Financial centres in global financial networks:

A quantitative analysis of investment banking deals

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Abstract

This thesis is structured around two primary objectives. First, to contribute to the literature on the world city network and the emerging literature on global financial networks by developing and empirically testing a new methodological approach for modelling urban networks that would aid the development of empirical research in these related streams of literature. Second, to provide empirical evidence showing the effects of positioning within global financial networks on individual financial services firms as well as financial centres. To achieve these objectives, this thesis first develops a novel modelling approach for empirical analysis of urban networks, which draws on the concept of underwriting syndicate as the primary building block of global financial networks. It also considers the consequences of the network boundary specification problem in the context of studying urban networks and compares the modelling approach it develops to the Interlocking World City Network Model (Taylor, 2001) and Alderson and Beckfield (2004) ownership ties approach. The empirical analysis that follows relies on data on investment banking deals sourced from Dealogic databases. The dataset built for the purposes of this thesis spans the 1993 – 2016 period and covers more than 1 million capital market transactions worldwide.

To achieve the second objective of this thesis, I have built spatial econometric and dynamic panel data models to uncover the effects of positioning within GFNs on individual financial services firms and financial centres. The results of this thesis indicate that inter-cluster network ties that connect financial services firms located in different financial centres are particularly valuable and they benefit both the performance of individual firms and lead to higher resilience of financial centres to demand shocks. In contrast, localised network connections are not found to be statistically significant in either context. Given the interdisciplinary nature of this thesis, its methodological developments and empirical findings, it contributes to

several related groups of literature, including the research on the world city network, global financial networks, underwriting syndicates and social network analysis. The implications of this thesis for public policy and corporate strategy relate primarily to the role of network connectivity in financial sector and the distinct role of syndication networks. I specifically relate this to contemporary issues including BREXIT, which as I discuss may have a material impact on the financial sector in the United Kingdom and beyond.

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Chapter 1 | Introduction

1.1. Background

Contemporary financial centres (FCs) with New York and London in the lead offer a great variety of financial services including underwriting of equity and debt securities, syndicated loans and advisory services to acquirers and targets in mergers and acquisitions (M&As). These service categories constitute some of the most prestigious and well-paid areas of finance to work in and are part of the portfolio of services offered by investment banks (Wójcik, 2012; Ioannotta, 2014). They are also used as widely accepted metrics for constructing ranking tables of financial services firms and are tracked closely by several data vendors including Thomson Reuters and Dealogic. Despite the association of these services primarily with investment banking, they are excellent examples of the interconnectedness of the financial and business services (FABS) sector at large. Each of these four types of capital market transactions typically involves one or multiple financial services, accounting, auditing and law firms. Securities issues also involve institutional investors and stock exchanges. These core types of capital market transactions therefore illuminate the ways in which an ecosystem of companies that form FCs works together to co-produce some of its most complex services (Wójcik et al., 2018a).

I will use an initial public offering (IPO) to offer an illustrative example. Although it is in principle possible for a company wishing to go public to issue its own shares and list them on a stock exchange, it is much more common for companies seeking public listing to hire an investment bank to underwrite the offering. This means that instead of the issuing company selling its shares directly to investors, the investment bank buys the shares from the issuing company and then sells them to

investors, typically at a price agreed prior to the offering with the issuing company. In doing so investment banks put themselves in the role of legal and reputational intermediaries between issuers and investors. Investment banks establish their reputations by underwriting offerings of securities repeatedly and this allows them to reduce the information asymmetries between issuers and investors, lower the risk of the transaction and achieve higher valuations for newly issued securities. The role of investment banks does not end after they execute an offering and instead they typically also become brokers in the secondary market for the given security (Dunbar, 2000).

In order to build an appreciation for the complexity of the FABS ecosystem within FCs, it is useful to consider also other types of FABS firms that play a role in IPOs. To begin with, investment banks allocate newly issued securities to both individual and institutional investors. Institutional investors, as the holders and managers of most of the global financial capital play a crucial role in these transactions and the relationship between investment banks and institutional investors is at the very heart of securities underwriting. There are also other, non-financial companies involved in IPOs. Investment banks need to prepare an IPO prospectus, a document detailing the issuer's business and the proposed new issue of equity securities. IPO prospectus features financial statements of the issuer, which are prepared by an accounting firm and verified by an external auditor. Additionally, issuer hires a law firm to draft legal contracts and to potentially represent the issuer in the event of a legal challenge from investors. Stock exchanges are currently typically organised as individual for profit companies and serve as obligatory passage points for securities offerings with their own standards and listing requirements. To complicate matters further, institutional investors buying these newly issued securities often at times act on the behalf of mutual,

pension or sovereign wealth funds, which in turn manage the funds of their beneficiaries (Pollock et al., 2004; Arjaliés et al., 2017; Clark and Monk, 2017).

This level of complexity of financial services and in parallel the ecosystem of FABS firms operating within FCs is a result of a long process of an evolutionary change that has been richly documented by economic historians (Kindleberger, 1974; Spufford, 2006; Cassis, 2010). The process of development of FCs can be seen as analogous to the process of urban economic development described by Jacobs (1969) and broadly follows the pattern of new work being added to old work, either due to pre-existing skills that make it feasible to carry out new tasks or an evolution of tasks due to their relatedness (Cassis, 2010).

Despite not being the first places providing financial services, Florence in Italy and Bruges in Belgium are considered the 14th century predecessors of the contemporary FCs, mainly due to the concentration of financial service providers in these cities and the variety of services offered (Spufford, 2006). These early European FCs have centred their activities around financing trade and their financial prowess has been built on the earlier economic success of these cities and their countries.

The centre of mass of European finance has slowly shifted over the next few centuries, first to Antwerp, followed by Amsterdam and finally London. While the emergence of these FCs was related to economic dominance of their countries and their position as important trade nexuses, the decline of FCs did not immediately follow contractions in their economic or trade significance. As an example, Amsterdam has remained a dominant FC of Europe long after Britain has far surpassed the size of Netherland's economy. In parallel to this shifting power balance among European FCs, the scope of their activities has far surpassed commodity trading. Merchant bankers have been helping European courts to raise funds for numerous wars, including those between France and Britain and

Napoleonic wars that involved all major European powers at the time (Spufford, 2006). Lending to monarchs that could rely on their tax income to meet repayments effectively meant the beginning of public finance.

Following the English Revolution of 1688, which created the legal and institutional foundations of the private property protection rooted in common law, trans-Atlantic merchants and later merchant bankers became involved in intermediating the issuance of government loans. While raising funds, they relied on their lists of investors, mainly wealthy individual and other merchants (Morrison and Wilhelm, 2007). Despite being briefly preceded by Hamburg and Frankfurt, Amsterdam with its stock exchange became the dominant FC of Europe over the 17th and 18th century. The early days of stock markets can be traced back to Amsterdam and the United East India Company, which was founded in 1602, had 1,143 shareholders and listed its shares on Amsterdam Stock Exchange (Spufford, 2006).

The opening of the London Stock Exchange in 1801 marked the shift of centre of mass of European finance from Amsterdam to London, following French invasion of the Dutch Republic in 1795 (Spufford, 2006; Cassis, 2010). The 19th century was also marked by rapid industrialisation of the United States, the growth of US capital markets and development of investment banking. This process was mainly driven by the heavy investment in railroads and industrial plants. The needs of these industries could no longer be met by domestic US savings and instead relied heavily on European capital markets and issuance of bonds both domestically as well as in Europe. Trans-Atlantic mercantile networks based on trust and intermediation played a key role in the development of these early capital markets and have provided some of the key extra-legal mechanisms for the operation of modern investment banking throughout the 19th and 20th century (Morrison and Wilhelm, 2007).

The underwriting syndicate also became used in late 19th century in the US, following its inception earlier in the same century in France (Pichler and Wilhelm, 2001). In the 20th century investment banking followed several structural changes and consecutive waves of regulation and deregulation that have led to its present shape. The shock of the Great Depression of 1930s led to multiple bankruptcies among the leading US investment banks, including the collapse of Goldman Sachs Trading Company (Morrison and Wilhelm, 2007; Galbraith, 2009). The 1947-53 anti-trust lawsuit US vs Morgan et al. challenged the mechanics of investment banking networks and the organisation of underwriting syndicates. Due to the lack of direct evidence of collusion among investment banks to prevent competitors from entering the market, a period of hands-off approach by US regulators has followed, culminating with revoking of the Glass-Steagall Act in 1999 (Morrison and Wilhelm, 2007).

During the second half of the 20th century investment banks were in addition to regulatory changes also transformed by technological developments in computing and financial economics. This meant that while some of their tasks became heavily standardised, even automated and the underlying knowledge codified, the value of tacit knowledge and relationships was retained in areas such as issuing of new securities, particularly IPOs and advisory activities in M&As. In contrast, brokerage activities in secondary markets as well as issuance of bond securities have witnessed a substantial reduction in margins, reflecting the increased standardisation of these activities and increase in competitive pressures (Morrison and Wilhelm, 2007).

In terms of internal organisation, investment banks have transformed on masse from partnerships to joint-stock companies during the late 20th century and pursued their own IPOs. This was partially in response to the higher capital requirements associated with their activities, primarily those relating to trading in secondary

markets. The archetype of a pure investment bank has also become rarer and in fact investment banking arms of universal banks, with JPMorgan Chase in the lead, have begun to dominate the market. Investment banks also began to offer a wider range of advisory and financial engineering services, to help their clients, to optimize their capital structure (Morrison and Wilhelm, 2007). As a result, they would advise their corporate clients to finance their activities using a variety of methods, often including equity and debt securities in addition to syndicated loans. Syndicated loans have become a popular addition to the portfolio of investment banking services, reflecting the better access to capital of publicly listed investment banks and the overlap between investment and commercial banking within the same organisations (Ioannotta, 2014).

Despite the economic rise of the United States, New York took several decades to become a serious competitor to London in international finance. Following the Second World War it seemed that New York was going to inevitably overtake London as a global FC. This ambition however faced a crucial challenge in form of the 1986 deregulation of financial services and the London Stock Exchange in Britain, which contrasted the relatively more stringently regulated US capital markets. This translated into the dominance of London in international finance and made London a popular platform FC for foreign banks, while New York was mainly supported by domestic financial activities. “By 1998 there were nearly six hundred foreign banks in London, when New York only had three hundred, and Tokyo only one hundred” (Spufford, 2006, p.33). Interestingly, this distinction between New York’s dominance by sheer size, but being domestically focused and London as the dominant FC in international finance can be seen even in very recent studies of international FCs (Wójcik et al., 2018ac).

There are several lessons to be learned from the rise and declines of FCs and the development of investment banking in the process. First, although FCs have

relied on the economic strength of their countries and domestic demand for their services at the early stages of their development, once they internationalised their activities, they would remain viable long after the economic significance of their domestic market declined. Second, the development of FCs and capital markets generally lagged behind the economic development of their countries. As a result, countries like the United States of America relied on overseas FCs for financing their economic growth, even long after they have outgrown the size of these countries (Spufford, 2006). Third, the evolution of practices in financial services was relatively uninterrupted by the rises and falls of individual FCs, particularly because the key merchants, merchant bankers and later investment bankers were highly mobile and moved from one FC to another as required in light of economic and political change. Social networks of individual financiers often span the boundaries of FCs and practices therefore co-evolved within a global network of FCs (Cassis, 2010). Fourth, although FCs and in particular investment banking rely on some critical level of institutional quality and legislation that protects private ownership, they in fact themselves owe their existence to the imperfections and incompleteness of laws and contracts (Morrison and Wilhelm, 2007). Finally, as a direct consequence of the previous point, social networks and trust became indispensable in investment banking due to its reliance on private information relevant to the pricing and strenght of demand for new securities offerings. This is a direct consequence of the inherent difficulties in legal treatment, valuation and contracting of trading relationships with such private information. It seems highly impractical and perhaps impossible that laws and contracts could be written and enforced well enough that would make social relationships and trust obsolete in these markets (Morrison and Wilhelm, 2007).

This final point brings me to the motivation for this project. It seems to be widely understood that social networks are not just one of the observed characteristics of

the investment banking industry, but the trust and interpersonal relationships embedded in these networks are the very thing that allows this industry to exist and operate (Morrison and Wilhelm, 2007). Studies in economic history show that FCs have been influenced heavily by their connections to other FCs and it was often these inter-city ties that allowed them to develop valuable business opportunities (Spufford, 2006; Cassis, 2010). Underwriting syndicates, as one of the key building blocks of networks within investment banking, have been widely studied within finance, management and strategy and their structure and motivation for formation are well understood and theorized (Pichler and Wilhelm, 2001; Pollock et al. 2004; Shipilov, 2006; Ljugqvist et al., 2009). At the same time, the study of FCs in economic geography suffers from the lack of systematic and global empirical research mapping network connections among FCs and considering their impact on individual firms and FCs at large. This is despite the clear interest of researchers in this phenomenon (Sassen, 2012; Wójcik, 2018).

There are a number of reasons, why I find this particular gap in the literature appealing. It not only presents a set of exciting methodological and empircal challanges, but it specifically calls for someone with the right skillset in finance, data management, network analysis, economic and financial geography. I have felt encouraged to pursue this research direction, as I studied finance for three years at the University of Birmingham and have worked on resarch projects on various aspects of investment banking, including analyst research and cross-listing of companies on overseas stock exchanges. While working on the second of these topics I have come across the work of Professor Clark and Professor Wójcik on governance of FABS and capital markets (Clark, 2000; Clark and Wójcik, 2007; Wójcik, 2012), which ultimately led me to approach Prof Wójcik and apply for DPhil at the School of Geography and the Environment. As a direct consequence of having experience with both finance and economic geography, I felt that I would

be well placed to approach this research problem. I have therefore decided to use the resources available to me during the course of this project to work towards bridging the gap between these related strands of literature and contribute to developing a novel methodological approach for mapping network ties among FCs based on syndicated investment banking deals (chapter 3). I then compare this approach to other related methods and investigate the consequences of the network boundary specification problem in the context of studies of urban networks (chapter 4). Additionally, I also consider the effect of positioning within syndication networks on the resilience of FCs (chapter 5) and the long-term growth of financial services firms (chapter 6).

During my time at the University of Oxford I have benefited from valuable experience that I have gained, while working on a variety of research projects as a research assistant and later research associate in finance and geography for Prof Wójcik (University of Oxford) and collaborating with Prof O'Neill (University of Western Sydney), Dr Knight (University of Sydney), Dr Urban (University of Oxford) and Mr Hashimoto (University of Oxford). These have included projects funded by the Centre for International Finance and Regulation (CIFR F001), the Hong Kong Research Grants Council (T31-717/12-R), the Australian Research Council (DP160103855) and the European Research Council (681337). Through my involvement in these research projects, I have been able to co-author four papers, in addition to my thesis chapters, which were submitted to Economic Geography, Environment and Planning A and the Journal of Economic Geography. Two of these papers have already been accepted for publication in Economic Geography and the Journal of Economic Geography. I am very thankful for these opportunities, as they helped me to gain the necessary experience and insights, to fully develop the ideas in my thesis.

1.2. Terms and definitions

I now proceed to explaining the key terms used in this thesis, including those in its title, which reflect both the topic and scope of the inquiry conducted here. The purpose of this is to aid the reader in understanding what is precisely meant by these terms, particularly those that are widely used in the related literature and do not have a single generally accepted definition. This thesis is broadly set in the discipline of economic geography. Due to its object of study and reliance on the literature in financial economics, it can be further categorised as being part of financial geography, a distinct subdiscipline of economic geography.

"Geography can be defined as the why and so what of where. In economic geography the where, why and so what questions are focused on understanding economy" (Clark et al., 2018). Financial geography is primarily concerned with studying the spatiality of finance and answering the, where, why and so what questions, which it shares with economic geography. In doing so it benefits from the cross-fertilisation of ideas between economic, cultural, political and social geography and financial economics. Financial geography then in parallel informs geography with finance and vice versa, thus opening and contributing to topics that lie at the overlap of these disciplines (Wójcik, 2018).

The contemporary research in financial geography focuses on the activities of financial and business services (FABS) firms and how they shape the geographical and relational organisation of the financial sector. FABS firms are generally understood to supply their services as inputs into the production process of other companies, rather than consumers, and despite a variety of working definitions of this sector, they typically include financial services, law, accountancy, management consultancy, information technology and human resources firms (Dicken, 2011). Financial centres (FCs) are simply defined as clusters of financial and business services (FABS) firms for the purposes of this thesis. As I will

elaborate on in the conceptual framework and methodology section of this chapter, the empirical focus of this thesis is on underwriting of equity and debt securities, syndicated loans and advisory services in M&As. Consequently, the empirical specification of FCs operationalised here does not cover all FABS, but is instead restricted to these activities.

Rather than considering FCs as strictly separate units, I treat them as clusters of firms, which are part of a global network. Global financial networks (GFNs) are understood as complex networks formed by the activities of FABS firms, which collaborate with each other and are not limited to any specific spatial scale (Wójcik, 2018). In order to operationalise GFNs empirically, I rely on the concept of inter-organisational project as the basic relational element and building block of these networks. Inter-organisational projects are defined simply as projects carried out in order to deliver a service to a client and this service is co-produced by multiple firms. Underwriting syndicates, syndicated loans and multiple advisor M&As are a prime examples of such inter-organisational projects (Pollock et al., 2004). I refer to all of them as syndicated deals for short. Networks formed through joint membership of financial services firms in syndicated deals are referred to as syndication networks in this thesis and they can be thought of as one of the many possible empirical realisations of GFNs.

Finally, both for conceptual and methodological reasons this thesis employs the distinction between parent and subsidiary companies. I follow the established definition of these terms, which refers to a company that owns a controlling (over 50%) stake in another company as the parent, which the controlled company is referreed to as a subsidiary. Due to the complexity of the contemporary corporate ownership networks, many data vendors including Dealogic use a simplification relating to such ownership ties. Every capital market transaction covered by Dealogic equity capital market, debt capital market, syndicated loans and M&As

databases has two fields relating to the service provider (i.e. underwriter of a securities issue), one referring to the bank subsidiary and one referring to the bank parent. The bank subsidiary field relates to the immediate legal entity that has underwritten the given transaction, while the bank parent refers to the ultimate parent of this entity. For companies that are independent, or in other words do not have a parent company, both the bank subsidiary and bank parent field would be filled with the same entity name.

1.3. Conceptual framework and methodology

There is presently not a fully developed theory that would explain how global financial networks (GFNs) operate and how positioning of FCs within GFNs impacts them and their constituent firms. The nascent literature on GFNs is however able to give us a framework indicative of the relevant actors and relationships that are at the core of GFNs and should be considered (Coe et al., 2014; Wójcik, 2018). What this literature lacks, however, is a more nuanced theorising of the microeconomic foundations and motivations for the existence of these networks and appropriate methods for measuring and analysing them. I can overcome some of these limitations by engaging with related strands of literature on the world city network (Taylor and Derudder, 2016), in evolutionary economic geography (EEG) (Martin and Sunley, 2011), financial intermediation (Clark and Monk, 2017; Arjaliés et al., 2017) and on underwriting syndicates (Pichler and Wilhelm, 2001; Pollock et al., 2004; Ljungqvist et al., 2009).

The motivation for combining these frameworks naturally emerges from the current state of the literature on FCs and investment banking, which is far from integrated and lacks a unified framework that can be readily used to address the need to jointly consider FCs, FABS firms and their networks. By enriching the GFNs framework with these related strands of literature, I am able to build a more comprehensive conceptual framework, built on well theorized network ties formed

through co-membership of financial services firms in syndicated deals. The combination of these perspectives provides a conceptual framework that can guide an enquiry into methodological challenges that presently pose barriers for the integration of microeconomic studies of financial networks and studies of FCs within GFNs. Similarly, it is necessary to combine the existing knowledge and concepts from these related strands of literature, to develop empirical studies explicitly considering the impact of positioning within GFNs on individual FABS firms as well as FCs.

The GFNs framework offers a high-level overarching framework for the research conducted here and can be thought of as a rough sketch of the picture of FCs within GFNs being painted here (Coe et al., 2014; Wójcik, 2018). The world city network concept developed within the global and world city research in turn offers a rationalisation for the existence of inter-city network ties formed by the activities of FABS firms and their relevance to both individual firms and city level processes. What it lacks however, are truly relational low-level building blocks for urban networks, which are instead derived from data on office locations of FABS firms (Taylor and Derudder, 2016). I consider a number of potential candidates for such building blocks of GFNs and select inter-organisational projects as one such possible suitable candidate. Underwriting syndicates are a specific type of such projects developed in the 19th century within investment banking (Pichler and Wilhelm, 2001). Underwriting syndicates are well theorized and understood within finance, management and corporate strategy and their temporary, yet highly persistent nature makes them suitable for studying network connectivity among FABS firms (Pollock et al., 2004). Focusing on underwriting syndicates therefore allows us to inform our modelling by a rich understanding of the microeconomic motivations and mechanics of syndication networks. This in turn aids us to overcome many limitations of the prevailing conceptualisations of FABS networks

within the global and world city research (Taylor, 2001; Alderson and Beckfield, 2004). Evolutionary economic geography complements our framework by offering a variety of modelling approaches for the evolution of clusters and is indispensable to our enquiry relating to the impact of positioning of FCs within GFNs on their resilience (Martin and Sunley, 2011; Frenken et al., 2015).

The methodology employed in this thesis is a combination of methods from social network analysis, spatial and dynamic panel data econometrics. We use social network analysis methods to measure and visualise network ties among FCs, calculate network structural measures and they are essential to the development of the methodological core of this thesis in chapter 3. In chapters 4-6, the primary use of social network analysis methods is to provide empirical evidence on positioning of FCs and individual firms in GFNs, employing a variety of measures of network centrality for firms and group network centrality of FCs (Everett and Borgatti, 1999; Jackson, 2010; Borgatti et al., 2018). In order to model the impact of positioning within GFNs on long-term growth performance of financial services firms, we employ spatial econometric modelling methods (Vega and Elhorst, 2015). We use System Generalised Method of Moments (GMM) to model the effect of network connectivity of FCs on their resilience to demand shocks (Arellano and Bover, 1995).

The main data input used in this thesis, which serves both to calculate revenue earned by individual firms from investment banking activities and serves as a low-level building block of our networks, is data on capital market transactions sourced from Dealogic databases. Four types of transactions are covered, namely, underwriting of equity and debt securities, syndicated loans and advisory services in M&As. Every transaction is identified by a deal number and in combination with the list of names of financial services firms involved, it serves as the basis for constructing an affiliation matrix, which links firms and deals. Given that many of

these deals feature multiple financial services firms, referred to as syndicated deals, such affiliation matrix can be converted to a firm adjacency matrix and can thus provide the necessary data for measuring network centrality of individual firms and visualising their networks. Adding hand collected data on location of financial services firms combined with the use of group network centrality measures (Everett and Borgatti, 1999) allows us to measure network centralities of FCs within networks formed by inter-firm syndication ties.

The majority of transactions includes data on the deal value. Data on fees earned from individual transactions are available for about 20% of transactions and we use estimates of these fees based on characteristics of transactions for the remainder of the sample. Such estimates are presently available within Dealogic databases and are within 5% margin of error. In addition to data on capital market transactions, this thesis utilizes also city level data sourced from Oxford Economics Global Cities 2030 database and country level economic, demographic and institutional statistics sourced from Oxford Economics, World Bank and Euromonitor Passport databases.

1.4. Thesis structure

This thesis follows a four paper route. It starts with an introduction chapter 1, which provides general background and overview of this thesis. It is then followed by chapter 2, which engages with the wider literature relevant to the topic of this thesis. This is then followed by four substantive chapters 3-6, which are organised as stand-alone research papers with their own research design sections. Finally, this thesis concludes with chapter 7. In accordance with the School of Geography and the Environment, University of Oxford regulations, all four substantive chapters of this thesis have been submitted to peer review journals and are presently under review. Chapter 3 of this thesis has been submitted to Urban Studies, chapter 4

to Geoforum, chapter 5 to the Journal of Economic Geography and chapter 6 to Regional Studies.

Given the four-paper route followed by this thesis, each of its substantive chapters is a fully self-contained research paper with its own objectives and research questions. There is however also a higher, overarching set of objectives that brings all the work conducted in this thesis together into an integrated whole. First, to contribute to the literature on the WCN and the emerging literature on GFNs by developing and empirically testing a new methodological approach for modelling urban networks that would aid the development of empirical research in these related streams of literature. Second, to provide empirical evidence showing the effects of positioning within GFNs on individual financial services firms as well as FCs. To fulfil these objectives, I devote chapters 3 and 4 to the first objective and chapters 5 and 6 to the second.

Chapter 2 engages with the wider literature relevant to the topic of this thesis and sets it in a wider context, to aid the interpretation of its findings presented in chapters 3 - 6. In doing so, chapter 2 starts with the evolution of research on clusters and follows this literature from the seminal work of Marshall (1920) on industrial districts to the contemporary literature in evolutionary economic geography, which conceptualizes clusters as complex adaptive systems (Martin and Sunley, 2011). While this conceptualisation is useful for methodological purposes, I acknowledge that the literature in this area has engaged relatively little with FABS and even less so with investment banking and is therefore in its own right not sufficient to provide a comprehensive conceptual framework for studying FCs and their networks.

To rectify this shortcoming, chapter 2 proceeds by engaging with a wide variety of research on FABS carried out within economic and financial geography, financial economics, management and strategy. Doing so not only puts investment banking

into perspective to the wider ecosystem of FABS, but it also explains the role of capital markets and networks. At the level of FCs this exercise proposes the relevance of localised inter-firm interactions and the relevance of localisation economies. Similarly, as the literature in financial geography interested in FCs and their networks, also chapter 2 proceeds by devoting an entire section to the global and world city research, which has been a very fertile ground for research on urban networks formed by the activities of FABS firms and MNEs (Alderson et al., 2010; Taylor and Derudder, 2016). Doing so enriches this thesis with theories, methods and empirical findings of a very rich literature studying this phenomenon, although at the same time it reveals its many shortcomings, some of which are exploited as gaps in the related literature directly addressed by this thesis.

Chapter 3 forms the methodological core of this thesis and develops a novel approach for modelling urban networks formed by activities of FABS firms termed 'inter-organisational project approach to the interlocking world city network model'. The primary objective of this chapter is to develop an empirically feasible approach based on inter-organisational project participation of FABS firms as an alternative to Taylor's (2001) interlocking world city network model (IWCNM). To make the process of developing this model as transparent and comparable to Taylor's (2001) IWCNM as possible, it is developed and presented in parallel to the IWCNM. We outline and discuss the differences between these two models throughout this chapter.

Our approach can be used for empirical analysis of network ties connecting FCs, such as those proposed within the GFNs framework (Wójcik, 2018). The primary point of departure of the approach developed in chapter 3 from Taylor's (2001) IWCNM is the primary data input. While IWCNM relies on an affiliation matrix of FABS firms and cities, which denotes where the offices of FABS firms are located, the primary data input into the model developed here is in the form of a

firm – project affiliation matrix. As shown in chapter 3, this seemingly subtle difference ultimately leads to a model that, not only is crucially based on relational, rather than attribute data, but it overcomes several important limitations and blind spots of the IWCNM. Additionally, it is specifically designed to allow for an analysis of FCs in GFNs based on inter-firm interactions, such as envisioned in the GFNs framework, which is simply not possible using the presently available approaches based on office location data or ownership ties (Taylor, 2001; Alderson and Beckfield, 2004).

Chapter 4 focuses on the network boundary specification problem in urban network analysis and its consequences for two established modelling approaches within the global and world cities literature (Taylor, 2001; Alderson and Beckfield, 2004) as well as the 'inter-organisational project approach to the IWCNM' developed in chapter 3. The primary objective of chapter 4 is to investigate the reliability and similarity of city network centrality measures derived from these three competing modelling approaches. We are specifically interested in the following research questions – (1) How similar are the city network centralities derived using office network, ownership ties and inter-organisational project approaches? (2) What sampling percentages are required to obtain results consistent with those from a whole network analysis? This exercise reveals that the results obtained from these three approaches are only weakly correlated and these differences persist regardless of the sampling percentage.

When considering sampling of networks by parent companies, I find that randomly sampled networks yield reliable node structural parameters only once at least 90% of parent companies were sampled, while networks sampled from the top of the list (largest first) yield reliable results once about 50% of parent companies were sampled. This is then contrasted with related empirical literature, which generally works with samples of 10% of the underlying population or even

much smaller, suggesting that their results are likely to be only weakly correlated with those that would have been obtained from a whole network analysis.

Chapter 5 studies the resilience of FCs to demand shocks. It develops a novel methodology based on quantifying the exposure of FCs to different segments of the market for securities underwriting services and allows the sensitivity of FC revenue to demand shocks to vary along the characteristics of FCs. The objective of this chapter is to empirically verify the effect of inter-city network ties among financial services firms on the resilience of FCs. Additionally, this chapter also considers the structure of client base, firm size distribution of FCs and the role of institutions. In doing so it aims to answer the following research question: What is the effect of the client base structure, bank concentration, network connectivity, and quality of institutions on the resilience of FCs to demand shocks?

This chapter draws methodologically on chapter 3 and utilizes the 'inter-organisational project approach to the IWCNM' to quantify the network centrality of FCs. It then applies a system generalized method of moments (GMM) estimator to a model of FC revenue growth, which includes a proxy of demand shocks as one of its explanatory variables. We interact this variable with characteristics of FCs to allow its coefficient to vary, thus allowing for a variation in sensitivity of FCs to demand shocks. This analysis shows that FCs, which are better connected within GFNs are more resilient to demand shocks than their lesser connected counterparts. The difference in sensitivity to demand shocks between the least and most connected FCs is on the order of two. The structure of the client base also plays an important role and FCs that operate a diversified specialisation model are relatively more resilient that those, which are highly diversified. FCs dominated by large financial services firms display more resilience to demand shocks. Despite its well-known relevance to FC development, quality of institutions is not found to impact resilience of FCs.

Chapter 6 is primarily concerned with individual financial services firms and their networks. Its primary objective is to study the relationship between network centrality of financial services firms within syndication networks, their long-term growth rate and the associated indirect effects on other financial services firms in their proximity. In doing so we distinguish between different types of network ties, namely localized and inter-city network ties, network ties between lead managers and co-managers and consider a variety of network centrality measures from the simplest degree centrality to more sophisticated measures that account for brokerage opportunities.

We focus on the following two research questions – (1) Do financial services firms with more central positioning within syndication networks grow faster? (2) How are financial services firms located within the proximity of well-connected firms affected? Our results indicate that well connected firms in fact outperform their lesser connected counterparts, ceteris paribus. Inter-city network connections and co-management ties are shown to be the sources of these benefits. Additionally, our evidence supports the notion that firms, which form such network ties, consequently intensify the competitive pressure within their FCs, which leads to reduced growth opportunities for other co-located firms.

Chapter 7 is the final chapter of this thesis and its main purpose is to draw conclusions and review the findings and contributions of the four substantive chapters that precede it. The aim here is not to simply repeat the findings as they were illustrated here or discussed in more detail in the individual substantive chapters of this thesis, but instead the emphasis will be on their interconnections and how they jointly contribute to the related literature and the objectives of this thesis. To accomplish this, I will reflect on how the contribution of this thesis helps to fill some of the gaps in the related literature. To illustrate the relevance of this research to the world outside of academia, I discuss the relevance of our findings

and methodological developments to public policy and strategy and illustrate their implications for ongoing public debates and developments in the financial sector, including BREXIT. Finally, I propose directions for the future research on FCs and GFNs that could draw on the work carried out in this thesis.

Chapter 2 | Financial and business services, clusters and networks

2.1. Introduction

The purpose of this chapter is to offer a synthesis of the most relevant strands of literature that this thesis engages with. The focus therefore will be on the contributions that this thesis either directly builds on or draws inspiration from for the development of its substantive chapters, rather than offering an uncritically exhaustive review of different perspectives on the topic. In doing so I focus on three principal elements that lay the foundations for rest of this thesis, namely financial and business services (FABS), clusters and networks.

FABS are understood as services provided by accounting, law, management consultancy and financial services firms to other companies. Discussing research on FABS offers context for this thesis by linking investment banking to the wider ecosystem of related companies, with whom they co-produce complex financial services such as issues of new equity or debt securities, advisory services in mergers and acquisitions or syndicated loans (Ioannotta, 2014; Wójcik, 2018). FABS have been widely researched by economic and financial geographers and their research draws on contributions from a variety of related disciplines including economics, finance, management and strategy, and economic history (Sassen, 2001; Desmarchelier et al., 2013; Coe et al., 2014).

Financial centres (FCs) are perhaps the most iconic geographical features of the contemporary capitalism. They can be thought of as clusters of FABS firms, typically located in the leading metropolitan areas, which compete as well as collaborate with each other to co-produce complex financial services. The recent trend in the research on FCs is in complementing the well-established portfolio of

case studies, surveys, comparative economic history research and quantitative studies using a variety of indirect measures of FC activity by conducting large scale global studies using data on individual capital market transactions (Wójcik et al., 2018a, 2018c). In order to benefit from the availability of these datasets beyond a mere description of the activity in capital markets and creating ranking tables of FCs, we must seek to explain the causal mechanisms underlying the observed patterns of spatial organisation of FABS, its spatial and temporal dynamics and degree of stability. If we are to do any of these things, we require frameworks, theories and models that can guide our inquiry and offer explanations for the benefits that clusters offer to their constituent firms, the nature of interactions among clustered firms, mechanisms underlying the evolution of clusters and factors affecting their resilience. These points of interest are closely tied to the research on clusters, which has evolved from Marshall's (1920) work on industrial districts to the contemporary cutting-edge research in evolutionary economic geography (Boschma and Frenken, 2006; Martin and Sunley, 2011; Boschma, 2015).

The role of network connectivity is considered throughout this chapter and the focus on network ties is also the uniting characteristic binding together the four substantive chapters of this thesis. Network connections among FABS firms have become an important topic of research in economic and financial geography, finance, management and strategy over the last two decades and are understood to not only be relevant to the performance of individual firms, but as an inherent feature of the way FABS operate (Pollock et al., 2004; Wójcik, 2018). In order to bring together a variety of relevant perspectives on conceptualising and measuring FABS networks, I consider research on both the horizontal and vertical dimensions of FABS inter-firm networks (Pichler and Wilhelm, 2001; Arjaliés et al., 2017) as

well as studies of urban networks formed by the activities of FABS firms (Taylor and Derudder, 2016).

The rest of this chapter is structured as follows. Section 2.2 offers a synthesis of literature on clusters and its evolution from the works of Alfred Marshall (1920) to the contemporary research in evolutionary economic geography (Boschma and Frenken, 2006). Section 2.3 considers research on FABS and financial centres and focuses on the work of financial geographers and related disciplines. Section 2.4 is centred on the research investigating urban networks formed by organisational actors. Section 2.5 summarizes this chapter and identifies gaps in the present literature, some of which are addressed in the substantive chapters (3-6) of this thesis.

2.2. Evolution of clusters, resilience and localisation economies

Agglomeration of economic activity and the existence of clusters is one of the most striking features of the economic landscape (Porter, 1990). Despite the substantial improvements in the information and communication technology, there are no widespread signs of reversal to the geographical clustering of economic activity and instead clusters remain a dominant feature of our economies across a wide variety of industries (Ellison et al., 2007; Beaudry and Swann, 2009). The evolution of thought on clusters has witnessed many discussions relating to the specification of this concept. Michael Porter proposes the following definition of a cluster, which captures the richness of the relevant actors and emphasizes the relevance of interactions among its members.

> *Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g., universities, standard agencies, trade associations) in a particular field that compete but also cooperate (Porter, 2000, p. 15).*

This broad view of clusters is not directly compatible with the established industry classification systems such as Standard Industry Classification (SIC) or

North American Industry Classification System (NAICS) and consequently researchers must look beyond these standardised industry categories to draw the boundaries of clusters. This challenge has been addressed in multiple ways, including the use of input/output linkages (Ellison et al., 2007), use of broad industry classification categories (Beaudry and Swann, 2009) and defining clusters based on the engagement of firms in a specific product or service market (Klepper, 2010). The last approach is closely linked to the approach adopted in this thesis and I will elaborate on this in the respective research design sections of chapters 3 - 6.

To appreciate the contemporary approaches to studying clustering of economic activity, its causes and consequences, it is important to understand the evolutionary roots of the present day thought on clusters. The work of Marshall (1920) is considered one of the seminal contributions to the study of geographical clustering of economic activity and his 'industrial district' is widely considered the intellectual predecessor of Michael Porter's (1990) cluster concept. Alfred Marshall drew his inspiration from the Sheffield metals cluster set in the 19th and early 20th century Yorkshire and proposed three complimentary hypotheses that rationalise both the reasons for clustering and impact of clustering on individual firms.

Firms located in clusters are proposed to benefit from specialised local labour market, input and output linkages and sharing of knowledge. This paradigm led to the view of clusters as being beneficial to their constituent firms by providing benefits that are spatially bounded and generally not available to other firms located outside of clusters. In turn these benefits, termed as localisation economies, are used to rationalise the motivation for the clustering of economic activity. It is assumed that firms purposefully locate within clusters to reap these benefits. Firms located within clusters are portrayed as benefiting homogenously from a know-how that is ubiquitously available to all. Firm heterogeneity and

network connectivity remain a part of the black-box of industrial clustering (Marshall, 1920; Arrow, 1962; Romer, 1986).

The cross-fertilisation between the fields of industrial dynamics and economic geography gave rise to a rich empirical literature that is heavily influenced by the Marshallian paradigm and aims to verify the proposed positive impact of localisation economies on firm performance (Frenken et al., 2015). Empirical work that considers the impact of clustering on firm performance is generally concerned with studying the link between clustering of firms operating within a single, or closely related industries, and entry of new establishments, firm growth and firm survival (Klepper, 2007; Beaudry and Swann, 2009; De Vaan et al., 2013). In turn research focused on the evolution of clusters and the impact of firm entry, growth and exits on the future trajectories of clusters is conceptually linked to evolutionary economic geography (Boschma and Frenken, 2006; Martin and Sunley, 2011) and research on product and industry life cycles (Thomson, 1968; Klepper, 2007).

The primary point of departure between the view of clusters as being the source of localisation economies, which both motivate firms to locate within clusters and convey benefits that lead to cluster firms performing better than non-cluster firms (Marshall, 1920; Arrow, 1962; Romer, 1986) and the work in evolutionary economic geography is whether localisation economies are necessary for clusters to emerge in the first place (Klepper, 2007; Boschma and Frenken, 2018). Firm level studies provide somewhat mixed evidence regarding the existence of localisation economies and their role in the clustering of firms. The entry of new establishments is consistently linked to the level of clustering across a variety of industries, however these patterns of spatial location of new establishments can be for most explained by the pre-existing location of their founders and therefore may not necessarily mean that firms locate within clusters to realize any localisation economies (Buenstorf and Klepper, 2009; Buenstorf and Geissler, 2011).

Alternative explanations suggest that this can simply be the result of spinoffs being created by former employees of incumbent firms, who are hesitant to relocate due to the associated costs and unwillingness to withdraw from their localised social networks (Stam, 2007). Evidence of localisation economies is however found in creative, high-tech and some service industries including financial services (Folta et al., 2006; Wennberg and Lindqvist, 2010).

Given that studies of entry of new establishments cannot reliably distinguish between the proposed positive influence of localisation economies and clustering of firms within clusters through spinoff dynamics, a process that does not rely on any positive externalities, scholars have turned to studying the link between clustering and firm performance. Firm performance is typically represented in related studies by firm growth (Rosenthal and Strange, 2005) or firm survival (Nyström, 2007). Empirical results relating firm growth to clustering vary considerably across industries and are typically less significant for service industries than manufacturing (Nyström, 2007; Beaudry and Swann, 2009). The link between clustering and firm survival on the other hand can be explained by other factors, such as the pre-existing experience of entrepreneurs in their sector in the case of spinoffs (Klepper, 2007; Buenstorf and Klepper, 2009; Heebels and Boschma, 2011) or the higher propensity of firms located in clusters to be acquired or merged with other firms (Weterings and Marsili, 2015).

It is a common practice among studies of the effect of clustering on firm performance not to consider firm heterogeneity and simply compare the performance of clustered and non-clustered firms to infer the benefit of localisation economies (Swann et al., 1996; Pandit et al. 2001). Controlling for firm heterogeneity by including firm age uncovers that young firms benefit more from localisation economies than older established firms. Locating within clusters tends to help young firms to catch up with the best practices in their industry, while

established and advanced firms are at the highest risk of ‘knowledge leaks’ to co-located competitors, thus lessening their competitive advantage (Rigby and Brown, 2013).

In parallel to the vibrant research on the effects of clustering on individual firms, there has also been much work devoted to developing new approaches to studying the evolution of clusters. Consistent with the ongoing theme of cross-fertilisation of ideas with the field of industrial dynamics, the first widely used approach to study of the evolution of clusters is rooted in the concept of product life-cycle (Thomson, 1968). The spatial product life-cycle approach builds on the premise of a technological cycle followed by products from their inception to maturity and predicts a spatial dispersion of industries following the emergence of dominant product design and a shift in emphasis from product to process innovation and cost efficiency. This induces companies to move from leading clusters and diverse urban areas to more peripheral areas and specialised cities, while pursuing cost cutting strategies and focusing on internal process innovation (Duranton and Puga, 2001).

As an alternative to the spatial product life cycle approach, Klepper (2007) proposes industry life cycle approach as a viable mechanism for formation and evolution of clusters that does not rely on positive externalities. The origins of clusters fall into the category of historical accidents under this approach and are given by the location of founders of the first companies that effectively plant the seed for the future cluster. These first companies eventually produce spinoffs, new companies operating in the same industry founded by their former staff. Given the natural tendency of entrepreneurs not to relocate unless necessary, when founding a new venture, the consecutive cycles of spinoff creation than leads to the emergence of clusters (Stam, 2007). Klepper (2007) confirms the lack of necessity of localisation economies for cluster formation by showing that the performance of

spinoffs can be explained by the pre-entry experience of entrepreneurs and location within cluster does not make a difference, ceteris paribus. In this sense it appears that it is in fact the superior routines that parent firms pass on to their offspring, spinoffs, that make firms located within clusters perform better than those outside of clusters (Klepper and Sleeper, 2005; Boschma and Wenting, 2007; Klepper, 2007).

Despite the elegance and empirical success of Klepper's (2007) approach, it has been followed by considerable effort towards the development of more flexible and nuanced approaches to cluster evolution. Suire and Vicente (2009) consider the role of herding behaviour and social legitimation in formation of clusters. They assert similarly as Klepper (2007) that localisation economies are not necessary for clusters to form and instead firms can simply herd to locations already occupied by recognized firms within their industry as a form of legitimizing their location choice to their stakeholders.

Ter Wal and Boschma (2011) develop a framework, which jointly considers firms, networks and industries and synthesizes the literature on industrial dynamics and EEG with network theory and the evolutionary theory of the firm. In doing so they aim to overcome the lack of emphasis on heterogeneity of firms in the existing literature on clusters and introduce an explicit conceptualisation of potentially uneven pattern of interactions among firms. The added value of their approach is in explicitly considering the heterogeneity of firms by accounting for their capabilities and positioning of firms in industry-wide networks. Despite this explicit division of scales to firm, network and industry, it is the industrial life cycle, that is considered the leading factor affecting the evolution of firms, their networks and consequently clusters.

Menzel and Fornahl (2010) develop a cluster life cycle approach that centres on learning among firms located in a cluster and their evolving knowledge

heterogeneity. Their model suggests an initial increase in knowledge heterogeneity followed by its ongoing decrease due to inter-firm learning within clusters and becoming more alike as a result. Martin and Sunley (2011) challenge the deterministic nature of life cycle approaches to cluster evolution and instead propose that there is unlikely to be a single model or dominant dynamic that could explain the variety of trajectories that clusters can follow in their evolution. As a solution they propose a paradigmatic shift from searching for a dominant dynamic to cluster evolution to conceptualising clusters as complex adaptive systems (Martin and Sunley, 2007). Their modified adaptive cycle model is effectively a very flexible framework, rather than a fully specified model, that allows not only for a variety of evolutionary paths, but it is also compatible with a wide variety of underlying micro-economic processes, which are expected to differ for clusters operating in different industries (Martin and Sunley, 2011).

The move towards conceptualizing clusters as complex adaptive systems brings to the forefront questions relating to change and stability of clusters and the concept of 'resilience' (Martin and Sunley, 2011). In a very general sense, resilience is linked to the varying ability of places to withstand and absorb economic or environmental shocks (Pike et al., 2010). There are three definitions of resilience, which have been widely discussed in the EGG literature to address the concerns about the fuzziness of this concept (Martin, 2012).

Engineering resilience is defined as the ability of a system to return to its pre-existing equilibrium following a shock. This definition of resilience is linked to the equilibrist approach in economics and is generally considered not to be well suited for EEG (Simmie and Martin, 2010). Ecological resilience is defined as the ability of a system to absorb shocks and maintain its core function, structure and feedbacks. In contrast to engineering resilience, it describes the properties of a system far from equilibrium and allows for a variety of outcomes, including shifts

to new equilibria. Nevertheless, it relies on the notion of equilibrium and focuses on the tolerance of a system to shocks. Its primary focus is the 'elasticity threshold' of a system, which indicates the maximum magnitude of a shock that a system can withstand, before moving to a new equilibrium state (Martin, 2012). Adaptive resilience, a concept from the complex adaptive systems (CAS) theory, is defined as the ability of complex systems to respond to shocks, while maintaining their core functions. It is understood as the ability of CAS to self-organise, or better said re-organise, in response to a shock and to bounce forward rather than to bounce back (Martin, 2012). Regional resilience (Fingleton et al., 2014; Martin et al., 2016; Ray et al., 2017) as well as cluster resilience (Holm and Østergaard, 2015; Wrobel, 2015) have been considered in recent empirical work, which emphasizes the relevance of industry structure, economic productivity and network connectivity to the ability of places to recover from recessions and develop new growth paths.

Despite the many virtues of the conceptual approaches to studying cluster evolution, resilience and the impact of clustering on individual firms discussed in this section, they fall short of providing a comprehensive and nuanced conceptual framework for studying financial and business services in general and investment banking in particular. It is for this reason that we must consider a wider selection of relevant fields, particularly those that study FABS as their primary subject matter. Doing so helps us to capture the underlying micro-economic processes relevant to these industries and allow us to build a much more nuanced understanding of the spatial organisation of investment banking, its relational structure and the implications of thereof to individual financial services firms and FCs at large.

2.3. Financial and business services

In the previous subsection I outlined the key themes and developments in the literature on clusters relevant to this thesis. As I touched upon already, the

research on clusters, albeit it includes some empirical studies that cover financial and business services (FABS) as a subset of the industries considered, does not go into a great deal of detail regarding the operation of FABS firms and the specific micro-economic processes relevant to their clustering, networks or resilience. I therefore complement this literature by the work of financial geographers and related disciplines with finance, management and strategy, economic and financial geography in the lead to fill these voids and develop a more nuanced understanding of FABS, financial centres (FCs) and capital markets.

Despite the considerable bias of the research on spatial clustering of economic activity in favour of manufacturing (Ellison et al., 2007; Frenken et al., 2015), it has been recognized that the spatiality of services is not a trivial question and warrants its own line of enquiry (Marshall and Wood, 1995). To begin with, it is important to make a distinction between consumer and producer services. While the former is primarily influenced by the spatial distribution of demand (Christaller, 1933; Berry, 1967), the latter cluster in the leading urban areas from which they can serve clients worldwide (Marshall and Wood, 1995; Sassen, 2001). Producer services are defined as "intermediate-demand (as opposed to final-demand) services that represent inputs into the production process of firms and other organisations (as opposed to households and individuals) across all sectors of the economy" (Coffey, 2000, p. 171).

This definition, although widely accepted, led to fuzzy boundaries of this concept and consequently there were not only number of different terms used by researchers, but they would also represent broader or narrower sets of underlying industrial categories. Producer services were treated as synonymous with business services (hUallachain and Reid, 1991), knowledge intensive business services (Shearmur and Doloreux, 2008), advanced producer services (APS) (Sassen, 2001; Jacobs et al., 2011), high-order producer services (Wernerheim

and Sharpe, 2003; Polese and Shearmur, 2004) and financial and business services (FABS) (Wójcik, 2018). Despite the variety of terms used, they have generally included financial services, law, accounting, auditing and management consultancy as their integral subcategories. FABS are certainly one of the narrower definitions of producer services, however as argued by Wójcik (2018), they often rely on each other to co-produce complex financial services such as issues of new equity and debt securities or M&A advisory services and consequently they should be treated within a single framework.

Studies of FABS have documented their growing economic significance (Daniels, 1993; Desmarchelier et al., 2013), concentration within world's leading metropolitan areas (Cassis, 2010; Wójcik et al., 2018a), recent trends, response to the global financial crisis (Wójcik, 2012; Wójcik et al., 2018c) and functional complementarity of these services (Clark, 2002). Clustering and increasing interconnectivity of FABS with investment banking and asset management in the lead have given rise to a global network of FCs (Wójcik, 2018).

Early research on FCs had to contend with the data gap between firm and national level of analysis, which has been at least partially responsible for the evidential crisis in this line of research over the 20th century (Kindleberger, 1974; Reed, 1981, 1989; Abraham et al., 1993; Liu and Strange, 1997; Laulajainen, 2003). These early studies have considered a variety of measures of FC development including number of subsidiaries of foreign banks located in a FC (Reed, 1981, 1989; Abraham et al., 1993; Liu and Strange, 1997; Choi et al., 2002; Laulajainen, 2003), geographical reach and types of services offered within individual FCs (Parr and Budd, 2000). Others have taken an approach of comparative economic and financial history to identify the origins and developmental trends of world's leading FCs (Kindleberger, 1974; Cassis, 2010). Case studies of FCs have also become an important part of this literature,

providing a nuanced account of scope, functional differentiation and practices within individual FCs (Leyshon and Thrift, 1997; Clark, 2002; Clark and Thrift, 2005; Engelen and Grote, 2009; Lai, 2012).

In recent years the increasing availability of data on capital market transactions led to the emergence of large scale quantitative studies of FCs. In a global study of the largest 150 metropolitan areas by FABS employment, Wojcik et al. (2018a) show that cities rely on quality of institutional environment of their countries, characteristics of their domestic labour market and the economies of scale facilitated by domestic demand for their services to succeed in cross-border finance and become international FCs. Wójcik et al. (2018b) analyse trends of FC revenue and its structural changes in the post global financial crisis period and propose a new typology of services carried out by FABS firms based on the World Trade Organisation (WTO) General Agreement on Trade in Services.

FABS firms located within FCs benefit from agglomeration economies, better access to clients and social legitimation, while at the same time they bear congestion costs and are subject to high degree of competition (Pandit et al. 2001; Cook et al., 2007). The biggest FCs generally offer the widest variety of FABS and attract the leading talent, which further reinforces their leading position (Parr and Budd, 2000; Clark, 2016). The intersection between finance and the 'real economy' brings to the forefront questions relating to the relational connections between financial circuits and production (Hall, 2013). To conceptualise the connection between FABS and the wider economy, a work is underway to integrate global financial networks (GFNs) with global production networks (GPNs) (Coe et al., 2014; Wójcik, 2018). As it stands the main challanges of this line of research are linked to our ability to capture such complex relational ties and to disentagle the marginal value of various inputs into the production process, including FABS.

To build an appreciation for the relational nature of FABS, one must consider the structure of their networks. This is a complex and multifaceted issue and consequently a discussion of FABS networks requires some structuring. The first distinction to be made is between non-market network connections, such as director interlocks, ownership ties or strategic alliences (Chung et al., 2000; Zaheer and Bell, 2005; Ahuja et al., 2009; Wall and van der Knaap, 2011) and network connections faciliated by market interactions (Pollock et al., 2004; Arjaliés et al., 2017).

The latter category bears particular relevance to this thesis and consequently the following discussion will focus on these types of network ties. Network ties among FABS firms faciliated by trading and co-production of complex services, often beyond the scope of any individual firm lead to a formation of vertically differentiated, but highly integrated networks (Arjaliés et al., 2017). In some instances FABS firms also develop a horizontal dimension of their networks through the formation of syndicates, which connect them with other functionally identical co-producers, while working jointly on a single project and for a single client. The rationale in such instance is that functionally equivalent co-producers can deliver higher quality services by pooling their human and network capital and thus exceed the capabilities of any single syndicate member (Pollock et al., 2004). I will now proceed to discuss in turn the vertical and horizontal dimensions of FABS networks.

Vertical dimension of FABS networks is given by functional differentiation of firms, which are connected through the market for their services. A parallel could be drawn with the input/output linkages of manufacturers in GPNs. Similarly, as manufacturing companies rely on their suppliers for components, which they then combine into final products, also FABS firms often rely on other FABS to co-produce their services. In this manner investment banks co-produce their

underwriting services necessary for new issues of securities using services of accounting and law firms as necessary inputs (Pollock et al., 2004; Wójcik, 2018).

In fact, capital markets as a whole are formed by chains of intermediaries that ultimately connect investors with the issuers of securities. Arjaliés et al. (2017) conceptualize these ties among financial intermediaries as a vertically differentiated 'investment chain', featuring investment banks and institutional investors as the core actors facilitating market interactions between investors and issuers. Investment banks in their capacity as brokers facilitate the access of institutional investors to both the primary and secondary market for equity and debt securities. At the same time investment banks underwrite new issues of securities on behalf of their clients, issuers, and allocate them to institutional investors, typically on discretionary basis using the bookbuilding procedure (Cornelli and Goldreich, 2001; Morrison and Wilhelm, 2007).

Institutional investors in turn make strategic decisions relating to the allocation of their client's investment capital and compete on the basis of a risk adjusted rate of return (Clark and Monk, 2017). The degree of vertical differentiation in the networks of FABS firms is given firstly by regulatory requirements and secondly by the economies of scale and scope. An example of the former is the mandatory division of labour in initial public offerings (IPOs) among securities underwriters, independent auditor, legal counsel and institutional investors (Pollock et al., 2004). In the latter case, institutional investors have a certain degree of flexibility regarding the tasks they insource and those that they outsource. As an example, institutional investors can aim to shorten the 'investment chain' by hiring portfolio managers, accountants, lawyers, investment advisors and analysts and carry out most tasks in-house. Alternatively, they can coordinate networks of contracted external service providers and intermediaries and outsource many of these tasks (Clark and Monk, 2017). As suggested earlier, the decision to insource or outsource is

effectively dictated by economies of scale and scope at the firm level, which dictate which of these options are the more cost efficient. Additionally, the search costs and risk associated with dependence on the market prices for outsourced services is also a factor influencing the degree of vertical integration in the institutional investment industry (Clark and Monk, 2017).

Horizontal dimension of FABS networks relates to connections among functionally equivalent firms that are connected through co-production of services for a single client. Underwriting syndicates are a prime example of such horizontal network connections among co-producers (Shipilov, 2006; Ljungqvist et al., 2009). Pichler and Wilhelm (2001) conceptualize underwriting syndicates as team production with a moral hazard problem, relating to the level of effort exerted by individual underwriters. The root of this problem lies in the difficulty of observing the level of effort exerted and the necessity to exert effort before an underwriting syndicate is formed. The associated risk of lowered screening effort exerted by underwriting syndicate members has been empirically documented (Shivdasani and Song, 2011). Consequently, the choice of both the structure of a syndicate and underwriting syndicate partners is a carefully crafted exercise, where the underwriting syndicate's potential members' reputation, internal capabilities and resources, network capital and ties to institutional investors are carefully considered (Li and Rowley, 2002; Rowley and Baum, 2004; Baum et al., 2005; Houston et al., 2018).

Investment banks involved in an underwriting syndicate share the responsibility of marketing the issue and engaging institutional investors prior to the offering to identify the level of demand and source information relevant to pricing of the offering. In contrast to vertical differentiation in FABS networks, there are generally no regulatory requirements or limitations of scope of individual firms driving the formation of underwriting syndicates. Instead, by pooling their human, reputational

and perhaps most importantly network capital in the form of their established relationships with institutional investors, underwriting syndicates are typically able to outperform offerings underwritten by sole underwriters in terms of underpricing, long-term returns, probability of withdrawal and stock price volatility (Jeon and Ligon, 2011; Bajo et al., 2016; Vithanage et al., 2016). Issuers consequently face lower risks as a result, they can obtain higher valuations of their equity shares and they face more favourable prospects for secondary market stock price performance and consequently additional offerings of securities in the future. This in turn affects market shares of securities underwriters and their access to future market opportunities (Dunbar, 2000; Fernando et al., 2005; Shipilov, 2006).

Not all investment banks benefit equally from their positioning within syndication networks. Shipilov (2006) shows that generalist banks[1] are best suited to take advantage of spanning structural holes in syndication networks, closely followed by specialist banks[2], while banks of moderate specialisation gain the least. In a related study Ljungqvist et al. (2009) identify engagement in co-management appointments in underwriting syndicates as a suitable way of establishing relationships with new clients and paving the road for more lucrative lead-management appointments in the future. Regardless that horizontal networking among FABS seems less necessary than their vertical network ties, underwriting syndicates in fact dominate over issues underwritten by sole banks on value weighted basis and are essential to the competitiveness and access to deal flow of securities underwriters (Pichler and Wilhelm, 2001; Shipilov, 2006; Ljungqvist et al., 2009).

[1] Banks underwriting securities for a wide variety of industries.

[2] Banks specialising in a small number of industries.

2.4. World city network

Despite the recognized relevance of networks to the development of FCs and the performance of individual FABS firms located within them (Wójcik, 2018), the empirical research on urban networks formed by the activities of FABS firms had been effectively non-existent until the beginning of the 21st century and formation of the Globalisation and World Cities (GaWC) research group at the Loughborough University (Taylor, 2001). The literature on the world city network (WCN) following the work of Taylor (2001) builds on a rich literature on urban development (Jacobs, 1969, 1984, 2000), global and world cities (Friedmann, 1986; Sassen, 1991, 2001) and social networks (Castells, 1996). This field of research draws on two key conceptualisations of leading urban areas and their role in the globalisation – Sassen's (2001) 'global city' and Friedmann's (1986) 'world city'.

Jacobs' (1969) theory of urban development lays the foundations for the WCN project by providing a theoretical framework of urban development in which cities can develop only by interacting and trading with each other. In this sense cities cannot develop simply by serving their immediate hinterland, but rely on other cities for developmental opportunities. Urban development is conditional on new work replacing old work, rather than just increasing the amount of old work, and can be achieved by the process of import replacement.

In the process of globalisation of economic activities and formation of multinational enterprises (MNEs) cities that host headquarters of these companies – world cities, develop influence over the wider economy. This in turn influences their development and their positioning within the international division of labour (Friedmann and Wolff, 1982; Friedmann, 1986). World cities are consequently put in the position of basing points of financial capital and serve as command and control centres exercising influence over the wider economy. Sassen (1991) rejects this notion of direct command and control and distinguishes her 'global city'

as a service centre, where advanced producer services (APS) firms produce and trade services that MNEs require to coordinate their global activities and thus exercise economic control. APS firms are consequently put in the position of actors that aid the process of globalisation, by allowing companies to outsource various specialised knowledge intensive activities and lower the barriers to accessing specialised knowledge and cost of coordinating MNEs. APS firms are proposed to have a higher propensity to cluster than manufacturing firms, due to their reliance on highly specialised labour markets, urban infrastructure facilitating global connectivity and proximity to other APS firms, which they rely on when co-producing their services. At the same time the proximity to clients is considered less important and instead global cities are understood as the focal points of a global network of APS firms, from which they serve their clients worldwide (Sassen, 2001).

Castells (1996) builds on Sassen's (1991) global city concept and develops it into a global network of cities, which are defined by what flows through them rather than what is located within them and attributes just as much, if not more, importance to the social networks connecting these cities, as he does to what they ultimately connect. Emphasis is also placed on the inclusiveness of such a global network of cities to a wide variety of places and flows and Castell's (1996) consequently rejects the notion that these processes would be limited to only a small number of cities at the top of the global urban hierarchy.

As a consequence of the differences between the 'global city' and 'world city' concepts, two related groups of literature have formed that conceptualise inter-city networks formed by the activities of the underlying organisational actors (Derudder, 2006). The first group follows the global city tradition and starts with the work of Taylor (2001). The second group is rooted in the world city concept, which is methodologically operationalised by Alderson and Beckfield (2004). The common

feature of these approaches is that they offer empirically feasible and conceptually established approaches for empirical analysis for urban networks formed by organisational actors and as a result have been widely adopted in applied research. I will now proceed to briefly outline each approach.

Taylor (2001) developed the Interlocking World City Network Model (IWCNM), an empirically feasible approach for modelling network connections among cities facilitated by the activities of APS firms. The key premise of the IWCNM is that APS firms operate networks of offices located across cities worldwide to provide a seamless service to their MNE clients. This reasoning is based on the observed joint internationalisation of MNEs and their APS providers, such as the leading accounting, law, financial services and management consultancy firms. Cities that host offices of the same APS firms are consequently connected through the interactions among these offices, which are understood to take the form of flows of information, resources, employees and management coordination of their activities. To operationalise the IWCNM, data on office locations of APS firms is proposed as an easily accessible and free input into the model along with a codified measure of office size/importance, which is used to construct edge weights representing the intensity of interactions among cities (Taylor, 2001).

Alderson and Beckfield (2004) build their approach on Friedmann's (1986) conceptualisation of the world city and use the ownership ties between MNEs and their subsidiary companies as the underlying measure of positioning of cities in the world city system. Drawing on the world city hypothesis (Friedmann, 1986), their approach is relevant to the influence of cities, or more specifically headquarters of MNEs located within them, over the global economy. The level of integration of cities into the world economy is then expected to influence the internal processes of city development through the new spatial division of labour, influencing their economic and employment structure. World cities consequently become sites of

accumulation of global capital, from which the wider global economy and manufacturing production is coordinated (Friedmann, 1986). As the primary input into their model of world city system Alderson and Beckfield (2004) use data on internal ownership structure of MNEs, namely the location data for their parent company headquarters and its subsidiaries. The resulting network ties are treated as being directed from the parent to the subsidiary company. Blockmodeling techniques are then used to identify cities at different hierarchical levels in the world city system.

The inception of these two approaches to modelling urban networks is followed by a wave of both static and dynamic studies investigating the structure of the WCN (Taylor and Derudder, 2016). The uniting characteristic underlying this early empirical evidence has been the drive to resolve the evidential crisis in the WCN research and to produce detailed empirical evidence on the structure of the WCN, the ranking of cities by network centrality, identifying cliques of highly connected cities and describing temporal changes in the positioning of both cities and firms (Taylor and Derudder, 2005; Neal, 2008; Derudder et al. 2010; Liu et al., 2014; Taylor et al., 2014).

The initial distinction between Taylor's (2001) and Alderson and Beckfield (2004) approach relating to their different industry focus has soon disappeared and both strands of literature have yielded empirical evidence across a broad spectrum of industries. Instead, comparative studies considering the differences in the positioning of cities within urban networks formed by different industrial sectors have established themselves as a relevant form of analysis (Taylor, 2005; Wall and van der Knaap, 2011; Toly et al., 2012; Sigler and Martinus, 2017). Dynamic studies of temporal changes of the positioning of cities in the WCN have revealed a great deal of stability, especially at the pinnacle of the list cities ordered by network centrality. Some interesting trends in the evolution of the WCN have been

also revealed, including the rise of first-tier Chinese cities with Beijing and Shanghai in the lead (Taylor and Aranya, 2008; Derudder et al., 2010; Derudder and Taylor, 2016).

The two most widely used approaches in the analysis of urban networks formed by the activities of organisational actors (Taylor, 2001; Alderson and Beckfield, 2004) outlined earlier in this subsection and the empirical evidence built upon them were subject to a range of conceptually and methodologically focused critiques. Nordlund (2004) identifies the use of attribute data on the spatial distribution of offices of APS firms to predict patterns of connectivity in the WCN as the primary weakness of Taylor's (2001) approach. Coupled with the post-structuralist critiques relating to the inability of the IWCNM to capture the complex micro-economic behaviours underlying the interactions among individuals and companies that underlie the WCN (Smith and Doel, 2011; Smith, 2014), it has become evident that a more nuanced approach that can address these complexities is needed (Derudder and Parnreiter, 2014).

Robinson (2002, 2005) criticises the global and world city research for its narrow focus on APS and western model of economic development, which she asserts leaves much of the developing world in the dark. In an attempt to facilitate a constructive dialogue between the global and world city researchers and post-colonial and post-structuralist critics, van Meeteren et al. (2016) call for engaged pluralism as the guiding principle of future debates. It is yet to be determined, whether the epistemological divide between these groups of researchers can be overcome. Nevertheless, there is an ongoing progress in the global and world cities research towards methodological and conceptual developments, which aim to both refine our understanding of the underlying micro-economic processes and to strengthen the quality of empirical evidence.

Methodological revisions were broadly based on the premise that although both approaches are methodologically rooted in the social network analysis literature, they feature only elementary techniques and do not take the full advantage of the rich set of methods available (Neal, 2013; Hennemann and Derudder, 2014; Hennemann et al., 2015). On the other hand, conceptual improvements deal with the role of human agency (Beaverstock, 2007; Watson and Beaverstock, 2014), power (Allen, 2010) and financialization (Bassens and van Meeteren, 2015) in the process of formation and operation of the WCN.

I first turn to the conceptual developments. Power has been a part of the global and world city research from its inception, although the way it is understood and conceptualised has evolved. While in the work of Friedmann (1986) power is conceptualised in a hierarchical way and cities that poses power are understood as having direct influence over the wider economy, including other less powerful cities. Consequently, relationships of dominance and subordination emerge as being characteristic of the global economic order and in turn influence the internal processes within cities, their development and structure of their economic activities and employment.

In Sassen's (2001) global city, APS firms are portrayed as the actors that facilitate the use of economic power by their clients and their own position is that of intermediating agents and service providers. The power rests in the hands of the ultimate decision makers, be that corporate boards or shareholders. Further developments in the conceptualisation of power in the WCN emphasize the importance of intermediation and brokerage as softer forms or power and highlight the need for sustained effort to shape networks in a way that benefits certain actors and grants them influential position within the network (Allen, 2010). Power and influence is in this context understood as becoming an obligatory passage point, that others rely on to interact and realize certain benefits, rather than the ability to

influence their actions directly. Examples of such obligatory passage points are FCs with London and New York in the lead that connect lenders and borrowers, investors and issuers, acquirers and targets and multitude of other parties to financial transactions. The power based on intermediation and brokerage in such networks is conditional on the ability of cities to both harbour the resources and even more importantly to carry out the work to incentivise and connect otherwise disconnected parties to intermediated transactions and to maintain these arrangements (Allen, 2010). Central positioning within the WCN network therefore gives cities power over the flow of resources, information and capital.

Neal (2011) proposes an easier to operationalise conceptualisation of power, based on the relative centrality of cities in the WCN. Cities that are connected to other highly connected cities are highly central, but not necessarily powerful, due to the assumed power balance in these city-dyads. On the other hand, highly connected cities with many connections to lesser connected cities are powerful, due to their proportionally higher centrality in the WCN in contrast to other cities they are connected to. In this sense reducing the conceptualisation of power from an absolute to relative notion and focusing on network power rather than hierarchical power leads to a conceptualisation that can be feasibly empirically operationalised and yet it maintains many of the key features of Allen's (2010) conceptualisation of power. Parnreiter (2014) argues for refocusing the attention to the power of APS firms over management and governance of their clients, oftentimes manufacturing, agricultural and raw materials firms constituting the global commodity chains, rather than the established focus on power relations in networks of APS firms. This is argued would help to close the gap between Sassen's (2001) conceptualisation of the role of APS firms and their influence over their clients and the prevailing empirical approach, focused on the office networks of APS firms (Taylor, 2004).

Closely tied to the conceptualisation of power in the WCN is that of financialization. The overlap between the two concepts lies in the mechanism through which global and world cities influence the wider economy. The influence of financialization goes far beyond the concentration of headquarters of MNEs in world cities (Friedmann, 1986) and the role of facilitating globalisation of corporations through the provision of APSs (Sassen, 2001). Instead, it is rooted in instilling financial capital logic to the operation of companies in all industries and the society at large (Hall, 2012).

In a move towards augmenting the Friedmann's (1986) world city hypothesis, Bassens and van Meeteren (2015) consider the role of APS firms in the process of financialization and how it relates to the process of overaccumulation in the contemporary capitalism. APS firms are in this context positioned as advisors to their clients, who help them to optimize their performance, catch up with the best practices in their industry, meet the demands of a variety of stakeholders and facilitate their access to capital markets. The value added offered by APS firms in these processes is their superior knowledge, expertise and ability to help their clients get a competitive edge. In an environment where overaccumulation of financial capital leads to lack of suitable investment opportunities, clients of APS firms rely on such services to both satisfy and attract their shareholders and ensure a competitive cost of capital (O'Neill, 2006).

In doing so, APS firms accumulate the knowledge and experience of their clients and ensure their own survival as a class of service providers by exacerbating the information asymmetry between themselves and their clients. APS complexes then become effectively obligatory passage points for accessing services necessary for operating publicly listed companies, accessing capital markets and credibly communicating with external stakeholders (Bassens and van Meeteren, 2015). The concentration of APS complexes in the global and world cities is reinforced by

the increasing complexity of services and human capital requirements necessary for meeting standards, which are in turn constructed by APS firms themselves. This consequently leads to APS firms having the ability to influence their corporate clients, albeit not directly, but through their superior understanding of how to best achieve some of their client's objectives (Parnreiter, 2010).

Van Meeteren and Bassens (2016) illuminate these processes on three cases of debt securities issues, all of which feature complex and spatially dispersed networks of APS firms that collectively engineer highly optimized financial services, featuring offshore jurisdictions and special purpose vehicles. In cases like these, APS firms can leverage their expert knowledge and contacts within their respective industries to deliver services and steer their clients' decision making in areas, which are beyond the client's internal capabilities. In doing so APS firms can optimize their clients' financial performance and provide them with access to investment capital at competitive rates (van Meeteren and Bassens, 2016).

The lack of focus on human agency and the predominantly structural approach to empirical analysis of the WCN has been the focus of a number of critics (Smith, 2003b, 2014; Smith and Doel, 2011; Watson and Beaverstock, 2014). Despite the initial focus of researchers on qualitative analysis and relational data (Taylor, 1997; Beaverstock et al., 2000) and a general agreement that mixed methods approaches are best suited for studying urban networks, it was the IWCNM that has soon gained the dominant position in this literature as the tool for empirical analysis (Taylor and Derudder, 2016). Consequently, the flows of information, people, human interactions, negotiations and decision making underlying the WCN formation and operation have been only assumed and quantified using attribute data on office locations, rather than empirically observed or explicitly theorized.

There are naturally exceptions to this leading trend in the global and world city research. Beaverstock (2007) uses qualitative data on the interactions of

investment banks with their clients and investigates the patterns of business travel of professionals within the global investment banking industry. The findings of this study emphasize that the business models of APS firms are not in any way limited by the spatial distribution of their offices and they routinely interact with clients worldwide and are able to establish temporary presence of their staff at clients' locations to facilitate flows of tacit knowledge, delivery of services that require face to face contact and to establish business relationships at distance.

Despite the limited scale of Beaverstock's (2007) analysis, it uncovers multiple important blind spots of the structuralist approaches to studying urban networks. First, model-based approaches to studying urban networks are generally highly restrictive in the types of actors they consider and consequently do not consider the full complexity of the process under investigation (Taylor, 2001; Alderson and Beckfield, 2004). Second, even within the restricted networks formed effectively by only one type of actor (APS firm or MNE), these approaches limit the attention to narrowly defined network ties based on the location of offices (Taylor, 2001) and relative location of parents and subsidiaries of MNEs (Alderson and Beckfield, 2004). As shown by Beaverstock (2007), this is insufficient to capture the richness of interactions within these networks. Watson and Beaverstock (2014) therefore argue that given the limited scope and effectively exhausted conceptual potential of the IWCNM as the leading structuralist approach to studying the WCN, it is now time for a turn towards qualitative, nuanced and human agency-based approaches (Saxenian, 2006; Parnreiter, 2010; Jons, 2011). It is through such detailed analysis of human behaviour that we can develop a more nuanced understanding of the micro-economic processes within urban networks and develop our theories further. It however remains an empirical challenge to extend such qualitative approaches to a more systematic analysis and to make their evidence cumulative, due to the small sample sizes used and limited prior guidance on which practices to focus on.

I now turn to the methodological developments in WCN research that follow primarily the work of Taylor (2001) and the IWCNM. The early empirical work on the WCN was primarily concerned with measuring centralities of cities, visualising urban networks and constructing ranking tables to produce much needed empirical evidence on the relative centrality of cities within the WCN (Taylor, 2004). The methodological challenges revealed at this stage therefore relate primarily to these areas of analysis.

One of the first waves of methodological improvements to the WCN literature relates to devising improved measures of positioning of cities in the WCN. Neal (2011) considers the distinction between centrality and power of cities and proposes a measure of power based on the relative connectivity of city-dyads. Partially in response to the widely criticised use of a projection function that converts two-mode firm-city networks to one-mode city networks, a key part of Taylor's (2001) methodology of constructing the WCN, Liu et al. (2014) consider city centrality measures obtained directly for the two-mode firm-city network. This in turn also opens the possibility to meaningfully apply measures of brokerage at both firm and city level. In an attempt to address the limitations of using office location and ownership links data, Martinus and Sigler (2017) consider geographical, economic, sociocultural and geopolitical measures of proximity among cities to approximate their propensity for interaction. Rossi et al. (2007) in turn propose measures of city centralities based on the flows of services from the city of service provider to the city of client.

In parallel to the efforts to devise more informative and reliable measures of positioning of cities in the WCN, the visualisation of the network itself has proven to be a challenge of its own. In the work of Taylor (2004) this has been addressed by using cartograms, sub-networks featuring a subset of cities and schematic network visualisations, all of which dealt with the potentially cluttered full network

visualisation by removing content and focusing on what has been considered most important. In contrast, Hennemann et al. (2015) seek ways of visualising full global networks with potentially thousands of cities and many tens of thousands of network connections, while accounting for the geographical location of cities. They address the difficulties of visualising large spatial networks featuring a large number of nodes and edges by using force-directed edge bundling algorithm as a way of reducing the visual output to the main patterns in the network structure.

While Taylor (2001) and Alderson and Beckfield (2004) suggest that their raw network centrality measures can be interpreted as valid measures of positioning of cities in urban networks, this view is challenged by Neal (2013, 2016) and Hennemann and Derudder (2014). City centralities calculated by simply adding network connections of the individual firms located within them are highly influenced by the economic size of cities, or in other words the number of firms located within them, and therefore they do not necessarily directly relate to the propensity of firms located in cities to form network connections. In order to address this problem, both Neal (2013, 2016) and Hennemann and Derudder (2014) draw on the notion of a reference (null) model, which allows them to identify any statistically significant patterns in city network centralities, that cannot be explained by a random assignment of firms' offices to cities. This unexplained element of the network structure then immediately lends itself to modelling various hypothesized processes of WCN formation. Liu et al. (2013) take on this challenge and propose the stochastic actor-oriented model as a suitable methodological setup for simulating realizations of WCN formed by a variety of hypothesized processes of network formation and then comparing it to the empirically observed realization of the WCN.

2.5. Summary

In this chapter I discussed the core literature that this thesis engages with. By doing so I provide a wider context for this thesis and the interpretation of its results. The structure of this chapter is divided into three themes – 2.2. evolution of clusters, resilience and localisation economies, 2.3. financial and business services and 2.4. world city network. In section 2.2. I discussed the evolution of research of clusters from Marshall's (1920) industrial districts to contemporary conceptualisation of clusters as complex adaptive systems in evolutionary economic geography (Martin and Sunley, 2011). In section 2.3. I reviewed literature that covers FABS as its primary subject matter. This section also considers the conceptualisation of financial networks and GFNs (Pollock et al., 2004; Wójcik, 2018). This is then followed by a detailed review of the global and world city research with emphasis on the WCN in section 2.4. (Taylor and Derudder, 2016).

Each of these research themes serves as an umbrella for contributions from multiple relevant disciplines contributing to its topic and overlaps between these themes naturally exist. The structure of this literature review presents an opportunity for identifying research gaps in a way that emphasizes not only what is missing in each stream of literature, but it immediately allows me to identify other areas of literature that I can draw on to aid me in filling these gaps. Despite the many overlaps in the subject matter of studies allocated into these research themes, the dialogue between researchers working on these topics has been somewhat limited. This is unfortunate, because as I will argue in the next couple of paragraphs, there are number of important gaps in the research on FCs and urban networks, that could be largely addressed by combining concepts and methods from these related fields of research and developing them into new analytical approaches to studying FCs and GFNs. Such cross-fertilisation of ideas among related research fields that interact with each other perhaps less than they

should is shown to be invaluable throughout the substantive chapters (3-6) of this thesis.

Engaging with the wider literature on FABS, clusters and networks allowed me to identify several important research gaps. Contrasting the literature on WCN (Taylor and Derudder, 2016) with conceptualisations of FABS networks developed within finance, management and strategy (Pichler and Wilhelm, 2001; Pollock et al., 2004; Shipilov, 2006; Ljungqvist et al., 2009) reveals some important differences, which are at least partially responsible for some of the shortcomings of the global and world city research focusing on the WCN (Taylor, 2001). It therefore appears as a natural way forward for this literature to incorporate the work on inter-firm networks already conducted within these related research fields and to develop new methods and models for studying urban networks, through the *actions* of organisational actors rather than the spatial distribution of their offices or subsidiary companies. Such methods are likely to not only introduce more variety into the WCN research, but can also help to overcome some of the shortcomings of the presently used methods, which have been criticised to focus overly on structure and effectively ignoring human agency and behaviour (Watson and Beaverstock, 2014). In doing so there is also a good opportunity to contribute with such methods to the emerging research on GFNs, which offers a promising framework, but is presently lacking analytical methods (Coe et al., 2014; Wójcik, 2018).

The research on cluster evolution and localisation economies discussed in this chapter only features a small number of empirical studies focusing on FABS and despite the pivotal role of networks to this sector, the effect of inter-firm network connectivity is not considered in any of these studies (Pandit et al., 2001; Cattani et al., 2003; Beaudry and Swann, 2009; Wennberg and Lindqvist, 2010). In line with the recent trend of controlling for firm heterogeneity in studies of localisation

economies, considering the role of network connectivity is a much overdue step forward for this literature. This is particularly valid in the context of studying FABS.

Despite the pre-occupation of the literature in financial geography and evolutionary economic geography with the effects of financial and economic crises on clusters, cities, regions and industrial sectors, this literature has not yet considered the resilience of FCs (Martin and Sunley, 2011; Wójcik, 2012; Marshall, 2013; Fingleton et al. 2014). This research gap is certainly worth investigating, given the importance of FCs to the financial sector and the implications of their resilience to the changes in spatial distribution of the financial sector revenue and employment following a shock. Similarly, empirical studies of cluster resilience are few and far in between and I am presently not aware of one that explicitly considers the resilience of FCs. This gap in the present literature seems particularly important in the light of the recent global financial crisis and the increasing emphasis on the stability of the financial sector.

The four substantive chapters of this thesis (3-6) aim to contribute to addressing and filling the research gaps identified here. Chapter 3 develops a novel methodological approach for modelling urban networks formed by the activities of organisational actors and illustrates it empirically using data on over 161,000 underwriting syndicates. Chapter 4 compares this model to two other widely used models of urban networks (Taylor, 2001; Alderson and Beckfield, 2004) and considers the implications of the network boundary specification problem in the context of analysis of urban networks (Laumann et al., 1989). Chapter 5 offers an empirical study of characteristics of FCs affecting their resilience to demand shocks and it explicitly considers network centrality of FCs as one of the explanatory factors. Chapter 6 provides a firm level analysis that investigates the impact of network connectivity and localised interactions among co-located financial services firms on their long-term growth.

Chapter 3 | An inter-organisational project approach to the Interlocking World City Network Model: Geographies of investment banking syndication, 2000-15

(Paper written with Dariusz Wójcik and Eric Knight)

Abstract

The Interlocking World City Network Model (IWCNM) has become the gold standard for empirical analysis in the World City Network research over the last 15 years. Despite numerous methodological improvements, it still relies on Taylor's (2001) legacy of using location data on offices of advanced producer services (APS) firms to indirectly estimate intercity network connections. To overcome this crucial limitation of the IWCNM, we propose a methodological alternative utilizing data on inter-organizational projects of APS firms to measure intercity network connections. We illustrate this approach using a global sample of 161,114 investment banking syndicates in the 2000 – 2015 period.

3.1. Introduction

Since Taylor's (2001) specification of the World City Network (WCN) formed by offices of advanced producer services (APS) firms, the Interlocking World City Network Model (IWCNM) has become the methodological 'gold standard' for empirical analysis of external urban relational processes in urban studies. This effort has generated a substantial empirical literature based on a variety of APS industries including law, accountancy, marketing, management consultancy, banking and financial services. The initial motivation of the Globalization and World Cities (GaWC) research group was to overcome the 'dirty little secret' of the global and world city research, which has been quite rightfully identified as the lack of

data and empirical evidence on intercity network connections associated with the activities of APS firms (Short et al., 1996). IWCNM utilizing data on office locations of APS firms has been proposed and accepted by many as an empirically feasible approach to overcoming this gap in the literature (Taylor and Derudder, 2016).

While IWCNM has been methodologically refined since, it still carries the legacy of APS firms' office location data as the primary input into the model, and the basis for indirect estimation of intercity network connectivity. In our opinion, this methodological foundation of IWCNM has become the new 'dirty little secret' of the WCN research. Unlike some critics who are completely dismissive of IWCNM and the global and world city research broadly speaking (Robinson, 2005; Smith, 2014; Smith and Doel, 2011), we are not suggesting throwing the baby out with the bathwater.

Instead, we set as the primary objective of this paper to develop an empirically feasible approach based on inter-organizational project participation of APS firms as an alternative to Taylor's (2001) IWCNM. This alternative approach allows us to specify the WCN without the need to rely on attribute data or overly restrictive assumptions regarding intercity network connectivity. Instead, it offers an opportunity for a direct empirical observation of relational ties among APS firms located in different cities. In addition, our approach fills numerous conceptually important blind spots of IWCNM identified by its critics and allows for empirical analysis of joint production of advanced producer services (Smith and Doel, 2011), power relations among firms (Smith, 2014) and whole networks, thus allowing for robust solutions to the network boundary specification problem (Kossinets, 2006). We develop our approach in parallel to the IWCNM and will show where appropriate, how it overcomes its limitations. Like Taylor (2001), we aim "to specify the world city network so that formal network analysis can be applied." In relation to Taylor's (2001) IWCNM, we see our approach as a step forward, but not through

refinement of existing practices, but rather through fundamental changes at its core.

We provide an empirical demonstration of our approach using data on 161,114 investment banking syndicates for the 2000 – 2015 period and offer suggestions for extending this approach empirically to other types of inter-organizational projects and APS industries. The application of IWCNM based on inter-organizational project data to investment banking networks is particularly relevant, as investment banks are central to the concept of global financial networks, which feature a broad range of financial and business services firms (Wójcik, 2018).

The rest of this paper is organised as follows. Firstly, we review relevant literature relating to the evolution of IWCNM, its critiques, methodological alternatives as well as specifications of inter-organizational networks developed outside the WCN literature. The IWCNM – inter-organizational project approach section offers a detailed presentation of our proposed modelling strategy. Next, we describe our dataset and offer an empirical illustration of the approach proposed here. In the concluding section, we reflect on the implications of our methodological approach and empirical findings for the WCN literature and the study of the global financial networks.

3.2. Literature review

3.2.1. IWCNM and studies of external urban relational processes

The WCN research, which gave rise to the IWCNM and the Central Flow Theory (Taylor et al., 2010) is built on the conceptual foundations set out by Jacobs (1969), Friedmann (1986), Sassen (2001) and Castells (1996). Jacobs (1969) distinguishes between static and dynamic cities and theorizes the process of dynamic city development through import replacement. Urban networks are at the heart of her thinking and her work is one of the building blocks in Taylor's (2004)

conceptualization of the WCN. Castell's (1996) conceptualization of cities as spaces of flows brings network connectivity among cities to the forefront of WCN thinking and turns focus to what dynamically flows through cities rather than what is statically located within them. Friedmann's (1986) world city hypothesis adds the notion of power to the conceptual toolbox used in the WCN literature and conceptualises world cities as command and control centres, from which the global economy is directed. World cities are also framed as basing points of global capital and are thought to form a hierarchical structure based on international division of labour (Friedmann, 1986). Sassen (2001) does not carry over the notion of hierarchical structure among world cities and instead develops a distinctively new concept of the 'global city'. While Friedmann's (1986) 'world cities' are centres of power, Sassen's (2001) 'global cities' are service centres hosting advanced producer services (APS) firms' complexes and their primary function is to produce services, which allow economic power to be exercised. This conceptual distinction is highlighted by Derudder (2006) and it carries important implications for research design and appropriateness of different data sources for investigating world-cityness and global-cityness.

While the previous studies have developed the conceptual foundations for the WCN research, until the formation of the GaWC research group, there had been no empirical evidence on intercity network connections facilitated by APS firms. Taylor (2001) specifies the world city network formed by interlocking offices of APS firms. The ambition of his work is to develop empirically feasible techniques for modelling intercity networks formed by ties among APS firms. The lack of suitable data sources to directly observe such flows in the form of telephone calls, emails, transactions, labour mobility or collaboration on inter-organizational projects has however hindered such efforts. Consequently, indirect measure of flows among APS firms need to be used for empirical analysis. This is operationalised by using

a matrix of 'service values' V, with rows representing cities and columns representing APS firms. Elements of V - $v_{i,j}$ are customarily coded on a 0 to 5 scale, with 0 for non-presence in a city and 5 for a global head-office. The individual network connectivity scores $r_{i,j}$ representing the strength of connection between two offices of a given firm are given by the product of service values for the given office-dyad (equation 3.1.). Estimates of flows for city-dyads are then given by the sums of connectivity scores for office-dyads that connect a given city-dyad (equation 3.2.). Finally, to calculate a measure of status of city a within WCN (N_a), Taylor (2001) proposed to sum the relational elements $r_{i,j}$ for each city *a*, thus giving us an aggregate measure of connectivity between city *a* and all other cities (equation 3.3.).

$$r_{ab,j} = v_{aj} \cdot v_{bj} \qquad (3.1.)$$

$$r_{ab} = \sum_{j} r_{ab,j} \qquad (3.2.)$$

$$N_a = \sum_{i} r_{ai} \quad a \neq i \qquad (3.3.)$$

This means that the assumed intercity flows are based on what is essentially attribute data on the size/importance of offices (Nordlund, 2004). As a result, any empirical research based on this specification of intercity network connections is subject to the following assumptions and limitations:

(1) Intercity ties are only derived from locations of offices of the same firm and no ties based on inter-firm interactions are empirically observable.

(2) The weights of intercity ties are proportional to the size/importance of offices of APS firms connecting the given city-dyad.

(3) Intra-firm flows are symmetrical between any combination of offices (e.g. the flow from global HQ to a minor office in a different city is the same as the flow in the opposite direction).

(4) Intra-firm flows only vary depending on the size/importance of offices involved (e.g. global HQ, regional HQ, minor office) and otherwise are the same across different firms and industries.

(5) All firms with at least one pair of co-located offices in the same city are assumed to be connected[3].

Notwithstanding these assumptions and limitations, IWCNM has become the 'gold standard' in the WCN research, given its ability to offer empirical evidence, albeit indirect, based on publicly available data from corporate websites (Taylor, 2001, 2005; Liu et al., 2014), surveys and interviews (Beaverstock et al., 2002; Beaverstock, 2007) and financial databases (Sigler and Martinus, 2016). Empirical contributions building on the IWCNM methodology include studies of banking networks (Rossi and Taylor, 2005), Islamic financial services (Bassens et al., 2010), NGOs, UN agencies (Taylor, 2005), Australian publicly listed corporations (Sigler and Martinus, 2016), APS firms (Derudder and Taylor, 2005; Taylor, 2013; Taylor et al., 2014), evolution of urban networks (Taylor and Aranya, 2008; Derudder et al., 2010; Liu et al., 2014) and contrasting the role of APS firms and cities in the WCN (Neal, 2008).

Since its conception, IWCNM has attracted a substantial interest and constructive criticism from a range of theorists. Robinson (2002, 2005) critiques IWCNM and the global and world city literature at large for being narrowly focused on APS firms and not being fully inclusive, especially so regarding cities in the global south. Consequently, prescribing an ideal of successful cities from economically developed countries as a model for cities in developing countries. One of the critiques striking at the very core of global and world cities research pointed out that in the modern economy the notion of 'command and control' as

[3] This assumption is only relevant, if one wanted to project the two-mode firm-city network to a firm-firm network.

framed by Friedmann (1986) is irrelevant, non-existent and termed it a neo-Marxist myth (Smith, 2014). Bassens and van Meeteren (2015) have argued convincingly that although there is not any absolute command and control in the WCN, the global economy is heavily influenced by a deeply rooted logic of financialization and APS firms studied in the context of IWCNM are in fact allowing economic power to be exercised by the owners of capital. Smith and Doel (2011) have identified an important blind spot of IWCNM, namely its inability to provide any empirical evidence regarding 'joint production within APS complexes', one of the central tenets of the 'global city' concept (Sassen, 2001). For a more detailed engagement with the post-colonial and post-structuralist critics we would like to refer the reader to van Meeteren et al. (2016), who provide an engaging review of global and world city literature and its critics. Finally, Watson and Beaverstock (2014) have argued that the WCN research has reached a theoretical impasse and advocate for qualitative research on developing a new conceptualization of agency in WCNs.

Other critics focus on the measurement issues and the underlying modelling methodology. Taylor's (2001) legacy of using office networks of APS firms as the principal data for estimating intercity flows is viewed as one of the key limitations, given that the intercity flows among APS firms' offices such as telephone calls, emails, labour mobility, transactions, collaboration on inter-organizational projects and other activities need to be assumed rather than directly observed (Derudder and Parnreiter, 2014). One of the early problems that has been identified is due to the projection function applied to the service values matrix (firm-city two-mode network), effectively converting it to a city adjacency matrix (city-city one-mode network). The resulting specification of WCN yields a very dense and flat network, creating the impression that effectively all cities are connected to each other. Nordlund (2004) points out that the projection function applied by Taylor (2001) to

obtain city adjacency matrix implicitly converts attribute data on office locations to relational data on intercity flows. Although it is possible to do this mathematically, the empirical validity of this operation relies on heavy assumptions and limitations (1) – (5), which we outlined earlier.

While the focus of the early IWCNM research has been on intercity connections, Neal (2008) highlights the importance of firm-level networks as objects of analysis and advocates that joint analysis of the city-level and firm-level networks can lead to new insights. He finds substantially larger variation of connectivity scores among cities than firms. In a follow up article, Neal (2011) offers a methodology for empirically distinguishing between centrality and power of cities in the WCN, thus helping to provide some empirical evidence on the hierarchical relationships in the WCN. While the approach proposed by Neal (2011) is based on relative measures of centrality of cities from which power balance is derived, it does not offer any empirical evidence that would allow us to assess any direct controlling relationships at firm level.

Another group of methodological critiques deals with the problem of interpreting and assessing the measures of network centrality of cities. Rather than interpreting network centralities at their face value, comparison with a relevant null model is proposed. Neal (2016) addressed this by adapting the stochastic degree sequence model to detect statistically significantly more connected cities than would have been expected by a random distribution of APS firms' offices drawn from the same degree distribution. Hennemann and Derudder (2014) purse a similar exercise using a randomised baseline model.

Although the IWCNM is the most popular model in the WCN research, there are alternative models and approaches for studying urban networks. These can be broadly divided to (1) infrastructure, (2) corporate organisation, (3) labour market mobility and (4) firm interaction studies. Infrastructure studies focus on physical

transportation based on airline passenger data, telecommunication based on internet connectivity data and comparative studies of the two (Derudder et al., 2004). While these studies offer a sophisticated analysis, they are only weakly conceptually connected to the global and world city literature (Derudder 2006). Corporate organisation studies are based on parent – subsidiary ownership links of MNEs and span a wide range of industries (Alderson and Beckfield, 2004; Alderson et al., 2010; Wall and van der Knaap, 2011). Beaverstock (2007) developed an approach based on labour market mobility in the global investment banking industry, which allows for the examination of both micro and macro networks formed by flows created by intercity and international business trips, fixed term assignments as well as labour force mobility across different organisations. Rossi et al. (2007) and Hanssens et al. (2012) pursue an approach based on provider – client ties by surveying how companies engage with their APS suppliers. Pan et al. (2017) use data on Chinese A-share IPOs to study urban networks through the interactions of accounting, securities and law firms involved in these transactions. While the last two groups of studies opened exciting new research directions, collecting sufficient data on either labour market mobility or APS firms' interactions remains an empirical challenge.

3.2.2. Alternative specifications of inter-organizational networks

While majority of the WCN research is based on office networks of APS firms, there are many alternative types of inter-organizational network ties that could be used instead. Inter-organizational ties that have been used in economic geography, finance, management and corporate strategy research include (1) investment banking syndication (Ljungqvist et al., 2009) (2) venture capital syndication (Hochberg et al., 2007), (3) interlocking directorates (Zaheer and Bell, 2005), (4) strategic alliances (Ahuja et al., 2009), (5) informal social relations (Pool et al., 2015), (6) labour mobility (Beaverstock, 2014), (7) ownership of subsidiaries (Wall

and van der Knaap, 2011), (8) co-patenting (Ter Wal, 2014) and (9) R&D collaboration (Balland et al., 2013). This long, but not exhaustive list, illustrates the richness of literature on inter-organizational connectivity.

To illustrate our approach, we will focus on investment banking syndicates, as a specific form of inter-organizational project. We do this for two primary reasons. First, investment banks as a subset of financial services firms perform an important role of facilitating the access of large corporate clients to the capital markets. By doing so they act as the legal and reputational gatekeepers for the global capital markets. They also routinely collaborate with other APS firms, such as accountancy, law, management consultancy and advertising firms, while jointly delivering services to their clients. All the above makes them a suitable indicator species for studying global financial networks, given their central position and key role within them (Wójcik, 2018). Second, both existing approaches for studying intercity connections facilitated by activities of corporations (Taylor, 2001; Alderson and Beckfield, 2004) as well as our approach relies on network structural measures developed within the social network analysis literature. Although not widely acknowledged in the WCN literature, social network analysis methods for studying network structural characteristics are generally quite unreliable, if only a small fraction of relevant actors or network connections among them is sampled from a real-world network (Kossinets, 2006). For this reason, it is crucial to use data sources that allow researchers to capture real world networks representing the phenomenon of interest as accurately and completely as possible.

Network connections based on investment banking syndication are derived from co-membership of banks in syndicated deals[4]. Baum et al. (2004) show that investment banking syndicates have occurred routinely since the 1950s, with a

[4] Syndicated deal in the context of investment banking is understood as a primary issue of equity or debt securities that is underwritten by multiple investment banks.

substantial increase in their frequency since 1980s. Given the relationship-oriented nature of investment banking, participation in syndicated deals and selection of syndicate partners is a key process with consequences for the very survival of investment banks (Shipilov, 2006; Ljungqvist et al., 2009). Investment banking syndicates feature different types of roles that banks can fulfil, which can be divided into two hierarchical groups – (1) lead management and (2) co-management appointments. Lead-managers, often referred to as bookrunners in primary equity and debt securities issues, carry the ultimate legal and reputational responsibility for primary offerings, are typically allocated a strategic fraction of securities prior to the offering, and generally earn most of the associated revenue. On the other hand, co-management appointments, although less profitable and prestigious, are perceived as a viable way to break into investment banking networks, develop one's reputation and improve the future prospect of obtaining lead-management appointments (Ljungqvist et al., 2009).

3.3. IWCNM – inter-organizational project approach

3.3.1. Inter-organizational project ties as the primary building blocks of WCN

In contrast to the current methodological foundations of the IWCNM, relying on office locations data, the approach proposed here uses inter-organizational projects as its primary building blocks. We will now illustrate it using capital market deals relating to primary issues of equity and debt securities as representative examples of such projects. Given that only transactions featuring multiple banks, so called syndicated deals, are informative of any network connections among banks, only these are used to construct bank – deal affiliation matrix. These can be represented as two-mode networks, where edges are only permissible between banks and deals, but not within these two groups. Consequently, we consider two banks to be connected, if they participated in the same syndicated deal.

	Syndicated deal ID number									
	1	2	3	4	5	6	7	8	9	10
JPMorgan	0	0	1	0	1	1	1	0	0	1
Morgan Stanley	0	1	1	0	1	0	1	0	1	0
RBS	1	1	1	0	0	0	1	1	0	0
Barclays	1	1	0	0	1	1	1	0	1	0
HSBC	0	1	0	0	0	0	0	1	1	1
Lazard	1	0	1	0	1	0	1	0	0	1
UBS	0	0	0	0	1	0	1	1	0	0
Credit Suisse	0	0	1	1	0	0	0	1	1	1

Figure 3.1. Bank – deal affiliation matrix (D).
Source: Authors' illustration.

Figure 3.1. shows an example of the structure of a bank – deal affiliation matrix. Connections between banks and deals can be either binary or weighted by either fee earned from the transaction or apportioned deal value. To obtain an adjacency matrix of bank connectivity, we convert the above affiliation matrix by the projection function proposed by Breiger (1974), shown in equation (3.4.) below:

$$B = D(D^T);\ b_{i,j} = 0\ if\ i = j \qquad (3.4.)$$

where D is a bank – deal affiliation matrix, D^T is a transpose of D, and B is a weighted bank adjacency matrix.

This gives us a weighted adjacency matrix as shown in figure 3.2. The elements of B - $b_{i,j}$ are frequencies of co-membership of bank-dyads in syndicated deals. They are not dependent on bank size or location of its offices by construction. As an alternative specification, the elements of matrix D - $d_{i,j}$ can be defined as either apportioned deal values or fees earned from transactions, thus allowing us to obtain a weighted adjacency matrix B, with elements $b_{i,j}$ representing value weighted ties, rather than frequencies of co-syndication.

	JPMorgan	Morgan Stanley	RBS	Barclays	HSBC	Lazard	UBS	Credit Suisse
JPMorgan	0	3	2	3	1	3	2	2
Morgan Stanley	3	0	3	4	2	3	2	2
RBS	2	3	0	3	2	3	2	2
Barclays	3	4	3	0	2	3	2	1
HSBC	1	2	2	2	0	1	1	3
Lazard	3	3	3	3	1	0	2	2
UBS	2	2	2	2	1	2	0	1
Credit Suisse	2	2	2	1	3	2	1	0

Figure 3.2. Bank adjacency matrix (B).
Source: Authors' illustration.

3.3.2. City network centrality

The established practice in the WCN literature is to treat cities as nodes within networks and APS firms as the underlying agents acting at sub-nodal level. This ultimately reflects that the one-mode city network is a projection obtained from a two-mode firm-city affiliation network. This approach however cannot be validly carried over, if co-membership of inter-organizational projects replaces data on office locations as the primary building block. Taylor's (2001) IWCNM only considers intra-firm connections between offices of APS firms located in different cities, which allows for calculation of the magnitude of intercity network connectivity simply by adding up the connections of all firm-dyads connecting a city-dyad. This is appropriate, because redundancy of connections does not play a role, if each office can by construction be connected to at most one other office of its own firm in each city. In the model proposed here firms can have network connections with any number of firms, whether they are in the same city or any other city in the world. Consequently, summing all inter-organizational ties connecting banks in a

city with the rest of the world can lead to misleading results regarding network centrality of cities. This procedure would not be able to distinguish between a) banks from one city being connected to a wide range of banks in the rest of the world and b) banks from one city having the same number of connections, but all being connected to just a single bank outside of their own city.

To overcome this problem, we use the *group degree centrality* measure proposed by Everett and Borgatti (1999) as an appropriate way to handle calculating city network centrality scores, when the underlying network is observed at a firm level. Here we purposefully use the simplest type of network centrality, to keep our exposition as accessible and comprehensible as possible. Naturally, more complex centrality measures, such as eigenvector centrality, flow centrality or page rank centrality can be extended to group level (Jackson, 2010).

Group degree centrality is based on the notion that only non-redundant connections of group members add to its centrality. We therefore count the number of banks outside city *a*, to which at least one bank within city *a* is connected to. Naturally each connection to a bank outside of city *a* is counted only once, even if multiple banks from the city are connected to it, thus eliminating any redundancies. To make these measures comparable across time, networks of varying sizes, and most importantly across different cities, we normalize each centrality score by its maximum possible value, which is the number of sampled banks outside of city *a*. This leads to an interpretation of the standardised group degree centrality measure as the fraction of realized external network connections (Everett and Borgatti, 1999).

We now turn to the contribution of individual banks to the centrality of cities in urban networks. Given that our approach allows for direct observation of ties among banks located in different cities, it makes the analysis of contributions of

individual banks to the centrality of their respective cities both feasible and informative. We focus on the following two measures:

(1) Group efficiency (k/G) defined as the ratio of the smallest subset of members of a group (k) that have the same group centrality as the full set of its members[5] to the size of the group (G) (Everett and Borgatti, 1999).

(2) Marginal contribution to group centrality – we calculate group centralities of the most central groups formed by subsets of banks located in the same city and then calculate the marginal contribution of the additional group member as the difference between group centrality of group with n members and that of n-1 members.

3.3.3. Intercity network ties

To obtain weighted intercity network ties, we proceed by converting the adjacency matrix B (figure 3.2.) into an edge-list of bank-dyads and include frequency of syndication ties $b_{i,j}$ as a weight for each edge. We then add the cities of operational headquarters[6] to every bank subsidiary[7] in this edge list and sum frequencies of syndicate ties by city-dyads, thus converting the original bank level edge-list to a city level edge-list. Finally, we convert it to an adjacency matrix C (figure 3.3.).

[5] In this context the full set of members (G) is the number of banks located in a city.

[6] We define operational headquarters as the functional head office, where the key staff is located, regular board meetings take place and front office investment bank staff are generally based. This can differ from financial headquarters, which can be located separately, often for tax purposes.

[7] Bank subsidiaries (lowest available units within the corporate hierarchy) are used to maintain geographical accuracy in respect to where the actual work has been carried out.

	New York	Edinburgh	London	Zurich
New York	0	8	14	12
Edinburgh	8	0	5	4
London	14	5	0	7
Zurich	12	4	7	0

Figure 3.3. City adjacency matrix (C).
Source: Authors' illustration

The elements of matrix C - $c_{i,j}$ are the frequencies of syndication ties among banks from city *i* and city *j*. As an alternative specification, we consider the directionality of intercity ties by adding information on the roles of banks in syndicated deals. We treat bookrunners of equity and debt securities deals as the lead managers and all other subordinate roles as co-managers. We then recreate edges among banks so that only those connecting banks with non-equal roles are kept and point from lead-managers to co-managers. To obtain a weighted adjacency matrix, we can use apportioned deal values or fees earned as the elements of bank – deal affiliation matrix D and proceed in the same fashion as outlined above.

3.4. Data

To illustrate our approach empirically, we use data from the Dealogic Equity Capital Market (ECM) and Debt Capital Market (DCM) databases, which represent detailed account of primary issues of equity and debt securities worldwide. They cover more than 100,000 initial public offerings, follow-on offerings, convertibles and over 1 million deals involving debt securities. We sampled the top 500

bookrunner subsidiaries[8] by total value of underwritten deals separately for ECM and DCM for each year from 2000 to 2015. We then hand collected data on the metropolitan areas[9] of their operational headquarters from a variety of sources including the Bureau van Dijk Orbis, Nexis UK, Bloomberg and corporate websites. We sampled all the syndicated deals that these banks were involved in, regardless of their role in each syndicate. This allowed us to cover between 96.65% and 99.96% of syndicated deals across the two products and time periods studied, totalling 161,114 syndicated deals.

3.5. Empirical illustration

The primary purpose of this section is to demonstrate some of the network structural properties that can be derived using the approach developed in the previous section. In addition, we want to highlight areas of empirical interest that can be interrogated using the inter-organizational project approach, but could not be meaningfully analysed using the office location approach, which currently prevails in the WCN research.

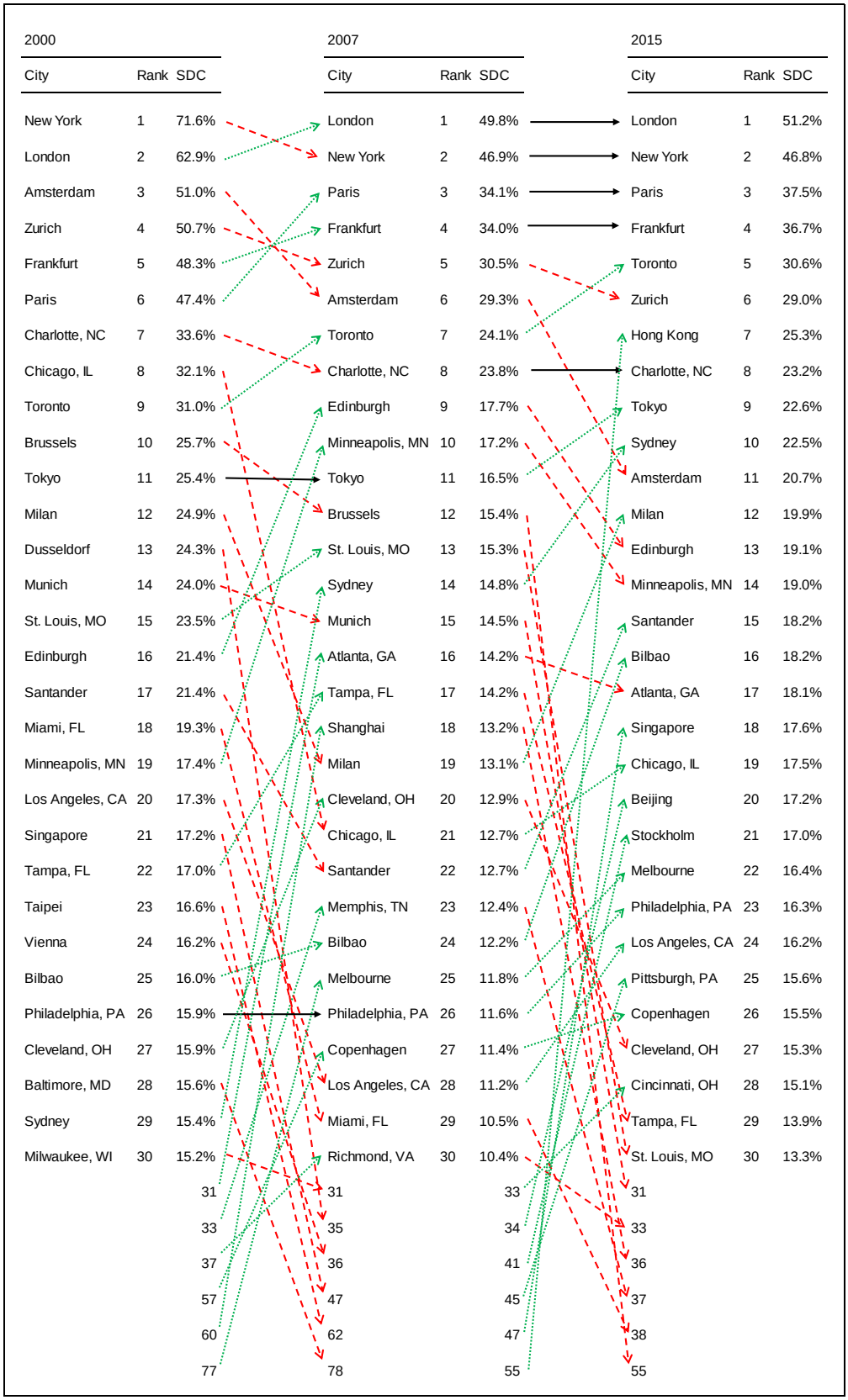
We will now proceed by deriving a WCN using the dataset detailed in the previous section. We begin with measuring city degree centralities and their evolution between 2000 and 2015. Table 3.1. summarizes these results and presents standardized group degree centralities, ranking of cities and its changes over time. In contrast to rankings and centrality scores based on data on office networks of APS firms (Taylor and Aranya, 2008), both the rankings and centrality scores of cities based on directly observable syndicate co-membership display

[8] Bookrunner subsidiary is defined in Dealogic ECM and DCM databases as a legal entity that has been directly involved in a primary issue in the position of a bookrunner. This means that if for example Goldman Sachs International (London) was the bookrunner on a particular deal, it would be listed as a bookrunner subsidiary and Goldman Sachs (New York) would be listed as a bookrunner parent.

[9] We adopted the definitions and geographical boundaries of metropolitan areas used by Oxford Economics – Global Cities 2030 database. For the metropolitan areas not listed in Oxford Economics, we used our judgement to mimic this approach.

more temporal and cross-sectional variance, particularly so for cities of lower ranks. At the same time, the top of the ranking table is relatively stable over time, reflecting inertia in the development of leading global financial centres (FCs) (Wójcik, 2013).

Table 3.1. Ranking of financial centres by network centrality.



Notes: SDC – Standardized group degree centrality.

Source: Authors' calculations based on Dealogic data.

Standardised group degree centralities presented in table 3.1. can be interpreted as percentages of banks outside of each FC that the banks within the given FC are connected to. We have observed a trend of declining network connectivity in the runup to the global financial crisis (GFC) and a partial recovery thereafter for well-established FCs in developed economies, while those in the emerging markets, with China in the lead, have strengthened their connectivity in the post-GFC period. Australia is an exception to this pattern, with both Sydney and Melbourne developing their network centrality steadily from 2000 to 2015.

An under-researched aspect of the WCN literature is the contribution of individual firms to the network centrality of cities. To address this, we use the *group efficiency* measure to calculate what fraction of the banks located in each city is directly contributing to the city's network centrality. The results for the largest 20 FCs[10] as of 2015 show that a substantial part of the banks in each city contributes to its centrality in a non-redundant manner. This ratio ranges from 15% for Seoul to 75% for Charlotte, NC. Figure 3.4. reveals that at the same time a small number of the best-connected banks in each city, generally no more than 5, dwarves the contributions of other banks in the city.

[10] We use a ranking table of FCs from Wójcik et al. (2018c) based on fees earned from core investment banking activities in 2015.

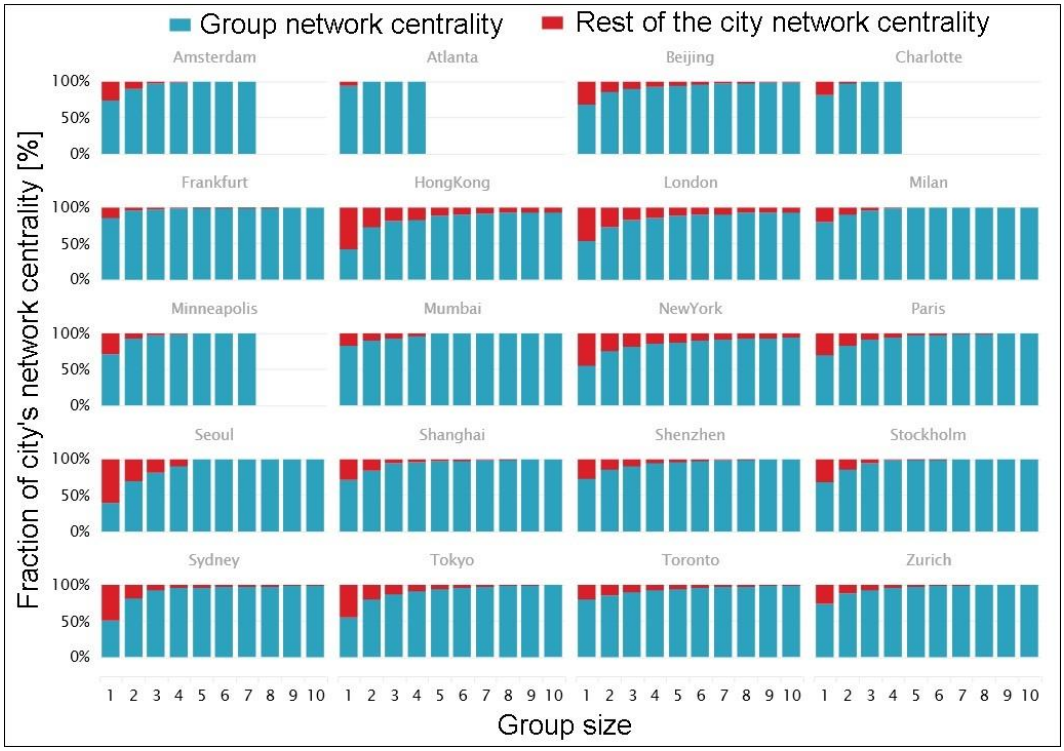


Figure 3.4. Group contribution to city centrality.
Source: Author's calculations based on Dealogic data.

Figure 3.5. illustrates the global financial networks of FCs for 2000, 2007 and 2015. The edges represent ties among cities weighted by frequency of syndication among their banks. We also examine in detail the 30 city-dyads with the highest frequency of syndication ties in 2015. This exercise reveals a substantial national and regional clustering in the WCN, given that the most connected city-dyads are within North America, Europe, Asia or within individual countries, rather than crossing continental boundaries. Exceptions naturally exist and the ties among New York, London, Zurich, Paris and Frankfurt are some of the strongest. New York – Charlotte, NC (the headquarters of Bank of America) is the city-dyad with the highest frequency of syndication ties (1289 ties) in 2015, closely followed by Beijing – Shenzhen (1109), Beijing – Shanghai (1096) and Shenzhen – Shanghai (1091). The long-worshipped NYLON ranks 7th with 859 syndication ties. We come to understand that this is at least partially due to the common occurrence of

subsidiaries of American banks locating in London and British banks in New York, leading to fewer intercity syndication ties among subsidiaries of investment banks located in New York and London and more among those co-located within these cities.

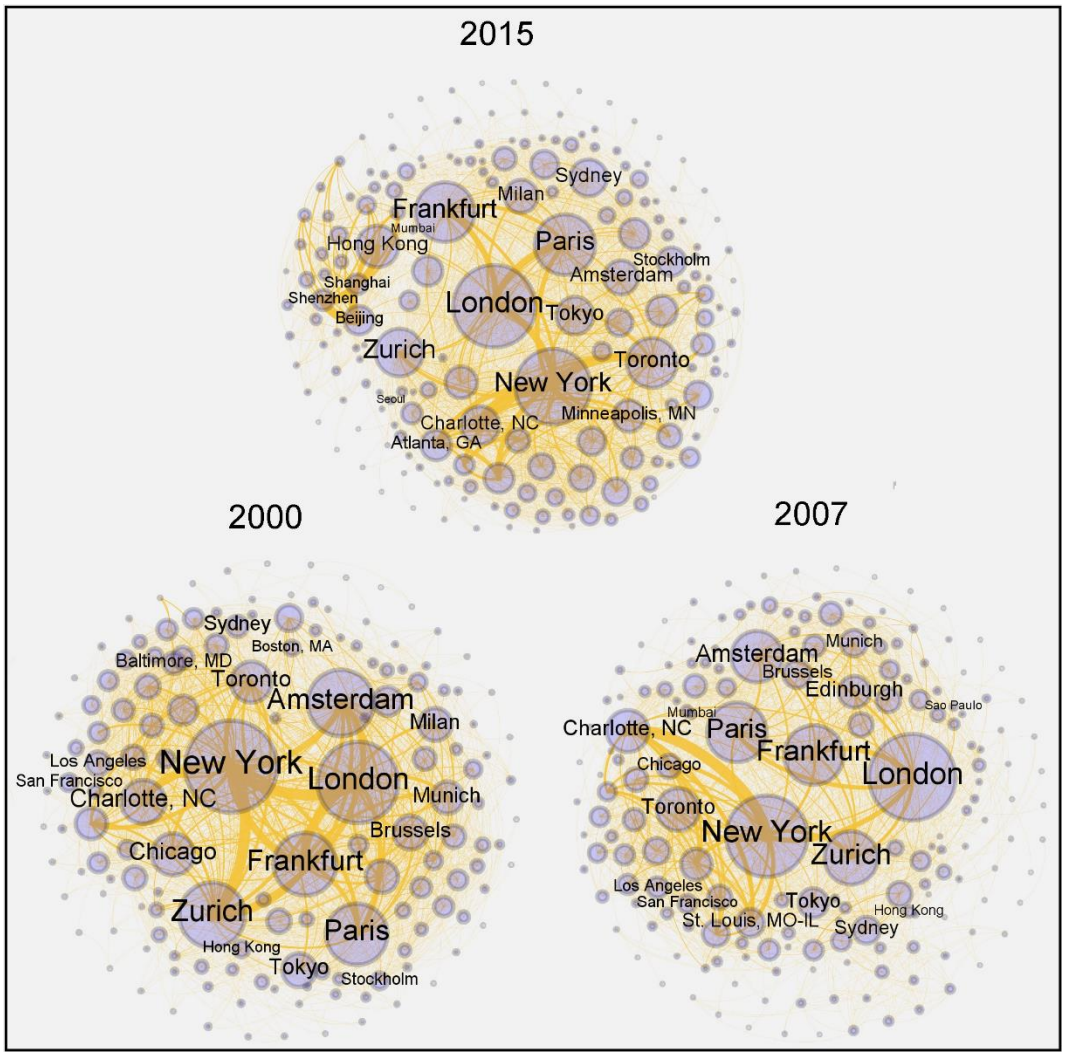


Figure 3.5. Global network of financial centres.

Notes: The size of nodes is proportional to the standardised group degree centrality of cities and thickness of edges is proportional to frequency of co-syndication. Fruchterman and Reingold (1991) algorithm has been used to visualise these networks. Only labels for top 20 FCs in each year are displayed.

Source: Authors' calculations based on Dealogic data.

3.6. Conclusions

The objective of this paper was to revise the methodological foundations of the IWCNM (Taylor, 2001) and to develop a new approach that allows for empirical analysis of the WCN based on truly relational data capturing ties among APS firms. The principal contributions of our approach to measuring intercity and interfirm network connectivity among APS firms and the ways in which it overcomes the limitations and blind spots of the IWCNM methodology based on office location data can be summarised as follows.

First, in contrast to the IWCNM based on office location data for which intercity ties are merely aggregations of intra-firm ties among offices located in different cities, our approach allows for empirical observation of ties among both subsidiaries of the same parent organisations as well as those owned independently. Second, while the estimates of weights of intercity ties based on IWCNM are assumed to be proportional to the size/importance of offices of APS firms, our approach requires no assumptions regarding the relationship between weighting of ties and size or any other attribute of the underlying actors. Third, the prevailing IWCNM methodology assumes that weights of intra-firm ties are symmetrical for any combination of offices. Our approach uses data on the hierarchy of roles in inter-organizational projects, which allows us to distinguish the directionality of ties depending on hierarchical relationships among project members. This offers an insight into potential hierarchical relationships among APS firms and subsequently cities. Fourth, intra-firm flows estimated using the IWCNM based on office location data vary only with the size/importance of the offices involved and otherwise are assumed to be constant across different firms and industries. Our approach does not impose any restrictions on the variation in network connectivity across firm-dyads or industries.

Fifth, although well established in the social network analysis literature, the projection function used by Taylor (2001) to convert two-mode city-firm affiliation network to one-mode city-city network has been criticised for leading to loss of information and leading to very dense and flat network with fairly small differences in network centralities of cities (Derudder and Parnreiter, 2014). This is in addition to a more serious problem identified by Nordlund (2004), relating to conversion of office attributes to relational data through this projection function. Instead of using a projection function to allow for calculating city network centralities, we circumvent this by calculating city network centrality scores directly from a firm level network by treating cities as groups of firms and using group degree centrality measures (Everett and Borgatti, 1999).

Sixth, the current IWCNM framework assumes all firms with at least one pair of offices located in the same city to be connected. Consequently, a projection function that would convert a firm-city service value matrix to a firm adjacency matrix is not well suited for studying network connectivity within cities. Our approach requires no assumptions regarding ties among co-located firms and instead allows for their direct empirical observation. Our model therefore also allows for a meaningful analysis of intracity networks. Consequently, research questions relating to intracity connectivity, such as those querying joint production of advanced producer services within APS complexes[11] can be interrogated.

As shown above, our approach addresses some of the key measurement problems faced by the IWCNM. It also answers the call of Watson and Beaverstock (2014) for approaches better rooted in individual or firm level agency, when investigating WCNs. The network ties considered here are clearly formed by firms

[11] Smith and Doel (2011) identify the inability of IWCNM to provide empirical evidence on joint production within APS complexes as one of its crucial failures, given its connection to the 'global city' concept (Sassen, 2001).

through their collaboration on inter-organizational projects. We use cities only as a heuristic to group firms and aggregate their ties. We don't believe that this in any way compromises the validity of firm level agency in forming network connections through involvement in inter-organizational projects. The agency of banks in formation of syndicated deals is generally well understood and researched (Baum et al., 2004; Shipilov, 2006; Ljungqvist et al., 2009) and therefore we can draw on this literature to overcome any existing weaknesses regarding firm level agency in the WCN formation.

Although our analysis is limited to the investment banking sector, it could be extended to a much broader set of APS and other industries. Parallels can be drawn between investment banking syndicates and other types of inter-organizational projects, such as syndicated loans, syndication of venture capital general partners, co-counselling of legal cases by law firms, collaboration of marketing firms on advertising campaigns or multiple accounting firms advising a client on an acquisition strategy. We therefore see our approach as being broadly applicable to a wide range of collaborative inter-organizational projects among APS firms and a powerful tool for studying intercity as well as inter-firm networks.

Our results indicate that there is a substantial variability in both connectivity scores of individual cities as well as their ranking over time. This is in sharp contrast to results of studies using the IWCNM (Taylor and Aranya, 2008; Derudder et al., 2010), which generally point towards very stable temporal dynamics. Although typically a substantial part of banks in FCs contribute to the network centrality of their city in a non-redundant manner, it is often the most connected group of only 3-5 banks that represents most connections that FCs have with the rest of the world. It is however noteworthy that these connections are spread out across hundreds of banks worldwide. Additionally, our analysis of intercity ties indicates that there is a substantial tendency towards regional and national clustering in the

WCN as revealed by the most connected city-dyads, corroborating the findings of Derudder and Taylor (2005) derived from a sample of 100 APS firms. Finally, our results indicate hierarchical relationships among FCs, with some cities dominating others as centres of lead managers. This finding warrants further enquiry regarding 'command and control' among APS firms in networks and corroborates the argument developed by Parnreiter (2014) for refocusing WCN research on the control functions of global cities.

Our modelling approach is subject to a range of limitations. Although we use relational data, which we argue represent interfirm and intercity network connections, they do so in a somewhat crude manner. Using frequencies of co-membership of syndicates is unlikely to give a very precise estimate of the flows of ideas, emails, telephone calls or people. This can be alleviated by weighting these transactions by their value either in terms of apportioned deal value or fees earned, but only partially so. Secondly, inter-organizational projects are only one of many ways in which APS firms or any other organisations may be connected. Ideally, a more comprehensive approach would aim to account for the multitude of network connections that exist among organisations.

Chapter 4 | The network boundary specification problem in the global and world city research: Can we trust empirical results from sampled networks?

(Paper written with Dariusz Wójcik)

Abstract

Despite the well-known dependence of vertex and network structural parameters on network boundary specification employed by researchers, there has so far been effectively no discussion of this in the global and world cities literature. Given the reliance of empirical studies of urban networks on the specification of network ties and the sampling of underlying actors that form these networks by their activities, we consider it of key importance to examine the dependence of network centralities of cities on network boundary specification choices regarding both network ties and actors. We contrast results across three distinctive modelling approaches based on: a) office networks, b) ownership ties and c) inter-organisational projects in addition to considering the effects of network sampling. Our results indicate that differences among these modelling approaches persist for all sampling percentages and results from sampled networks can be reliable under some circumstances.

4.1. Introduction

The scholarship concerned with studying urban networks through the lenses of corporate networks grounded conceptually in the seminal works of Jacobs (1969), Friedmann (1986), Sassen (2001) and Castells (2010) has crystalized in the form of three main methodological approaches. These can be broadly divided into those following (1) Taylor's (2001) Interlocking World City Network Model (IWCNM)

based on office location data of advanced producer services (APS) firms, (2) ownership linkages among parent companies and subsidiaries of multinational enterprises (Alderson and Beckfield, 2004) and (3) inter-organisational project collaboration (Pažitka et al., 2018a). We refer to them shortly as the (1) office networks, (2) ownership ties and (3) inter-organisational project approach.

The broad division of the existing approaches described here stems primarily from either explicit or implicit choices of the respective researchers regarding the network boundary specification underlying their research design. Network boundary specification in this context refers to the choices researchers make regarding what is and what is not part of the network under study. This problem can be divided into two parts – 1) network ties (edges) and 2) actors (vertices). As a matter of empirical feasibility, researchers generally impose restrictions on both the ties and actors included. Unlike in studies of statistically independent observations, network data by definition includes dependencies among observations and for this reason the network boundary specification problem is of fundamental importance to the validity, robustness and scientific value of studies that focus on network structural properties (Laumann et al., 1989). The established practice in studies of urban networks is to derive the centrality of cities in urban networks by aggregating the network connections of individual organisations obtained from disaggregated firm level networks. Consequently, the implications of the network boundary specification problem are just as relevant to this literature and its conclusions.

In all of the studies that we surveyed from this literature, the network boundaries are clearly defined both in terms of the specification of network ties (edges) considered as well as actors (vertices) included. Specification of network ties is generally dictated by the nature of the phenomenon under consideration and availability of data for its empirical observation. Actor inclusion is typically restricted

by actors‘ importance or geographical area of interest. Interestingly, none of the studies that we surveyed explicitly discuss the network boundary specification problem and its consequences or reference relevant methodological studies from social network analysis. The primary research objective of this paper therefore is to investigate the reliability and similarity of city network centrality measures derived from three competing modelling approaches used in the global and world cities research. We are specifically interested in the following research questions – (1) How similar are the city network centralities derived using office network, ownership ties and inter-organisational project approaches? (2) What sampling percentages are required to obtain results consistent with those from a whole network analysis?

We use data on all syndicated deals[12] available in Dealogic Equity Capital Market (ECM) and Debt Capital Market (DCM) databases for 2015, representing collectively 2,192 legal entities involved in the underwriting of 13,666 equity and debt securities primary issues. This dataset allows us to construct three different types of edges based on (1) office networks, (2) ownership ties and (3) inter-organisational projects and allows us to compare results on city network centralities obtained using the same underlying actors. In addition, we sample from these whole networks[13] and compare results across sampled and whole networks at sampling percentages ranging from 1% to 95% of underlying actors.

Our results indicate that differences among these modelling approaches persist for all sampling percentages as expected and results from sampled networks converge on those obtained from whole networks as sampling percentage

[12] Syndicated deals are primary issues of capital market securities (equity or debt securities) underwritten by multiple securities firms. We therefore treat them as inter-organisational projects.

[13] Given the comprehensive nature of Dealogic databases, we treat these networks as being complete for the purposes of studying underwriting syndicates of equity and debt securities.

increases. We achieve reliable results with samples as small as 50% of the underlying actors. Most empirical studies of urban networks, however work with samples of less than 10% of the underlying actors, which as we show may not be sufficient for robust empirical analysis.

The rest of this paper is organised as follows. Firstly, we review the relevant literature on urban networks and contributions from social network analysis related to the network boundary specification problem. The research design section details the methodological basis of the three modelling approaches considered, outlines the methods used for comparing results across different networks and presents our dataset. In the results section, we contrast the results derived across (1) office networks, (2) ownership ties and (3) inter-organisational projects approaches as well as those for sampled and whole networks. In the concluding section, we reflect on the implications of the network boundary specification problem for literature on urban networks and make suggestions for future research.

4.2. Literature review

4.2.1. Global and world city research

The global and world city research as well as the wider literature investigating urban networks through the lens of corporate networks rests on the theoretical foundations laid out in the works of Jacobs (1969), Friedmann (1986), Sassen (2001) and Castells (2010). While Friedmann's (1986) ‘world cities’ are conceptualized as centres of power and their world-cityness is examined empirically in studies of ownership links (Alderson and Beckfield, 2004), Sassen's (2001) ‘global cities’ are service centres hosting advanced producer services (APS) firms’ complexes. The primary function of APS firms is to deliver services, such as underwriting of securities, accounting and auditing, management consultancy, marketing and legal services to other businesses. These types of services are designed to make it feasible and economical for owners of financial

capital to exercise their economic power, protect their interests and monitor companies that they have invested in at an unprecedented scale. In addition, APS firms' services allow corporate boards to manage highly complex organisations, gain access to necessary knowledge and skills, without having to keep all the necessary expertise inhouse. Taylor's (2001) Interlocking World City Network Model (IWCNM) has become the principal methodological tool for studying global city-ness. This literature naturally has its critics, who point out both methodological and conceptual weaknesses in the prevailing IWCNM approach (Nordlund, 2004; Neal, 2013) as well as some of the conceptual underpinnings of this literature (Robinson, 2002, 2005, Smith, 2003a, 2003b, 2014; Smith & Doel, 2011). In turn van Meeteren et al. (2016) challenge many of the conceptual critics of this literature and Pažitka et al. (2018a) offer an alternative modelling approach that overcomes some of IWCNM's limitations.

In this literature review we will take a slightly different approach from the previous reviews of studies covering urban networks (Derudder, 2006; Liu et al., 2013). We restrict our attention to studies of corporate networks, given that telecommunication or physical transportation networks are not conceptually strongly grounded in the associated global and world cities literature and instead form a distinctive group. As a way of categorizing empirical studies, we focus on the network boundary specification restrictions imposed by researchers. To do this in a meaningful and systematic manner, we refer to table 4.1. Generally, the research design of every empirical network analysis needs to address two fundamental restrictions on the boundaries of the studied network - the types of network ties (edges) considered and actors (vertices) included. Columns and rows of table 4.1. categorize these restrictions. Naturally these are not all possible restrictions, but we focus on these because of their prominence in empirical studies of urban networks reviewed here. The cells (A1 – C3) of table 1 can therefore be

interpreted as potential combinations of restrictions on both network ties and actors.

Table 4.1. Classification of empirical studies on urban networks formed by corporate activities.

Edge / Actor	Office networks	Ownership ties	Inter-organisational project ties
Industry	A1	A2	A3
Importance	B1	B2	B3
Geographical location	C1	C2	C3

Notes: Actors (rows) denote restrictions on the inclusion of actors; Edges (columns) denote restrictions on the inclusion of types of network ties.

Source: Review of literature by authors' (Alderson et al., 2010; Taylor and Derudder, 2016; Pažitka et al., 2018a)

Taylor (2001) specifies the World City Network (WCN) formed by interlocking offices of transnational APS firms. This means that in terms of the network boundary specification, the empirical studies that follow this research design fall into the first column of table 4.1., depending on the restrictions they impose on the inclusion of actors (Derudder et al., 2010; Neal, 2008; Taylor, 2005). Empirical studies following Taylor's (2001) research design impose some restrictions on either industry, importance, geographical location of actors or some combination of these. Taylor et al. (2002) study a sample of leading APS firms[14], by selecting those with at least 15 offices, including at least one in Europe, Northern America and Asia-Pacific. They sample those firms with publicly available data on their office locations and restrict themselves to 100 firms to keep the data collection process manageable. Following this sampling procedure, Beaverstock et al. (2000)

[14] Financial service, accountancy, law, advertising, and management consultancy (add numbers).

use a sample of leading 74 APS firms, Neal (2008) uses a sample of 100 APS firms, Taylor and Aranya (2008) use samples of 100 (2000) and 80 (2004) APS firms, Bassens et al. (2010) use a sample of 28 leading Islamic financial institutions. Derudder et al. (2010), Derudder and Taylor (2016), Hennemann and Derudder (2014), all use sample of 175 leading APS firms made available by the GaWC research group on their website. Due to specifications of their research design, Liu et al. (2013) use a smaller sample of 53 APS firms, a subset of the large samples used in other GaWC studies. In all but one of the cases mentioned above, APS firms from the following five broad industrial categories are sampled – financial services, accountancy, advertising, law, and management consultancy. In a unique study on 16 different networks, Taylor (2005) considers UN agencies, global NGOs and APS firms among many other networks. Similarly, Toly et al. (2012) contrast networks of 76 global NGOs and 33 global energy corporations. In contrast to these studies with global scope, others also impose explicit geographical restrictions on their samples. Sigler and Martinus (2017) draw a sample of 1,840 companies listed on the Australian Securities Exchange (ASX) and Rossi and Taylor (2005) analyse a sample of 31 leading Brazilian banks.

While the focus of the GaWC research network is on studying urban networks formed by offices of organisations, a related stream of literature focuses on power relations by observing ownership linkages among parent companies and subsidiaries of multinational enterprises (MNEs). The studies of Alderson and Beckfield (2004) and Alderson et al. (2010) use global samples of 500 leading MNEs and fall into cell A2 in table 4.1. Both studies consider network connections to be directed from the parent to the subsidiary and only count edges in this direction. In a follow up study, Wall and van der Knaap (2011) analyse a network of 100 leading MNEs to examine the assumed power structure of the WCN.

A distinctively different modelling approach is that of Pažitka et al. (2018a). This approach is based on inter-organisational projects as the elementary building blocks of the WCN and falls into the third column of table 4.1. Pažitka et al. (2018a) use data on 161,114 investment banking syndicates to build a model of WCN and its evolution for the 2000 – 2015 period. In a related study Pan et al. (2017) use data on 2296 IPOs of Chinese domestic firms on Shanghai and Shenzhen stock exchanges for the period 1993 – 2014. Both studies demonstrate the scalabiliy of this approach and its usefulness especially for large scale studies focusing on network evolution.

A word of caution is however in order. While for the office networks and ownerhip ties approaches it is typically given that all network connections for each firm will be included, if that firm is sampled, this is not as simple for the inter-organisational project approach. Inter-firm and subsequently inter-city network ties are the product of co-membership of inter-organisational projects. Consequently, the validity of the sampling procedure employed for these projects is key to the reliability of this approach. Any missing data on either inter-organisational projects or their members can therefore impact the reliability of vertex and network structural parameters. A good example of this fallacy is the study of Pan et al. (2017). Restricting their dataset to two out of three China's stock exchanges, omitting the Hong Kong Stock Exchange, resulted in a restriction on the network boundary, which cuts right across some of the strongest ties in this urban network, consequently, creating severe bias against Hong Kong based firms. This resulted in one of the key financial centres and the gateway connecting China with the global capital markets to be completely sidelined. Consequently, it needs to be considered very cerefully, whether the type of network tie selected is representative of the object of study and whether it does not impose any undue

restrictions on the observed network, which could lead to a heavily distorted image of the underlying network of interest.

4.2.2. Network boundary specification problem

The network boundary specification is recognized by researchers in social network analysis as one of the most important decisions to be made in empirical studies using network data. It entails decisions made by researchers regarding the specification of network ties considered and inclusion rules for actors in the studied network. While the specification of ties depends primarily on the phenomenon under study and availability of measurable interactions, the choice of actors to be included should reflect the true boundaries of the network. Historically, researchers have adopted two principal approaches to specifying boundaries of networks – (1) realist and (2) nominalist approach. Realist approach requires studied subjects to self-identify the boundaries of the network by reporting their network connections to other actors. In contrast, nominalist approach relies on a researcher to draw the network boundaries. The realist approach is generally better suited to studies involving fieldwork and primary data collection, while studies relying on secondary data often adopt the nominalist approach (Laumann et al., 1989).

Any restrictions on the inclusion of actors or ties imposed by researchers that result in an incomplete sociocentric[15] image of the network lead to a missing data problem. This is a much more serious concern in network analysis than it is in analysis of statistically independent observations, because observed vertex and network structural measures rely potentially on all observed vertices and edges. Consequently, even if a random sample of vertices is taken, there are no guarantees that this will lead to a sampled network with structural properties that are representative of the whole network. For a researcher following a nominalist

[15] Sample that includes all vertices and edges of a network.

approach, opting to identify the network boundary herself rather than relying on studied subjects to identify boundaries of their network, there are two principal approaches available – (1) sociocentric and (2) egocentric approach (Doreian & Woodard, 1994). Following a sociocentric approach is feasible, if there is a prior knowledge on the full set of actors belonging to a given network. In situations when this is not the case, it is possible to pursue the egocentric approach and identify the approximate boundaries of a network by repeated rounds of snowball sampling (Stumpf et al., 2005). In certain types of studies, the network boundary specification is of lesser concern or even inconsequential. This is the case for studies of dyadic network relationships, where the impact of such connections on the underlying actors is the object of study, rather than the network structure (Carpenter et al., 2012; Handcock & Gile, 2010).

The methodological research on network boundary specification, network sampling and missing data in networks, which represent three sides of the same problem, has focused primarily on the measurement error, bias and reliability of vertex and network level structural attributes in one-mode networks resulting from randomly missing data. In a pioneering study Galaskiewicz (1991) considered the effect of network sampling on the vertex level in-degree centrality measures in two empirical networks constituting a broad range of private, public and third sector organisations. The results of these simulations indicate that the variance of measurement errors decreases with sampling percentage and number of trials. Network density has been found to be inversely related to the precision of vertex centrality estimates and only sampling percentage, but not the sample size matters. Bolland (1988) found that the Pearson correlation between vertex centralities in unperturbed networks and those with simulated errors in the data decreases approximately linearly with the number of simulated errors. In a related study, Johnson et al. (1989) consider the effect of initial sample size, number of

choices and number of sampling waves on the precision of vertex in-degree centralities. Their results indicate there is a trade-off between these parameters, when attempting to decrease measurement error. Allowing for higher number of fixed choices leads to just as accurate estimates of vertex centralities as in a comparable study with more sampling waves, thus reducing costs without impacting the robustness of results. These findings are corroborated by a broader simulation study of Borgatti et al. (2006), which shows that the precision of vertex centralities declines smoothly and linearly with the fraction of missing data.

McCarty et al. (2007) show that accurate estimates of vertex centralities can be obtained by restricting the length of a free-choice list offered to respondents in a survey and show that sampling as little as 60% of each actor's network ties yields centralities consistent with their true values. In a large-scale study based on 59 empirical networks Costenbader and Valente (2003) show that different centrality measures vary greatly in their correlation with their true values, when only a fraction of a network is sampled. Their results indicate that the centrality measures commonly used by social scientists are generally reliable for sample sizes of at least 80% of vertices and their respective edges, while effectively none are reliable for sample sizes of less than 20%. Zemljič and Hlebec (2005) consider the effect of measurement errors associated with network surveys and their impact on the reliability of vertex centrality measures. Local measures are shown to be more robust than global measures and network density mitigates the impact of measurement error on reliablity of centrality measures.

Perhaps the most important finding regarding the association between network sampling and inference based on network structural measures is that of Stumpf et al. (2005), who show that subnetworks created by drawing random samples from scale-free networks are not scale-free. This is corroborated by the work of Lee et al. (2006), who show that vertex sampling, edge sampling and snowball sampling

all lead to substantially varying estimates of network structural measures across three large-scale empirical networks – protein interaction, Internet and scientific publication network. Consequently, they cannot be used reliably to draw inference regarding network structural measures, whether at vertex or network level, for the underlying scale-free network.

In contrast to much of the related literature, Kossinets (2006) considers the effect of three different sources of missing data – network boundary specification, survey non-response and censoring by vertex degree on network structural measures of bipartite graphs. Network boundary specification and censoring by vertex degree are shown to have the most severe impact on estimates of network structural measures, while survey non-response is of much smaller relevance, especially if bipartite graphs feature high degree of redundancy. Limiting their attention to perturbations of edges in eight key theoretical models of networks and three empirical networks, Villas Boas et al. (2010) examine the sensitivity of vertex and network structural parameters to edge deletion, addition, and rewiring. Their findings indicate that hierarchical structural measures offer a good trade-off between robustness under edge perturbations and ability to discriminate between different network topologies, while the more traditional measures such as vertex degree, vertex betweenness centrality or shortest path length are either too sensitive to edge perturbations or not able to sufficiently discriminate between different network topologies.

It has been shown across the wider literature on the topics of network sampling, missing data and network boundary specification that these matters should be given full consideration by researchers investigating vertex and network structural parameters. Network boundary specification is also relevant to studies using blockmodels (Žnidaršič et al., 2012), Exponential Random Graph Models (Valente et al., 2013) or Stochastic Actor-Oriented Models (Leszczensky & Pink, 2015).

Apart from the most simplistic of scenarios[16] it seems to be difficult to predict the consequences of network boundary restrictions that lead to important omissions in the network data and even more so to correct for it. For this reason, it seems that especially in the investigation of structural properties of networks it is important to obtain a reasonably complete dataset capturing both vertices and edges of the network accurately.

4.3. Research design

The analysis conducted in this paper is divided into two parts. First, we compare the network city centralities derived from three different approaches for modelling urban network connectivity – office network (Taylor, 2001), ownership ties (Alderson and Beckfield, 2004) and inter-organisational project approach (Pažitka et al., 2018a). Second, we contrast the results derived from networks with sampling percentages from 1 per cent to 95 per cent of parent companies[17] to those from whole network analysis.

4.3.1. Modelling approaches in urban network analysis

Taylor's (2001) Interlocking World City Network Model (IWCNM) derives estimates of urban network connectivity from the spatial distribution of offices of advanced producer services (APS) firms. This is operationalized by using a matrix of 'service values' V, with rows representing cities and columns representing firms. Elements of V - $v_{i,j}$ are customarily coded on a 0 to 5 scale[18], with 0 for non-presence in a city and 5 for a global head-office. The individual network connectivity scores $r_{i,j}$ representing the strength of connection between two offices

[16] Random networks and random patterns of missing data.

[17] We sample at the parent company, because this sampling method can be meaningfully applied to all three modelling approaches and allows for like with like comparison of the results.

[18] Due to the limitations of our data, we only code offices on a three-point scale: 5 = global HQ, 4 = national HQ, 3 = regular office.

of a particular firm are given by the product of service values for the given office-dyad (equation 1). Estimates of flows for city-dyads are then given by the sums of connectivity scores for office-dyads that connect a given city-dyad (equation 4.2.). Finally, to calculate a measure of status of city *a* within the WCN (N_a), Taylor (2001) proposed to sum the relational elements $r_{i,j}$ for each city *a*, thus giving us an aggregate measure of connectivity between city *a* and all other cities (equation 4.3.). N_a can be therefore interpreted as a weighted degree centrality of cities, produced by summing network connectivity across all firms located in that city and counting only those connections that connect offices of firms in city *a* with those outside of it.

$$r_{ab,j} = v_{aj} \cdot v_{bj} \qquad (4.1.)$$

$$r_{ab} = \sum_{j} r_{ab,j} \qquad (4.2.)$$

$$N_a = \sum_{i} r_{ai} \quad a \neq i \qquad (4.3.)$$

In contrast to the IWCNM, Alderson and Beckfield (2004) base their approach on ownership ties among parent companies and their subsidiaries. They count only directed network connections from the city of the parent to the city of the subsidiary. This contrasts with the IWCNM, which is based on undirected and consequently symmetric ties. City network centralities in Alderson and Beckfield (2004) approach are given by the number of subsidiaries outside of city *a* owned and controlled by parent companies headquartered in city *a.*

Finally, the inter-organisational project approach (Pažitka et al., 2018a) relies on data on syndicated deals, in the form of a firm-deal affiliation matrix[19]. This is then converted to a firm adjacency matrix by the projection function below:

$$B = D(D^T);\ b_{i,j} = 0\ if\ i = j \qquad (4.4.)$$

where D is a bank – deal affiliation matrix, D^T is a transpose of D, B is a weighted bank adjacency matrix and $b_{i,j}$ are frequencies of co-membership of firm-dyads in syndicated deals.

To calculate city centralities, we convert adjacency matrix B to an edge-list and complement it with data on operational headquarters[20] of subsidiaries. We then use the methodology for calculating group degree centrality developed by Everett and Borgatti (1999) to derive the network centrality of cities, which is defined as the sum of non-redundant network connections between firms in city *a* and those outside of city *a*. The non-redundancy condition ensures that network connections are not double counted and at most one connection to every firm outside of city *a* is counted towards its group degree centrality score.

We standardise all city network centralities by the maximum available value, separately for each approach. We then proceed to compare city network centrality results for all three pairwise combinations of approaches outlined earlier in this section. We do this for 8 different settings as outlined in table 4.2. below:

[19] Firms are recorded at the lowest available subsidiary level reported in Dealogic ECM and DCM databases in relation to each deal in order to maximize the geographical accuracy of allocating deals to cities.

[20] We define operational headquarters as the publicly known head office of the company, where most of its top-level management team and key personnel is normally based. This is in contrast with financial headquarters, which is often located separately for tax or other purposes.

Table 4.2. Variations of settings for the comparison of results across three modelling approaches.

	City network centrality		City ranking by network centrality	
	Random sampling	Top-down sampling	Random sampling	Top-down sampling
Pearson correlation coefficient	1	2	3	4
JSD / KLD	5	6	7	8

Notes: Notes: JSD – Jensen-Shannon divergence, KLD – Kullback-Leibler divergence. JSD is used to compare centrality scores between different modelling approaches. KLD is used to compare centrality scores obtained from different samples using the same modelling approach (Lin, 1991; Vedral, 2002).

Source: Authors' research design.

Motivation for the research design described in table 4.2. is to consider both random sampling, which has been commonly used in studies of network sampling and network boundary specification (Borgatti et al., 2006; Costenbader & Valente, 2003; Galaskiewicz, 1991; Lee et al., 2006; Handcock & Gile, 2010; Stumpf et al., 2005) as well as sampling from the top of a list of firms ordered by size (top-down sampling), which has been widely employed in the global and world city literature. Examples include Alderson and Beckfield (2004) and Alderson et al. (2010) studying samples of top 500 multinationals, Rossi and Taylor (2005) sampling 31 leading banks in Brazil, Taylor and Aranya (2008) using a sample of 80 leading APS firms, Liu et al. (2013) studying the evolution of urban networks formed by office networks of leading 53 APS firms and Pažitka et al., (2018a) sampling top 500 investment banking subsidiaries for every year from 2000 to 2015. Given the abundance of studies of urban networks in the global and world city literature that consider city network centralities and produce ranking tables (Alderson et al., 2010;

Neal, 2008; Taylor, 2005), we consider both the raw network centralities and their respective ranking. Finally, to compare results from different networks, we employ the Pearson correlation coefficient, Jensen-Shannon divergence (Lin, 1991) and Kullback-Leibler divergence (Vedral, 2002) used in the research of network sampling and network boundary specification (Villas Boas et al., 2010; Zemljič & Hlebec, 2005).

Pearson correlation coefficient can be used as a measure of linear correlation between two variables. In this instance, we use it to compare city network centralities for the same set of cities obtained using either two different modelling approaches or from sampled and whole networks as will be shown in the next two subsections. If conceptually distinct modelling approaches are considered, Pearson correlation coefficient applied to the city network centrality scores can be interpreted as a measure of similarity. For the case of comparison of network centralities derived from sampled and whole networks, Carmines and Zeller (1979) show that it can be validly interpreted as a measure of reliability.

Kullback-Leibler (KLD) (Vedral, 2002) and Jensen-Shannon divergence (JSD) indices (Lin, 1991) are entropy-based measures, which have been widely used to quantify the distance between two probability distributions. Villas Boas et al. (2010) show that KLD is well suited for quantifying the perturbation of the network structural parameters, by comparing their probability distributions across unperturbed (whole network) and perturbed (some missing data) states. Sampled networks investigated by us are analogous to networks with missing vertices and therefore KLD is appropriate to test the extent of perturbation caused by various degrees of missing data[21]. In turn, to compare the results derived by using competing modelling approaches, we use JSD (Lin, 1991), which is better suited

[21] Sampling fraction of 50% in turn means that 50% of parent companies from the whole network are missing.

for comparison of network structural parameters from networks with different topologies and is symmetric and commutative in the sense that the order of the probability distributions compared does not matter.

To show how these measures of similarity vary across a wide range of sampling percentages, we report results on the samples of parent companies ranging from 1% to 100% of the parent companies available in our dataset. Results relating to randomly sampled parent companies are averaged across 50 randomly drawn samples of each sampling percentage and those for top-down sampling are reported for a single pairwise comparison for each sampling percentage.

4.3.2. Sampled vs whole networks

The next part of our analysis is concerned with comparing results on city network centralities obtained from sampled networks[22] with those obtained from the whole network[23]. To do this, we calculate Pearson correlation coefficient and JSD for pairwise combinations of city network centralities obtained at sampling percentages ranging from 1% to 95% and those from the whole network. Similarly, as in the previous subsection, we do this across 8 different settings shown in table 2. In the first instance, we use a bootstrapping procedure similar to that of Costenbader and Valente (2003) based on 50 random samples at each sampling interval. We then average Pearson correlations and JSD across these samples and report their averages at each sampling interval. We also consider networks obtained by top-down sampling and report Pearson correlations and JSD for each sampling percentage. Top-down samples are obtained by sampling parent companies from the top of an ordered list, using number of syndicated deals they

[22] We use sampling percentages ranging from 1% to 95% of parent companies available in our dataset.

[23] Given the comprehensive coverage of Dealogic ECM and DCM databases we treat all of the securities companies involved in all of the syndicated deals combined as the full set of actors.

were involved in 2015 as the ordering variable. We repeat this analysis separately for each of the three modelling approaches.

4.3.3. Data

To allow for a whole network research design, we identified all the syndicated capital market deals in the Dealogic Equity Capital Market (ECM) and Debt Capital Market (DCM) databases for the year 2015. This search yielded 13,666 deals in total – 2,539 and 11,127 from ECM and DCM databases respectively. The number of deals varies widely across securities firms and the bulk of the deals feature the largest investment banks. As an example, Morgan Stanley has been involved in 2,472 deals, Bank of America Merrill Lynch in 2,143 and JPMorgan in 2,070 deals.

We then identified all the securities firms involved in these deals, leading to a sample of 272 parent companies with one or more subsidiaries and 1,126 independent companies[24] operating out of a single headquarter location. Collectively, the parent companies in our sample control a portfolio of 1,066 subsidiaries involved in ECM and DCM deals. Similarly, as in the case of the distribution of deals per firm, the distribution of subsidiaries per parent is also heavily skewed with the largest banks controlling a disproportionately large number of subsidiaries. HSBC controls 29 subsidiaries involved in ECM and DCM deals, Citi and JPMorgan both control 20 subsidiaries and ING and Deutsche Bank control 18 and 17 subsidiaries respectively.

As the next step, we identified the metropolitan areas of headquarters of operations at both subsidiary and parent level. Parent companies in our sample are located across 279 cities globally and the subsidiaries cover an archipelago of 306 cities. To identify the cities in which securities firms have their offices, we relied on the Dealogic ECM and DCM data, which allowed us to identify the lowest level

[24] We define independent companies as those that do not have a parent company or subsidiaries.

subsidiaries for each company involved in each capital market deal. Given the organisational structure of the securities industry, securities firms operate legally separate subsidiaries across different countries and occasionally own a portfolio of subsidiaries located in a single country. The location of operational headquarters of these subsidiaries is consequently informative regarding the geographical distribution of the key offices of each parent company. Given the nature of capital market deals and the expertise required for their underwriting, we assume that they are underwritten by the headquarters of the respective subsidiaries of securities firms and allocate them accordingly. HSBC has been involved in ECM and DCM deals through a network of offices located in 19 cities worldwide, office networks of Citi and Deutsche Bank are located across 13 cities and the office network of BNP Paribas covers 12 metropolitan areas. In terms of geographical distribution, our sample covers 573 securities firms in Americas, 992 in EMEA and 627 in Asia-Pacific.

4.4. Results

Our results can be divided into two groups. First, we consider the correlations and JDS of the city network centralities for pairwise combinations of three distinct methodological approaches to modelling urban networks – office network (Taylor, 2001), ownership ties (Alderson & Beckfield, 2004) and the inter-organisational project approach (Pažitka et al., 2018a). Second, we compare the results derived from sampled networks and those from whole networks of securities firms involved in ECM and DCM syndicated deals.

Figure 1 presents the comparison of city network centralities derived from the three contrasting approaches detailed in the research design section. The four graphs in the top row of this figure present Pearson correlation coefficients and those in the bottom row show JDS for pairwise combinations of modelling approaches. We include Pearson correlations primarily for their ease of

interpretation, while JSD provides a more sophisticated way of comparing probability distributions of two variables. The most important result that can be infered from figure 4.1. is that regardless of whether random or top-down sampling is employed and regardless of the fraction of firms that are sampled, material differences in the network centralities and ranks of cities persist. This is very much in line with our expectations given the important conceptual differences between these approaches.

The distributions of city network centralities obtained using office network and ownership approaches become more similar as we sample higher percentage of parent organisations. The speed of adjustment is considerably faster for top-down sampling in contrast to random sampling, which progressively adjusts until all of the organisations are sampled. At the same time the distance between the distributions of network centralities obtained using the inter-organisational project approach on one side and office network and ownership ties on the other increase with sampling percentage. This is primarily due to the fact that both office network and ownership ties approaches are only driven by firms operating out of multiple locations, while the inter-organisatinal project approach also utilizes the data on single location firms, which consitute 51.4% of our sample.

Similarly, although the ranks of cities determined by office centrality and ownership ties approaches are converging as we increase the sampling percentage, those from inter-organisational project approach in fact move further apart from the first two approaches at low sampling percentages. The gap in JSD widens between office-ownership pair on one side and office-syndication and ownership-syndication pairs on the other, even at higher sampling percentages. We can therefore conclude that although the city network centralties obtained from office network and ownership ties approaches become more similar in both relative and absolute sense as we collect more data on parent organisations, this is not

mirrorred by the results for the inter-orgnisational project approach, which in fact become more dissimilar.

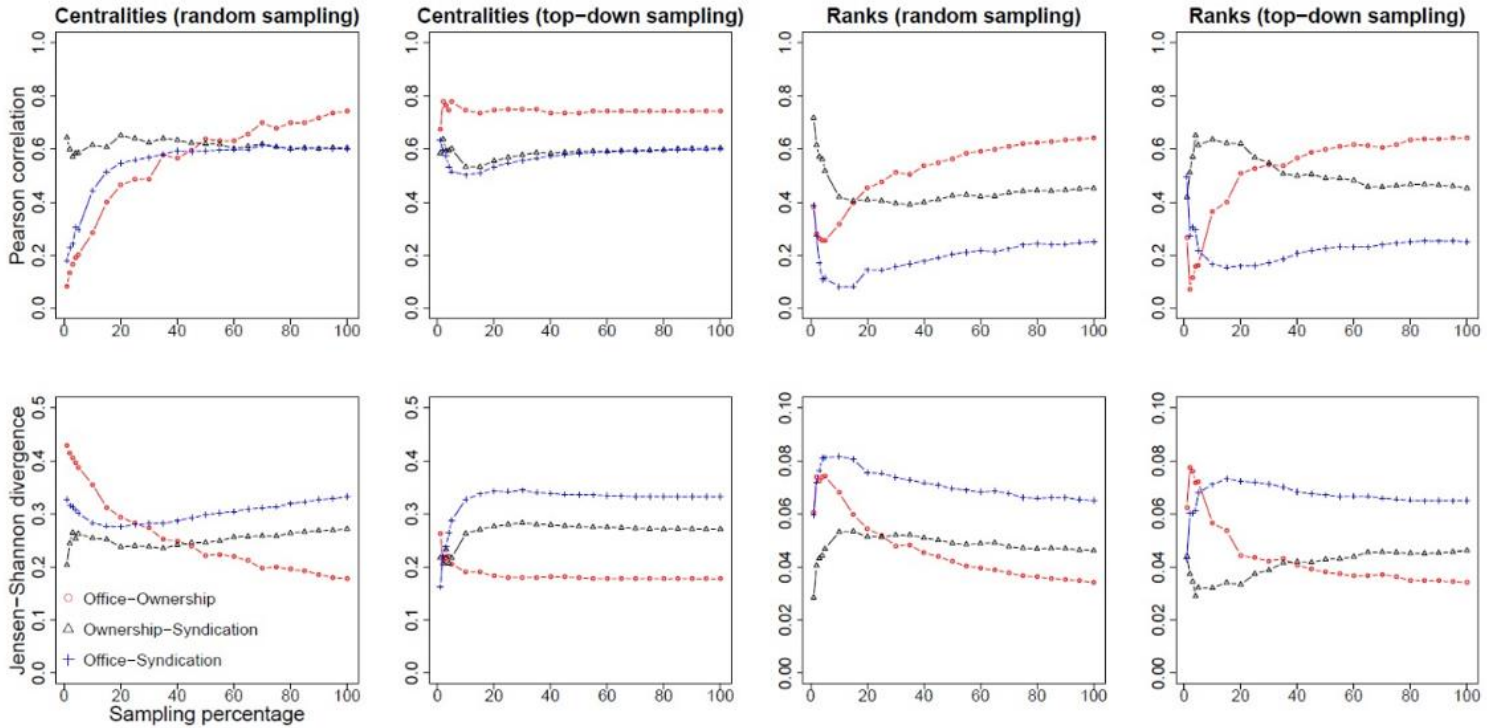


Figure 4.1. Comparison of results across three modelling approaches.

Notes: Office – office networks approach, Ownership – ownership ties approach, Syndication – inter-organisational project approach.

Source: Authors' results based on Dealogic data.

We now move on to comparing results obtained from the whole network analysis and those from sampled networks. We do this separately for office networks, ownership ties and inter-organisational project approaches. Our results regarding city network centralities indicate a convergence following a concave trajectory of a remarkably similar shape for all three approaches. While randomly sampled networks require nearly all of securities firms to be sampled for their results to converge on those obtained from the whole network, sampling from the top of the list speeds this process up considerably and samples of as little as 50% of firms yield results that are very close to those obtained by sampling the entire network. This is an important finding not only for pragmatic purposes and reducing the cost of data collection in urban network analysis, but it also supports the notion that the key network features, at the very least regarding city network centralities, can be approximated reasonably well by sampling only a fraction of the underlying actors.

Word of caution must be however exercised here. This finding is only applicable to situations where a well-defined ordered list of all relevant actors is either available to begin with or can be derived from the data. If this is not the case and random sampling is applied instead, the results may not be reliable, even if high percentage of the relevant actors is sampled. In addition, the most important vertices in the network and their respective ranking can be impacted disproportionately, when random sampling is applied. In contrast, if top-down sampling is applied, the results for the top 20 cities are comparably or more reliable than those for the whole sample of cities. This is certainly good news for studies of financial and business services firms, MNEs or listed corporations, for which a plethora of ranking tables is available.

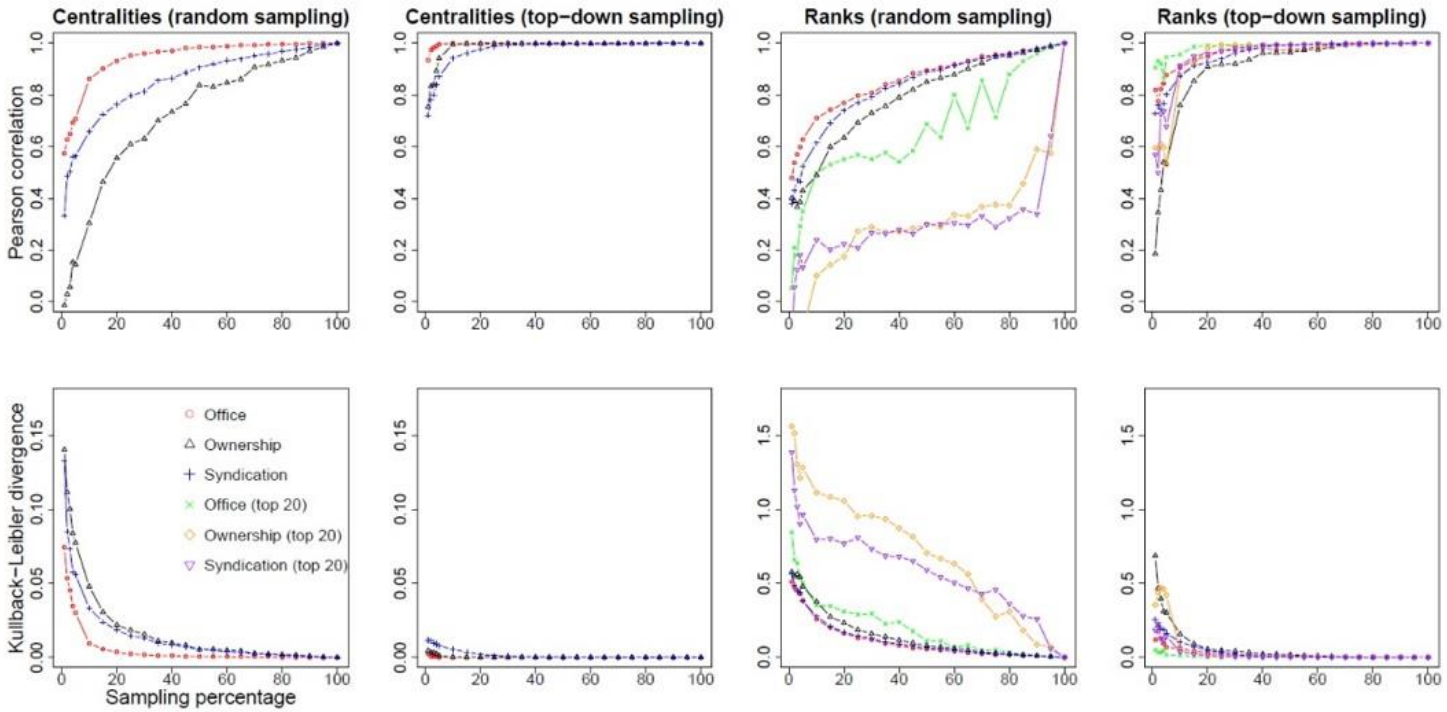


Figure 4.2. Comparison of results across sampled and whole networks.

Notes: Office – office networks approach; Ownership – ownership ties approach; Syndication – inter-organisational project approach; top 20 – comparison of ranking of the top 20 cities in the whole network.

Source: Authors' results based on Dealogic data.

4.5. Conclusions

The purpose of this paper has been to investigate the reliability and similarity of city network centrality results derived from three competing modelling approaches used in the global and world city research. We have been specifically interested in the following two research questions – (1) How similar are the city network centralities derived using office network (Taylor, 2001), ownership links (Alderson and Beckfield, 2004) and inter-organisational project (Pažitka et al., 2018a) approaches? (2) What sampling percentages are required to obtain results consistent with those from a whole network analysis?

Our results indicate that despite a certain degree of adjustment in the Pearson correlation coefficients and Jensen-Shannon divergence indices, important differences between the results derived from the three competing approaches studied here prevail. This taken together with the conceptual differences among these approaches leads us to conclude that they are best thought of as being complementary and suited for slightly different types of research questions, rather than being viable substitutes for each other. Our evidence therefore empirically corroborates the conceptual debates in the global and world city literature regarding the differences between office network and ownership links approaches (Derudder, 2006), the office networks and inter-organisational projects, inter-organisational projects and ownership ties approaches (Pažitka et al., 2018a). We contribute to these debates by reviewing, conceptually contrasting and empirically verifying similarities and differences in the city network centralities derived from these three modelling approaches.

We then proceed to analysing the reliability of city network centrality results derived using these three approaches by comparing results obtained from networks with sampling percentages ranging from 1% to 95% of the parent companies with those from the whole network analysis. Despite the argument

advanced by (Burt, 1983), suggesting that less than whole network sampling has a severe impact on network data, our results indicate that it is possible to sample network data and still obtain reliable results on vertex structural attributes. Our results using simulated random samples of actors are broadly consistent with those of Costenbader and Valente (2003), Borgatti et al. (2006) and McCarty et al. (2007) and show that network centralities obtained from sampled networks become more similar to those from the whole network as the sampling percentage increases. Sampling network vertices naturally leads to a degree of uncertainty about the estimated centralities, however as we show in our analysis of networks constructed by top-down sampling of vertices, results obtained from sampled networks become highly correlated with those for the whole network for sampling percentages of 50% and higher. In case of randomly sampled networks, correlations between network centralities from sampled and whole networks are generally less satisfactory even for very high sampling percentages (e.g. 90%). Consequently, it seems preferable to use sampling techniques that ensure that the most central actors are not omitted, such as top-down sampling considered here or snowball sampling, which has been shown to have similar properties (Galaskiewicz, 1991; Johnson et al., 1989).

In the context of the global and world city literature, most studies benefited from a prior knowledge regarding the importance or size of their underlying actors and benefit from the desirable properties of top-down sampling. It is however a reason for concern that the sample sizes typically employed in studies of urban networks fall short of the required sampling percentages identified here by a high margin and work with sampling percentages of typically less than 10% of the underlying population (Alderson et al., 2010; Bassens et al., 2010; Liu et al., 2013; Rossi & Taylor, 2005).

The analysis presented here is subject to a few limitations. First, we only consider three specific network centrality measures that have been applied in the global and world city literature. There is a plethora of other network structural parameters that have been considered in related studies and could be relevant here as well. The reason we focus on these network centrality measures is due to their importance to the literature on urban networks and the frequency of their application in empirical studies. Second, we consider random sampling and sampling from the top of an ordered list. There are other widely used sampling procedures, such as snowball sampling, which has been widely used in the social network analysis. We omitted snowball sampling here, given that to the best of our knowledge it has not been applied in studies of urban networks, which almost exclusively rely on sampling from the top of an ordered list, either available in a form of an externally made ranking table, such as Fortune Global 500 used by Alderson et al. (2010) or derived from the data itself, such as the top 500 investment banks by deal value used by (Pažitka et al., 2018a). Finally, unlike many empirical studies of urban networks (Pan et al., 2017; Sigler & Martinus, 2017; Taylor, 2005), we do not consider multiple industries that we could compare urban networks for. This would certainly be an interesting extension to our analysis.

We hope that our findings and recommendations will be considered by applied researchers when designing and interpreting studies of urban networks based on organisational networks and that others will build on this contribution.

Chapter 5 | Resilience of financial centres to demand shocks: A dynamic panel data analysis, 1993 - 2016

(Paper written with Dariusz Wójcik and Michael Urban)

Abstract

We investigate the resilience of financial centres to demand shocks using a unique dataset of over 1.7m market interactions between underwriters of equity and debt securities and their clients in the period 1993-2016. We utilize a proxy for demand shocks based on the exposure of financial centres to individual market segments and consider how resilience varies across different characteristics of financial centres. Our results show that external network connections, structure of client base and bank concentration influence resilience. On the other hand, we find that the quality of institutions and intra-cluster network structure are not significant.

5.1. Introduction

Both anecdotal and empirical evidence suggests that financial services firms cluster in leading metropolitan areas and from these focal points of the financial system they serve clients from all over the world. This holds in particular for investment banking, corporate finance and asset management (Clark et al., 2017; Wójcik et al., 2018). Clusters of financial services firms, conceptualised as financial centres (FCs) have been studied by economic geographers (Cook et al., 2007) and historians alike (Cassis, 2010) and have been shown to develop through a long running path dependent process, which generally lags behind the political and economic development of their countries. Once established, leading FCs display a great deal of stability and continue to function successfully, even after the economic and political power of their home countries fades away. In fact, the

history teaches us that it typically took revolutions and wars to make them decline considerably or disappear (Spufford, 2006).

Evolutionary economic geography is preoccupied with the evolution of clusters and their developmental paths, including reasons for their emergence and eventual demise (Martin and Sunley, 2011; Ter Wal and Boschma, 2011). In addition, a burgeoning literature drawing on the concept of adaptive resilience considers the effects of economic shocks on regional and cluster growth paths (Holm and Østergaard, 2015; Martin, 2012). Adaptive resilience refers to the ability of complex systems such as regions or clusters to withstand external or internal shocks. The objects of interest in this paper are clusters of financial services firms involved in underwriting equity and debt securities, to which we refer to shortly as financial centres (FCs). In particular, we are interested in the resilience of FCs to demand shocks. To guide our inquiry, we use the categorisation of factors affecting adaptive resilience developed by Boschma (2015) and consider the impact of industry structure[25], networks, and institutions. Our research question is therefore as follows. What is the mediating effect of the client base structure, bank concentration, network connectivity, and quality of institutions on the resilience of financial centres to demand shocks?

We operationalise a measure of FC vulnerability to demand shocks based on their exposure to individual market segments divided by client industry, nationality, service type and deal size. We then model the sensitivity of FC aggregate revenue to changes in market demand and investigate the variation of this sensitivity along the hypothesised determinants of resilience. To estimate our models, we use the System Generalized Method of Moments (GMM) estimator (Arellano and Bover, 1995) and a proprietary dataset collated from Dealogic Equity Capital Market

[25] In order to measure the variety of activities conducted by financial services firms, we consider the dispersion of their revenue across market segments divided by client‘s industry, nationality, service type and deal size.

(ECM) and Debt Capital Market (DCM) databases covering over 1.7 million market interactions of investment banks with clients between 1993 and 2016. Our sample period covers multiple financial crises and recessions including the 1997 Asian financial crisis, the dot.com bubble, global financial crisis and the Eurozone crisis.

Our results indicate that the structure of the client base and bank concentration of FCs in addition to their external network connections are significant determinants of their resistance to demand shocks, while the quality of institutions is not significant. This does not prove that institutions do not play a role in FC development. Instead it suggests that higher quality institutions do not necessarily serve as a shield against the market forces.

The rest of this paper is organised as follows. In the next section we review relevant literature from economic geography, finance, management and strategy and develop our hypotheses. In the research design section, we provide a detailed overview of our dataset and econometric methodology. The results section provides interpretation of our results and a range of robustness checks. We finish with conclusions and recommendations for future research.

5.2. Cluster resilience, financial centres and networks

Early contributions in evolutionary economic geography (EEG) focus on path dependence, lock-in and conceptualise cluster evolution as a set of mutually reinforcing processes that maintain clusters on a particular developmental path, unless disturbed by substantial external shocks or internal processes, which have the potential of shifting cluster evolution to a new equilibrium path (Martin and Sunley, 2006). Product life cycle and industry life cycle approaches have dominated this early literature as two dominant perspectives on the mechanisms underlying the evolution of clusters and the subsequent spatial distribution of industries (Frenken et al., 2015). Although providing valuable insights for explaining some phenomena, their core premise – life cycle of consecutive stages

from birth to death - has not provided a satisfactory description of how clusters evolve. The adaptive cycle model, a complex system dynamics model rooted in the Panarchy theory, has been proposed by Martin and Sunley (2011) as a more flexible framework for studying the evolution of clusters. This flexible conceptualization of cluster evolution allows for a variety of developmental paths depending on the ability of clusters to adapt and respond to changing external conditions such as demand shocks, changes in the market structure, new technological developments and regime shifts within industries, competition from other related clusters as well as internal bottom-up processes among cluster members. The concept of resilience is at the core of the adaptive cycle model and the Panarchy theory and is believed to be relevant not only to the ability of clusters to withstand shocks, but to their long term evolution in general (Allen et al., 2014; Martin and Sunley, 2011).

The EEG literature typically considers three distinct definitions of resilience (Martin, 2012; Boschma, 2015). Engineering resilience refers to the ability of a system to recover to its pre-existing equilibrium growth path following a shock. Ecological resilience refers to the ability of a system to absorb shocks and maintain its core function, structure and feedbacks. Unlike engineering resilience, it describes the properties of systems far from equilibrium and allows for a variety of outcomes, including shifts to new equilibria. Finally, the most widely adopted definition of resilience in EEG is that of adaptive resilience[26], which is linked to complex adaptive systems (CAS) theory. Evolutionary resilience is generally understood as an ability of complex systems to adapt to various market and environmental shocks and to maintain their core functions, if necessary by reallocating resources and changing their structure (Simmie and Martin, 2010).

[26] Alternatively, it is also referred to as evolutionary resilience.

Empirical contributions from the EEG focusing on resilience can be divided into those studying regions and clusters. Quantitative studies of economic resilience of regions typically consider effects of economic recessions, wars and financial crises on regional economic growth and employment. Economic structure of regions has been hypothesized to influence resilience both due to diversification as well as due to varying abilities of different industries to respond to shocks. The effect of economic structure on resilience is investigated in studies of British (Martin et al., 2016), Canadian (Ray et al., 2017) and Australian (Courvisanos et al., 2016) regions, generally supporting this hypothesis. In a contrast to these results, Cellini and Torrisi (2014) find in a long-run study (1890-2009) of Italian regions, that regional economic differences in Italy are highly persistent and economic shocks have very symmetric effects. Regional economic productivity is linked to regional resilience in a study of the economic impact of the global financial crisis on European regions. The least productive regions were shown to suffer the most during the global financial crisis, while the Eurozone monetary union is argued to amplify this effect (Fingleton et al., 2014).

In contrast, studies of cluster resilience focus on the impact of economic recessions or industry specific shocks on individual industries and their spatial distribution. Holm and Østergaard (2015) consider the impact of the dot.com bubble on employment in Danish ICT clusters and identify three functionally different types of cluster resilience – (1) adaptive resilience, (2) rigid resilience and (3) entrepreneurial resilience. Their findings highlight that there is not simply one recipe for building resilience and different industry structures can be resilient in different ways. Wrobel (2015) analyses firms in the mechanical engineering industry in Germany and concludes that inter-firm connections facilitated by co-location within clusters led to higher resilience and lower employment losses during the crisis.

Geographers studying financial and business services (FABS) firms have long been interested in the phenomenon of clustering of FABS firms in urban areas, their networks and the associated implications for the industry dynamics (Shearmur and Doloreux, 2015). Financial services firms located in leading FCs benefit from complementarities among the services they offer, access to suitably qualified and plentiful labour force, as well as institutions that promote the development of financial markets (Clark, 2002; Wójcik et al., 2018). Cook et al. (2007) present a survey-based evidence on factors affecting the location of financial services firms in London. Their findings corroborate the positive effect of MAR spillovers, while factors underlying Jacobs externalities are associated with both centripetal as well as centrifugal forces. Pandit et al. (2001) study the impact of clustering on firm growth in FCs. Their results indicate positive impact of localisation economies on firm growth as well as on entry of new establishments. In addition, numerous conceptualizations of FABS urban networks and related empirical works show that FABS firms operate geographically distributed networks of offices (Taylor and Derudder, 2016), exercise control across a portfolio of subsidiaries (Alderson and Beckfield, 2004) and collaborate on inter-organisational projects, which often bring together FABS firms located across a global set of cities (Pažitka et al., 2018a). Notwithstanding its many contributions, financial geography has not engaged directly with the concept of resilience, despite the obvious vulnerability of the financial sector to crises.

To apply the concept of adaptive resilience to FCs, we need to complement the EEG literature with a more nuanced understanding of how financial services and capital markets operate. Capital markets connect owners of financial capital (investors) with organisations that seek investment capital (issuers), typically in exchange for debt or equity claims in the form of tradeable securities. Financial services firms operate as intermediaries in capital markets and facilitate capital

flows between investors and issuers. Arjaliès et al. (2017) conceptualize these ties among financial intermediaries that ultimately connect investors and issuers as a vertically differentiated 'investment chain', which features investment banks and asset managers as the key agents facilitating market interactions on the behalf of their clients. The role of investment banks in the investment chain is to facilitate the access of issuers to the securities markets by underwriting issues of securities and allocating them to asset managers. Asset managers on the other hand are responsible for allocating the investment capital of their clients to a portfolio of investment opportunities (Clark and Monk, 2017). These intermediation relationships put investment banks in a position of considerable power, given that they serve in parallel as gatekeepers for both issuers and asset managers to securities markets and exercise considerable discretionary power over the allocation of newly issued securities to asset managers (Jenkinson and Jones, 2009).

In addition to the vertically differentiated 'investment chain' connecting issuers and investors, investment banks are also part of complex horizontal networks of syndication ties, connecting them to other banks through common membership in underwriting syndicates (Ljungqvist et al., 2009; Shipilov, 2006). Coupled with the segmented nature of markets for securities underwriting and barriers related to financial, network, reputational and human resources available to individual banks, the positioning of investment banks in syndication networks shapes their access to a variety of market opportunities (Fernando et al., 2005; Shipilov, 2006). Underwriting syndicates are currently the dominant form of securities underwriting (Pažitka et al., 2018a) and despite being dissolved upon deal completion, they exhibit a high degree of persistence of network ties across time (Xiao and Rowley, 2002). Bookrunners are generally responsible for selecting other syndicate members on behalf of the issuer and behave as network architects when

constructing syndication networks, balancing short term and long term objectives (Pollock et al., 2004). Despite the fact that leading investment banks often have the capacity to underwrite deals individually, they typically prefer to involve other banks to improve access of their clients to institutional investors willing to make long term investments in the client's shares as well as to contribute to pricing of the issue (Jenkinson and Jones, 2004; Pollock et al., 2004).

5.3. Hypotheses

To formulate our hypotheses, we draw on the framework of Martin and Sunley (2015), which identifies five elements of resilience – (1) shocks, (2) vulnerability, (3) resistance, (4) robustness and (5) recoverability, and the propositions of Boschma (2015), which divide potential determinants of resilience to industry structure, networks and institutions. Our hypotheses are conceptually linked to adaptive resilience (Martin, 2012). This is motivated by our ambition to study the ability of FCs to minimize the impact of demand shocks by a combination of anticipatory actions leading to higher levels of resilience prior to a shock and reactionary actions drawing on these pre-existing resources and structures at the time of impact. We begin with establishing a link between aggregate revenue of financial centres and changes in the level of demand and then proceed by considering how this relationship varies conditional on characteristics of financial centres.

H.5.1. Aggregate revenue of financial centres is influenced by changes in the level of demand for securities underwriting services. Ceteris paribus, financial centres grow when the level of demand in the market segments they are exposed to increases and contract as it decreases.

Central positioning in syndication networks gives investment banks privileged access to deal flow and expands the variety of market opportunities they can take advantage of. The most central actors also exercise a considerable power over the

membership of underwriting syndicates (Pollock et al., 2004). Connections with banks in other geographically distant FCs are particularly valuable, given that they give investment banks access to new market segments, including those beyond their immediate reach. Ter Wal and Boschma (2011) hypothesize that clusters integrated into global networks within their industry display better growth performance ceteris paribus, particularly during downturns in the industry. Suire and Vicente (2014, p. 154) propose that "[t]he resilient properties of clusters are, ceteris paribus, a function of their core/periphery and disassortative[27] network structure, as well as their degree of geographical openness". High density of intra-cluster networks is linked to cognitive and technological lock-in and limited ability to adapt to external shocks. Martin and Sunley (2011) propose that as clusters grow they accumulate resources and become more interconnected. This in turn reduces resilience, unless clusters can avoid forming strong networks through constant mutation and innovation. Network connections among banks located in the same FC are of limited value with respect to resilience, given that they often serve overlapping market segments and are consequently subject to the same demand shocks. Being embedded in such dense localised networks can therefore restrict the ability of investment banks to adapt to changes in market structure and their ability to move to new market segments.

H.5.2. Financial centres with a higher number of external network connections are more resilient to demand shocks.

H.5.3. Financial networks with denser intra-cluster networks are less resilient to demand shocks.

[27] Disassortative network structure is characterised by a higher propensity of nodes with many ties to connect to lesser connected nodes, rather than to other highly connected nodes.

H.5.4. Financial centres with disassortative networks are more resilient to demand shocks than fully diversified financial centres.

Industrial structure has been shown as relevant to resilience at both the level of individual industries and regions (Holm and Østergaard, 2015; Martin et al., 2016). The key economic forces in this instance are agglomeration economies on one hand and the risk reduction associated with diversification of economic activities on the other. In this context, we consider the effect of the variety of activities undertaken by FCs by measuring the diversification of their revenue by client industry and nationality. Farhauer and Kröll (2012) propose that 'diversified-specialisation' leads to a long run growth stability and is built by specialising in a portfolio of industries/activities that allow the optimal combination of benefits from both related and unrelated variety, while reducing the impact of sector specific shocks. FCs that concentrate their revenue in a carefully selected portfolio of market segments, rather than being fully diversified, are likely to harbour the expertise and market power to protect their future revenue, while at the same time limiting their exposure to demand shocks to individual market segments.

H.5.5. Financial centres that operate a 'diversified specialisation' model in terms of their client base are more resilient to demand shocks.

Holm and Østergaard (2015) show that clusters dominated by large and established firms are better suited to resist shocks to the business cycle. Investment banking is dominated by large banks, which benefit from economies of scale, reputational capital and bigger balance sheets to withstand shocks. In addition, large banks have proven to be able to influence policy and secure emergency financing from governments during the times of crises (Wójcik, 2013).

H.5.6. Financial centres with higher concentration of revenue at firm level are more resilient to demand shocks.

Finally, drawing on the proposition of Boschma (2015) regarding the impact of institutions on resilience, the literature linking quality of institutions to capital market development (La Porta et al., 1997) and the empirical evidence of Wójcik et al. (2018a) connecting quality of institutions such as rule of law and enforcement of contracts to the development of international FCs, we hypothesize that higher quality institutions make FCs more resilient.

H.5.7. Financial centres located in countries with higher quality of institutions relevant to financial services are more resilient to demand shocks.

5.4. Research design

5.4.1. Data

To measure the size of FCs as our dependent variable we use revenues earned by financial services firms from underwriting of equity and debt securities offerings aggregated at the level of metropolitan statistical areas (MSAs)[28]. We initially sample all capital market deals available in Dealogic ECM and DCM databases for the period 1993 – 2016. This yields 584,680 deals in total, 100,777 for ECM and 483,903 for DCM. For each deal we identify the issuer as well as the underwriting syndicate members at bank subsidiary level. Our dataset contains 15,032 bank subsidiaries and 91,879 issuers and features 1,727,111 million market interactions among them. The revenue data available in the Dealogic ECM and DCM databases is apportioned among individual banks conditional on their role, share of the securities underwritten and is representative of the revenue earned by banks from deals with the given industrial, geographical and size characteristics. Dealogic employs a designated data science team to manage their data on apportioning revenue to individual banks and their models are periodically calibrated and

[28] We use the boundaries for MSAs used by Oxford Economics Global Cities 2030 database for those MSAs covered by this database. For the rest of our sample, we mimic this boundary setting procedure.

provide revenue estimates earned from individual deals within 5% margin of error. To allocate bank subsidiaries to MSAs, we hand collect data on their addresses of headquarters of operations from a variety of sources, including Orbis, Amadeus, FAME, Bloomberg, Nexis UK and corporate websites. This allows us to obtain addresses of 12,827 bank subsidiaries, while the remaining 2,205 we could not identify. These typically relate to very small subsidiaries with typically fewer than 5 deals and without a traceable online footprint. This translates only to a modest missing data problem for our purposes, given that 1,716,394 / 1,727,111 (99.4%) of market interactions in our dataset are covered by bank subsidiaries for which we have data on headquarter location. We further restrict the FCs included into our panel dataset by setting a minimum threshold of $10 million in annual revenue. We do this to limit the noise in the data caused by either very small clusters or single firms. This yields a panel dataset of 178 MSAs for 1993 – 2016. They represent a global sample with 56 MSAs in Americas, 79 in EMEA and 43 in Asia-Pacific and cover 62 countries.

In our analysis we focus on the interaction terms between a proxy for changes in the level of demand, termed market demand proxy (MDP), and variables hypothesized to impact FC resilience. To proxy for changes in demand and the impact of demand shocks, we divide the global revenue for each year into 4,675 market segments by product (ECM/DCM), general industry group[29], client nationality and deal size. We then calculate the market shares of FCs in these individual segments and average them for up to five[30] previous years to account for the exposure of FCs to individual market segments. We then multiply these averaged market shares by the sizes of the respective market segments at time (t) and sum them for each FC. This gives us a proxy for changes in the level of

[29] Dealogic general industry group classification

[30] We conduct robustness checks for average for one to five years preceding the current period and report our main results using 3-year averaging.

demand weighted by the exposure of each FC to individual market segments. This specification of MDP allows us to obtain estimates of the impact of demand shocks on FC revenue and its variation across a set of potential determinants of FC resilience. Other explanatory variables, their definitions and data sources are detailed in appendix A.5.1., while appendix A.5.2. presents descriptive statistics.

5.4.2. Econometric modelling methodology

As our starting point, we specify a dynamic panel data model as shown in equation (5.1.) below. This model allows us to study the effect of various determinants X_k on FC revenue and account for the dynamics of this process by including a first lag of the dependent variable $y_{i,t-1.}$ We then introduce a MDP variable and interact it with hypothesized determinants of resilience, to arrive at the model shown in equation (5.2.). The coefficient estimates on these interaction terms β_j are of primary interest to our analysis, given that they are indicative of the variation in the sensitivity of FC revenue to demand shocks. To interpret the magnitude of this variation, we evaluate the partial derivative of FC revenue with respect to changes in MDP in equation (5.4.) by holding all but one of the significant interacting variables at their sample mean and varying the remaining variables, one at a time, from their minimum to maximum sample values. The MDP variable serves as a measure of changes in the level of demand by holding exposure of FCs to individual market segments fixed and allowing the size of market segments to vary at time (t). Consequently we interpret the partial effect of MDP on FC revenue as the effect of demand shocks, while taking into account the varying exposure of FCs to different market segments. In the presentation of our results we report both short term and long term effects. The former are based on the partial derivatives calculated from our coefficient estimates, while the latter are obtained by dividing our coefficient estimates by the rate of convergence (1-α).

$$ln(y_{i,t}) = \alpha\, ln(y_{i,t-1}) + \beta_k\, ln\left(X_{k(i,t)}\right) + u_{i,t} \quad (5.1.)$$

$$ln(y_{i,t}) = \alpha\, ln(y_{i,t-1}) + \beta_1 ln\left(MDP_{i,t}\right) + \beta_k ln\left(X_{k(i,t)}\right) + \beta_j\left(ln\left(MDP_{i,t}\right) * ln(X_{k(i,t)})\right) + u_{i,t} \quad (5.2.)$$

$$\ln(y_{i,t}) - \ln(y_{i,t-1}) = \alpha\,[\ln(y_{i,t-1}) - \ln(y_{i,t-2})] + \beta_1\,[ln\left(MDP_{i,t}\right) - ln\left(MDP_{i,t-1}\right)] + \beta_k[\ln(X_{k(i,t)}) - \ln(X_{k(i,t-1)})] + \beta_j\,[\left(ln\left(MDP_{i,t}\right) * \ln(X_{k(i,t)})\right) - \left(ln\left(MDP_{i,t-1}\right) * \ln(X_{k(i,t-1)})\right)] + \varepsilon_t + v_{i,t} \quad (5.3.)$$

$$\frac{\partial \ln(y_{i,t})}{\partial \ln(MDP_{i,t})} = \beta_1 + \sum_1^j \beta_j \ln(X_{k(i,t)}) \quad (5.4.)$$

$$u_{i,t} = \mu_i + \varepsilon_t + v_{i,t} \quad (5.5.)$$

We use the Arellano and Bover (1995) System GMM to jointly estimate equations (5.2.) and (5.3.) above. This approach allows us to obtain consistent coefficient estimates even for endogenous explanatory variables and benefits from considerably lower standard errors than more commonly used Difference GMM estimator, when modelling highly autocorrelated series. System GMM estimator can utilize a set of instrumental variables (IVs) composed exclusively of internal instruments. This eliminates the need for external instruments and allows us to create valid instruments using second and higher order lagged values of potentially endogenous explanatory variables. There is generally a trade-off between efficiency and finite sample bias. Using higher number of IVs typically leads to lower standard errors, while more parsimonious sets of instruments lead to lower finite sample bias. In all of our models we use only second order lagged values as IVs and test for their validity using the Sargan test of overidentifying restrictions and AR(2) autocorrelation test (Arellano and Bond, 1991).

5.5. Results

Our preliminary results uncover a substantial heterogeneity in the evolutionary paths of leading FCs. As shown in figure 5.1. below, London and New York have

maintained their leading position over the last three decades, although neither has yet fully recovered to its pre-2008 revenue levels. Established European FCs have mostly stagnated or even declined recently, particularly Zurich, which has now shrunk to about one fifth of its pre-2008 revenue levels. In contrast, Chinese FCs with Beijing in the lead have grown rapidly, particularly since the break of the century and six of them including Shanghai, Shenzhen and Hong Kong now rank in the top 20 FCs globally. Perhaps most importantly for our purposes, it seems to be the exception rather than the rule for FCs to closely follow the global revenue trends, whether during the times of crises or otherwise.

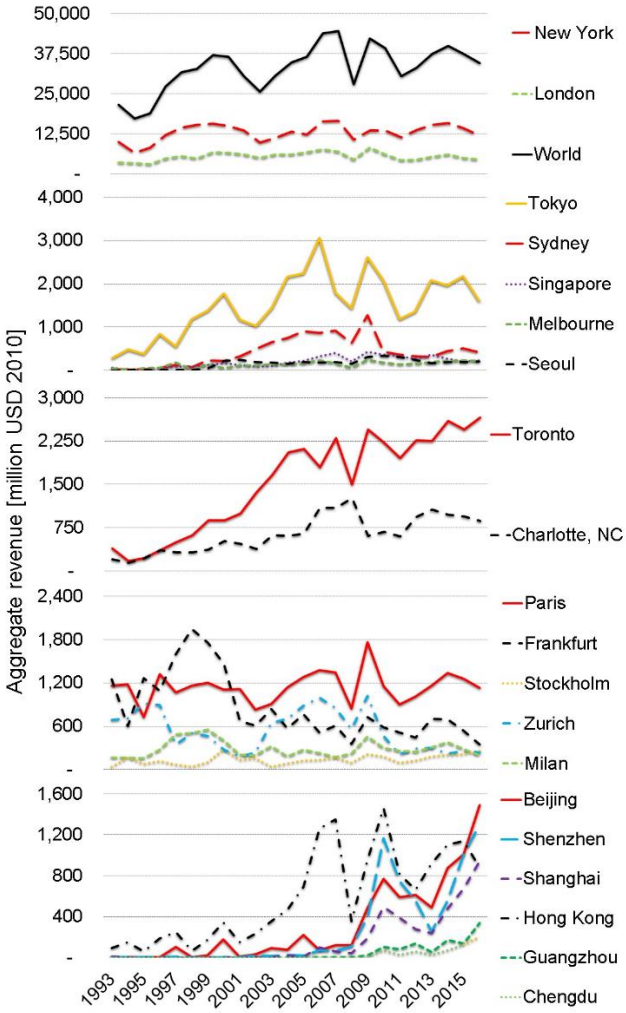


Figure 5.1. Evolution of FC revenue, 1993 – 2016.

Notes: This figure shows the annual revenue of the top 20 FCs (as of 2016) from 1993 to 2016 in inflation adjusted 2010 USD million.

Source: Author's calculations based on Dealogic data.

5.5.1. Main results

We now proceed to interpreting our main results presented in table 5.2. To aid the quantification of the effect of demand shocks on FC revenue, we also include table 5.1., which presents the estimated impact of a negative 10% demand shock on FC revenue and its variation across the distribution of variables that moderate the impact of demand shocks. For each interacting variable in table 5.1. we present the value of this partial derivative for its sample minimum, 25th percentile, mean, 75th percentile and maximum. Additionally, we also include a ratio of this partial derivative at sample minimum and maximum of each interacting variable to quantify the magnitude of variation in this effect across its distribution.

Table 5.1. Determinants of financial centre resilience.

		max	75th pctl	mean	25th pctl	min	min/max ratio
City degree centrality	ST	-2.45%	-3.29%	-3.90%	-4.68%	-4.93%	2.01
	LT	-4.49%	-6.01%	-7.11%	-8.50%	-8.94%	
Client nationality HF index	ST	-3.05%	-3.09%	-3.90%	-4.52%	-6.57%	2.15
	LT	-5.58%	-5.65%	-7.11%	-8.21%	-11.82%	
Client industry HF index	ST	-2.38%	-3.72%	-3.90%	-4.26%	-4.55%	1.91
	LT	-4.36%	-6.77%	-7.11%	-7.75%	-8.27%	
Bank HF index	ST	-3.24%	-3.47%	-3.90%	-4.37%	-4.29%	1.33
	LT	-5.91%	-6.33%	-7.11%	-7.95%	-7.81%	

Notes: ST - short term effect, LT - long term effect; min/max ratio - the ratio of % decrease in FC revenue as a result of 10% demand shock evaluated at the sample minimum and maximum of each interacting variable, while holding the remainder to the interacting variables at their sample mean.

Source: Results of authors' analysis based on table 5.2.

H.5.1. We uncover a positive relationship between changes in the level of demand and FC revenue, statistically significant at 1% level. We estimate that for a FC with minimum values of all interacting variables, in other words one with fully diversified client base, revenue dispersed among a large number of banks and no external network connections, a 10% decrease in demand would lead to a 9.6% short term and a 17.0% long term reduction in revenue. These effects vary

considerably along the distribution of the interacting variables and shrink to a 3.9% (0.7%) short term and a 7.1% (1.2%) long term reduction in aggregate revenue, when all interacting variables are set to their mean (maximum) values. To build a better understanding of the magnitude of the effect of each interacting variable, we evaluate the partial derivative of FC revenue in respect to MDP, while holding all but one interacting variables at their sample mean and varying the remaining variable.

H.5.2. FCs with a higher number of external network connections to other FCs are more resilient to demand shocks. We estimate that while a FC without any external network connections is expected to lose 4.9% of its revenue in the short term and 8.9% in the long term due to 10% reduction in market demand, these losses are reduced to an estimated 2.5% in the short term and 4.5% in the long term for a FC with the sample maximum number of external network connections.

H.5.3. We do not find any statistically significant interaction between MDP and intra-cluster network density, indicating that such localized network connections do not appear to affect resilience in the same way as external network connections of FCs. We can therefore reject this hypothesis.

H.5.4. Similarly, the city network assortativity is not found to be significantly linked to FC resilience. This corroborates the unique role of external network connections that span the boundaries of FCs in respect to cluster resilience.

H.5.5. Our results are consistent with the hypothesis that diversified specialisation enhances resistance to demand shocks. We estimate that while FCs with fully diversified revenue in respect to client nationality are expected to lose on average 6.6% of revenue in the short term and 11.8% in the long term as a result of 10% decline in demand, these figures drop to 3.1% in the short term and 5.6% in the long term for FCs specialising in a small portfolio of geographical areas. Similarly, FCs specialising in portfolios of industries are typically more resilient to

demand shocks than those fully diversified. Our estimates indicate that FCs with revenue fully diversified by industry lose an estimated 4.6% of revenue in the short term and 8.3% in the long term as a result of 10% decline in demand, while those specialising in a small portfolio of industries lose only estimated 2.4% in the short term and 4.4% in the long term.

H.5.6. The presence of large financial services firms is linked to higher resistance of FCs to demand shocks. FCs with a skewed firm size distribution and high concentration of revenue at firm level fare better in the face of demand shocks. They are estimated to lose an estimated 2.4% of revenue in the short term and 4.4% in the long term due to 10% decrease in demand, while FCs with fully dispersed revenue at firm level are estimated to lose 4.6% in the short term and 8.3% in the long term.

H.5.7. Finally, our results do not provide any support for the hypothesis that the quality of institutions, specifically the rule of law and the cost of contract enforcement, leads to higher resistance of FCs to demand shocks. We therefore reject this hypothesis.

Table 5.2. Main results

	Dependent variable: natural logarithm of net revenue																							
	Model 1			Model 2			Model 2			Model 3			Model 4			Model 5			Model 6			Model 7			Model 8		
	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat
[1] lag(Net revenue)	0.461	***	7.54	0.453	***	7.72	0.452	***	7.43	0.474	***	7.39	0.461	***	7.39	0.480	***	8.13	0.515	***	8.10	0.496	***	8.38	0.462	***	7.63
[2] Market demand proxy (MDP)	0.957	***	7.88	0.902	***	7.84	0.929	***	8.11	0.947	***	7.90	0.922	***	7.80	0.957	***	7.85	0.772	***	7.38	0.764	***	7.47	0.906	***	7.74
[3] FABS employment (city)	0.133	**	2.06	0.102	*	1.84	0.138	**	2.39	0.126	**	2.02	0.119	*	1.90	0.112	*	1.93	0.117	*	1.90	0.093		1.57	0.112	*	1.65
[4] City degree centrality	0.609	**	2.43	0.516	**	2.26	0.570	**	2.36	0.722	***	2.73	0.631	**	2.48	0.588	**	2.43	0.445	**	2.03	0.473	**	2.06	0.575	**	2.34
City degree centrality * MDP	-0.036	**	-2.51	-0.030	**	-2.31	-0.034	**	-2.48	-0.041	***	-2.78	-0.036	**	-2.52	-0.034	**	-2.51	-0.026	**	-2.15	-0.027	**	-2.11	-0.033	**	-2.41
[5] City network density	0.687	***	2.79	0.575	**	2.55	0.538	**	2.41	0.635	**	2.15	0.763	***	2.74	0.690	***	2.91	0.763	**	2.44	0.713	**	2.48	0.483	**	2.09
[6] Client nationality HF index	10.036	***	3.29	8.334	***	2.98	9.127	***	3.15	9.885	***	3.20	8.250	***	2.73	9.805	***	3.11	7.096	**	2.49	6.849	**	2.52	8.069	***	2.71
Client nationality HF index * MDP	-0.556	***	-3.38	-0.461	***	-3.07	-0.507	***	-3.25	-0.549	***	-3.30	-0.460	***	-2.83	-0.542	***	-3.21	-0.395	***	-2.62	-0.379	***	-2.62	-0.448	***	-2.81
[7] Client industry HF index	5.643	**	1.97	5.350	**	2.03	5.023	*	1.86	5.093		1.51	7.240	**	2.34	6.849	**	2.39	4.947	**	2.06	3.626		1.32	5.289	*	1.89
Client industry HF index * MDP	-0.339	**	-2.06	-0.321	**	-2.12	-0.304	**	-1.96	-0.306		-1.58	-0.431	**	-2.43	-0.407	**	-2.47	-0.296	**	-2.15	-0.218		-1.38	-0.319	**	-2.00
[8] Bank HF index	6.271	***	2.71	5.851	***	2.76	6.179	***	2.76	6.226	***	2.82	6.337	***	2.86	5.286	**	2.26	4.028	*	1.84	4.095	*	1.93	7.063	***	3.19
Bank HF index * MDP	-0.298	**	-2.31	-0.274	**	-2.32	-0.297	**	-2.34	-0.292	**	-2.37	-0.297	**	-2.43	-0.245	*	-1.87	-0.177		-1.44	-0.169		-1.45	-0.341	***	-2.77
[9] Bank entry	0.261	***	5.85	0.253	***	6.18	0.237	***	5.83	0.276	***	5.78	0.272	***	5.60	0.255	***	6.30	0.234	***	5.20	0.292	***	6.18	0.266	***	6.18
[10] Bank exit	-0.100	**	-2.48	-0.090	**	-2.39	-0.099	**	-2.57	-0.088	*	-1.94	-0.083	*	-1.93	-0.111	***	-2.80	-0.093	**	-2.03	-0.092	**	-2.05	-0.106	***	-2.63
[11] City industrial structure HF index	2.436	**	2.11	1.848	*	1.76	2.418	**	2.25	3.781	***	2.62	3.803	**	2.58	2.349	**	2.18	1.703		1.39	2.160	*	1.70	2.772	**	2.39
[12] FABS productivity				-0.057		-0.97																					
[13] FABS specialisation							0.035		0.26																		
[14] Rule of law										-0.215		-0.61															
[15] Cost of enforcement of contracts													0.063		0.59												
[16] Market cap. domestic comps (% GDP)																-0.028		-0.55									
[17] Average PISA score																			-0.028		-0.06						
[18] % of population with higher education																						-0.091		-1.01			
[19] City network assortativity																									0.113		0.30
Sargan test [p-value]	1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00			1.00		
Autocorrelation test (2) [p-value]	0.68			0.65			0.69			0.67			0.64			0.61			0.93			0.87			0.71		
GMM instrumented variables (lags used)	[1-11] second lags			.-11, 12] second lag			-11, 13] second lag			-11, 14] second lag			-11, 15] second lag			-11, 16] second lag			-11, 17] second lag			-11, 18] second lag			-11, 19] second lag		
Number of observations	2115			2115			2115			2115			2115			2009			1835			1863			2093		

Notes: *** significant at 1% level, ** 5% level, * 10% level. All variables are transformed to a natural logarithm. All models are estimated using a System GMM estimator. All models include time period fixed effects. Market demand proxy has been calculated using market shares by segment averaged across t-1, t-2 and t-3. To estimate these models we use data on 145 metropolitan areas for 1997-2016. Number of observations is reported as a sum of observations for equations in levels and first differences.

Source: Authors' analysis.

5.5.2. Robustness checks

We start by comparing our main results (table 5.2. – model 1) to those obtained by adding additional control variables – table 5.2. - models 2 - 7). Our main results related to the partial derivatives of the MDP variable display only very small variation in the estimated coefficients and are qualitatively consistent throughout the estimated models. We note that albeit the coefficient estimates on client industry HF index and its interaction term with MDP become marginally insignificant in two out of seven models in table 5.2., this is likely to be due the effect of adding insignificant variables to the model and consequently increasing the variance of the error term.

Appendix A.5.3. shows our robustness tests related to the use of different samples of MSAs, time periods and omitting variables sourced from the Oxford Economics Global Cities 2030 from our model, as they are only available for a subset of MSAs. Model 1 (A.5.3.) shows our main results and is included for reference purposes. Model 2 (A.5.3.) is estimated using the same sample, however it shows the effect of excluding FABS employment (city) and city industrial structure variety on our results. As a consequence, the coefficient estimate on client industry HF index in model 2 (A.5.3.) is imprecisely estimated, although the interaction term with MDP remains statistically significant. Model 3 and 4 (A.5.3.) are based on extended datasets, which we obtain by lifting the sampling restriction of only including MSAs covered by Oxford Economics and extending our sample period to 1993 – 2016. Model 3 (A.5.3.) confirms our main results, although model 4 (A.5.3.) shows marginally insignificant estimates on the client industry HF index and its interaction term.

Finally, we consider the effect of using different specifications of the MDP on our results. Appendix A.5.4. presents results of this exercise. Our results display only very small variation in the estimated coefficients and all signs and statistical

significance of estimated coefficients are consistent regardless of whether two, three, four of five-year averaged market shares are used. We note that using market shares of FCs by segment for previous year leads to a lower precision of our coefficient estimates, particularly those on the MDP and its interaction terms with city degree centrality and client nationality HF index, the former being in fact statistically insignificant in this instance. Our understanding is that if the market is divided into many segments, market shares by segment obtained from any single year offer a relatively noisy measure of exposure of FCs to these segments. Averaging such market shares by segment over several preceding years can help to eliminate some of this noise and lead to more accurate coefficient estimates.

5.6. Conclusions

Taking the conceptual work on adaptive resilience in EEG (Boschma, 2015; Martin and Sunley, 2011) as our point of departure and complementing it with nuanced understanding of the mechanics of capital markets and financial intermediation (Arjaliès et al., 2017; Clark et al., 2017; Ljungqvist et al., 2009), we have considered the impact of demand shocks on FC revenue. Our results indicate that although on average demand shocks have a highly predictable, effectively proportional, impact on FC revenue, there is a considerable variation in the sensitivity to demand shocks across FCs. We identify the structure of client base, external network connections and concentration of revenue at bank level to have a statistically and economically significant impact on FC resilience. On the contrary, our empirical evidence does not support the link between the quality of institutions, intra-cluster network structural properties and resistance of FCs to demand shocks.

Contrary to intuition, it is in fact the ‘diversified specialization’ model that makes FCs more resilient to demand shocks, rather than complete diversification of revenue along the nationality and industry of clients. To fully appreciate the benefits of diversified specialization and firm size distribution skewed towards the

very large investment banks, one needs to look closer at the way contemporary investment banking is organized. Underwriting syndicates are presently the dominant form of service delivery on a value weighted basis (Pažitka et al., 2018ab) and banks with dominant market shares within individual market segments and central positioning within syndication networks tend to exercise a considerable power over the way underwriting syndicates are structured, who gets to participate and on what terms (Pichler and Wilhelm, 2001; Pollock et al., 2004). This consequently gives them a great deal of flexibility to influence the deal flow within the syndication network and effectively regulate the amount of revenue they receive. This power is not absolute, but we find it plausible and consistent with our empirical evidence that FCs with such dominant position within syndication networks and individual market segments are more capable or resisting demand shocks and protecting their revenue than those that are fully diversified and with limited influence over the membership of underwriting syndicates.

Our results are subject to several limitations. First, although we are interested in FCs, we are unable to capture them in their full complexity and richness and must instead limit ourselves to the underwriting of equity and debt securities. Albeit narrowly focused, we believe that doing so is useful due to the quality and comprehensive nature of data available for these services. Second, our econometric models do not account for all possible factors that influence FC revenue and resilience. Third, although adaptive resilience has been conceptualized within the EEG as consisting of multiple dimensions, including resistance, recovery, re-orientation and renewal (Martin, 2012), our research design is focused only on the first of these dimensions. Finally, as we discuss in the introduction, the process of FC development runs over very long periods of time and is conditioned on previous economic and political development of

countries that host them (Spufford, 2006). Unfortunately, our data covers only the 1993 – 2016 period and is further restricted for our main results.

We hope that future research can expand on our work and overcome some of its limitations. It would be particularly important to take a more comprehensive view of the financial services industry and consider how different types of financial and business services firms interact with each other and how these interactions contribute to the development and resilience of FCs.

Appendix

Appendix A.5.1. Variable definitions and data sources

Variable name	Definition	Data source
[1] Net revenue	Net revenue [USD] earned from equity and debt securities underwriting aggregated at the level of metropolitan area. It equals to gross revenue net of expenses including costs of road show, prospectus, execution and legal costs.	Dealogic
[2] Market demand proxy	Market demand proxy is calculated by multiplying historical market shares per segment by the current (t) size of market segments and summed for each FC. Market segments are based on client industry, nationality, transaciton size and service category (ECM/DCM) and yield 4675 such categories.	Dealogic
[3] FABS employment (city)	Employment in financial and business services aggregated at the level of metropolitan areas.	Oxford Economics Global Cities 2030 database
[4] City degree centrality	Group degree centrality (Everett and Borgatti, 1999); location in the same MSA is used as a criterion for group membership.	Dealogic
[5] City network density	Number of realized / number of maximum potential number of ties in intra-city syndication networks.	Dealogic
[6] Client nationality HF index	Herfindal index (Rhoades, 1993) calculated based on shares of fees by client nationality; calculated separately for each FC. Proxy for diversity of client base of each FC in respect to client nationality.	Dealogic
[7] Client industry HF index	Herfindal index (Rhoades, 1993) calculated based on shares of fees by client general industry group (Dealogic GIG classification); calculated separately for each FC. Proxy for diversity of client base of each FC in respect to client industry.	Dealogic
[8] Bank HF index	Herfindal index (Rhoades, 1993) calculated based on shares of fees earned by underwriters of securities (Dealogic - bank subsidiary); calculated separately for each FC. Proxy for diversity of client base of each FC in respect to concentration of revenue at bank subsidiary level.	Dealogic
[9] Bank entry	Number of bank subsidiaries that were involved in ECM / DCM deals in a particular FC, which have not been active in the preceding time period.	Dealogic
[10] Bank exit	Number of bank subsidiaries that were involved in ECM / DCM deals in a particular FC, which have been active in the preceding time period, but not in the current time period.	Dealogic
[11] City industrial structure HF index	Herfindal index (Rhoades, 1993) calculated based on shares of Gross Value Added (GVA) of board industry categories - consumer services, financial and business services, transport, public services, industry and agriculture; calculated separately for each FC.	Oxford Economics Global Cities 2030 database
[12] FABS productivity	Gross Value Added per employee in financial and business services; calculated at the level of a MSA.	Oxford Economics Global Cities 2030 database
[13] FABS specialisation	Gross Value Added (FABS) / Gross Value Added (All sectors)	Oxford Economics Global Cities 2030 database
[14] Rule of law	Percentile ranking by a rule of law index.	World Bank - World Governance Indicators database
[15] Cost of enforcement of contracts	Cost of enforcement of contracts as a percentage of claim.	World Bank - Doing Business database
[16] Market cap. domestic comps (% GDP)	Market capitalisation of domestic listed companies as a percentage of GDP.	World Bank - World Development Indicators database.
[17] Average PISA score	Average of PISA scores in mathematics, reading and science.	Euromonitor Passport
[18] % of population with higher education	Percentage of population above the age of 15 with higher education	Euromonitor Passport
[19] City network assortativity	Network assortativity coefficient calculated for intra-city netoworks of bank subsidiaries separately city by city. Ranges from -1 (completely disassortative) to +1 (completely assortative) and measures the propensity of banks to form network ties with either similarly central banks (assortative). Alternatively banks with high network centrality can prefer to form ties with those with low centrality (disassortive).	Dealogic

Source: Dealogic, The World Bank, Oxford Economics and Euromonitor Passport.

Appendix A.5.2. Descriptive statistics

Variable name	Time period	OE MSAs only	Missing data %	Min	Median	Mean	Max	SD
Net revenue [mil USD]	1993 - 2016	No	0.0%	3.81	44.74	341.75	17005.13	1434.52
Net revenue [mil USD]	2000 - 2016	No	0.0%	3.81	49.20	368.08	17005.13	1519.15
Net revenue [mil USD]	2000 - 2016	Yes	0.0%	3.83	54.34	395.19	17005.13	1574.58
Market demand proxy [mil USD]	1993 - 2016	No	0.0%	0.00	42.58	331.74	16140.51	1376.96
Market demand proxy [mil USD]	2000 - 2016	No	0.0%	0.00	46.87	353.77	16140.51	1438.90
Market demand proxy [mil USD]	2000 - 2016	Yes	0.0%	0.00	54.39	380.25	16140.51	1491.21
Market demand proxy [mil USD] (2 year avg.)	1993 - 2016	No	0.0%	0.00	40.95	324.07	15983.68	1367.31
Market demand proxy [mil USD] (2 year avg.)	2000 - 2016	No	0.0%	0.00	47.26	351.63	15983.68	1433.99
Market demand proxy [mil USD] (2 year avg.)	2000 - 2016	Yes	0.0%	0.00	52.76	378.06	15983.68	1486.12
Market demand proxy [mil USD] (3 year avg.)	1993 - 2016	No	0.0%	0.00	37.83	315.66	15936.43	1358.31
Market demand proxy [mil USD] (3 year avg.)	2000 - 2016	No	0.0%	0.00	44.93	349.64	15936.43	1432.10
Market demand proxy [mil USD] (3 year avg.)	2000 - 2016	Yes	0.0%	0.00	51.81	375.98	15936.43	1484.17
Market demand proxy [mil USD] (4 year avg.)	1993 - 2016	No	0.0%	0.00	34.79	304.41	15829.22	1340.68
Market demand proxy [mil USD] (4 year avg.)	2000 - 2016	No	0.0%	0.00	44.22	347.88	15829.22	1428.90
Market demand proxy [mil USD] (4 year avg.)	2000 - 2016	Yes	0.0%	0.00	50.92	374.10	15829.22	1480.88
Market demand proxy [mil USD] (5 year avg.)	1993 - 2016	No	0.0%	0.00	30.95	291.77	15664.20	1316.80
Market demand proxy [mil USD] (5 year avg.)	2000 - 2016	No	0.0%	0.00	43.75	345.99	15664.20	1426.12
Market demand proxy [mil USD] (5 year avg.)	2000 - 2016	Yes	0.0%	0.00	48.86	372.08	15664.20	1478.01
FABS employment (city) [thousands]	2000 - 2016	No	7.2%	13.41	329.39	496.55	3316.32	521.26
FABS employment (city) [thousands]	2000 - 2016	Yes	0.0%	13.41	329.39	496.55	3316.32	521.26
City degree centrality	1993 - 2016	No	0.0%	0.00	44.00	81.43	975.00	106.36
City degree centrality	2000 - 2016	No	0.0%	0.00	28.00	66.06	975.00	98.35
City degree centrality	2000 - 2016	Yes	0.0%	0.00	27.00	67.43	975.00	100.96
City network density	1993 - 2016	No	0.0%	0.00	0.11	0.17	1.00	0.20
City network density	2000 - 2016	No	0.0%	0.00	0.10	0.14	1.00	0.17
City network density	2000 - 2016	Yes	0.0%	0.00	0.10	0.14	1.00	0.17
Client nationality HF index	1993 - 2016	No	0.0%	0.06	0.86	0.72	1.00	0.30
Client nationality HF index	2000 - 2016	No	0.0%	0.06	0.87	0.74	1.00	0.28
Client nationality HF index	2000 - 2016	Yes	0.0%	0.06	0.86	0.74	1.00	0.28
Client industry HF index	1993 - 2016	No	0.0%	0.06	0.24	0.31	1.00	0.21
Client industry HF index	2000 - 2016	No	0.0%	0.06	0.23	0.30	1.00	0.21
Client industry HF index	2000 - 2016	Yes	0.0%	0.06	0.22	0.29	1.00	0.20
Bank HF index	1993 - 2016	No	0.0%	0.03	0.35	0.43	1.00	0.29
Bank HF index	2000 - 2016	No	0.0%	0.03	0.34	0.42	1.00	0.29
Bank HF index	2000 - 2016	Yes	0.0%	0.03	0.32	0.40	1.00	0.28
Bank entry	1993 - 2016	No	3.2%	0.00	3.00	6.63	85.00	11.65
Bank entry	2000 - 2016	No	0.0%	0.00	3.00	6.57	84.00	11.16
Bank entry	2000 - 2016	Yes	0.0%	0.00	3.00	6.91	84.00	11.47
Bank exit	1993 - 2016	No	3.2%	0.00	3.00	6.25	127.00	11.49
Bank exit	2000 - 2016	No	0.0%	0.00	3.00	6.28	81.00	10.93
Bank exit	2000 - 2016	Yes	0.0%	0.00	3.00	6.66	81.00	11.23
City industrial structure HF index	2000 - 2016	Yes	1.9%	0.18	0.24	0.24	0.53	0.03
FABS productivity [USD/employee]	2000 - 2016	Yes	1.9%	12640.47	124479.81	131271.33	440017.67	68038.05
FABS specialisation	2000 - 2016	Yes	1.9%	0.09	0.32	0.31	0.49	0.08
Rule of law	2000 - 2016	Yes	4.7%	2.39	90.91	78.04	100.00	23.37
Rule of law [1]	2000 - 2016	Yes	0.3%	2.80	90.70	78.38	100.00	22.96
Cost of enforcement of contracts	2000 - 2016	Yes	20.7%	7.70	18.40	22.43	135.30	14.94
Cost of enforcement of contracts [2]	2000 - 2016	Yes	2.1%	7.70	18.40	22.01	135.30	15.05
Market cap. domestic listed companies (% GDP)	2000 - 2016	Yes	6.1%	7.98	82.80	99.65	1254.47	101.45
Average PISA score	2000 - 2016	Yes	15.9%	326.40	494.83	488.85	555.90	37.86
% of population with higher education	2000 - 2016	Yes	14.5%	5.40	24.30	22.94	36.50	8.02
City network assortativity	2000 - 2016	Yes	1.9%	-1.00	-0.62	-0.61	0.55	0.21

Notes: OE MSAs only - metropolitan statistical areas coverd by Oxford Economics Global Cities 2030 database. [1] [2] Albeit data on percentile ranking by rule of law and cost of enforcement of contracts are available for nearly all countries analysed here, this data is not available for all time periods considered. We therefore substitute each missing data point by its preceding value or alternatively the next available value if the former is not available.

Source: Authors' calculations based on Dealogic, Oxford Economics Global Cities 2030, Euromonitor Passport and World Bank databases.

Appendix A.5.3. Robustness checks by time period and sample of MSAs

	Dependent variable: natural logarithm of net revenue											
	Model 1			Model 2			Model 3			Model 4		
	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat
[1] lag(Net revenue)	0.461	***	7.54	0.503	***	8.16	0.496	***	8.50	0.527	***	10.26
[2] Market demand proxy	0.957	***	7.88	0.970	***	8.08	0.983	***	8.54	0.790	***	7.11
[3] FABS employment (city)	0.133	**	2.06									
[4] City degree centrality	0.609	**	2.43	0.595	**	2.28	0.573	**	2.43	0.361	**	1.97
City degree centrality * Market demand proxy	-0.036	**	-2.51	-0.035	**	-2.36	-0.034	**	-2.51	-0.021	**	-2.02
[5] City network density	0.687	***	2.79	0.968	***	3.06	0.792	**	2.49	0.598	**	2.25
[6] Client nationality HF index	10.036	***	3.29	10.715	***	3.57	11.921	***	4.10	8.335	***	3.27
Client nationality HF index * Market demand proxy	-0.556	***	-3.38	-0.581	***	-3.60	-0.646	***	-4.09	-0.447	***	-3.23
[7] Client industry HF index	5.643	**	1.97	5.180		1.64	5.355	*	1.84	4.022		1.42
Client industry HF index * Market demand proxy	-0.339	**	-2.06	-0.315	*	-1.75	-0.325	*	-1.94	-0.243		-1.49
[8] Bank HF index	6.271	***	2.71	6.747	***	2.99	5.000	**	2.34	5.795	***	3.11
Bank HF index * Market demand proxy	-0.298	**	-2.31	-0.321	**	-2.56	-0.229	*	-1.94	-0.268	***	-2.59
[9] Bank entry	0.261	***	5.85	0.276	***	6.02	0.278	***	5.47	0.368	***	7.31
[10] Bank exit	-0.100	**	-2.48	-0.067		-1.61	-0.059		-1.43	-0.093	**	-2.13
[11] City industrial structure variety	2.436	**	2.11									
Sargan test [p-value]	1.00			1.00			1.00			1.00		
Autocorrelation test (2) [p-value]	0.68			0.53			0.41			0.99		
GMM instrumented variables (lags used)	[1-11] (second)			[1-2, 4-10] (second)			[1-2, 4-10] (second)			[1-2, 4-10] (second)		
Time period	1997 - 2016			1997 - 2016			1997 - 2016			1993 - 2016		
Oxford Economics MSAs only	Yes			Yes			No			No		
Number of observations	2115			2115			2235			2760		
Number of MSAs	145			145			163			178		

Notes: *** significant at 1% level, ** 5% level, * 10% level. All variables are transformed to a natural logarithm. All models are estimated using a System GMM estimator. All models include time period fixed effects. Market demand proxy has been calculated using market shares by segment averaged across t-1, t-2 and t-3. Number of observations is reported as a sum of observations for equations in levels and first differences.

Source: Authors' analysis.

Appendix A.5.4. Alternative specifications of the market demand proxy variable

	Dependent variable: natural logarithm of net revenue														
	Model 1			Model 2			Model 3			Model 4			Model 5		
	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat
[1] lag(Net revenue)	0.505	***	8.40	0.492	***	8.15	0.461	***	7.54	0.408	***	7.09	0.392	***	6.69
[2] Market demand proxy (MDP)	0.892	***	7.39	0.940	***	7.58	0.957	***	7.88	0.935	***	7.80	0.813	***	6.51
[3] FABS employment (city)	0.130	**	2.02	0.126	*	1.88	0.133	**	2.06	0.138	**	2.24	0.172	***	2.73
[4] City degree centrality	0.554	**	2.32	0.609	**	2.55	0.609	**	2.43	0.535	**	2.03	0.328		1.39
City degree centrality * MDP	-0.033	**	-2.48	-0.036	***	-2.67	-0.036	**	-2.51	-0.031	**	-2.05	-0.018		-1.34
[5] City network density	0.748	***	2.98	0.778	***	3.10	0.687	***	2.79	0.698	***	2.88	0.679	***	2.87
[6] Client nationality HF index	9.233	***	3.03	10.009	***	3.25	10.036	***	3.29	8.196	***	2.88	5.689	*	1.81
Client nationality HF index * MDP	-0.514	***	-3.15	-0.555	***	-3.36	-0.556	***	-3.38	-0.458	***	-2.99	-0.328	*	-1.92
[7] Client industry HF index	5.423	**	2.03	6.272	**	2.21	5.643	**	1.97	6.603	**	2.23	7.322	**	2.52
Client industry HF index * MDP	-0.332	**	-2.17	-0.377	**	-2.32	-0.339	**	-2.06	-0.393	**	-2.31	-0.434	***	-2.62
[8] Bank HF index	6.315	***	2.83	6.245	***	2.68	6.271	***	2.71	6.426	***	2.85	6.805	***	2.86
Bank HF index * MDP	-0.305	**	-2.43	-0.296	**	-2.27	-0.298	**	-2.31	-0.304	**	-2.45	-0.321	**	-2.43
[9] Bank entry	0.237	***	5.87	0.258	***	6.05	0.261	***	5.85	0.270	***	6.04	0.329	***	6.16
[10] Bank exit	-0.110	***	-2.80	-0.103	**	-2.54	-0.100	**	-2.48	-0.078	**	-2.00	-0.115	**	-2.51
[11] City industrial structure variety	2.666	**	2.18	2.350	**	1.99	2.436	**	2.11	2.695	**	2.46	3.908	***	3.32
Number of years used for averaging market shares by segment	5			4			3			2			1		
Sargan test [p-value]	1.00			1.00			1.00			1.00			1.00		
Autocorrelation test (2) [p-value]	0.70			0.76			0.68			0.48			0.40		
GMM instrumented variables (lags us	[1-11] (second)			[1-11] (second)			[1-11] (second)			[1-11] (second)			[1-11] (second)		
Number of observations	2115			2115			2115			2115			2115		

Notes: *** significant at 1% level, ** 5% level, * 10% level. All variables are transformed to natural logarithm. All models are estimated using a System GMM estimator. All models include time period fixed effects. Market demand proxy has been calculated using market shares by segment averaged across t-1, t-2 and t-3. To estimate these models we use data on 145 metropolitan areas for 1997-2016. Number of observations is reported as a sum of observations for equations in levels and first differences.

Source: Authors' analysis.

Chapter 6 | Cluster dynamics of financial centres in the United Kingdom: Do connected firms grow faster?

(Paper written with Dariusz Wójcik)

Abstract

This study investigates the connection between network connectivity and firm growth on a sample of 3,224 financial services firms located in the United Kingdom in the aftermath of the global financial crisis. Our findings, based on a spatial econometric model of long-term firm growth, indicate that firms, which span structural holes, engage in co-management appointments and have network connections to related companies in other financial centres grow faster. In contrast, such connections generate substantial negative indirect effects to proximate firms, leading to a divergence of growth rates between globally connected and locally embedded firms.

6.1. Introduction

The aftermath of the global financial crisis (GFC) has seen a sharp reduction in employment in financial services in the United Kingdom[31], shrinking bank balance sheets[32] and reduction in global investment banking revenue[33] (Wójcik and MacDonald-Korth, 2015; Wójcik et al., 2018b). Underneath the veil of this grim picture, however, there was a lot of variation in the effects of the GFC on individual financial centres (FCs) and even more so on individual firms. Firms in peripheral

[31] Wójcik and MacDonald-Korth (2015) show a decline of 8% (88,000 jobs) in UK financial services employment between 2008 and 2012 using ONS-BRES data.

[32] The average and median total assets growth rates of our sampled companies between 2007 and 2015 are both negative.

[33] Findings of Wójcik et al. (2018b) indicate that the global investment banking fees in 2015 were 60.52% of their 2007 value.

regions were affected the most, while those in the largest FCs were somewhat shielded (Marshall, 2013). Parr and Budd (2000) examine a highly unequal urban hierarchy of FCs in the UK and highlight substantial functional differences between different tiers of FCs. While London hosts most of the big banks and offers a wide range of complementary products (Clark, 2002), the remainder of FCs in the UK, with Edinburgh in the lead, offer only a fraction of the capabilities of London (Parr and Budd, 2000). Consequently, different FCs and firms performed very differently in the post-GFC period. The implications of these processes are far reaching and extend beyond the financial sector due to the interconnectedness between financial services and the real economy (Hall, 2013; Coe et al., 2014; Wójcik, 2018).

The financial geography literature offers several contributions assessing the effect of GFC on financial services (Marshall, 2013; Wójcik and MacDonald-Korth, 2015), however a substantial gap remains regarding the variation in growth performance of firms. Coe et al. (2014) and Wójcik (2018) developed the global financial networks (GFNs) framework, which puts networks formed by the activities of financial and business services (FABS) firms at its heart, but this literature is yet to produce empirical studies of GFNs. Pandit et al. (2001) study the effect of clustering on firm growth, however their study predates the GFC and they do not consider the role of network connections. A substantial literature focusing on firm growth exists in economics (Evans, 1987; Macpherson and Holt, 2007), however it does not consider potential interactions among co-located firms or the role of networks. Complementing this work with the research on financial networks (Pichler and Wilhelm, 2001; Pollock et al., 2004; Clark and Monk, 2017; Arjaliés et al. 2017; Wójcik, 2018) leads us to a research design that puts positioning of individual firms in financial networks at the forefront of explaining their long run growth performance and allows for spatial interactions among co-located firms.

The primary objective of this paper is to study the links between network centrality of financial services firms within syndication networks[34], their long-term growth rate and the associated indirect effects on other financial services firms in their proximity. Due to the relationship oriented nature of investment banking, the primary sub-sector of financial services considered here, financial services firms rely on their network capital to access valuable business opportunities, to develop relationships with new clients and to remain competitive. Consequently, it is likely that positioning within syndication networks has important consequences for future prospects and long-term growth of financial services firms. To explore this proposition, we focus on the following two research questions – (1) Do financial services firms with more central positioning within syndication networks grow faster? (2) How are financial services firms located within the proximity of well-connected firms affected?

We use a sample of 3,224 financial services firms sourced from the Bureau van Dijk FAME database and estimate a series of spatial econometric models of their average annual growth rates in the 2007 – 2015 period. We construct several specifications of network centrality variables, including degree centrality, betweenness centrality and network constraint. We use data on syndicated capital market deals[35] supplied by Dealogic, to operationalise our measures of network centrality. Our results indicate that firms with higher levels of network centrality grow faster ceteris paribus. This effect holds for network centrality measures based on the number of network connections, brokerage as well as size of financial centres that they are connected to. Network centrality however leads to a divergence of growth rates between central and peripheral firms. This suggests

[34] Syndication networks are formed by co-membership of financial services firms in equity and debt securities underwriting syndicates, syndicated loans or M&As, where they jointly deliver a complex service to a single client.

[35] Equity capital market (ECM), debt capital market (DCM), syndicated loans (LOANS) and mergers and acquisitions (M&As).

that any benefits associated with networking of financial services firms primarily benefit the connected firms and in turn lead to increased competitive pressure and lower growth prospects for other proximate firms. We consequently interpret these connections as a source of competitive advantage for the connected firm. This implies that during a period of decline in financial services, firms lacking inter-cluster network connections are at a decisive disadvantage.

The remainder of this paper is organised as follows. The second section reviews relevant literature on the topic and develops four hypotheses. Section three details the research design and section four presents the results. Finally, section five concludes, discusses limitations of this study and offers recommendations for future research.

6.2. Literature and hypotheses

Literature on geographical clustering of economic activity and the conceptualizations of clusters can be traced at least as far back as the work of Marshall (1920) and the trinity of original propositions for clustering of firms - labour force pooling, proximity to buyers and suppliers and sharing of knowledge, still bears relevance. The seminal work of Krugman (1991) on increasing returns to scale and the associated positive externalities of clustering led to a rapid increase in research on clusters. Early contributions followed the work of Jacobs (1969), on the benefits of 'urbanisation economies', and Marshall–Arrow–Romer's on 'localization economies' (Marshall, 1920; Arrow, 1962; Romer, 1986).

The break of the century has seen a revival of this literature with the work of Porter (1990, 2000), Sassen (2001) and Swann and Preverez (1996). While Porter (2000) puts clusters at the centre-stage of understanding competition in modern knowledge-based economies, Swann and Preverez (1996) developed conceptual and methodological framework for studying the link between firm growth and cluster size, allowing for empirical tests of urbanisation and localisation economies.

Sassen (2001) proposed increasing specialisation in FABS firms' activities, availability of skilled labour force, ease of access for clients and ability to utilize locally embedded network resources to deliver projects beyond the capabilities of individual firms as sources of agglomeration economies and reasons for increasing centralisation of financial and business services (FABS) firms in urban areas.

The empirical work that follows can be divided into two themes – (1) studies of the effect of clustering on firm entry, growth and survival and (2) studies of the evolution of clusters (Frenken et al., 2015). Given the empirical focus of this study, we primarily focus on the first theme. Instead of the common practice of focusing on links between cluster size and firm level outcomes, we utilize spatial econometric methods that allow us to disentangle the direct[36] and indirect[37] effects of a variety of firm level variables. In doing so, we focus our attention on network centrality and limit the discussion of additional control variables to a minimum to save space.

The subject of firm growth has attracted a lot of research in economics, giving rise to competing theories linking learning, knowledge, and firm growth (Evans, 1987; Macpherson and Holt, 2007). These theories however treat firms in isolation and are focused on manufacturing establishments. Financial and economic geographers have contributed to these debates by studying the effects of clustering on firm growth (Pandit et al., 2001, Fingleton et al., 2004; Beaudry and Swann, 2009), while contributions from finance and business studies corroborate the link between firm growth and network connectivity (Shipilov, 2006; Ljungqvist et al., 2009).

Geographers studying FABS firms have long been interested in the problem of clustering of firms in urban areas (Cook et al., 2007; Shearmur and Doloreaux,

[36] Direct effects refer to the impact of explanatory variables on the focal firm.

[37] Indirect effects refer to the impact of explanatory variables on other, co-located firms.

2015) as well as the networks formed by FABS that connect cities (Taylor and Derudder, 2016; Wójcik, 2018). While the former studies are primarily interested in reasons for clustering and localised interactions, the latter focused on conceptualising and operationalising measures of network connectivity among cities.

Cook et al. (2007) present a survey-based evidence on factors affecting the location of financial services firms in London. Their findings corroborate the positive effect of MAR spillovers, while factors underlying Jacobs externalities are associated with both centripetal as well as centrifugal forces. Pandit et al. (2001) study the impact of clustering on firm growth in financial services. Their results indicate positive impact of localisation economies on firm growth as well as on entry of new establishments. Co-location with companies from other sectors does not seem to affect firm growth, however it appears to discourage new entrants. The latter point is consistent with the results of Cook et al. (2007) that list overcrowding of London as a powerful centrifugal force. Clark (2002, 2016) identifies spatial concentration of expertise, skills and talent required to deliver complex financial services and their complementarities as some of the key forces reinforcing the spatial concentration of financial services in the City of London and its ability to serve clients worldwide.

There are presently several complementary modelling approaches in geography that consider networks of FABS firms and MNEs in the context of cities and clusters. Taylor (2001) bases his interlocking world city network model (IWCNM) on office networks of FABS firms, Alderson and Beckfield (2004) consider ownership ties within MNEs and Pažitka et al. (2018a) use inter-organisational projects. The global financial networks (GFNs) framework developed by Coe et al. (2014) and Wójcik (2018) is broader in scope and

considers the ties between FCs, offshore jurisdiction and the rest of the world (i.e. clients) facilitated by FABS.

To understand the growth dynamics of financial services firms, we must look beyond the locational advantages provided by clustering and consider their relational ties within the industry. Capital markets are central to understanding relationality in the context of the four types of financial services considered here. The existence of capital markets is a necessary condition for the existence of financial intermediaries that facilitate their operation and in turn the services provided by financial intermediaries shape the structure and organisation of capital markets (Arjaliés et al., 2017; Clark and Monk, 2017).

Underwriting of equity and debt securities includes financial intermediation services provided by investment banks to their clients - issuers. In doing so, investment banks buy securities from the issuer, which they then sell to the first, oftentimes institutional investors. This stage in securities trading is typically referred to as a primary market. These securities are then traded among investors, a stage commonly referred to as a secondary market. Transactions involving purchases of either the entirety or a block of equity shares of a listed company are referred to as mergers and acquisitions (M&As). In these transactions financial services firms can act as advisors to acquirers and targets and represent the interests of each party's shareholders. Syndicated loans in turn possess traits of both commercial banking and investment banking and can be offered by both types of banks. Syndicated loans are originated by a mandated lead arranger, who underwrites the entire loan and then sells parts of the loan to other participants of the syndicate (Ioannotta, 2014). Financial services firms involved in these services therefore form network ties through the medium of market, either as collaborators working on the same side of a transaction or representing interests of opposing

parties, buyers and seller, in a transaction. We will now, in turn, discuss both vertical and horizontal dimensions of such networks formed by market interactions.

Investors and issuers, the two principal parties in capital markets, are typically connected by complex chains of financial intermediaries, thus leading to a vertically differentiated, but highly integrated structure of financial services (Arjaliés et al., 2017). These chains of financial intermediaries feature investment banks as the central intermediaries responsible for underwriting new issues of securities on the behalf of their clients – issuers and allocating them to asset managers, who in turn represent the interests of investors. Investment banks rely heavily on their reputational capital, which they develop over time by jointly satisfying the need of issuers to maximize proceeds raised from the issuance of new securities and that of asset managers, who compete on a risk adjusted rate of return and rely on favourable valuation of securities allocated to them by investment banks (Clark and Monk, 2017). To satisfy these seemingly competing objectives, investment banks have relied on their ability to reduce information asymmetries between investors and issuers by acting as reputable intermediaries, who put their reputation at stake and guarantee a fair valuation of the securities they underwrite (Dunbar, 2000).

In addition to the vertical dimension of networks of financial intermediaries described in the previous paragraph, it is commonplace for financial services firms to also form horizontal network connections with other firms with the same functional role. Given the focus of this paper, we illustrate this on an example of investment banks, although this phenomenon is not limited to this sector. To optimize their role as intermediaries between issuers and asset managers, investment banks form underwriting syndicates, which allow them to pool their expertise, financial resources and perhaps most importantly their reputational and network capital. Consequently, a group of investment banks collaborating on a

single issue of securities, an underwriting syndicate, can leverage its ties to a wider pool of institutional investors than any individual bank and deliver a superior service to the issuer by reducing the costs of offering and maximizing proceeds (Pichler and Wilhelm, 2001; Pollock et al., 2004).

Bajo et al. (2016) document that initial public offering (IPO) underwriters with central positioning within syndication networks can leverage their network to both disseminate information about new issues among institutional investors as well as to extract information relevant to the pricing of new issues. The inclusion of reputable co-managers and universal banks in underwriting syndicates is documented to lead to lower floatation costs and in turn higher net proceeds for issuers (Jeon and Ligon, 2011). Vithanage et al. (2016) corroborate this evidence by a study of multiple lead underwriting syndicates and show that by pooling their reputational capital, investment banks can reduce informational asymmetry between investors and issuers. This leads to lower IPO underpricing, lower variance of returns and superior long-run returns for investors. From the perspective of underwriting syndicate members, there are number of factors that motivate investment banks to participate. Dunbar (2000) links several of these factors to the variance in market share of investment banks in IPO underwriting and corroborates the notion that benefits that underwriting syndicates offer issuers as well as asset managers in turn lead to higher market shares of investment banks that convey them.

It is however not only the sheer number of network ties that investment banks form within syndication networks that seems to affect the benefits that they derive from their network centrality. Burt (2004) proposes that actors in social networks can serve as brokers by spanning structural holes and thus connecting otherwise disconnected actors within the network. Brokerage function is hypothesized to benefit such actors by giving them a privileged access to information and resources

flowing through the network and may also give them a form of network power over other actors, by intermediating their connections to others. In the context of investment banking syndication networks, brokerage is related to the ability of investment banks to access deal flow and gain places in underwriting syndicates. Consequently, banks with strategic positioning within syndication networks that span structural holes are shown to benefit from higher market shares in the future (Shipilov, 2006).

H.6.1. Firms with higher network centrality within syndication networks grow faster and they jointly benefit from both the number of ties to other firms and the brokerage opportunities provided by their position in syndication networks.

It is understood that just as the benefits of syndication reaped by clients depend on the characteristics of syndicate members, also the benefits that individual banks obtain from participating in underwriting syndicates vary across banks. Engaging in co-management appointments allows lesser connected investment banks to develop relationships with issuers and improve their chances of securing lead management appointments in the future (Ljungqvist et al., 2009). In contrast, only well established and reputable banks can reduce information asymmetry between issuers and investors and in turn allow them to benefit from lower flotation costs, reduced risk of offering and better long run investment performance (Jeon and Ligon, 2011; Bajo et al., 2016; Vithanage et al., 2016).

This in turn leads to increases in the market share of investment banks (Dunbar, 2000). Consequently, for an underwriting syndicate to deliver the benefits mentioned earlier, it needs to feature both reputable banks and underwriters with appropriate expertise. The former is necessary to reduce information asymmetry and reassure asset managers and investors that the offering is priced appropriately, while the latter is necessary to arrive at the appropriate valuation of the offering in the first place. Banks with an established reputation and pre-existing

ties with issuers are typically selected as lead-managers of securities offerings and earn majority of the revenue from such deals. It is however not feasible for every bank for have in-house equity research analysts covering every stock and this consequently creates opportunities for lesser established investment banks to join underwriting syndicates, particularly if their analysts cover the issuer's stock (Ljungqvist et al., 2009). In contrast to lead-managers, which typically serve pre-existing clients, co-managers are often able to establish new relationships with issuers, which may ultimately lead to more lucrative lead-management appointments in the future. Consequently, we would expect that engaging in co-management appointments is more likely to lead to the expansion of bank's clientele and future growth than lead-management appointment, which instead serve as means of maintaining relationships with existing clients.

H.6.2. – Firms benefit more from engaging in co-management appointments than in lead-management appointments in respect to their long-term growth prospects.

In parallel to the developments in the literature on financial networks and financial intermediation, which treats networks as a non-spatial phenomenon, there has been a distinction made in the literature on clusters between localised interactions among co-located firms and long-distance network connections that in turn connect related, but spatially distant clusters (Bathelt et al., 2004; Wolfe and Gertler, 2004). Clustering of financial services in the City of London is often cited as a prime example that underlines the relevance of both localised and long-distance interactions and owes its success to its ability to simultaneously concentrate key expertise and talent in space, allowing it to deliver a wide variety of cutting edge financial services (Clark, 2002, 2016), and to benefit from its connections within globally integrated financial networks that link it to both financial services firms in other financial centres as well as clients (Wójcik, 2013).

Provided it is in fact the access to deal flow that motivates banks to strategically form their networks by spanning structural holes in syndication networks as hypothesized by Shipilov (2006), it is plausible that inter-cluster network ties could convey benefits that intra-cluster ties do not. First, financial services firms located in different geographical areas are likely to have smaller overlap in the client base and consequently such network connections are more likely to lead to forming relationships with new clients (Wójcik et al., 2018b). Second, inter-cluster network ties are more likely to span structural holes and connect otherwise disconnected participants in these networks. Third, inter-cluster network ties open access to new market segments and allow financial services firms to benefit from the reputational capital and local expertise of their syndication partners. Finally, access to a wider pool of institutional investors is an established reason for the formation of underwriting syndicates. Provided there is a lesser overlap in the pools of institutional investors that investment banks located in different FCs are connected to, we would expect that forming inter-cluster network ties could lead a bigger pool of institutional investors involved in an offering. This in turn has implications for the valuation of the offering, first-day returns and stock price volatility (Vithanage et al., 2016).

H.6.3. – Inter-cluster network connections are more valuable in respect to firm's growth prospects than localised intra-cluster network connections.

Our final point relates to the indirect effect of network centrality on other financial services firms located in the proximity of the focal firm. This is an important consideration in the context of FCs, given that the interest here lies not only in the performance of individual firms, but also in the wider implications for other firms located in the same FC. Participation in underwriting syndicates is linked earlier in this section to a multitude of outcomes that make financial services firms more

attractive to their clients and give them a competitive advantage against other firms operating in the same markets (Bajo et al., 2016).

As financial services firms establish a more central positioning within syndication networks, they gain better access to deal flow through both the advantages they can offer to their potential clients and the benefits of their network capital they can provide to their future syndication partners (Shipilov, 2006; Ljungqvist et al., 2009). This therefore leads to a clear competitive advantage for better connected firms, who are then able to outcompete lesser connected firms for the same finite business opportunities. We expect this competition effect to be present primarily within FCs, given that although at least in principle financial services firms can serve clients all over the world, there is a substantial geographical bias towards geographical proximity in advisor – client ties (Wójcik et al., 2018b).

Financial services firms also tend to purposefully co-locate with their close competitors to monitor their activities and to offer the same degree of accessibility to their clients. This is identified as one of the centripetal forces that draws financial services firms into the leading FCs, such as London (Cook et al., 2007). As a direct result, financial services firms tend to compete more directly and for a more overlapping pool of clients with those located within the same FC, while financial services firms located in different geographical areas tend to have a lesser overlap in the segments of the market that they serve (Wójcik et al., 2018bc). We would therefore expect that an increase in network centrality of a focal firm would increase the competitive pressure on other proximate firms and reduce their growth prospects, ceteris paribus.

H.6.4. Firms with central positioning in syndication networks outcompete other proximate financial services firms and effectively grow at their expense, leading to a negative spatial spillover associated with network centrality.

6.3. Research design

The literature on spatial clustering of economic activity typically adopts a definition of clusters based on market and non-market connections among co-located firms, which rely on similar inputs, use similar technologies and knowledge, compete and co-operate, rather than simply being spatial concentrations of firms from the same industry (Porter, 1990, 2000). Consequently, standard industrial classifications are not ideal for defining clusters and can lead to serious omissions in sampling. We begin with selecting two industry categories – commercial banking[38] and investment banking and securities dealing[39], which are at the core of FCs and sample companies with total assets data available for at least one year in the period 2007 – 2009 from the Bureau van Dijk FAME database.

We restrict ourselves to those with primary trading address in England, Scotland or Wales. This yields 2,868 companies with the required data available. We then search the Dealogic databases[40] for all advisors that have served UK clients as underwriters of primary offerings of equity and debt securities, participants in syndicated loans or advisors in M&As. Given that nationalities of advisors are not available in Dealogic databases, we cross-reference the names of advisors from Dealogic with the FAME database to identify those headquartered in the UK. This results in an overlap of 1,184 companies. We combine these two groups, leading to a sample of 3,224 companies.

In terms of industrial structure, universal banks (39%) and investment banks (33%) dominate our sample. Other types of financial firms are also covered, including management consulting firms, based on their participation in advisory roles for the four types of services considered here. In terms of geographical

[38] North American Industry Classification System (NAICS) 2012 - 522110

[39] NAICS 2012 - 523110

[40] ECM, DCM, LOANS and M&As.

location, our sample is heavily weighted towards Inner London (47.5%) and Outer London (9.8%) NUTS2 regions. However, it also represents the rest of the UK, with 42.7% of sampled companies located outside of the capital city. Figure 6.1. details the geographical distribution of our sample.

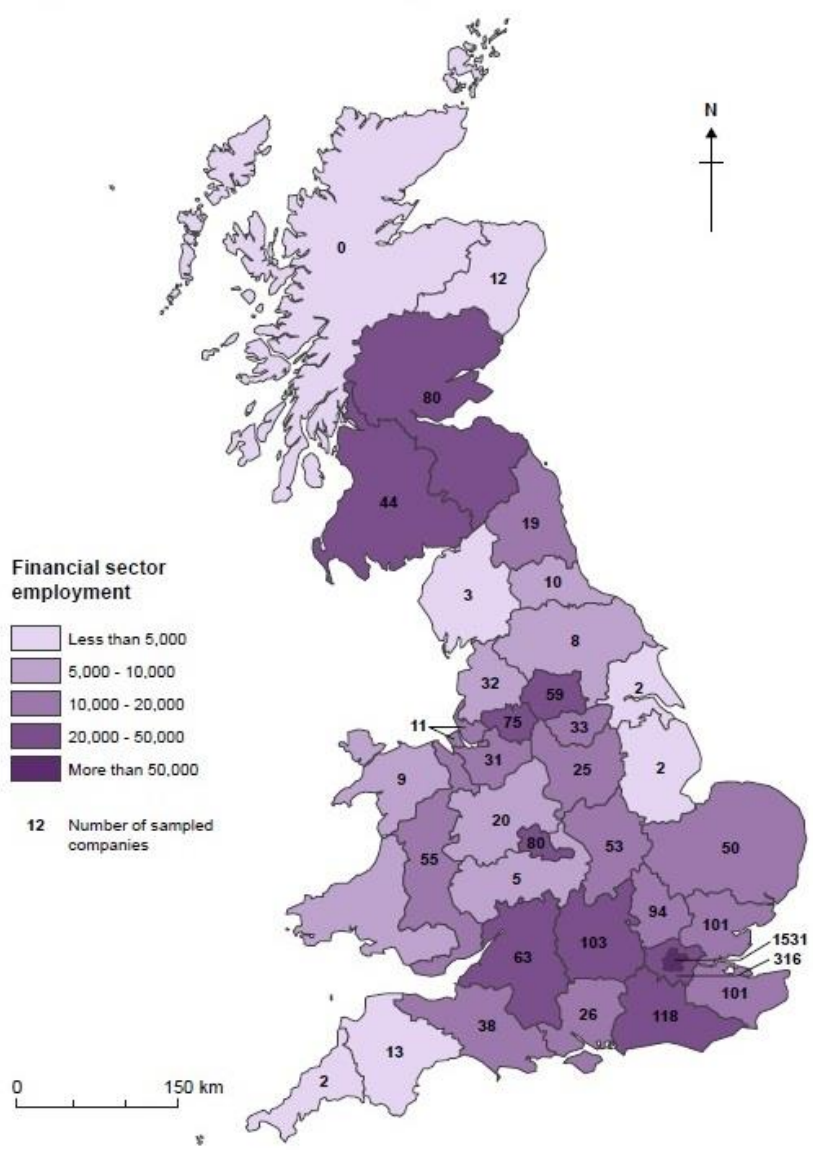


Figure 6.1. Geographical distribution of sampled companies.

Notes: Financial sector employment is the sum of full time employment in financial services activities except insurance and pension funding (SIC 2007 code 64) plus employment in activities auxiliary to financial services and insurance activities (SIC 2007 code 66). Employment data has been sourced from the Office for National Statistics -BRES and is measured as of 2007. Number of sampled companies is pooled across 2007–2009 and is based on availability of company total assets data from the FAME database. Regional boundaries are consistent with the NUTS 2 2010 classification.

Source: Authors' analysis based on ONS – BRES and FAME data.

We use a spatial econometric model with local spillovers, presented in the equations 6.1. – 6.3. below. Equation 6.1. is estimated by the spatial Durbin error model (SDEM) and equations 6.2. and 6.3. detail the structure of error term (Anselin, 2013):

$$y = X\beta_1 + WX\beta_2 + u \quad (6.1)$$

$$u = \lambda Wu + \varepsilon \quad (6.2)$$

$$\varepsilon \sim N(0, \sigma_\varepsilon^2 I_N) \quad (6.3)$$

Where y is the dependent variable, X is a vector of explanatory variables, β_1 is a vector of direct effects, W is a spatial weighting matrix, β_2 is a vector of indirect effects, u is a spatially correlated residual, ε is normally distributed residual with mean zero and constant variance, and λ is the spatial error autocorrelation coefficient. The β_1 coefficients can be interpreted as partial derivatives in the same way as in non-spatial models, while the β_2 coefficients are interpreted as cross-partial derivatives, meaning that they are the average spatial spillovers falling on each neighbour. This interpretation of β_2 coefficients relies on the use of binary symmetric adjacency matrix in the place of the spatial weighting matrix (W). As an alternative and more general specification we have also considered the Spatial Durbin Model (SDM), which includes a spatial lag of the dependent variable in addition to the functional form of the SDEM model, however our data does not support the hypothesis that the spatial autoregressive coefficient in this model would be statistically significantly different from zero, which lead us to the specifications outlined above (Vega and Elhorst, 2015).

While spatial econometric models of long-term growth are common in studies of regions or countries (Fingleton and López-Bazo, 2006), they are less common in micro-economic studies (Bell and Bockstael, 2000). Such applications present their unique set of challenges, given that the spatial weighting matrix (W) can no

longer be meaningfully based on contiguity and positions of actors are not fixed in space indefinitely. We consider several specifications of W based on varying great circle distances in the range 30-70 km to show that our results are reasonably robust to the size of neighbourhood specified. Our specification of W does not account for firms that move their head office among cities, however it is robust to relocations within metropolitan areas set by the great circle boundaries specified above. Given that FABS firms seldom move their headquarters from one city to another, we expect that this only has a marginal effect on our results. The dataset we obtained from FAME had a small number of missing observations on date of incorporation[41] and firm postcodes[42]. To preserve the sample size, we hand-collected the missing data from a variety of sources including corporate websites, Bloomberg and the Nexis UK.

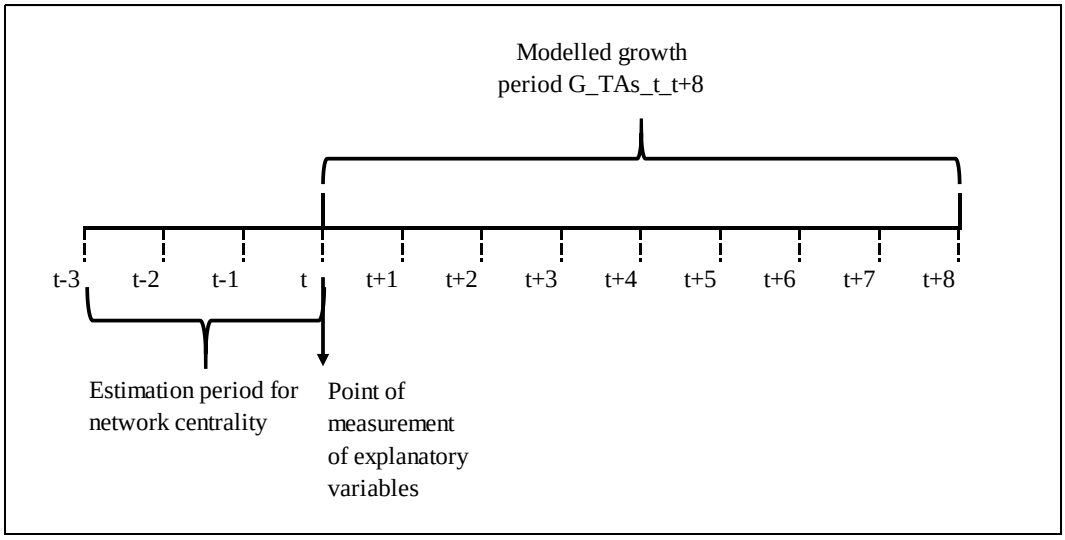


Figure 6.2. Measurement of variables in time.
Source: Derived from Evans (1987) and Hochberg et al. (2007).

Figure 6.2. provides a schematic illustration of the setup that we use for our econometric models. Our explanatory variables are measured at the beginning or

[41] We use incorporation dates to determine firm age.

[42] We use GPS coordinates of firm's postcode centroid obtained from Google maps to construct each firm's neighbourhood.

prior to the growth period modelled. The growth period represents an eight-year window, over which we calculate an average annual growth rate of total assets. We also use shorter six-year windows for robustness checks. The averaging of growth rates across multiple annual time periods is warranted, given that annual firm growth rates are generally too volatile to model. We therefore define our dependent variables as follows:

$$G_{t1,t2} = \frac{\ln(TA_{t2}) - \ln(TA_{t1})}{\text{t2} - \text{t1}} \qquad (6.4)$$

where $G_{t1,t2}$ is the growth rate of total assets averaged across a (t2-t1) period, $\ln(TA_t)$ - the natural logarithm of total assets at the beginning of the period, and $\ln(TA_{t2})$ - the natural logarithm of total assets at the end of the period.

The set of explanatory variables used in our models is detailed in table 6.1 and the descriptive statistics are in appendix A.6.1. To control for clustering of both related and unrelated activities, we construct two variables – natural logarithm of full-time employment in own sector and full-time employment in all other sectors at NUTS 2 level. Own sector in this context is defined as employment in financial services activities except insurance and pension funding[43] plus employment in activities auxiliary to financial services and insurance activities[44]. Employment data has been sourced from the Office for National Statistics – BRES database. In studies of firm growth, there is typically a sizeable fraction of the sampled companies for which growth rates are not available, because they have exited the sample during the studied period. If exits are not random and are correlated with explanatory variables in the growth equation, this may result in biased coefficient estimates. To address this problem, we use the Heckman's (1979) correction method for dealing with selection bias in the sampling process.

[43] SIC 2007 code 64

[44] SIC 2007 code 66

We rely on the concept of inter-organisational project to operationalise our measures of network centrality of financial services firms. Inter-organisational projects are defined simply as projects involving multiple financial services firms and a single client, as a form of service provision (Pažitka et al., 2018a). We do not consider all possible inter-organisational projects, but instead we focus on underwriting syndicates of equity and debt securities, syndicated loans and M&As with multiple advisors serving a single client, either acquiror or target.

To construct measures of network centrality of individual financial services firms, we use affiliation matrices, which include data on syndicated deals in these four categories and the respective syndicate members for each deal. Our affiliation matrices are populated with data for three years preceding the beginning of measurement period for our dependent variable. Two companies are considered connected through a syndication link, if they have been the service providers in the same deal, as recorded in the Dealogic databases.

To address the network boundary specification problem, we do not restrict our networks to the United Kingdom, but base our network centrality measures on a global network of 7,458 firms involved in the provision of these services. This sample was obtained by sampling the top 500 bookrunners (ECM, DCM), mandated lead arrangers (LOANS) and acquirer/target advisors (M&As) in each year between 2000 and 2015. On value weighted basis this sample represents in excess of 99% of transactions in these markets.

We consider multiple measures of network centrality including degree centrality, betweenness and Burt's (2004) network constraint (Jackson, 2010). We distinguish between intra-cluster and inter-cluster ties, by dividing our degree centrality measure into two separate viariables based on the relative positioning of financial services firms. Additionally, we also distinguish between network ties

formed by lead management appointments[45] and co-management appointments[46]. This leads to a directed network, where ties are directed from lead-managers to co-managers. We include these distinctions between long-distance and localised network connections and lead roles and co-management roles to allow for differences in the effect of different types of network ties, as proposed by Ljungqvist et al. (2009) in the context of lead/co-management appointments and Bathelt et al. (2004) in the context of localised vs long distance interactions. Bathelt et al. (2004) also propose that the value of long distance network ties is likely to be influenced by the size and importance of the cluster that they connect the focal firm to. To account for this, we also include a specification of inter-cluster ties weighted by the aggregate fees of the FC that these ties connect the focal firm to.

[45] ECM – bookrunner, DCM – bookrunner, LOANS – mandated lead arranger, M&As acquirer / target advisor.

[46] Non-lead managers, co-managers, underwriters.

Table 6.1. Definitions of variables and data sources.

Variable name	Definition	Data source
G_TA_t_t+j	Average annual growth rate in total assets for the stated time period, where j is either six or eight years. G = [ln(TA(t)) - ln(TA(t+j))] / j	Authors' calculations based on FAME data
Age	Firm age [years]	FAME
Total assets	Total assets [th GBP]	FAME
Survival probability	Probit estimate of survival probability conditional on age, total assets and their interaction term.	Estimates based on FAME data
Financial services employment (NUTS 2)	Full time employment in financial services at NUTS 2 regional level	BRES - ONS
Other employment (NUTS 2)	Full time employment in all industries other than financial services at NUTS 2 regional level	BRES - ONS
Degree centrality	The number of adjacent edges of each node. This is the number of firms that firm *a* is connected to through its underwriting syndication ties	Author's calculations based on Dealogic data
Betweenness centrality	Betweenness centrality of a node is defined by the number of shortest geodesic paths connecting other nodes that pass through this node.	Author's calculations based on Dealogic data
Network constraint	Measure of brokerage in networks based on the propensity of a node to span structural holes (Burt, 2004). It varies between 0 and 1 and it is higher for nodes with fewer and more redundant ties (higher density of ties among the nodes that it is connected to).	Author's calculations based on Dealogic data
Degree centrality (intra-cluster ties)	Only ties to other firms within the same metropolitan area are counted.	Author's calculations based on Dealogic data
Degree centrality (inter-cluster ties)	Only ties to other firms outside its own metropolitan area are counted.	Author's calculations based on Dealogic data
Degree centrality (inter-cluster ties - weighted by alter's FC size)	Sum of inter-cluster ties weighted by alter's financial centre size. Each financial centre is only counted once and the links are weighted by the aggregate fees earned from the four products (ECM, DCM, LOANS, M&As) considered here.	Author's calculations based on Dealogic data
Degree centrality (co-management ties)	Only ties from non-lead banks to lead banks are counted.	Author's calculations based on Dealogic data
Degree centrality (lead management ties)	Only ties from lead banks to non-lead banks are counted.	Author's calculations based on Dealogic data

Source: FAME, Dealogic, ONS-BRES

6.4. Results

6.4.1. Main results

H.6.1. – To begin with, we use three different specifications of network centrality to model its direct effect on long-term firm growth. We start with a simple degree centrality measure (table 6.2 – model [1]), which represents the number of network ties that a focal firm has with other financial services firms. The coefficient estimate on the degree centrality variable implies that for every 10% increase in the number of ties with other firms there is an estimated 0.24% increase in the annual growth rate.

We then use betweenness centrality in model [2] to account for brokerage opportunities offered by the focal firm's positioning in the syndication network. This measure of network centrality is based on the number of shortest paths between pairwise combinations of actors in a network that pass through the focal actor. It however does not account for the number of direct ties between the focal actor and other actors in the network. Our coefficient estimate on betweenness centrality implies a mere 0.12% increase in annual firm growth due to 10% increase in betweenness.

In the context of financial services and syndication networks it has been argued that both the brokerage opportunities and the sheer number of network ties are important (Shipilov, 2006). We therefore also employ Burt's (2004) network constraint measure, which effectively combines the previous two measures and varies with both the number of connections and their redundancy, or in other words brokerage opportunities. Our estimate in model [3] implies a 1.99% increase in firm growth per 10% decrease in network constraint[47]. We understand the much larger

[47] Burt's (2004) network constraint ranges between 0 and 1 and it goes towards zero as the number of ties of a focal actor increases and their redundancy decreases. This means that when it is close to zero, it is implied that an actor has many ties and connects many otherwise disconnected actors in the network.

estimated marginal effect of the network constraint variable in contrast to either degree centrality of betweenness as an evidence in favour of the joint significance of both the number of ties and the brokerage opportunities presented by them and a likely multiplicative relationship between the two types of centralities in respect to the benefits they offer.

We now move on to considering the contribution of different types of network ties to long-term firm growth. We first consider the distinction between ties formed through lead management and co-management appointments. This is then followed by the distinction between inter-cluster (long distance) and intra-cluster (localised) network ties. During this part of our analysis we use measures of network centrality derived from degree centrality, because network centralities that incorporate measures of brokerage (e.g. betweenness or network constraint) are not particularly suitable for the analysis for sub-networks and such results could therefore be misleading (Jackson, 2010).

H.6.2. – Building on the work of Ljungqvist et al. (2009) on co-management appointments, we make the distinction between network ties formed by co-management and lead management appointments. To do this, we construct syndication networks with ties directed from lead managers to co-managers. This allows us to make a distinction between network centrality acquired through the involvement in hierarchically different levels of appointments. Our results indicate that network ties formed through co-management appointments increase long-term firm growth by an estimated 0.59% per 10% increase in network centrality (table 2 – model [5]). In contrast, lead management appointments lead to an estimated 0.33% reduction in firm growth per 10% increase in network centrality. This finding is consistent with the results of Ljungqvist et al. (2009), which suggest that despite the lower fees and prestige associated with co-management appointments, they are a viable way of developing relationships with new clients

and increasing probability of obtaining more lucrative lead-management appointments with the same client in the future. In contrast, lead-management appointments are typically assigned to firms that already have a well-established relationship with the client and are therefore unlikely to lead to an expansion of one's client portfolio and enhanced growth prospects in the future.

In fact, provided that financial services firms have a limited capacity for the number of deals they can get involved in, lead and co-management appointments will be effectively traded off against each other. This would then likely result in higher future growth prospects of firms that invest their effort and sacrifice current revenue in favour of co-management appointments, while those that prefer lead management appointments benefit from increased revenue in present, but in turn do not expand their client portfolio and potentially suffer from reduced growth prospects in the future.

H.6.3. – We now consider the distinction between intra-cluster (localised) and inter-cluster (long distance) network ties. Our results in table 6.2 model [4] indicate that the value of network connectivity in respect to firm growth is primarily due to inter-cluster network ties, which are estimated to increase firm growth by 0.28% per 10% increase in their frequency. This value is very close to the 0.24% estimated for degree centrality, which counts both inter-cluster and intra-cluster ties. Combined with the insignificant coefficient estimate on intra-cluster ties, this evidence suggests that localised ties carry little value for firm growth, while inter-cluster ties are the drivers of firm growth. We also consider a different specification of this variable and use weights based on the size of FC that inter-cluster ties connect the focal firm to. The coefficient estimate on this specification of the inter-cluster ties implies a 0.51% increase in firm growth for every 10% increase in inter-cluster network ties (table 6.2 – model [5]).

H.6.4. - To test this hypothesis, we shift our attention to the indirect effects of network centrality on firm growth. This means that instead of focusing on the focal firm's growth, we consider the effect of changes in the network centrality of the focal firm on the growth rate of other co-located firms. The point estimates presented in table 6.2. – model [3] suggest that there is an estimated 0.25% decrease in the average annual growth rate of each firm within the proximity of a connected firm for a 10% decrease in its network constraint. As we discussed earlier, a decrease in network constraint means that the focal firm either increased its number of network connections or the brokerage opportunities in its network have improved. It is important to keep in mind that this is not the cumulative effect across all neighbours as customarily presented in studies using row-standardised W, but the average effect on each neighbouring firm. Therefore, particularly in big financial centres with many well-connected firms and even more small and lesser connected firms, such as London, the resulting competitive pressures could become a substantial impediment to the growth of lesser connected and locally embedded firms. This might explain the relatively higher exit rates of small and young financial services firms evident from our probit estimates presented in table 6.2.

Table 6.2. Main results.

Main equation	[1]			[2]			[3]			[4]			[5]			[6]		
	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat
Direct effects																		
Age	0.274	***	3.18	0.285	***	3.29	0.261	***	3.02	0.274	***	3.18	0.257	***	2.97	0.273	***	3.15
Age ^ 2	-0.033	**	-2.43	-0.035	**	-2.55	-0.031	**	-2.27	-0.033	**	-2.44	-0.030	**	-2.22	-0.032	**	-2.33
Total assets	-0.041	***	-6.28	-0.043	***	-6.63	-0.043	***	-6.69	-0.040	***	-6.18	-0.044	***	-6.98	-0.041	***	-6.26
Total assets ^ 2	0.001	**	2.50	0.001	***	2.99	0.001	***	2.93	0.001	**	2.42	0.001	***	3.32	0.001	***	2.99
Degree centrality	0.025	***	4.86															
Betweenness centrality				0.013	***	4.41												
Network constraint							-0.187	***	-4.99									
Degree centrality (intra-cluster ties)										0.000		-0.02						
Degree centrality (inter-cluster ties)										0.030	***	3.19						
Degree centrality (inter-cluster - weighted by alter's FC size)													0.053	***	4.68			
Degree centrality (co-management ties)																0.062	***	4.22
Degree centrality (lead management ties)																-0.034	**	-2.33
Survival probability	-0.201	**	-2.11	-0.209	**	-2.19	-0.186	*	-1.95	-0.201	**	-2.11	-0.183	*	-1.91	-0.199	**	-2.08
FABS employment	0.039	**	2.00	0.042	**	2.13	0.039	*	1.95	0.041	**	2.03	0.043	**	2.18	0.041	**	2.06
Other employment	-0.047		-0.99	-0.054		-1.13	-0.047		-0.99	-0.049		-1.04	-0.059		-1.24	-0.046		-0.96
Age * Total assets	-0.001		-0.44	-0.001		-0.40	-0.001		-0.46	-0.001		-0.38	-0.001		-0.48	-0.002		-0.72
Indirect effects																		
Age	-0.005		-0.20	-0.011		-0.39	-0.004		-0.16	-0.008		-0.28	-0.004		-0.15	-0.007		-0.27
Age ^ 2	0.001		0.16	0.001		0.27	0.001		0.16	0.001		0.21	0.000		0.09	0.001		0.34
Total assets	0.000		-0.12	0.000		-0.05	0.000		0.27	0.000		-0.25	0.001		0.55	-0.001		-0.35
Total assets ^ 2	0.000		0.28	0.000		-0.26	0.000		-0.22	0.000		0.21	0.000		-0.65	0.000		0.90
Degree centrality	-0.004	***	-2.60															
Betweenness centrality				-0.002	**	-2.14												
Network constraint							0.024	**	2.09									
Degree centrality (intra-cluster ties)										-0.001		-0.26						
Degree centrality (inter-cluster ties)										-0.005	*	-1.70						
Degree centrality (inter-cluster - weighted by alter's FC size)													-0.007	**	-2.24			
Degree centrality (co-management ties)																-0.014	***	-2.72
Degree centrality (lead management ties)																0.000		0.00
Survival probability	-0.010		-0.38	-0.004		-0.16	-0.012		-0.47	-0.008		-0.29	-0.010		-0.39	-0.007		-0.29
FABS employment	0.000		0.11	0.000		-0.07	0.000		0.13	0.000		0.09	-0.001		-0.65	0.000		-0.10
Other employment	-0.002		-0.83	-0.002		-0.74	-0.002		-0.81	-0.002		-0.82	0.000		-0.12	-0.002		-0.89
Age * Total assets	0.000		0.58	0.001		0.88	0.000		0.50	0.000		0.71	0.000		0.72	0.000		0.17
Adjusted R-squared	0.192			0.185			0.189			0.186			0.189			0.192		
Survival equation																		
Age	2.674	***	19.69															
Total assets	0.195	***	9.33															
Age * Total assets	-0.107	***	-7.73															

Notes: *** significant at 1% level, ** 5% level, * 10% level; Dependent variable for all main equations is an average annual growth rate of total assets for the period 2007 - 2015 (G_TA_2007_2015). All variables apart from survival probability are transformed by taking a natural logaritm and 1 is added to the value of variables including zeros, to avoid undefined values. All main equations are estimated by the spatial Durbin error model. Survival equations are estimated by probit and are identical across all models reported in this table and we therefore only report its coefficient estimates once to avoid repetition. Survival equations are estimated on the full sample (N = 2,830) and main equations are estimated on the sample of survivors - those firms that have data on total assets available for both the beginning and the end of the period modelled (N = 1,246).

Source: Authors' analysis.

6.4.2. Robustness checks

In order to verify the robustness of our results, we rerun our analysis for three additional time periods in addition to the main sample period used for our main results (2007-2015) and verify the stability of our results to the specification of the spatial weighting matrix (W). The importance of the first point relates to the beginning of our sample period at the eve of the global financial crisis. This was naturally a very turbulent period, for the financial sector in particular, and financial services firms have employed a variety of responses, including deleveraging, moving into new markets and laying off a part of their workforce (Marshall, 2013;

Wójcik and MacDonald-Korth, 2015). For this reason, it is plausible that some of the factors that we have not controlled for could be affecting our results and leading to omitted variable bias. Provided that some of these factors are specific to the global financial crisis and are in fact driving our results, we should see some material changes in our results, if we rerun our analysis on different time periods.

We therefore rerun our analysis for 2007-2013, 2008-2014, 2009-2015 in addition to our main sample period of 2007-2015. Our results show a great degree of persistence in this respect. The partial effect of network constraint based on the coefficient estimate for 2007-2015 is 1.99% increase in firm growth per 10% decrease in network constraint. This increases to 2.01% for 2007-2013, 2.13% for 2008-2015 and decreases to 1.98% for 2009-2015. For all practical purposes such small variation in our estimates is effectively inconsequential.

Table 6.3. Results by sample period.

Main equation	[1]			[2]			[3]			[4]		
	β̂	***	t-stat	β̂	***	t-stat	β̂	***	t-stat	β̂	***	t-stat
Direct effects												
Age	0.481	***	3.83	0.295	***	3.21	0.162	*	1.91	0.261	***	3.02
Age ^ 2	-0.064	***	-3.21	-0.039	***	-2.69	-0.018		-1.56	-0.031	**	-2.27
Total assets	-0.047	***	-5.71	-0.052	***	-6.73	-0.050	***	-6.17	-0.043	***	-6.69
Total assets ^ 2	0.001	***	2.65	0.001	***	2.65	0.001	***	3.36	0.001	***	2.93
Network constraint	-0.186	***	-4.33	-0.200	***	-4.63	-0.189	***	-4.30	-0.187	***	-4.99
Survival probability	-0.167	*	-1.82	-0.123		-1.40	-0.143		-1.06	-0.186	*	-1.95
FABS employment	0.054	**	2.34	0.036	*	1.69	0.044	**	2.06	0.039	*	1.95
Other employment	-0.049		-0.89	-0.043		-0.80	-0.039		-0.79	-0.047		-0.99
Age * Total assets	0.000		-0.02	0.001		0.32	0.000		-0.03	-0.001		-0.46
Indirect effects												
Age	0.051		1.55	-0.004		-0.14	0.003		0.13	-0.004		-0.16
Age ^ 2	-0.008		-1.58	0.003		0.66	0.001		0.34	0.001		0.16
Total assets	0.002		0.85	0.003		1.54	0.002		1.09	0.000		0.27
Total assets ^ 2	0.000		-1.13	0.000		-0.53	0.000		0.50	0.000		-0.22
Network constraint	0.023	*	1.90	0.028	**	2.18	0.032	**	2.56	0.024	**	2.09
Survival probability	-0.043	**	-2.05	-0.018		-0.81	-0.015		-0.42	-0.012		-0.47
FABS employment	-0.002		-1.15	0.002		1.29	0.001		0.52	0.000		0.13
Other employment	0.002		0.80	-0.006	**	-2.08	-0.004		-1.52	-0.002		-0.81
Age * Total assets	0.000		0.40	0.000		-0.66	-0.001		-0.87	0.000		0.50
Adjusted R-squared	0.157			0.176			0.148			0.189		
Sample period	2009 - 2015			2008 - 2014			2007 - 2013			2007 - 2015		
Survivors	1351.000			1438.000			1486.000			1246.000		
Sample size (N)	2485.000			2663.000			2830.000			2830.000		
Survival equation												
Age	3.612	***	19.38	2.934	***	14.28	1.575	***	13.72	2.674	***	19.69
Total assets	0.310	***	8.73	0.236	***	6.38	0.142	***	7.86	0.195	***	9.33
Age * Total assets	-0.148	***	-7.96	-0.099	***	-3.60	-0.032	*	-1.89	-0.107	***	-7.73

Notes: *** significant at 1% level, ** 5% level, * 10% level; Dependent variable for all main equations is an average annual logarithmic growth rate of total assets for the stated sample period. All variables apart from survival probability are transformed by taking a natural logaritm and 1 is added to the value of variables including zeros, to avoid undefined values. All main equations are estimated by the spatial Durbin error model. Survival equations are estimated by probit. Survival equations are estimated on the full sample (N) and main equations are estimated on the sample of survivors, which have data on total assets available both at the beginning and at the end of the sample period.

Source: Authors' analysis.

Spatial econometrics has been criticised, although the jury is still out on whether rightfully, for the dependence of coefficient estimates on the structure of spatial weighting matrices (W) used (LeSage and Pace, 2014). In order to make sure that our results are not driven in any material way by our choice of great circle distance (50km) to construct our spatial weighting matrix, we consider other plausible values

ranging from 30km to 70km. We deem this range to be appropriate and wide enough, given that it should represent a single metropolitan area.

Our results presented in table 6.4. show only minimal variation in the estimated direct partial effects on the network constraint variable. Estimated partial effects of network constraint range between 1.82% (40km) and 2.05% (70km) increase in firm growth rate for 10% decrease in network constraint. As expected, the variation in the indirect effects of network contraint is slightly higher and they range between 0.23% (70km) and 0.45% (40km) reduction in growth rate of every co-located firm as a result of 10% decrease in network constraint of the focal firm. Despite the largest estimate being almost twice as large as the smallest, the qualitative interpretation or statistical significance of these results does not change, while we alter the great circle distance used to construct W. Consequently, our findings and conclusions are qualitatively invariant to the choice of great circle distance, within some plausible range.

Table 6.4. Sensitivity of results to the great circle distance.

Main equation	[1]			[2]			[3]			[4]			[5]		
	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat	β	***	t-stat
Direct effects															
Age	0.224	**	2.52	0.247	***	2.80	0.261	***	3.02	0.298	***	3.46	0.272	***	3.19
Age ^ 2	-0.026	*	-1.85	-0.029	**	-2.09	-0.031	**	-2.27	-0.035	**	-2.57	-0.034	**	-2.51
Total assets	-0.043	***	-6.74	-0.043	***	-6.64	-0.043	***	-6.69	-0.043	***	-6.65	-0.041	***	-6.23
Total assets ^ 2	0.001	***	2.74	0.001	***	2.84	0.001	***	2.93	0.001	***	3.69	0.001	**	2.35
Network constraint	-0.183	***	-4.83	-0.171	***	-4.55	-0.187	***	-4.99	-0.187	***	-4.97	-0.193	***	-5.17
Survival probability	-0.128		-1.31	-0.146		-1.50	-0.186	*	-1.95	-0.207	**	-2.18	-0.183	*	-1.94
FABS employment	0.034	*	1.69	0.030		1.64	0.039	*	1.95	0.036	*	1.81	0.044	**	2.41
Other employment	-0.001		-0.01	-0.002		-0.05	-0.047		-0.99	-0.026		-0.54	-0.066		-1.36
Age * Total assets	-0.001		-0.27	-0.001		-0.39	-0.001		-0.46	-0.003		-1.28	0.000		-0.21
Indirect effects															
Age	-0.055		-1.60	-0.033		-1.05	-0.004		-0.16	0.036		1.40	-0.012		-0.49
Age ^ 2	0.008		1.44	0.004		0.91	0.001		0.16	-0.005		-1.24	0.000		0.12
Total assets	-0.001		-0.63	-0.002	*	-1.90	0.000		0.27	-0.001		-0.45	0.002		0.96
Total assets ^ 2	0.000		-0.50	0.000		0.95	0.000		-0.22	0.000	**	2.54	0.000		-1.41
Network constraint	0.027	**	2.27	0.043	***	3.60	0.024	**	2.09	0.030	**	2.56	0.022	*	1.90
Survival probability	0.062	*	1.83	0.047		1.64	-0.012		-0.47	-0.032		-1.32	0.014		0.60
FABS employment	0.001		0.76	0.002		1.25	0.000		0.13	0.002		1.41	0.000		-0.35
Other employment	-0.002		-0.61	-0.003		-0.90	-0.002		-0.81	-0.003		-1.17	-0.001		-0.34
Age * Total assets	0.001		1.26	0.001		0.86	0.000		0.50	-0.001	*	-1.66	0.001		1.13
Adjusted R-squared	0.190			0.195			0.189			0.189			0.189		
Great circle distance [km]	30			40			50			60			70		
Survival equation															
Age	2.674	***	19.69												
Total assets	0.195	***	9.33												
Age * Total assets	-0.107	***	-7.73												

Notes: *** significant at 1% level, ** 5% level, * 10% level; Dependent variable for all main equations is an average annual growth rate of total assets for the period 2007 - 2015 (G_TA_2007_2015). All variables apart from survival probability are transformed by taking a natural logaritm and 1 is added to the value of variables including zeros, to avoid undefined values. All main equations are estimated by the spatial Durbin error model. Survival equations are estimated by probit and are identical across all models reported in this table and we therefore only report its coefficient estimates once to avoid repetition. Survival equations are estimated on the full sample (N = 2,830) and main equations are estimated on the sample of survivors - those firms that have data on total assets available for both the beginning and the end of the period modelled (N = 1,246).

Source: Authors' analysis.

6.5. Conclusions

The primary objective of this paper has been to study the impact of network centrality of financial services firms on their long-term growth rate and the indirect effects on other financial services firms in the proximity of the focal firm. To isolate this effect from other potential sources of spatial spillovers, such as labour force pooling, input-output linkages and urbanisation economies we also controlled for employment in closely related and other sectors at NUTS 2 level. We also included well established predictors of firm growth including firm size and age as control variables.

Our study is not the first to either consider the effect of network centrality on firm growth or to consider clustering in the study of firm growth (Shipilov, 2006; Frenken et al., 2015). Instead, its main contribution is in bridging the gap between these related, yet separately evolving strands of literature and developing an analytical setup that allows for modelling the relationship between network centrality and firm growth, that accounts for clustering and localised interactions among firms. The empirical results of this thesis speak to both groups of literature and explicitly consider financial services firms, which have been heavily under-researched in studies of firm growth (Macpherson and Holt, 2007; Frenken et al., 2015).

Our results paint a picture of substantial heterogeneity of firm growth rates within clusters. While our findings are consistent with the hypothesis that network centrality aids firm growth, we also find substantial differences in the value of different types of network connections and the direction of the indirect effect of network centrality is opposite to its direct effect. Our results relating to different conceptualisations of centrality corroborate those of Shipilov (2006) and suggest that accounting for both the sheer number of network ties and the brokerage opportunities presented by firm's positioning in syndication networks is better suited to account for the impact of network centrality than either conceptualisation separately.

In contrast to Shipilov's (2006) study we explicitly consider financial services firms as being part of FCs and account for potential localisation and urbanisation economies, to isolate the effect of network centrality at firm level and its wider significance for the clusters as whole. To achieve the latter, we model the indirect effects of our explanatory variables on other firms within the cluster using spatial Durbin error model. This part of our analysis corroborates other related studies that identify signs of localised competition within FCs (Clark, 2002; Cook et al., 2007). The work carried out here also contributes to the studies of the world city network

(Taylor and Derudder, 2016) and GFNs (Coe et al., 2014; Wójcik, 2018) by developing a suitable research design and providing empirical evidence relating to the impact of network connectivity on financial services firms and its indirect effects on other firms within FCs.

We also consider the distinction between different types of network ties, which have been suggested by related studies to potentially have different consequences to both individual firms and clusters. Bathelt et al. (2004) predict that network ties connecting clusters should enhance the competitiveness and growth of clusters, an effect enhanced by network connectivity within clusters and limited by the absorptive capacity of firms. We find that the connected firms generally benefit from forming inter-cluster network ties and this effect varies with the size of FCs they are connected to. On the other hand, the observed indirect effects are overwhelmingly negative and can be interpreted as a growth of connected firms at the expense of others in their proximity, as the result of localised competition.

The next distinction is made between network ties formed through lead management and co-management appointments. This part of our analysis builds explicitly on the work of Ljungqvist et al. (2009), who interrogate co-management appointments and argue that they can serve as stepping stones for financial services firms to develop relationships with new clients and may ultimately lead to more lucrative lead management appointments in the future. This part of our analysis reveals that it is in fact co-management ties that drive future growth, while lead management ties restrict future growth opportunities in exchange for immediate gain. This evidence is consistent with the proposition of Ljungqvist et al. (2009) that co-management appointments serve to expand the portfolios of clients of investment banks, while lead management appointments are typically assigned to banks with whom the client already has an established relationship.

In terms of the methodology used, this paper furthers the work of studies of financial services firms such as that of Pandit et al. (2001), by controlling for firm heterogeneity and by allowing for econometric modelling of indirect effects of explanatory variables on co-located firms by using spatial econometric techniques, instead of using non-spatial lifetime growth models, which have become a popular choice in related studies (Swann and Preverez, 1996; Pandit et al., 2001; Beaudry and Swann, 2009). Although the methods used here are not new, their unique combination and application in this context breaks a new ground and will hopefully inspire future research on FCs based on micro-economic level of analysis. Our results also underline the value of researching economic-geographical phenomena at firm level, given that simply looking at clusters or regions can often overlook important heterogeneity observable only at the firm level – such as the differing effects of network centrality on connected firms and other firms in their proximity.

There are several important implications of our findings for public policy and corporate strategy. First, our results relating to the divergence of growth rates between well-connected and lesser connected firms imply that financial services would become more concentrated at firm level, in the absence of any countervailing forces. Consequently, this mechanism has the potential to exacerbate the too big to fail problem, particularly if larger firms are more likely to develop central positioning within GFNs to begin with.

Second, with the looming prospect of United Kingdom's departure from the European Union and the inherent uncertainties regarding the terms of their future relationship, the following question emerges. What is the likely impact of BREXIT on UK's positioning within GFNs and how is this going to affect its financial sector? This is naturally a very complex and multifaceted question that will eventually yield many research papers and books. We will attempt to shed some light on this question using some of our findings. London, as a global FC, not only derives

nearly 30% of its revenue[48] from clients based in other EU states, but it also serves as a gateway FC for foreign banks wishing to access European capital markets. Consequently, its ties with rest of the EU are relevant both to its ability to serve significant share of its clientele as well as to attract subsidiaries of foreign banks, which contributed 45% of fees earned by London based firms in 2015 (Wójcik et al., 2018c). We would therefore expect that depending on the severity of barriers that the post-BREXIT relationship of UK with the EU will present, at least part of the revenue earned from both EU clients and subsidiaries of foreign banks located in the UK may be in jeopardy.

Third, as we show, inter-cluster network ties are the source of enhanced growth prospects for financial services firms. Given that the UK does not host any other major global FCs other than London and European FCs with Paris and Frankfurt in the lead are second only to New York in the frequency of co-syndication with London based firms, it is likely that any disruption in these network ties could lead to a material contraction of London based firms (Pažitka et al., 2018a). We also expect that in the event or increased regulatory burdens associated with serving EU clients or co-syndicating with EU based firms, it is likely to be the smaller financial services firms that will find them the most difficult to overcome. This is likely to exacerbate the problem of divergence in growth rates between globally connected and locally embedded firms.

Finally, European FCs are presently of course not the only places that London is connected to within GFNs. The NY-LON axis is quoted as the most significant tie in GFNs and London is also connected to all other major FCs in the world, including Tokyo, Hong Kong, Singapore, Sydney, Toronto, Chicago and many others (Wójcik, 2013; Pažitka et al., 2018a). The question therefore remains, whether London could refocus its activities and networks towards the rest of the

[48] This relates to securities underwriting, syndicates loans and M&As advisory services.

world following BREXIT to mitigate its effects or alternatively, the ties of London to other FCs could suffer as a result of BREXIT, if it compromises its function as a gateway to European capital markets. In such an event, it is plausible that the damage caused by BREXIT could in fact spread through London's financial networks, rather than to be absorbed by them. As a worse case scenario for London, it could end up being circumvented in GFNs and a new gateway city for subsidiaries of foreign banks wishing to access European capital markets could emerge.

Our work is restricted to England, Scotland, and Wales and although we focus on long-term firm growth, we use at most eight years of data. With better data availability in the future, this research can hopefully be extended to cover longer-time periods and more countries. More work needs to be done to identify the specific mechanism behind what is identified as the effect of localised competition between firms with high network centrality and their lesser connected counterparts. Finally, our analysis is subject to the usual caveats regarding the use of partial correlations in studying causal relationships. Nevertheless, a case has been made here for why a causal relationship is likely to exist between network centrality and firm growth. We hope that future research will build on this contribution.

Appendix

Appendix A.6.1. Descriptive statistics

Variable name	Time period	Observations	Missing	Min	Median	Mean	Max	SD
G_TA_2007_2015	2007 - 2015	1,246	1,584	-1.58	-0.02	-0.01	1.85	0.24
G_TA_2007_2013	2007 - 2013	1,486	1,344	-2.10	-0.01	-0.01	1.98	0.28
G_TA_2008_2014	2008 - 2014	1,438	1,225	-2.10	0.00	0.00	2.46	0.28
G_TA_2009_2015	2009 - 2015	1,351	1,134	-2.10	-0.01	-0.01	2.47	0.28
Age [years]	2007 - 2015	2,829	0	0.00	1.00	7.01	142.00	13.86
	2007 - 2013	2,829	0	0.00	1.00	7.01	142.00	13.86
	2008 - 2014	2,663	0	0.00	2.00	8.53	143.00	14.26
	2009 - 2015	2,483	0	0.00	5.00	10.13	144.00	14.70
Total assets [th GBP]	2007 - 2015	2,829	0	1.00	215.00	6,027,388.72	1,689,308,000.00	68,867,463.12
	2007 - 2013	2,829	0	1.00	215.00	6,027,388.72	1,689,308,000.00	68,867,463.12
	2008 - 2014	2,663	0	1.00	299.00	6,186,411.12	1,612,822,000.00	68,725,892.11
	2009 - 2015	2,483	0	1.00	450.00	7,143,567.91	1,656,437,000.00	78,685,139.98
Survival probability	2007 - 2015	2,829	0	0.00	0.17	0.43	1.00	0.43
	2007 - 2013	2,829	0	0.02	0.44	0.53	1.00	0.38
	2008 - 2014	2,663	0	0.00	0.50	0.54	1.00	0.41
	2009 - 2015	2,483	0	0.00	0.59	0.53	1.00	0.41
Financial services employment [full time employees]	2007 - 2015	2,829	0	1,748.00	31,321.00	132,647.71	251,399.00	114,537.71
	2007 - 2013	2,829	0	1,748.00	31,321.00	132,647.71	251,399.00	114,537.71
	2008 - 2014	2,663	0	1,689.00	256,332.00	140,840.52	256,332.00	117,120.83
	2009 - 2015	2,483	0	1,471.00	240,199.00	137,518.73	240,199.00	108,731.61
Other employment [full time employees]	2007 - 2015	2,829	0	118,292.00	1,131,282.00	1,118,581.62	1,607,369.00	509,767.17
	2007 - 2013	2,829	0	118,292.00	1,131,282.00	1,118,581.62	1,607,369.00	509,767.17
	2008 - 2014	2,663	0	114,080.00	1,656,539.00	1,167,722.94	1,656,539.00	529,660.94
	2009 - 2015	2,483	0	113,814.00	1,696,362.00	1,202,631.90	1,696,362.00	551,185.24
Degree centrality	2007 - 2015	2,829	0	0.00	0.00	37.60	3,976.00	245.14
	2007 - 2013	2,829	0	0.00	0.00	31.80	3,976.00	225.09
	2008 - 2014	2,663	0	0.00	0.00	30.22	3,690.00	206.53
	2009 - 2015	2,483	0	0.00	0.00	27.79	3,490.00	188.27
Betweenness centrality	2007 - 2015	2,829	0	0.00	0.00	3,602.02	836,632.08	38,125.92
	2007 - 2013	2,829	0	0.00	0.00	3,015.44	836,632.08	34,934.21
	2008 - 2014	2,663	0	0.00	0.00	3,268.30	771,456.11	34,001.65
	2009 - 2015	2,483	0	0.00	0.00	3,439.48	1,076,837.45	40,040.78
Network constraint	2007 - 2015	2,829	0	0.00	1.00	0.89	1.00	0.29
	2007 - 2013	2,829	0	0.00	1.00	0.91	1.00	0.27
	2008 - 2014	2,663	0	0.00	1.00	0.90	1.00	0.28
	2009 - 2015	2,483	0	0.00	1.00	0.89	1.00	0.29
Degree centrality (intra-cluster ties)	2007 - 2015	2,829	0	0.00	0.00	1.31	89.00	6.95
	2007 - 2013	2,829	0	0.00	0.00	1.11	89.00	6.41
	2008 - 2014	2,663	0	0.00	0.00	1.15	90.00	6.45
	2009 - 2015	2,483	0	0.00	0.00	8.70	1,008.00	58.70
Degree centrality (inter-cluster ties)	2007 - 2015	2,829	0	0.00	0.00	12.99	1,060.00	74.33
	2007 - 2013	2,829	0	0.00	0.00	11.01	1,060.00	68.30
	2008 - 2014	2,663	0	0.00	0.00	10.84	1,017.00	65.27
	2009 - 2015	2,483	0	0.00	0.00	10.21	1,008.00	60.93
Degree centrality (inter-cluster ties - weighted by alter's FC size) [mil 2012 USD]	2007 - 2015	2,829	0	0.00	0.00	12,898.97	135,357.23	32,574.82
	2007 - 2013	2,829	0	0.00	0.00	11,168.74	135,357.23	30,554.15
	2008 - 2014	2,663	0	0.00	0.00	8,319.46	93,784.84	21,352.07
	2009 - 2015	2,483	0	0.00	0.00	7,772.04	84,446.38	19,196.16
Degree centrality (co-management ties)	2007 - 2015	2,829	0	0.00	0.00	2.06	306.00	14.63
	2007 - 2013	2,829	0	0.00	0.00	1.73	306.00	13.42
	2008 - 2014	2,663	0	0.00	0.00	1.39	241.00	10.84
	2009 - 2015	2,483	0	0.00	0.00	1.41	201.00	10.28
Degree centrality (lead management	2007 - 2015	2,829	0	0.00	0.00	3.69	679.00	36.60
	2007 - 2013	2,829	0	0.00	0.00	3.09	679.00	33.54
	2008 - 2014	2,663	0	0.00	0.00	2.16	471.00	22.57
	2009 - 2015	2,483	0	0.00	0.00	1.84	464.00	20.67

Source: Authors' calculations based on Dealogic, FAME, ONS-BRES data

Chapter 7 | Conclusions

7.1. Introduction

This thesis is structured around two primary objectives. First, to contribute to the literature on the WCN and the emerging literature on GFNs by developing and empirically testing a new methodological approach for modelling urban networks that would aid the development of empirical research in these related streams of literature. Second, to provide empirical evidence showing the effects of positioning within GFNs on individual financial services firms as well as FCs. It is the purpose of this chapter to show, how this thesis achieves these objectives and to demonstrate the significance of this work to the related literature as well as its wider implications for public policy and corporate strategy.

The first objective of this thesis is the subject matter of chapters 3 and 4. Chapter 3 is primarily concerned with the development of the inter-organisational project approach to the IWCNM and contrasting it to Taylor's (2001) IWCNM, which it sets out as a relevant reference point, given its wide use in the global and world cities literature. This chapter also offers an empirical illustration of this approach, which shows the structure of urban networks connecting FCs for 2000, 2007 and 2015. Chapter 4 considers the network boundary specification problem in the study of urban networks and compares three competing modelling approaches, namely Taylor's (2001) IWCNM, Alderson and Beckfield (2004) ownership ties model and the inter-organisational project approach to the IWCNM, developed in chapter 3 of this thesis. The second objective is achieved in chapters 5 and 6. Chapter 5 considers the effect of characteristics of FCs including the quality of institutions of their countries, the structure of their client base, their firm size distribution and positioning within GFNs on the resilience of FCs to demand shocks. Chapter 6

then considers the effect of positioning within GFNs on the long-term growth of individual financial services firms as well as an indirect effect on other co-located firms within their clusters. Collectively the four substantive chapters of this thesis therefore develop, test and empirically apply a novel methodology for studying the structure of the WCN and GFNs and its impact on individual firms and FCs.

The remainder of this chapter is structured as follows. Findings presented in isolation in the four substantive chapters of this thesis are restated and their interconnections and joint significance is discussed in section 7.2. I then identify the relevant groups of literature to which this thesis contributes and discuss, how it fills some of the research gaps identified in this literature in section 7.3. Section 7.4 explores the wider implications of this thesis to public policy and corporate strategy and identifies ways in which policymakers and managers of financial services firms can benefit from its findings. Section 7.5 discusses the limitations of this thesis. Finally, section 7.6 identifies viable areas for future research and proposes how future work can build on this thesis.

7.2 Restatement of findings

7.2.1. Key findings

I now proceed to restate the key findings of each substantive chapter of this thesis. This is then followed by a synthesis of these findings, which highlights how these chapters work together to fulfil the overarching objectives of this thesis and how the interconnections between these chapters lead to their integration. I start each subsection with the title of the respective substantive chapter and restate the hypotheses being tested, where appropriate (chapters 5-6).

An inter-organisational project approach to the Interlocking World City Network Model: Geographies of investment banking syndication, 2000-15

The starting point of chapter 3 is a review of the literature that builds on Taylor's (2001) IWCNM, which became established as the most widely used model of urban networks in the global and world city research. We consider the area of research to be of direct relevance to this thesis, as it focuses on networks formed by the activities of FABS firms that connect cities. The point of departure between this thesis and the global and world cities literature is in our criticism of the weak methodological basis of the IWCNM, which directly compromises the value of empirical results derived from it. This critique relates primarily to the use of attribute data on office locations to derive measures of relational interactions among cities (Taylor and Derudder, 2016). Five limitations of the IWCNM are identified, which limit empirical studies, that rely on this model.

(1) Intercity ties are only derived from locations of offices of the same firm and no ties based on inter-firm interactions are empirically observable.

(2) The weights of intercity ties are proportional to the size/importance of offices of APS firms connecting the given city-dyad.

(3) Intra-firm flows are symmetrical between any combination of offices (e.g. the flow from global HQ to a minor office in a different city is the same as the flow in the opposite direction).

(4) Intra-firm flows only vary depending on the size/importance of offices involved (e.g. global HQ, regional HQ, minor office) and otherwise are the same across different firms and industries.

(5) All firms with at least one pair of co-located offices in the same city are assumed to be connected.

In contrast to Nordlund (2004), we do not stop at identifying some of the shortcomings of the IWCNM, but instead rebuild this model from the ground up, using a different conceptualisation of network ties, based on the notion of inter-

organisational projects. Consequently, in the model proposed here cities are not connected by the overlaps in office networks of firms, but instead by empirically observable interactions among firms located in different cities through their involvement in inter-organisational projects. To operationalise this model, we use data on 161,114 underwriting syndicates of equity and debt securities for 2000-15, which allows us to describe and visualise a global network of FCs.

This exercise helps us to illustrate how this model overcomes the five assumptions of the IWCNM listed above. First, the use of data on subsidiaries in tandem with inter-organisational projects that connect these subsidiaries means that network ties are observable both within and among firms. In contrast, modelling approaches restricted to intra-firm network ties only, such as connections among offices of a single firm, miss out on potentially the bigger part of the network formed by inter-firm interactions. As I show in chapter 4, this has implications for the reliability of measurement of node structural measures, such as network centralities, and can potentially lead to misleading results.

Second, instead of relying on quite arbitrary assumptions relating to the quantification of network interactions among FCs, we use either the frequency of co-syndication or optionally the value weighting of syndicated deals to model the weights of network ties. We argue that this provides a more defensible basis for such network analysis, which is based on observable, rather than assumed interactions.

Third and fourth, our approach does not rely on any prior assumptions regarding the structure of interactions among or within firms. Empirically it is limited to a particular type of interaction – involvement of inter-organisational projects, however this is a very flexible specification with plentiful data available to allow for a very rich documentation of complex patterns of network connectivity. In contrast, in the case of office data used by IWCNM, such interactions are structured in a

way that presupposes certain symmetry across firms and industries, for which there is no empirical evidence. As an example, the intensity of interactions is assumed to be the same between a head office and a regional office across all firms and industries. Our model in contrast allows for an unrestricted pattern of variation in network connectivity across firms and industries.

Fifth, although the focus of the IWCNM is on inter-city network ties, this is not to say that network connections within cities are not considered of relevance to the global and world cities literature. Taylor's (2001) IWCNM, however is not well suited for studying these types of ties, given that a projection function that would convert a firm – city affiliation matrix into a firm adjacency matrix would automatically imply that all firms with a pair of offices located in the same city are connected. Consequently, such analysis would be effectively uninformative. Our model in contrast allows for a meaningful analysis of both firm and city level networks, thus allowing for both the study of inter-city and intra-city network ties.

The network boundary specification problem in the global and world city research: Can we trust empirical results from sampled networks?

Chapter 4 of this thesis investigates the consequences of the network boundary specification problem, which despite being considered perhaps the single most important problem in network analysis, has been effectively ignored by the global and world city research on urban networks (Laumann et al., 1989; Taylor and Derudder, 2016). Our results can be divided into two groups. First, we consider the similarity of city (FC) network centralities derived from three competing modelling approaches based on – office networks (Taylor, 2001), ownership ties (Alderson & Beckfield, 2004) and the inter-organisational projects (Pažitka et al., 2018a). The last approach is the one developed in the chapter 3 of this thesis. Second, we compare the results derived from sampled networks and those from whole network

analysis, to assess the impact of sampling of firms on the stability of centrality measures of cities.

Our results relating to the first point of the inquiry suggest that the city network centralities derived from these three approaches are only weakly correlated and do not converge on each other as the sampling percentage of firms increases. This is understandable, given the conceptual differences between these approaches and it underlines the consequences of the choice of network ties studied, as one of the two parts of the network boundary specification problem. The second part of this exercise shows the correlations between results obtained from partially sampled and whole networks, separately for each modelling approach considered. Our results indicate that for randomly sampled networks, both city network centralities and their ranking converge slowly to the values obtained from the whole network analysis and do not become reliable until at least 90% of the underlying firms were sampled. This pattern is broadly shared by all three competing approaches.

Most empirical studies in the related literature however do not sample firms randomly, but instead use ranking tables of firms and sample companies from the top of an ordered list (Taylor, 2004; Alderson et al., 2010). Therefore, to make our analysis more representative, we also consider such a sampling procedure. This is shown to improve the rate of convergence substantially and reliable results on both city network centralities and their ranking can be obtained with samples of as few as 50% of the underlying population of firms. We then review the sample sizes used by empirical studies of urban network in the global and world city research and conclude that the vast majority of empirical work in this literature works with sample sizes substantially smaller, often less than 10% of the underlying population. This therefore is expected to lead to results on city network centralities, which are very weakly correlated with those from whole networks and

consequently quite unreliable. Neither of the approaches we examined seems to be particularly resistant to this and we therefore recommend that the use of either whole networks, if possible, or reasonably complete samples for future empirical research on urban networks.

Resilience of financial centres to demand shocks: A dynamic panel data analysis, 1993 – 2016

While the previous two chapters were methodologically focused and their findings were best described by discussing the characteristics of the modelling approach developed (chapter 3) and methodological recommendations made (chapter 4), the following two chapters are empirical studies, which test sets of hypotheses derived from the related literature. I therefore focus on the hypotheses being tested and the empirical results that speak to the validity of these hypotheses in the next several paragraphs. Although these chapters are not merely limited to the relevance of network centrality of FCs and individual firms, the inclusion of these variables helps the empirical work conducted in this thesis to go beyond description of the structure of networks connecting FCs. Instead, it allows us to test hypotheses relating to the impact of network centrality on FCs and individual firms located within them, thus providing evidence on the implications of positioning within GFNs.

H.5.1. Aggregate revenue of financial centres is influenced by changes in the level of demand for securities underwriting services. Ceteris paribus, financial centres grow when the level of demand in the market segments they are exposed to increases and contract as it decreases.

This is our baseline hypothesis and the remainder of the results in this chapter effectively relies on the existence of a statistically significant relationship between the changes in level of demand, weighted by the exposure of FCs to different market segments, and the aggregate revenue of FCs. We find this relationship to

be significant at 1% level and has the predicted positive sign. The magnitude of this effect is in line with our expectations and changes in the level of demand lead to almost identical percentage changes in the revenue of FCs. More specifically, 10% reduction in the level of demand leads to an average 9.6% reduction in revenue. This effect is however found not to be constant and in fact varies materially across FCs depending on some of their observable characteristics relating to the structure of their client base, network centrality and firm size distribution.

H.5.2. Financial centres with a higher number of external network connections are more resilient to demand shocks.

H.5.3. Financial centres with denser intra-cluster networks are less resilient to demand shocks.

H.5.4. Financial centres with disassortative networks are more resilient to demand shocks.

Our results relating to the effect of network connectivity variables uncover a distinction between the effect of inter-city network ties and intra-city network structure. Inter-city network ties that link firms located in a FC with those in the rest of the world make FCs more resilient to demand shocks. This effect is statistically significant at the 5% level and the coefficient estimates imply that the most connected FCs lose only about half the revenue per a unit shock in demand, in contrast to the least connected FCs. Interestingly, the properties of intra-city syndication networks, including network density and assortativity are not found to be statistically significant. This suggests that perhaps due to the larger overlaps in the client portfolios, such localised network connections are not adding to the resilience of FCs.

H.5.5. Financial centres that operate a 'diversified specialisation' model in terms of their client base are more resilient to demand shocks.

In contrast to a perhaps more intuitive expectation that full diversification leads to resilience, we find that in fact FCs that specialise in a not fully diversified portfolio of market segments are in fact more resilience to demand shocks. This finding is consistent with the notion of 'diversified specialisation' developed by Farhauer and Kröll (2012).

H.5.6. Financial centres with higher concentration of revenue at firm level are more resilient to demand shocks.

Our findings indicate that FCs with a firm size distribution skewed towards the concentration of revenue in a small number of large firms display higher degree of resilience than those with dispersed revenue at the firm level. This is likely to be symptomatic of the higher probability of survival of large firms in the event of demand shocks as well as their market power, which makes it easier for them to access new market opportunities, in the event of decline in the current market segments.

H.5.7. Financial centres located in countries with higher quality of institutions relevant to financial services are more resilient to demand shocks.

Despite the generally accepted necessity of certain threshold quality of institutions for financial development, we do not find any statistically significant effect of the quality of institutions, including rule of law and enforcement of contracts on the resilience of FCs to demand shocks. This therefore implies that although quality of institutions matters for the establishment of FCs and investment banking in general and some critical level of quality of institutions is perhaps indispensable for capital markets to operate successfully (Morrison and Wilhelm, 2007; Wójcik et al., 2018a), once established, FCs and their revenue are not

shielded from market forces by the institutional environment of their countries. Instead, it is their positioning with GFNs, the presence of large firms and structure of their client base that influence their resilience.

Cluster dynamics of financial centres in the United Kingdom: Do connected firms grow faster?

In chapter 6 the focus shifts from FCs, which was the unit of analysis in chapter 5, to their constituent firms, their networks and localised interactions. Our findings relate the impact of different types of network ties to the long-term growth of financial services firms and the spatial spillovers they generate to other co-located firms, which we understand as the effect of localised competition.

H.6.1. Firms with higher network centrality within syndication networks grow faster and they jointly benefit from both the number of ties to other firms and the brokerage opportunities provided by their position in syndication networks.

Our findings indicate that firms with more central position within syndication networks grow faster, ceteris paribus. This finding is derived from models of long term growth, which already control for firm size, age, survival probability, localisation and urbanisation economies. What is however more interesting, not all types of network ties contribute equally to the long-term growth prospects of financial services firms. We therefore consider the distinction between localised and inter-city network ties, lead-management and co-management appointments as the source of network centrality of firms.

H.6.2. – Firms benefit more from engaging in co-management appointments than in lead-management appointments in respect to their long-term growth prospects.

When we split network ties to those formed by co-management and lead management appointments, we find that it is the former that enhances long-term

firm growth, while the latter does not. We link this result to the work of Ljungqvist et al. (2009), who find that firms engaging in co-management appointments can establish relationships with new clients, while lead management appointment are generally assigned to firms that already have a pre-existing relationship with the client. This would therefore imply that firms engaging in co-management appointment are likely to expand their portfolio of clients and so to say plant seeds for future lead management appointments. On the other hand, firms acting as lead managers earn higher fees in the present, but this presents an implicit trade-off in the form of reduced growth opportunities in the future. This holds particularly, if firms can only take part in a limited number of syndicated deals and therefore the number of lead management and co-management appointments are traded off against each other.

H.6.3. – Inter-cluster network connections are more valuable in respect to firm's growth prospects than localised intra-cluster network connections.

We then proceed by separating network ties by the relative location of syndication partners into intra-cluster (localised) and inter-cluster ties. This exercise reveals that it is in fact the inter-cluster ties that are the source of enhanced growth prospects. Intra-cluster ties are not found to enhance firm growth. This finding indicates that in fact geography matters in syndication networks. The literature on underwriting syndicates suggests that one of the advantages of syndication stems from the expansion in the pool of institutional investors that the syndicate can reach, in contrast to any individual syndicate member (Pollock et al., 2004). Provided that co-located financial services firms have bigger overlaps in the institutional investors they are connected to than firms located in different FCs, this would mean that geographically dispersed syndicates would have access to a wider pool of institutional investors and would perform better. Additionally, formation of syndication ties with geographically distant

partners is also likely to open access to market opportunities in segments of the market that were previously not exploited or provide opportunities for hedging against the decline in demand in already exploited market segments.

H.6.4. Firms with central positioning in syndication networks outcompete other proximate financial services firms and effectively grow at their expense, leading to a negative spatial spillover associated with network centrality.

Our results are consistent with this hypothesis and suggest that highly connected financial services firms grow at the expense of their co-located competitors. The idea of localised competition resonates in the literature on FCs (Clark, 2002; Cook et al., 2007). What is meant here, is, that although to certain extent all financial services firms that offer the same type of service compete with each other, it is in fact the firms that operate within the same FC and offer the same services that are each other's closest competitors. There are numerous reasons for this, including the way companies access FABS (Clark, 2002) and the purposeful co-location of close competitors involved in the same markets and market segments (Cook et al., 2007). Provided therefore that there is a finite demand for financial services, it is therefore inevitable that when a firm increases its competitive advantage, it will draw clients and revenue from its competitors. At the same time, if close competitors tend to co-locate with each other, this must inevitably lead to indirect negative partial effects of variables that are associated with competitiveness. Consequently, our finding that an increase in network connectivity has a negative indirect effect on other proximate firms is consistent with the notion of localised competition among financial services firms.

7.2.2. Synthesis of findings

I now proceed to discussing the interconnections among the findings of four substantive chapters of this thesis. In doing so, my objective is to show how these chapters work together towards achieving the objectives of this thesis and to

emphasize, how they collectively paint a much more complete picture of FCs in GFNs than any one of them could on its own.

Chapter 3 develops the 'inter-organisational project approach to the IWCNM' and effectively sets the methodological foundations in respect to network analysis for the remaining three substantive chapters. Consequently, chapter 3 can be thought of as the methodological core of this thesis and the modelling approach that it develops is then utilized throughout this thesis. Additionally, to its critique of the IWCNM, it offers methodological guidance and alternative modelling framework to researchers interested in the WCN and GFNs. Finally, its descriptive empirical evidence on the structure of global syndication networks is used as one of the sources of data on network centrality of FCs and firms in the following chapters, which extend it using econometric modelling techniques.

Chapter 4 extends this critique of the global and world city research focused on modelling urban networks and considers the impact of the network boundary specification problem on the reliability of node structural parameters in urban networks (Alderson et al., 2010; Taylor and Derudder, 2016). Chapter 4 connects with chapter 3 by building on one of its limitations, namely, not having empirically contrasted the modelling approach it develops with other closely related methods. Its consideration of the network boundary specification problem (Laumann et al., 1989) also informs chapter 3 by providing guidance on the appropriate sampling percentages for this approach and its empirical similarity, or the lack there of, with the IWCNM and ownership ties modelling approaches (Taylor, 2001; Alderson and Beckfield, 2004). What both of these chapters have in common, however, is that they are very much methodologically focused and any empirical evidence that they yield along the way primarily serves to test the modelling approach developed in chapter 3, to compare it to other related methods or to verify its reliability. In order to put this modelling approach to a more productive use and get answer some

important empirical questions relating to FCs and financial services firms, we need to consider the findings of chapters 5 and 6.

Both chapter 5 and 6 rely on the methodological developments and guidance of chapters 3 and 4 and if fact the research conducted within these chapters would not have been possible in its present form, if it was not informed by the work carried out in the previous two chapters. Chapter 5 extends the descriptive character or the empirical illustration of the 'inter-organisational project approach to the IWCNM' provided in chapter 3 by using network centrality scores of FCs as one of the explanatory variables in a model aiming to identify factors influencing the resilience of FCs to demand shocks. In doing so it offers empirical evidence linking external network ties of FCs to their resilience, while the intra-cluster network structure of FCs does not appear to matter. This therefore not only offers a more involved empirical application of the model developed in chapter 3, but it also justifies its focus on inter-cluster (or inter-city) network ties.

Finally, chapter 6 corroborates the distinction between inter-cluster and intra-cluster network ties identified in chapter 5 and offers empirical evidence linking inter-cluster network ties to firm growth. The direct effect of this variable is positive and highly statistically significant. In turn, the indirect effect on other co-located firms is negative, implying a localised competition. This chapters draws methodologically on the work carried out in chapter 3, although it does not aggregate its data at FC/city level, but instead uses firms as the unit of analysis. The model developed in chapter 3 includes a firm adjacency matrix as one of its components that is later used to calculate city/FC adjacency matrix and therefore it can also be applied at firm level of analysis. Chapter 6 enhances the work carried out in the previous chapters by explicitly considering brokerage and more complex measures of network centrality. Additionally, it considers not only the distinction between localised and long-distance network ties, but it also adds another layer of

complexity by considering network ties formed through different types of appointments in syndicated deals.

To summarise, the four substantive chapters of this thesis collectively develop, test and empirically apply a novel methodological approach for modelling GFNs, WCN and optionally firm level syndication networks. Empirical applications include a description of the WCN across time (chapter 3), study of resilience of FCs to demand shocks (chapter 5) and the impact of network connectivity on firm growth (chapter 6). In doing so this thesis offers a viable methodological framework and guidance for applied researchers interested in GFNs and urban networks formed by the activities of FABS.

7.3 Contributions to literature

The contribution of this thesis to the related literature is twofold. First, it develops a methodological approach for empirical analysis of the WCN and GFNs, which is based on well-established social network analysis methods and conceptualisation of network connections based on underwriting syndicates (Everett and Borgatti, 1999; Pichler and Wilhelm, 2001; Pollock et al., 2004; Jackson, 2010; Wójcik, 2018). Second, this thesis also contributes to the related literature on clusters, FCs, WCN, GFNs and underwriting syndicates by delivering empirical evidence on the structure of urban networks connecting FCs formed by syndication ties among investment banks and the effect of positioning within these networks on long-term growth performance of individual firms and resilience of FCs as whole (Shipilov, 2006; Martin and Sunley, 2011; Holm and Østergaard, 2015; Wójcik et al., 2018a, Wójcik, 2018). I will now in turn discuss each group of contributions in more detail.

The ’inter-organisational project approach to the IWCNM’ developed in chapter 3 bridges the gap between research on the WCN and work on investment banking networks conducted within finance and business studies (Taylor and Derudder, 2016; Shipilov, 2005, 2006; Ljungqvist et al., 2009). In doing so it overcomes many

limitations and blind spots of the presently most widely used approach to modelling urban networks, namely the IWCNM, and allows for easier scalability of applied research (Taylor, 2001). This in turn allows researchers to more convincingly address the network boundary specification problem, which as we show, presents a serious challenge for the existing empirical literature on urban networks formed by organisational actors (Laumann et al., 1989). In addition to the WCN research, this approach is also very much applicable in the context of GFNs and it fills the void of lacking methodological framework for measuring GFNs (Coe et al., 2014; Wójcik, 2018). This work can also be considered an extension of the work conducted in social network analysis on group network centrality measures, as it extrapolates these concepts to the context of urban networks that connect groups of actors located in different metropolitan areas (Everett and Borgatti, 1999).

As I demonstrate, the network centrality scores of FCs derived using the 'inter-organisational project approach to the IWCNM' differ from and do not converge on those obtained using the Taylor's (2001) IWCNM or Alderson and Beckfield (2004) model based on ownership ties. These results corroborate the conceptual differences between these three methods with empirically observable differences in network centralities. This therefore serves as an additional evidence of the distinctiveness of the model developed in chapter 3 and its value in complementing or perhaps even replacing some of the existing modelling approaches.

This thesis also contributes to the related literature on clusters, FCs, WCN, GFNs and investment banking syndicates by delivering empirical evidence that goes beyond mere description of the structure of GFNs formed by syndication ties among investment banks that connect FCs. Instead, it also offers empirical evidence that sheds light on the effect of positioning within syndication networks on firm growth and resilience of FCs to demand shocks. In doing so, this thesis steps out of the shadow of the established format of empirical studies on urban

networks, and in addition to mapping network connections, it considers their relevance to the units they connect, be that individual firms or FCs (Taylor and Derudder, 2016).

This exercise leads to intuitive, albeit empirically novel results. Central positioning of financial services firms within syndication networks enhances their long-term growth prospects and in contrast dampens those of their co-located competitors. This is consistent with the prediction that underwriting syndicates improve the access of financial services firms to deal flow and increase their competitiveness by delivering more favourable outcomes for their clients. These include higher valuation of new issues, lower risk of withdrawal, lower underpricing of equity securities and higher long run returns (Jeon and Ligon, 2011; Bajo et al., 2016; Vithanage et al., 2016). We then consider the effect of network centrality of FCs on their resilience to demand shocks. We find that external network connections of FCs make them more resilient to demand shocks, while the intra-cluster structure of their networks does not seem to affect their resilience. This line of enquiry contributes jointly to the emerging literature on GFNs and cluster resilience in evolutionary economic geography, which is only starting to develop empirical evidence (Martin and Sunley, 2011; Holm and Østergaard, 2015; Wójcik, 2018).

7.4 Implications for public policy and corporate strategy

The 2008-9 global financial crisis has revealed the vulnerabilities of the financial system associated with its interconnectivity and common exposure of strategically important financial institutions to common toxic assets, securitised subprime US mortgages. While the interconnectivity of financial services firms through either lending networks and common exposure to investment assets has proven to lead to instability under some conditions, such as freezing of credit markets or fire sales

of (toxic) assets, this thesis documents that not all types of network connectivity are bad and destabilising to the financial sector (Shiller, 2012).

Syndication networks, which are based on collaboration on inter-organisational projects, are in fact shown to lead to resilience and higher degree of stability of FCs and consequently the financial sector as a whole. The consequences of this are that for the purposes of both policy making and corporate strategy, network connectivity should not be treated as a single homogenous concept. Instead, to make any reasoning about network connectivity within the financial sector meaningful, one must specifically define the types of network connections she wants to consider and derive any arguments in such specific context. For this reason, the recommendations I can make for public policy, based on the results of this thesis relate specifically to syndication networks and cannot be easily extended to other types of networks, particularly those that involve counterparty risk, such as lending networks.

In light of this argument, when considering the potential mediating effect of network connectivity on the impact of various shocks to the financial sector, such as the global financial crisis or the looming prospect of departure of the United Kingdom from the European Union, it is important to consider how specific types of network connections are likely to either amplify or reduce the impact of such shocks. Additionally, it is also an important consideration of how such shocks can impact on the structure of such networks and how this in turn affects firm level and sector wide outcomes. Although at this stage any discussion of the potential BREXIT deal is speculative at best, it is very likely that future relationship of the United Kingdom with the European Union is going to entail more, rather than fewer barriers for financial services firms operating in the UK and those in other EU member states to collaborate with each other on joint projects. The results presented in this thesis therefore imply that depending on the severity of such

barriers following BREXIT, financial services firms in the UK involved in the activities studied here are likely to face reduced growth prospects. This is likely to affect disproportionately the firms that currently benefit from syndication ties with their European counterparts and those that serve clients based in other EU member states. On the other hand, lesser connected firms may benefit from a relative reduction in the network connectivity of their co-located competitors. Overall, BREXIT is likely to lead to a contraction in the size of the financial sector in the UK and make FCs in the UK less resilient to demand shocks. It is to be kept in mind that the economic significance of these effects will very much depend on the final terms of United Kingdom's departure from the European Union and is likely to vary from almost inconsequential to quite severe.

The implications for public policy therefore relate primarily to the value of syndication ties among financial services firms. Such ties have been shown to be of value to both the growth prospects of individual financial services firms as well as resilience of FCs. This specifically relates to inter-city ties, while localised ties are not found to have these properties. Consequently, it seems desirable for policymakers not to create any unnecessary barriers to such syndication ties, whether among financial services firms located within different FCs within one country or internationally.

The question of whether there is any scope for a more proactive role for policymakers in these networks is a complex one. What needs to be kept in mind is that such positive properties associated with positioning in syndication networks is tied to the current regime of self-selection among financial services firms to co-syndicate. It has been shown in the related literature that such decisions are made based on the merit of individual syndicate members and involve considerations of trust and managing risk, particularly because of the reputational exposure that syndication entails (Pichler and Wilhelm, 2001; Li and Rowley, 2002; Ljungqvist et

al., 2009). It therefore seems quite difficult for policymakers to be able to contribute to the optimisation of the network structure of syndication networks directly.

What could however be of interest to policymakers are the identified negative indirect effects found between highly connected financial services firms and other lesser connected firms located in their FCs. This finding implies that if the object of policymaking it is to create the right environment for domestic financial services firms to establish themselves and for FCs in a country to become more than platforms for foreign financial services firms, a strategy of reducing barriers to entry of highly connected and already well established overseas financial services firms may be counterproductive. It can be expected that the entry of such well-established and highly connected competitors would intensify the competitive environment and would make it very difficult for domestic financial services firms to grow and develop.

The case of the People's Republic of China can be cited as a fairly recent case of a country developing its capital markets effectively from scratch from early 1990s onwards and it has created numerous barriers that have shielded the domestic financial services firms from overseas competitors. Some of these restrictions have been progressively relaxed as both the domestic capital markets and financial services firms within China have developed, although the current state of affairs is far from open international competition. It however remains an open question, whether such protectionist policymaking can be helpful in developing internationally competitive financial services (Pistor and Xu, 2005).

The implications for corporate strategy will be discussed next. The networking strategy of individual financial services firms is effectively a firm level decision, however it is not entirely up to any single firm, whether its networking strategy could be successfully executed. For this reason, being aware of the benefits of central positioning within syndication networks, which this thesis uncovers, is only half of

the battle. In order for individual financial services firms to benefit from the understanding of the benefits of central positioning within syndication networks, they need to also understand, how they can best optimize their individual networks to derive the most benefit from their network capital. While the related literature on network formation and selection of syndication partners aims to identify the empirical determinants of syndicate partner selection, it is also important to consider the effects of various types of ties on firm level outcomes, such as performance or growth (Li and Rowley, 2002; Lechner and Dowling, 2003; Ljungqvist et al., 2009).

The results derived in this thesis suggest that it is possible to identify, which types of network ties contribute to firm growth and which do not. We find that inter-city ties, that carry brokerage opportunities and ties formed through co-management, rather than lead management appointments carry the most value, while localised ties and ties formed through lead-management appointments do not appear to lead to enhanced growth prospects for firms. Provided that firms only have a limited capacity for the number of syndication ties they can maintain and their creation therefore carriers an opportunity cost, it would be desirable for individual firms to manage their networks in a manner that aims to maximise the number of ties that carry the greatest benefits, i.e. enhanced growth prospects, and avoiding ties that carry no identifiable benefits. This means that individual firms, albeit not able to force others to connect with them, can focus their attention and effort on creating specific types of ties that suit their networking and firm strategy the most and therefore effectively becoming conscious architects of their own networks.

7.5 Limitations

As I discuss in the individual substantive chapters (3-6) of this thesis, it is subject to multiple limitations relating to the theoretical perspectives adopted, methods

used and scope of the empirical analysis conducted. This thesis is conceptually framed at the intersection of world city network research (Taylor and Derudder, 2016), GFNs (Wójcik, 2018), evolutionary economic geography (Martin and Sunley, 2011) and research on underwriting syndicates (Pichler and Wilhelm, 2001; Pollock et al., 2004). Combining these perspectives falls short of a fully integrated theoretical framework of how FCs and GFNs operate, however it provides a good basis for understanding the motivation for the existence of GFNs, their expected structure and propositions relating to the expected benefits that positioning within them carries for both individual firms and FCs. Combining these strands of literature therefore allows me to develop new methods for studying GFNs and FCs jointly and conduct empirical analysis in a manner informed by both microeconomic and cluster level theories.

I am selective in the perspectives I utilize and limit my attention to those that lend themselves well for statistical and network analysis and are compatible with social network analysis techniques, which are indispensable in this thesis. I understand that other, much different perspectives exist, such as the actor-network theory, which could be considered in this context. Those following this perspective however explicitly reject structuralist form of analysis and their work is therefore epistemologically incompatible with the research conducted here (Smith, 2003ab; Smith and Doel, 2011).

The uniting element of all four substantive chapters of this thesis is the focus on network connections among financial services firms. I however do not consider all possible forms of network connectivity. Instead, the scope of this thesis is restricted to a single conceptualisation of network connections among financial services firms, namely syndication ties formed through the co-membership of underwriting

syndicates of equity and debt securities[49]. As I describe in more detail in the second chapter of this thesis, this is only one of many ways that FABS (or any other) types of firms can connect with each other. Additionally, also connections between FABS firms, their clients and offshore jurisdictions play an important role in GFNs, although for different reasons (Wójcik, 2018). These types of network connections certainly deserve their own attention and would be best addressed in a separate study.

There are however compelling reasons, why we focus on syndication ties out of the many alternative conceptualisations of network ties. Underwriting syndicates are well theorized and understood by finance academics and many of their aspects can be extended to understand much broader phenomena relating to co-production of services by competing producers (Pichler and Wilhelm, 2001; Pollock et al., 2004). The high quality and comprehensiveness of databases covering capital market deals, including primary issues of equity and debt securities, allows for easily scalable and truly global analysis of syndication networks. As I show in chapter 4, availability of data on whole networks is a crucial consideration for robustness of empirical results and replicability of research that considers network and node structural parameters. Finally, co-membership of underwriting syndicates offers a truly relational and meaningful building blocks for network analysis, offering a direct representation of inter-firm interactions.

The econometric and network analysis conducted in this thesis is also subject to a number of limitations. First, the scope of the analysis is restricted by the types of activities considered and is limited by data availability to a maximum sample period of 1993 – 2016. The core of the analysis of this thesis considers equity and debt securities underwriting services and chapter 6 extends this by including

[49] In chapter 6 I also consider co-membership of syndicated loans and M&As as empirical extensions of this approach.

syndicated loans and M&As. In addition, I only study the syndication ties and revenue earned by securities underwriters (chapters 3-6), syndicated loan underwriters and M&As acquirer and target advisors (chapter 6) and do not explicitly consider accounting, law and other FABS firms that contribute to these transactions. The reason for doing so is primarily rooted in the way data on capital transactions is collected. While the comprehensiveness of coverage of transactions for securities and syndicated loans underwriters and M&A advisors is a primary focus and one of the key measures of database quality for companies like Thomson Reuters or Dealogic, coverage of accounting, law and other FABS firms working on these transactions is considered an auxiliary activity with correspondingly worse coverage and rampant missing data problem. Correcting for such deficiencies in these databases would effectively equate to hand collecting such data items for hundreds of thousands of such transactions and is therefore not feasible.

Second, I only use secondary data on capital market transactions, firms and urban, regional and country level statistics. I do not collect any primary data in the form of interviews or surveys. This therefore imposes some hard limits on this thesis in form of the relevant and available secondary data. Consequently, I am unable to investigate the underlying behaviours, motivations and thought processes behind the formation of syndication ties.

Third, the empirical analysis conducted in this thesis relies primarily on social network analysis and econometric modelling methods. As a result, it is most informative about the structure of the networks investigated, the stability and reliability of their structural parameters and offers evidence of statistically significant relationships among variables hypothesized to be related. What it does not do however, is to provide us with a nuanced understanding of human agency, thought processes and motivations underlying the studied phenomena. It therefore

leaves many opportunities open for qualitative researchers eager to conduct such interviews and drill into the practices and behaviours underlying underwriting syndicates to fill these gaps.

Finally, the focus of this thesis is on improving the existing methods for studying urban networks and using node structural parameters as explanatory factors for firm performance and cluster resilience. This thesis however does not study the mechanism underlying the formation and evolution of these networks. Despite some existing work on the topic, the process of evolution of syndication networks does not lend itself well even to the state of the art modelling techniques due to its specific structural properties, which violate the underlying assumptions of Markov chain processes, namely the evolution of networks in micro steps of one tie formed or dissolved at a time (Snijders et al., 2010). I therefore leave this question for future research to answer.

7.6 Directions for future research

The most immediate directions for future research can be identified by examining the limitations of this thesis, which I discuss in detail in the previous section. Additionally, the scope of the GFNs framework (Coe et al., 2014; Wójcik, 2018), which in many respects surpasses the work carried out in this thesis can be a viable roadmap for future research. Perhaps the single most important direction that future research in this area should consider is extending the methods and analysis of this thesis to a wider set of FABS. There are very compelling reasons for doing this.

First, financial services firms are not the only firms that engage in the production of financial services in general and neither the types of services associated with capital market transactions as studied here. Instead they are co-produced with other FABS firms, such as accounting, law, management consultancy and sometimes even information technology and other firms. To build a better

understanding of such co-production of FABS and the role of inter-organisational projects in these networks, it would be very valuable to build a more complete image of these ecosystems of firms.

Second, extending the research conducted here beyond the four types of capital transactions considered would also have an important merit. The activities of individual organisations are rarely quite so narrowly focused that they would neatly fall into such a small set of categories and therefore it would be useful to consider, how contemporary financial institutions evolve and move into other, more innovative types of services. This however naturally presents its own set of empirical challenges, which will need to be addressed as part of future research. My own ambition in this respect is to work towards identifying suitable opportunities for the investigation of co-production of at least a limited set of services by a wider variety of FABS firms and studying the structure of such co-production networks.

The formation and evolution of GFNs is not yet well understood or empirically researched and therefore this also creates a potentially very fruitful area of future research. Developing models of network evolution would be very useful not only to build an appreciation of the causal mechanisms underlying GFNs, but it could also be used for simulating the impact of various distortions to the network structure on its stability and likely future trajectories. This is exactly the type of research that would be needed to predict the impact of various exogenous shocks on GFNs, such as the upcoming departure of United Kingdom from the European Union (BREXIT). Understanding the ability and willingness of FABS firms to overcome various regulatory or proximity related barriers in collaborating with each other would then allow for a simulated scenario based analysis based on expectations of the severity of barriers that BREXIT can create for FABS in the United Kingdom and the rest of Europe.

While the focus of this thesis was on underwriting syndicates, a form of inter-organisational projects, that feature co-producers delivering a service for a single client, the scope of the GFNs framework goes far beyond this narrow view of FABS networks. FABS within the GFNs framework are understood as connecting FCs with offshore jurisdictions and the rest of the world (i.e. issuers, investors). This means that it would also be interesting to consider the transactional networks between FABS and their clients in the rest of the world. Offshore jurisdictions are typically treated as a topic of their own, particularly due to the importance of law and regulation in this context. Consequently, the connections between FCs and offshore jurisdictions facilitated by FABS on the behalf of their clients and with implications for the rest of the world (i.e. taxpayers, states, public finance etc.) are likely to follow their own set of organising principles. It is for this reason that one model is unlikely to explain all these different types of network connections and instead all of them need to be considered on their own merits.

There is also a substantial scope for future research in exploiting the identified, yet unfilled gap in the present literature – the thought processes, human behaviours, motivations and power relations underlying the formation and operation of GFNs (Clark et al., 2012; van Meeteren and Bassens, 2016; Clark, 2018). Although the outcomes of these processes can be identified from statistical and network analyses, such results are in their very nature only indirectly related to the underlying processes. In other words, one can identify statistical patterns that are consistent with certain human behaviours or thought processes, but this is not to say that it cannot be consistent with others. This problem of inseparability of some competing models of human behaviour in research based on secondary data and quantitative techniques is a problem that is perhaps best resolved by engaging the relevant actors and carrying out detailed fieldwork to pinpoint the relevant processes responsible for the observable patterns in the data. The work

carried out in this thesis can therefore be helpful in guiding such an enquiry by having identified statistical regularities in representative datasets. It now remains to enrich these findings with more nuanced understanding of these phenomena based on human agency and individual thought processes.

Appendix - List of abbreviations

APS	Advanced producer services
ASX	Australian Securities Exchange
BREXIT	Departure of the United Kingdom from the European Union
BvD	Bureau van Dijk
CAS	Complex adaptive system
CIFR	Centre for International Finance and Regulation
DCM	Debt capital market (database)
ECM	Equity capital market (database)
EEG	Evolutionary economic geography
FABS	Financial and business services
FAME	Financial Analysis Made Easy (database)
FC	Financial centres
GATT	General agreement on trade is services
GaWC	Globalisation and World Cities (research group)
GFC	Global financial crisis
GFN	Global financial networks
GMM	Generalised method of moments
GPN	Global production networks
ICT	Information and communication technology
IPO	Initial public offerings
IVs	Instrumental variables
IWCNM	Inter-locking world city network model
LOANS	Syndicated loans (database)
M&As	Mergers and acquisitions
MDP	Market demand proxy
MNE	Multinational enterprise
MSA	Metropolitan statistical area
NAICS	North American Industry Classification System
SDEM	Spatial Durbin error model
SDM	Spatial Durbin model
SIC	Standard Industry Classification
WCN	World city network
WTO	World Trade Organisation

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