energy.

8.3 CONCLUSIONS AND IMPLICATIONS FOR ACADEMIC RESEARCH

In order to encourage higher levels of investment in low carbon infrastructure by institutional investors, improved independent analysis based on new data and information is necessary. Academia has a major role in provide the intellectual and evidence framework to build infrastructure as an asset class.

The theoretical frameworks which underpin the main assumptions of the thesis lie at the intersection between financial intermediation and theory of finance (Arjaliès et al. 2017; Clark 2017), the governance of infrastructure (Burger and Hawkesworth 2010; Helm and Tindall 2009), Modigliani and Miller 1958); financial geography, asset allocation and portfolio optimization (Clark and Wójcik 2007; Wojcik 2013; Markowitz 1952, Fama 1970, Litterman 2004). Advancing the dialogue on the subject of infrastructure as an asset class will address several areas of research.In the table below summarized main takeaways for academic research.

Table – Academic Relevance of the thesis

Topic Relevance	**Key Takeaways**
Chapter 3: Mapping risks and financing for low carbon infrastructure	
Financial Intermediation	This thesis presents latest efforts to map, current institutional (pension funds) holdings in low carbon infrastructure, i.e. their stock of investment. The mapping provides first of its kind independent information and ~~aims to cover~~ crucial data gaps identified in the literature
Financial Intermediation	Support regulators in determining fair regulated prices by appropriately including risk charges in the costs of capital. Indeed, the same need to create new knowledge on the risks of long-term investment is also patent on the regulatory side. More accurate risk measures may imply lower capital charges, and the more effective and efficient intermediation of long term capital.
Chapter 4. Country Survey: Pension Fund Investment In Infrastructure – The Demand for long term investment in Infrastructure	
Asset Management/ Financial Economics	Long term Investors and ESG. As investors with a typically long-term horizon, institutional investors have a particular incentive to consider ESG risks in infrastructure, which may materialize in the medium to long-term. Further research is needed on how to incorporate sustainability criteria in infrastructure investment, and ESG impact on financial performance.
Asset Management/ Financial Economics	Regardless of strategic asset allocation objectives, infrastructure may have a role in meeting liability-driven investment objectives. A strong infrastructure investment mandate can also improve asset/owner governance and alignment of interests.

Chapter 5. ESG, Private Markets impacts on Institutional Investment in Infrastructure	
Theory of finance and financial intermediation	As investors are increasingly factoring ESG into investment decision and risk management processes for infrastructure.. Transparent parameters allowing for adequate monitoring of ESG performance are important from a risk management perspective.
Theory of finance and financial intermediation	Long Term Investors by type of institution (pension fund, insurer, SWFs). Long-term asset allocations decisions affecting low carbon infrastructure are based on the type of institution. Asset allocation of SWFs and PPRFs varies widely depending on their specific objectives and mandates while pension funds are constrained by the nature of their liabilities
Chapter 6. Low Carbon Infrastructure Investment	
Asset Management/ Financial Economics	Investors and asset managers would benefit from improved information on performance evaluation and for asset allocation decisions to or within the infrastructure asset class. A better understanding of these risk properties by investors reduces the information gap on this alternative asset class, helping to match suitable investments with investor preferences. A potential outcome could be opening new channels of funds to infrastructure.
Asset Management/ Financial Economics	Describing with strong empirical evidence the role of infrastructure investments in the asset allocation process, allows the integration of infrastructure assets into the asset/liability investment framework
Chapter 7. Partnering with Instituional Investors and Recycling capital for low carbon infrastructure	
Economic geography	Economic geography literature using relational geometries, focusing on the growing presence of private finance and non-state organizational structures such as institutional investors in infrastructure
Theory of Contract	Financial intermediation ~~though~~ contracts in infrastructure allows also an understanding of institutional design and deliver models for infrastructure and more specifically, the ways in which investors approach risk and uncertainty.
Theory of Contract	This work will be instrumental to improve public infrastructure procurement as well. Governments get a better understanding of the risks of public infrastructure investments and the risk exposure potentially shifted to the private sector, ensuring efficiency of risk sharing mechanisms (i.e. risk guarantees and pricing of contracts).
Role of State	Governance and Allocation of risk for low carbon infrastructure Because of the highly political nature of infrastructure investing, it is difficult to remove the influence of governments from any initiative for private institutional infrastructure investment, which emphasises the need for collaboration between the public and private parties to achieve the desired outcomes. This includes green investment banks, state owned and development institutions increasing their role in delivering infrastructure, especially in emerging markets.

Long Term Investors by type of institution (pension fund, insurer, SWFs)

This thesis draws on the theory of finance and financial intermediation to explain how the world of finance has developed over the last decades focusing on institutional investors as potential sources for long-term financing. Evidence on asset allocation and infrastructure investment is often based on partial information - small samples of investors – or qualitative target allocation data sources - not at investor level - making difficult to compare portfolio strategies across sectors and countries. Further academic research is needed on asset allocation trends, approaches investors are taking to ESG and alternative investment and on asset class performances. This would benefit pension funds facing difficult choices on investment allocation in their fiduciary roles and regulators called to supervise the overall pension system risk.

Long-term asset allocations decisions affecting low carbon infrastructure are based on the type of institution. Academic literature in relation to long term investing has been focusing on risk appetite and whether long-term investors should pursue a higher level of risk in their portfolio because of their longer investment horizon. Asset allocation of SWFs and PPRFs varies widely depending on their specific objectives and mandates while pension funds are constrained by the nature of their liabilities. Normative studies on long-term investments have been focusing on SWFs, endowments and alternative investment. There is a complete lack of research on pension funds in infrastructure framing the discussion from a pension policy design point of view.

Long term Investors and ESG

As investors with a typically long-term horizon, institutional investors have a particular incentive to consider ESG risks in infrastructure, which may materialize in the medium to long-term. Further research is needed on how to incorporate sustainability criteria in infrastructure investment, and ESG impact on financial performance.

Private investors approaching infrastructure are facing an “information gap”. There seems to be a disconnect between the investment narrative – a series of intuitions drawn from economics – and the observed

performance of available investment products, due to a lack of clarity of relevant assets related to the relative novelty of the asset class and a lack of empirical evidence on the investment characteristics.

Taken together, these studies are useful to understand the potential characteristics, but conclusions cannot be drawn that affirm the infrastructure and renewable investment narrative. The literature review provided finds heterogeneous results often not statistically robust. Hence, the empirical explanation of infrastructure performance is incomplete and many of these characteristics need to be affirmed or refuted in order to better define infrastructure asset class parameters. There are still problems with sampling biases (region, diversification, and time period) along with issues with comparability to private markets and unlisted infrastructure.

While there is increased investor interest in adopting ESG approaches, the linkage between ESG factors in infrastructure and infrastructure investment risks and returns is not well understood, and the literature is nascent. Academic literature had been focusing on the relation between ESG and corporate financial performance recognizing that long term investors may gain excess returns in integrating ESG factor in their investment process. For infrastructure as reporting is still immature, scoring has focused on firm's management approach and transparency of performance rather than direct performance.

Lack of standardization and ESG data on infrastructure assets limits the ability to explore the link between the ESG performance and the financial performance. Tools to analyze climate change risk would be used by all parts of the financial sector, making climate change stress testing and scenario analysis a part of due diligence and long-term financial analysis processes for banks, corporations, and institutional investors.

Building on this analysis, the establishment of rigorous sustainability-related indices[111] would facilitate the formation of investment products such as ETFs, index funds, and other strategies that invest exclusively in businesses that meet certain ESG requirement This would improve access to green investments for all

[111] Including the Dow Jones Sustainability Index, FTSE4Good, the Stoxx Europe Sustainability Index, the NYSE Euronext Low Carbon 100 Europe Index, the Bombay BSE Greenex and the Johannesburg Stock exchange SRI Index, amongst others.

investors, many of whom lack the resources to perform due diligence and who prefer to outsource such decisions to investment managers.

Governance and Allocation of risk for low carbon infrastructure

Because of the highly political nature of infrastructure investing, it is difficult to remove the influence of governments from any initiative for private institutional infrastructure investment, which emphasises the need for collaboration between the public and private parties to achieve the desired outcomes. This includes green investment banks, state owned and development institutions increasing their role in delivering infrastructure, especially in emerging markets.

Major challenges in the management of private/public funds are represented by the approach taken to embrace market principles while still supporting public policy objectives. Government bodies have very different social objectives from the return objectives of fiduciary investors. An appropriate, transparent governance structure and decision-making process needs to be put into place.

Further work is needed on the allocation of risk and uncertainty between infrastructure investors and between investors and the public (Clark 2018). This analysis needs to be framed with realistic expectation of institutional investors appetite for risks and practical constraints. Low carbon infrastructure present specific characteristics also to be taken into account.

Regulators with an appropriate degree of political independence, with a politically specific mandate, can ensure that durable assets are financed at very low weighted costs of capital (WACCs), through various designs for long term contracts (Allan & others 2020). At the same time recent literature has been looking at major issues and efficient ways for institutional investor to access infrastructure, focusing on collaborative models of institutional investment and relational investing. There is a growing trend amongst institutional investors towards more efficient ways of long-term capital deployment (Fang and others 2014; Monk and Sharma 2015a; Della Croce and Sharma 2014; Arezki, Bolton and others 2016).

8.4 THESIS LIMITATIONS

The first limitation of the thesis has to do with the choice of research methods. The methods employed in the thesis are qualitative and quantitative descriptive statistics to define the trends in private sector financing and the role of institutional investors, whereas in looking at new models and products in infrastructure I use a case studies approach. I have opted for a mix of qualitative and quantitative approach due to the lack of data common to private markets. While I was informed by numerous quantitative studies as part of conducting literature reviews, the results emerging from the qualitative research can be complemented by further quantitative enquiries.

The COVID crisis offers a unique opportunity for the development of private infrastructure as a global asset class with a reconsideration of the underlying risk to the performance of the asset. With additional performance data it will be possible to demonstrate the merit of infrastructure as a traditionally defined separate asset class or a new combination of investment factor exposure and whether investing in infrastructure (listed or unlisted) can create additional diversification benefits for investors.

Further understanding on investors approaches to infrastructure and low carbon infrastructure in particular is needed. Observing performance of the infrastructure investment universe, and constructing benchmarks based on historical returns creates inputs into the asset allocation process, and permits the evaluation of long-term objectives through the definition of success metrics. However looking at current and future infrastructure risks (i.e. climate change), further work should focus on scenario analysis aligning private and public expectations.

From a regulatory point of view, the difference in financial structure (corporate vs project) and the changing risk level profile across different phases (greenfield vs brownfield) are particularly important in the

recalibration of risk weights for prudential regulation. The regulation being one of the drivers of infrastructure financing of banks and institutional investors (i.e. Basel and Solvency)[112.]

The second limitation has to do with the scope of the DPhil thesis. While I believe I am able to provide several important contributions to the economic geography, private sector role and sustainable finance literature and policy, the DPhil thesis focuses mainly on a government/public use of the findings in a G20 context in two specific policy areas: pension funds and infrastructure investment.

The time and resource limitation of the DPhil implies that the study does not expand in further asset allocation empirical studies on asset management side or infrastructure delivery models in the infrastructure governance area.

To better understand of long-term investors in infrastructure further analysis is needed on pension design and regulation affecting the liabilities side and consequences for portfolio allocations and infrastructure investment. Framing this analysis at country level and considering also infrastructure governance and policies will results in effective policy implications in the pension fund and infrastructure areas.

Despite the increasing interest in long term investors, only a limited amount of information has historically been available regarding the investment strategies actually implemented by pension funds, sovereign wealth funds or PPRFs. Granular statistical data is scarce at asset or sector level forcing the literature to focus on the use of case studies of selected investors or more normative studies on asset allocation. This has led to considerable uncertainty about the exact nature of the strategies of the broader market and their evolution over time.

Beyond the lack of data, there is a lack of analysis in academia and policy institutions on the connection between policies affecting investors' portfolios strategies and political decisions for infrastructure. The institutional investor's investment strategies and the decision to invest in infrastructure are based on strategic

[112] Recently, in November 2016, the European Commission has proposed to reduce capital charges for insurers and banks investing and lending to certain infrastructure investments.

asset allocation and asset-liability management considerations. At the same time government choices about different types of private funding models and forms of financing of infrastructure are based on political priorities and national constraints. In order to ensure alignment of interest and long-term sustainability of infrastructure investment better understanding is needed of market opportunities in light of investor and government objectives.

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