Department of Economics Discussion Paper Series

Housing and Macroprudential Policy

John Muellbauer

Number 1056
November, 2024

Department of Economics
Manor Road Building, Manor Road
Oxford, OX1 3UQ

ISSN 1471-0498

Housing and Macroprudential Policy

John Muellbauer

Abstract

Housing has been heavily implicated in many financial crises, e.g. in the Global Financial Crisis of 2008-9. Since the GFC, new macroprudential frameworks have been introduced across the globe, with housing-related tools prominent. This paper explains how the housing-related financial accelerator operates, and discusses institutional differences affecting the transmission and amplification of house price and credit shocks and therefore risks to the financial system and to the resilience of households. The objectives of housing-related macroprudential policy are discussed and research on diagnosing potential housing risk critically reviewed. Limitations of the literature on the effectiveness of housing-related macroprudential tools in international panel studies are examined, including from the neglect of country-heterogeneity, except in fixed effects. How aggregate cost-benefit analyses of the consequences of macroprudential policies has benefitted from the development of the Growth-at-Risk framework is explained. Research is reviewed on the distributional implications, often negative in the short-run, for example, on access to credit of lower income and first-time buyer households, but beneficial in the longer run. The importance of a general equilibrium approach integrating micro and macro data is emphasised, and developments in the agent-based modelling approach are discussed. The need to coordinate macroprudential policies with other housing-related policies is highlighted.

Keywords: housing and financial stability, macroprudential policy, borrower-based measures, effectiveness of loan-to-value and debt-to-income restrictions, costs and benefits of macroprudential policy, distributional effects of macroprudential policy.

JEL codes: E32, E44, E58, G10, G28.

Acknowledgements
This paper was commissioned for the Research Handbook of Macroprudential Policy. I would like to express my appreciation to Janine Aron for discussion and greatly improving the clarity of the text. The paper has also benefitted from earlier work with Jagoda Kaszowska commissioned by Finansinspektionen in Sweden on borrower-based macroprudential measures, and discussions of many of the issues at the subsequent workshop in February 2024 and at the CGFS-Banque de France conference on macroprudential policies to mitigate housing market risks in June 2024. I am grateful to David Aikman, and to Roland Meeks at the IMF for thoughtful comments, and to Dame Colette Bowe and FPC staff at the Bank of England for helpful discussions.

CONTENTS

1. Introduction.

Since the Global Financial Crisis (GFC) of 2008-9, there has been far greater attention by financial regulators and central banks to risks to financial stability. Macroprudential policy governance structures have been reformed and risk indicators and toolkits enhanced. The aim is to reduce systemic risk and to improve the resilience of the financial system as a whole by limiting the build-up of financial vulnerabilities, thus avoiding costly economic downturns or financial crises that disrupt credit and other financial services vital for stable economic growth. Housing and real estate were heavily implicated in the GFC, and indeed in earlier banking crises, for example, in Norway, Finland and Sweden in the early 1990s. Schularick and Taylor (2012) delve into the historical patterns of real estate cycles and their association with financial instability. They identify a recurring pattern wherein periods of rapid credit growth and booming real estate markets are often followed by sharp corrections and financial crises. Their findings suggest that policymakers should pay close attention to the dynamics of real estate markets to prevent future crises. Mian and Sufi (2014) have also highlighted the crucial link between real estate booms, excessive borrowing, and subsequent financial crises. They argue that the housing market can act as a 'trigger' for broader economic downturns. For instance, in the lead-up to the 2008 global financial crisis, the rapid expansion of mortgage credit fuelled a housing bubble, which eventually burst, leading to widespread foreclosures, bank failures, and a severe recession. Moreover, research by the Bank for International Settlements (2017a) sheds light on the interconnectedness between real estate markets and the broader financial system. They emphasise the role of real estate as a channel through which financial imbalances can propagate across borders, amplifying the impact of crises. In particular, the BIS has warned about the risks posed by excessive real estate lending and the potential for price bubbles to destabilise both domestic and global financial systems. Unsurprisingly, housing has received special attention in the development of new macroprudential frameworks, discussed in BIS (2017b).

In the development of these frameworks, identifying and mitigating potential vulnerabilities has been seen as the key, Adrian et al. (2015) and Adrian (2017), with household vulnerabilities receiving emphasis. The work on growth-at-risk (e.g. Adrian (2019); Prasad et al. (2019)), and summarised in this *Handbook* by the chapter by Nina Boyarchenko, has burgeoned and influenced macroprudential policy. This emphasises the downside risk to GDP and the role that financial factors play in generating such risk. However, a major downturn in GDP does not necessarily involve a full-blown financial crisis. For example, suppose that excessively loose lending standards result in a build-up of financial vulnerabilities and over-shooting of asset prices and credit beyond fundamentals, especially for real estate, due in part, as Adrian (2017) argues, to the tendency of market participants to form extrapolative expectations. When negative shocks arrive, bad loans mount and with higher NPL ratios, the capability and appetite of lenders to provide credit to the private sector shrinks. A rapid tightening of loan standards then exacerbates the downturn, with negative repercussions including higher levels of bankruptcies, home repossessions, loss of jobs and income. Such a classic credit cycle can occur without a widespread financial crisis, especially where the banking system is oligopolistic, generally profitable and well capitalised enough to survive an otherwise damaging recession.

In the context of housing, there are two major triggers for payment arrears and foreclosures, which drive NPL ratios of the mortgage lenders. The large literature on the “double trigger” model, surveyed in Aron and Muellbauer (2016 a,b) points to negative equity and cash-flow problems in servicing debt as the key issues. Negative equity can arise if a period where high loan-to-value loans have been prominent, is followed by a major fall in house prices. Cash-flow problems can arise if income drops

and unemployment rises, and in floating rate environments, interest rates rise. If home equity cushions are too small to make selling the home an option for borrowers to avoid cash-flow problems, that can contribute to payment defaults and foreclosures.

Institutional heterogeneity across countries and, indeed over time, including the prevalence of floating vs fixed interest rate loans and the structure and regulation of the banking system, greatly influences the risks of such damaging credit cycles and financial crises. This is the theme of Section 2, which highlights key characteristics of financial systems and of housing institutions that affect the transmission and potential amplification of shocks between the real economy and the financial sector.

How to diagnose potential risks, for example by measuring lending standards and signs that a housing market is too overheated, or that mortgage debt is excessive is the subject of Section 3. The dashboards of risks developed by the European Systemic Risk Board and other regulators emphasise these risks. What gaps remain and how improvements in tracking granular and macro data could help such diagnoses are discussed.

The burgeoning literature on the evaluation of the effectiveness of macroprudential tools is the subject of Section 4. Policy makers need to choose policies from a menu of available buyer-based measures (BBMs), such as limits on loan-to-value (LTV) or debt-service-to- income (DSTI) ratios, and lender-based measures such as risk-weights or aggregate or sectoral counter-cyclical capital buffers on lending institutions.

Macroprudential measures can have costs to the individuals and lenders whose choices are constrained, as well as benefits. Cost-benefit analysis based on aggregate GDP, discounted over a policy-relevant horizon, is one policy evaluation method. Research on Growth-at-risk is well suited to analysing the intertemporal aggregate cost-benefit trade-off. But this ignores distributional effects, research on which is reviewed in Section 5, which also examines the data and research methods appropriate to evaluating the welfare consequences of macroprudential measures.

Macroprudential measures can be the second or third best policy option when markets are deeply dysfunctional. Section 6 examines the coordination with other policies and how other government policies can ease the task of macroprudential authorities to promote economic stability.

Section 7 draws brief conclusions.

2. The case for macroprudential intervention: the financial accelerator and institutional heterogeneity.

The financial accelerator propagates and amplifies real estate shocks to the wider economy, which can result in a financial crisis and seriously damage household wellbeing. Institutional heterogeneity in real estate markets across the different countries, and the institutional evolution over time, can affect the transmission channels of real estate prices as well as the scope for amplification of such shocks. Mitigating the resulting risks is the rationale for macroprudential policy interventions, but these need to be sensitive to the institutional structure of each economy.

2.1 The financial accelerator for real estate and the financial system.

It is now well-accepted that the linkages between the financial system and global economy, some non-linear and destabilising, were not well understood before and during the GFC. In that crisis, falling real estate prices were amplified within the financial system, and by its interaction with the real economy, leading to further price collapses. Examining how the processes of interaction between the real estate market, the financial system, and the real economy operated in the GFC gives important insights into risks for financial stability. More generally, this helps to illuminate the complex ways in which real estate markets interact with the economy, including in more normal cyclical fluctuations. This also provides a useful background for thinking about the complex channels of monetary transmission via real estate, which are relevant for coordinating monetary and macroprudential policy.

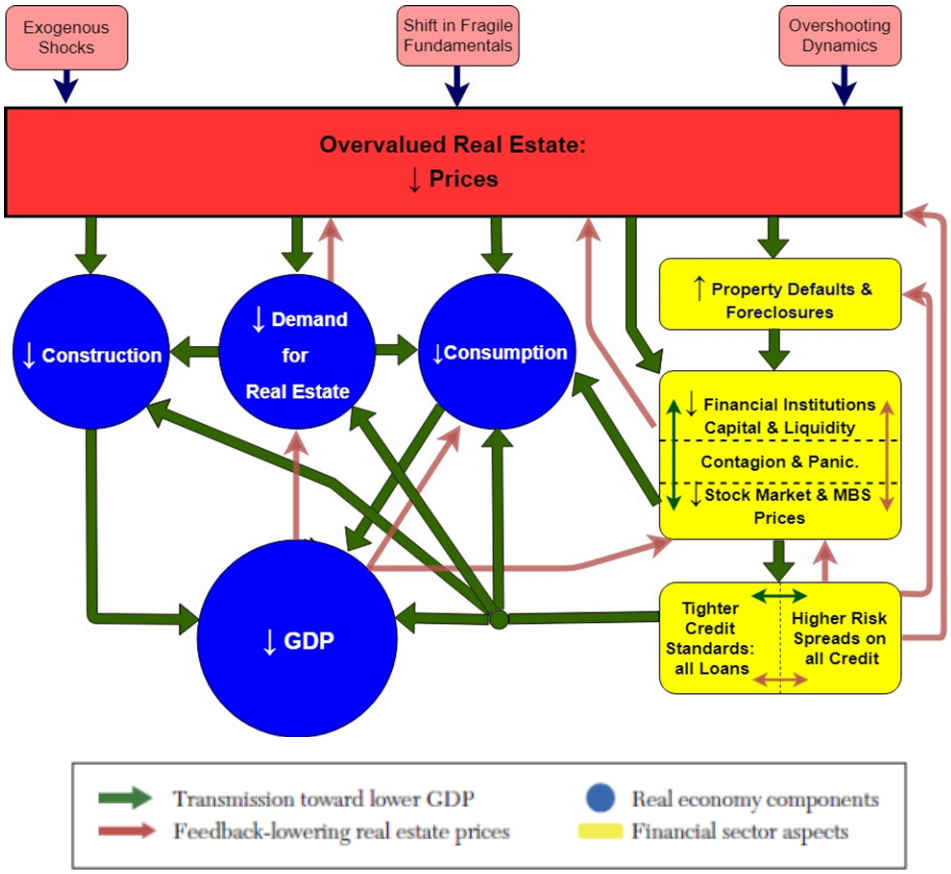
One example of a poorly understood linkage is the pre-crisis deterioration of lending standards in the US. This was a major factor in the boom and subsequent sub-prime crisis, see spatial evidence by Dell' Ariccia et al. (2012), and the tightening of standards in the crisis then amplified the downturn. Lax lending standards pre-crisis, combined with the tendency of market participants mainly to form house price expectations by extrapolating recent house price changes Duca, Muellbauer and Murphy (2021a) and Kuchler et al. (2022)), caused a substantial over-valuation of house prices relative to fundamentals, creating serious risks for financial stability.

Depending on local circumstances, the possibility of amplifying transmission and feedback processes, can generate a powerful financial accelerator. Figure 1 illustrates how a house price fall from an overvalued housing market transmitted in the US during the GFC, and we offer contrasts with European nations.

The transmission channels from falling real estate prices (top red rectangle) to the real economy are shown on the left-hand side of Figure 1 (blue circle). Lower real estate prices, amplified by extrapolative expectations from recent price declines, caused a fall in demand for real estate and lowered the profitability of building. Many home-builders were bankrupted after a collapse of cash flow and of the value of their land banks, with an ensuing slump in residential investment. An important demand channel is to consumer spending (the third thick transmission arrow from the left). The lower house prices weakened consumer spending, since housing collateral is an important driver of consumption in economies such as the U.S. GDP then fell with reduced consumption and construction.

The transmission channels from falling real estate prices into the financial sector are shown on the right-hand side of Figure 1 (yellow rectangles). With the decline of real estate prices and the concomitant rise of many mortgage payments (due to reset clauses), there was a rise in mortgage delinquencies and foreclosures, shown in the small top rectangle. Real estate losses mounted at financial intermediaries, particularly on commercial mortgage-backed securities and private label (residential) mortgage-backed securities. The combination of losses on commercial and residential real estate undermined the capital positions of commercial and investment banks. This included the lightly-regulated shadow banks, which had accumulated large real estate positions. Contagion within the financial system soon amplified these shocks. This contagion is indicated within the middle yellow rectangle on the right of Figure 1.

Figure 1: The Financial Accelerator in the US Sub-Prime Crisis.



Source: Duca et al. (2021).

There were further effects on credit availability and risk spreads through the tightening of lending standards, and even beyond the real estate market. This is depicted by the transmission channel from the middle to the lower yellow rectangle on the right (and see e.g. Brunnermeier (2009) and Bernanke (2018) and Duca, Muellbauer and Murphy (2021a) for more details).

In the Euro area, Spain and Ireland had severe banking crises in 2009-10, with similar mechanisms at work but via simpler structures of more bank-based financial systems.[1] Maturity mis-match was particularly serious in Ireland. Elsewhere in the Euro area, e.g., Italy and Greece, banking problems were far more the consequence of the sovereign debt crisis than of real estate problems, per se. Differences in institutions and in financial regulation, see Maclennan, Muellbauer and Stephens (1998) and Cerutti, Dagher, and Dell'Ariccia (2017), explain the relative stability of outcomes in countries such as Germany, the Netherlands and France, even with pronounced credit and real estate cycles in the latter two economies. Table 1 summarises the key mechanisms underlying the different channels and feedbacks for real estate in the financial accelerator, and documents how heterogeneity in housing-related institutions and regulatory changes across countries over time are important for stabilising or amplifying the shocks.

[1] There were also many parallels in the Scandinavian crises of the early 1990s. At its root was financial deregulation, combined with mortgage interest deductibility at high marginal tax rates, which triggered enormous house price and credit booms. Negative shocks for Scandinavian countries arrived with German unification in 1990, driving up interest rates in Europe, and for Finland, a collapse of its exports to the former Soviet Union, see Honkapohja (2009).

Table 1: Transmission and amplification of a negative house price shock in the GFC.

Channels and feedbacks	Key mechanisms	Sources of heterogeneity between countries: amplifying or stabilising?
From falling house prices to the real economy, and back.	Lower construction volumes as profits fall and land banks lose value.	Pre-crisis ratio of real estate investment to GDP differs; elasticity of construction volumes to real estate prices differs; share of public sector housing differs.
	Lower consumer spending as collateral for home equity withdrawal falls.	Access to home equity loans differs greatly between countries, e.g., high in the US, low in Germany.
	Lower spending on property services as real estate demand drops and transactions volumes decline.	Ratio of property services to GDP differs, e.g., with degree of financialisation.
	Amplification as extrapolation of falling prices, and lower incomes further reduce demand for real estate.	Tendency to extrapolate is higher where homebuyers are more heavily geared and where property taxes are weakly linked to current market values.
From falling house prices to the financial sector, and back.	Mortgage delinquencies and foreclosures rise.	Greater where lax regulation permits high levels of gearing both for banks and borrowers, and fixed rate mortgages slow transmission of policy mitigation, though when rates rise, the impact is faster in floating rate environments.
	Losses mount at financial intermediaries, particularly on commercial mortgage-backed securities and private label (residential) mortgage-backed securities, undermining capital positions of banks.	Greater where high levels of maturity mismatch exist in funding mortgages.
	Credit availability to the real estate sector falls and risk spreads rise.	Greater where systemic risk is high, i.e. where the degree of leverage, maturity mismatch, the degree of interconnectedness, levels of complexity and/or the prevalence of mispricing of risk pose problems. In turn, these depend on the quality of prudential regulation and financial sector structure.
	Amplification occurs via contagion in the financial sector and falling prices of financial assets (e.g., Brunnermeier, 2009; Bernanke, 2018).	Greater with high interconnectedness and complexity.
From the financial sector to the real economy.	Credit availability to the other sectors falls and risk spreads rise.	Greater where corporations have high debt levels and vulnerable balance sheets.
Amplification via feedback on real incomes.	Impact on investment.	Greater where household debt levels are high, liquid assets low, and households are dependent on new credit.
	Impact on consumption via tighter credit and lower financial asset values.	Greater where household illiquid financial assets to income ratios are high.

From the real economy to the financial sector.	Fall in GDP and household incomes cause further drop in profits in financial sector.	Greater where financial sector is heavily geared.

Source: Constructed by author.
Notes: Systemic risk is defined by Adrian et al. (2015) as "the potential for widespread financial externalities—whether from corrections in asset valuations, asset fire sales, or other forms of contagion—to amplify financial shocks and in extreme cases disrupt financial intermediation".

2.2 The financial accelerator: the importance of institutional heterogeneity.

Institutional differences between countries matter greatly for transmission and amplification, as exemplified in the final column of Table 1. The main categories of institutional differences are laid out in Table 2. One category concerns the tenure structure (whether owner-occupied, market rented or socially rented), the prevalence of rent controls and the allocation rules governing access to social housing. For countries with a high fraction of market renters, the transmission of higher house prices to non-housing consumption is likely to be lower, while a large socially rented sector reduces the scope for amplification of house price shocks.

Another key difference between countries, and over time, concerns the proportions of adjustable and fixed rate mortgages, and the durations of fixed contracts (including pre-payment penalties for refinancings of fixes). Amortisation requirements, see Table 2, can also differ between countries. The lengthening of loan contracts, or the switching to interest-only loans, in response to tighter regulation or higher prices, effectively loosens lending standards since the monthly repayment element of debt service is then reduced. The experience of the inflation and interest rate shocks in 2022-24 has strongly reinforced the importance of the fixed/floating distinction. In general terms, with floating rates, the risks of higher rates are transferred to households, with knock-on effects on aggregate consumer spending and the wider economy, and bank profitability can even increase. With fixed rates, the financial system bears more of the risk, including the risk of bank runs if deposits are very concentrated or 'flighty'.[2] With floating rates, if the source of instability does not stem mainly from higher interest rates, as long as monetary policy is unconstrained,[3] easier monetary policy can quickly ease the cash-flow problems for households and other borrowers and support house prices. The US crisis in 2008-2011 was far worse than in the UK for two main reasons: more lax preceding lending standards; and predominantly fixed-rate mortgages, so that lower policy rates did not quickly ease financial pressure on highly levered US households unable to refinance their mortgages as the usual refinancing channel was impaired.

The lender response to defaults of housing loans also differs across countries (and within large countries such as the US), e.g. whether mortgage are full recourse or not, see Table 2. For example, in the US, there is recourse to potential foreclosure, though this varies by State. By contrast, in France, most housing loans are instead covered by a collective insurance scheme among lenders. Negative equity is much less of an issue under collective insurance arrangements, as long as the mortgage continues to be

[2] On the other hand, since in Europe, for example, there is no mark-to-market of the fixed rate loan book of banks (i.e. a revaluation of the loan book at current prices when interest rates change), lenders are protected in that their loan book valuation remain the same even when interest rates alter.
[3] Examples of constraints on monetary policy are membership of a monetary union, where monetary policy is set outside the country in question; high inflation, which prevents cuts to rates as in 2023-4; and being in a small open economy vulnerable to capital flows.

paid. Hence, onerous debt-service problems for individuals create much more of a risk to financial stability in France than does negative equity (by contrast with the US where both matter).

Another category that affects the amplification of shocks, concerns whether home equity withdrawal is permitted and under what regulatory conditions. If permitted, this amplifies house price shocks through the consumption channel, with wider stability implications. Access to home equity loans tends to be easier in floating rate environments, or where short-term fixes prevail, such as in the UK, Australia, New Zealand, South Africa, Norway and Sweden. The US and Denmark with fixed rate mortgages are exceptions to this, as they also have easy equity withdrawal.

The funding source for housing finance, whether retail or wholesale deposits, bank or non-bank, whether securitized or not, or from a covered bond, is relevant because funds may not be sustainable, and there can be duration mismatches between the funding source and the duration of the mortgage. The failure of the Northern Rock Building Society in the UK (though duration mismatch was not the only factor, Shin, 2009), and most of Irish banking system during the GFC are cases in point. In some countries, loan brokers play an important part in the nature and dynamics of funding. With rewards to brokers coming from high transactions volume, loan quality can suffer. In the US, the ill-matched incentives of loan originators and servicers contributed to poor loan quality in the house price boom of the 2000s, exacerbating the financial crisis.

Table 2: Institutional difference that affect the transmission and amplification of shocks and policy

Housing institutional differences
Tenure structure: owner-occupied, private and social rented, rent controlled or not.
Proportions of adjustable and fixed rate mortgages.
Amortisation requirements: that is, how much of a loan has to be repaid each period.
Are housing loans full recourse: that is, can lenders easily access housing collateral? Or is there a public or private collective insurance scheme covering housing loans?
Is home equity withdrawal permitted (i.e. extending loans based on housing collateral without a connected property transaction) and how easily can it be implemented?
Funding sources for housing finance: from retail or wholesale deposits, securitized or not, covered bond?
The nature of property taxes: linked to recent market values, size and fairness.
Is mortgage interest tax-deductible, size and limitations?
The size of real estate transactions costs such as transfer duty and agent fees.
The tightness of planning controls.
The sensitivity of residential investment to house prices.
Non-housing institutional differences
The structure of the financial system: degree of leverage, maturity mismatch, the degree of interconnectedness, levels of complexity.
Micro- and macroprudential policy (non-housing).
Source and type of shocks, and the fiscal capacity to respond to shocks.

The structure of taxation is another important institutional feature: whether and how (e.g. with what limits) mortgage interest is tax-deductible; and the structure of property taxes, including the frequency of valuations. Tax deductibility of mortgage interest encourages household leverage, which tends to increase house price volatility. The use of proportional (or progressive) property taxes, with frequent

revaluations, has important stabilizing effects on house prices, including by providing an incentive against high leverage.[4] Where property taxes are unrelated to recent market valuations and where generous tax deductibility of mortgages has encouraged high levels of household gearing, house prices are likely to be more volatile. The size of transactions taxes such as stamp duty (the transfer tax in the UK) and real estate agents' fees, which can change with technology and competition rules, can have multiple adverse effects for household vulnerability. Lowering transactions costs increases flexibility both for location and tenure switching. For first-time buyers, the flexibility could affect their purchase options when faced with tighter loan standards or shocks to house prices, interest rates or income. For house-owners, providing they have a net equity cushion, low transactions costs give the option of downsizing or switching tenure when interest rates rise or they become unemployed, reducing their vulnerability.

Tight planning controls on land supply have a significant impact on labour market flexibility and hence on the resilience of households in the face of shocks.[5] This has been established by OECD research on mobility by Causa and Pichelman (2020). For both owner-occupier and rental markets, the state of supply and demand in the housing market affects household vulnerability. A tight housing market restricts the options for households facing negative shocks. And a limited supply of housing with rising demand drives up house prices relative to incomes, itself inducing vulnerability.

Another element of the transmission mechanism that can potentially amplify shocks to the housing market is the sensitivity of residential investment to fluctuations in house prices, interest rates and credit conditions. Sensitivity refers to how quickly residential investment responds to higher house prices and how elastic investment is to higher house prices, in the medium- to long-run. A slow and inefficient land use planning system tends to reduce both. The collapse of highly-sensitive residential investment in the GFC in Ireland, Spain and the US contributed substantially to the fall in GDP and the rise in unemployment.

Even Table 2 does not do full justice to the idiosyncrasy of institutional differences. Examples are Denmark's unique covered mortgage bond, South Korea's jeonse, wherein tenants advance a large capital sum to landlords in lieu of rent, to be repaid when the tenancy ends, and cooperative housing schemes widespread in countries such as Austria and Sweden.

Collectively, adverse combinations of several institutional features listed in Table 2 can result in high percentages of housing values represented by land. For example, in the UK, regressive property taxes unrelated to market values, tight planning controls, poor infrastructure development, and the shrinking of the social housing stock (council housing), all contributed to raise the value of housing values represented by land.[6] In recent years, over 70 percent of the average value of UK homes has been in the land, with less than 30 percent in the buildings. This is the highest such share among the G7 economies, see Muellbauer (2023). As land values are far more volatile than building costs, and more prone to overshooting, these high land share percentages necessarily increase risks to financial stability and to household vulnerability. On this criterion, the UK looks more at risk than other advanced countries.

[4] This stabilising potential is missing in the UK and in Sweden. In the UK, the domestic property tax, the Council Tax, is highly regressive and based on outdated 1991 valuations. Sweden reduced the domestic property tax in 2008, and capped it at a low level.

[5] This is exacerbated by failures to provide complementary infrastructure investment with housing development, such as transport links.

[6] Another factor is the disproportionate property rights of landowners in the UK as compared with other countries. On this, and the selling off of council housing, inter alia, see Muellbauer and Soskice (2023).

Since the GFC far more attention has been given to institutional differences between countries in accounting for the highly heterogeneous nature and impact of real estate booms and busts, and indeed their absence in some countries, e.g. Crowe et al. (2013). This is exemplified by a widely-cited panel study, Cerutti, Dagher, and Dell'Ariccia (2017), which focused on housing finance differences between countries measured in 2005. These encompass a subset of those listed in Table 2: the maximum available loan-to-value ratio on a housing loan, the term to maturity, mortgage interest tax relief, whether mortgage rates are fixed or adjustable and the funding type (retail deposit, wholesale, securitised, covered bonds or other). Cerutti et al. analyse an (unbalanced) panel dataset of 50 countries for 1970–2012 and find that house price booms are more likely in countries with higher LTV ratios and mortgage funding based on wholesale sources or securitization. This is consistent with the earlier discussion of leverage. They note that most house price booms end with a recession, and that such downturns tend to be deeper and longer when preceded by booms in both residential mortgages and other private debt, and with reliance on non-retail deposit funding that can cause duration mismatch on lenders' balance sheets. However, they do not explicitly consider the consequences of differential access to home equity withdrawal. Maclennan, Muellbauer and Stephens (1998) had earlier pointed out that Ireland, the UK, and to a lesser extent Sweden, tended to be at one extreme of a cluster of the above institutional features, which would imply that membership of the European monetary union would result in high risks of instability given the constraint of a largely exogenous monetary policy and a fixed exchange rate.[7]

Turning to non-housing institutional differences, see Table 2, these include the structure of the banking system in terms of the degree of leverage, maturity mismatch, the degree of interconnectedness, and levels of complexity. Vulnerabilities can arise from high levels of interconnectedness and duration mismatch with serious implications for the depth of a potential crisis. The nature of bank regulation and the application of other (non-housing) macroprudential policies such as overall and sectoral capital requirements on lenders and the Counter Cyclical Capital Buffer (CCyB) setting,[8] affect the leverage of lenders to the housing market. In turn, lower levels of bank leverage tend to result in more cautious loan standards for households, reducing vulnerabilities in the face of negative shocks.

Finally, the nature of the shocks that could destabilize the economy and increase household vulnerability, and the macroeconomic and distributional context in which they occur, matter greatly, and their effects interact with the above characteristics. For a small open economy, an exogenous inflation shock that raises nominal interest rates, as in 2022-23, is clearly different to an exogenous shock to credit availability and risk appetite, as in the 2008-09 GFC and the subsequent European sovereign debt crisis. High levels of income inequality in the lower quintiles of the household income distribution and weaknesses in the social safety net predispose households to greater vulnerability following shocks. The fact that inflation in 2022-3 was most pronounced for food and energy, which have large budget shares for poorer households, also exacerbated household vulnerabilities. The government's fiscal capacity is another potentially important issue as it could limit the extent of fiscal measures to help vulnerable households.

[7] These arguments proved an important input into the 'Five economic tests' the UK Treasury set in 1997 before deciding that the UK should not join EMU.

[8] Under Basel III, the countercyclical capital buffer sets banking sector capital requirements to protect the banking sector from periods of excess aggregate credit growth often associated with the build-up of system-wide risk. In downturns, relaxing the CCyB helps to reduce the risk that the supply of credit will be constrained by regulatory capital requirements that could undermine the performance of the real economy.

2.3 The case for macroprudential policy.

Claessens (2015) argued that "only externalities justify a macroprudential approach". A formal analysis of such an externality was set out in a New Keynesian model by Korinek and Simsek (2016), who examine a demand externality arising from a liquidity trap, where the lower bound on interest rates applies. They show that limiting household leverage through macroprudential policy can then improve welfare. However, real estate is missing in their model and the function of debt is merely to smooth consumption over time. The non-linear system dynamics and hence the scope for multiple equilibria revealed by the above discussion of the role of real estate in the GFC implies a far more general justification for macroprudential intervention than that given by Korinek and Simsek. A second justification lies in correcting the market failures arising from systematic distortions of incentives in finance. These were prominent in the GFC.[9] A third justification is the protection of poorly-informed consumers. Research on financial literacy suggest that many consumers do not fully understand compound interest, and many stock and housing market participants tend to buy near the top of the market and sell near the bottom. The reduction in volatility that macroprudential policy could help bring about, e.g. of house prices, would especially benefit the less sophisticated consumers. The signal-to-noise ratio in their information environment should improve with lower volatility, resulting in smaller errors in decision-making. The argument here is that there is therefore a role for macroprudential policy *in addition* to that played by market conduct authorities concerned with consumer protection.

3. The development of housing-related macroprudential policy.

After the experience of the GFC, the monitoring of financial stability and the development of macroprudential policies has become a high priority at central banks and at the IMF and the BIS. Radical changes have occurred in Europe, for example with the setting up of the ESRB and the development of large financial stability departments at the ECB and at all the national central banks. Many countries have raised capital requirements on banks, toughened micro-regulation, carried out regular stress tests on banks and have implemented a range of macroprudential tools, both capital and borrower-based. The IMF has played a key role. For example, its Financial Soundness Indicators for many countries and its Financial Sector Assessment Program have enhanced the scrutiny of risks to financial stability, including from cross-border spill-overs from countries with systemically important financial institutions (SIFIs). Analytical work at the IMF and the BIS, e.g. BIS (2017b) has advanced understandings of financial stability risks and encouraged the development of micro- and macroprudential policies around the globe. Among these, housing related macroprudential policies have received special attention, as housing and housing-related credit have been prominent in many past crises.

3.1 The objectives of housing-related macroprudential policy.

Being clear about the objectives of macroprudential policies to mitigate housing-related risk is an important starting point. For the 14 countries studied by CGFS (2023), summarised in this Handbook in the chapter by Ryan Banerjee and Philip Wooldridge, all macroprudential authorities put maintaining

[9] Michael Lewis's "Big Short" and the Charles Ferguson film "Inside Job" explained to a wide audience how mis-aligned incentives in finance led to 'liar' and 'no income, no job' (NINJA) mortgage loans, and how the 'too big to fail' factor impacted on bank (mis-) behaviour.

lender resilience as one of their two main objectives. Nine also placed maintaining borrower resilience as a main objective, though two regarded it as less important than lender resilience. One reason this matters is that, as explained in the Introduction, a classic credit cycle can occur without a widespread financial crisis, especially where the banking system is oligopolistic, generally profitable and well capitalised enough to survive a damaging recession, which would undermine the resilience of households and credit-dependent SMEs. A second reason why this difference in objectives matters concerns the use of restrictions on loan-to-value ratios which tends to affect more the resilience of lenders, and the use of restrictions on loan-to-income or debt service-to-income to income ratios, which tends to affect more the resilience of borrowers, especially in floating rate mortgage markets. A third reason why the difference matters is that objectives of macroprudential policy depend strongly on the supervisory framework for banks and other financial institutions and the resolution framework for failing institutions. A tough framework for microprudential supervision of financial institutions allows macroprudential policy to place a higher priority on household relative to financial sector resilience.

Communicating clearly about the objectives can help build long-term support for macroprudential policies. Potentially, a greater emphasis on borrower resilience could help in this respect. As discussed in section 5, candid communication about the cost-benefit trade-offs and the uncertainties faced by the macroprudential authority should help build long-term support.

3.2 Diagnosing potential housing risks.

The effective application of macroprudential tools to address macro-objectives requires a risk-monitoring framework to analyse the risks to lender resilience, as well as household vulnerability, emanating from housing and mortgage markets.

As noted above, since the GFC, Europe has seen a remarkable transformation of the frameworks for financial regulation, macroprudential policy formulation and implementation, and risk monitoring. A great deal of effort has been expended in improving databases, forecasting models, and the conceptual framework for risk monitoring, by the ESRB, the EBA, the ECB, at country central banks and at other regulators, backed by the BIS and the IMF, especially for real estate risks. However, there remain data gaps in granular data provision in some countries, and concerning commercial real estate data, more generally.

The ESRB includes ten indicators in its real estate risk dashboard, in three groups, ESRB (2022). These cover house price over-valuation, lax lending standards and household vulnerability. 'Collateral stretch' covers risks to the value of homes with four indicators of possible house price over-valuation. These are the three-year growth rate of real house prices, deviations of house prices from a trend, the deviation of the house price to income ratio from its historical average, and estimated over-valuation from an econometric model at the ECB.[10] See Box 1 for the background on methods for estimating over- and under-valuation of house prices. 'Funding stretch' is concerned with too lax lending standards, covered by three indicators: the three-year growth rate of real housing loans, deviations of housing loans from trend and the interest rate spread on loans for house purchase.[11] Finally, 'household stretch' is concerned with over–indebtedness of households and risks to their ability to service debt. The three indicators are

[10] Information about the model can be found in the 2015 Financial Stability Report of the ECB (their Box 3, but where little detail is given). It is based on an approach outlined in our Box 1.
[11] This spread is defined as the lending rate minus the funding cost, measured by the relevant market reference rate, or the interest rate swap of a corresponding maturity for fixed rate loans.

household debt relative to income, household financial assets relative to debt, and the debt service to income ratio for households.

Box 1: A flexible method of estimating over- or under-valuation of house prices.

Most economists accept that house prices are driven by dynamic adjustment around fundamentals, so that over- and under-valuation can occur during the adjustment process.[12] Abraham and Hendershott (1996) make the crucial observation that by including lagged changes in house prices in the model, one can have overshooting after a series of positive shocks, pushing prices above fundamentals – the 'bubble builder'. When the fundamentals worsen, one can get a 'bubble burster', as the correction of the previous overvaluation gathers speed with falls in house prices adding to downward momentum. This implies, given lagged adjustment, overvaluation when fundamentals worsen and the opposite for undervaluation.

The most widely accepted framework for determining house prices in the long-run is the inverse demand framework, where a housing demand equation is inverted, taking the lagged supply of housing as given. The fundamentals in the inverse demand framework will, at the least, include a real interest rate (or a user cost variable) and income on the demand side, and the lagged housing stock on the supply side. Expected income growth could well be relevant too, for the same reason that economists argue that permanent income should be one of the drivers of consumption. And in the context of adjustable mortgage rates, Kearl (1979) has argued for the nominal mortgage rate to be included as a cash-flow measure of housing affordability. Unfortunately, controls for loan standards (which change over time) are often omitted from the demand drivers (exceptions, for example, are Duca et al. (2016) and Chauvin and Muellbauer (2018)). This suggests six potentially important controls. Most models are mis-specified for three reasons: excluding longer lags, see below; excluding expected income growth (or permanent income); and excluding changing loan standards.

When a user cost variable is used, some authors proxy expected house price appreciation by past appreciation in user cost,[13] testing for the most relevant memory length (e.g. Duca et al. 2016). However, most researchers use a real interest rate rather than user cost, and instead introduce lagged house price appreciation via a reduced form dynamic adjustment process (e.g. Anundsen 2021). This process typically follows a category of models discussed by Abraham and Hendershott (1996), using a simple partial adjustment model of house prices. VARs have been commonly used to estimate such models, however, this entails that all variables enter with the same lag length, and typically, short lags, such as 1 or 2 quarters, are selected. However, if memories of past appreciation go back further, this would be totally missed by mechanical application of the VAR methodology (e.g. Duca et al. (2011, 2016) suggest lags of up to 4 *years* on US data).

The empirical questions concern the specification of the fundamental variables and the specification and estimation of the lagged house price growth effects (past appreciation).

However, in practice, a wider range of information and qualitative analysis, addressing particular features of individual countries, feeds into the overall assessment of housing risks, as indicated in ESRB (2022), Jarmulska et al. (2022) and Ryan et al. (2023). For example, where available,[14] part of the risk assessment in individual countries relies on the fraction of high LTI and high LTV housing loans, which are indicators both of loose lending conditions and of household vulnerability. Often, other country-specific indicators are considered, such as the proportion of lenders tightening loan standards from the

[12] This contrasts with a world of 'rational expectations without frictions', where house prices enter as a 'jump variable'. This is how the DSGE literature treats house prices (e.g. Iacoviello and Neri 2010). In the real world, sluggish adjustment of actual house prices is common and far from being consistent with jump variables.

[13] The user cost applied to purchase of a home is usually defined as the house price multiplied by an adjusted real interest rate. The latter consists of a tax-adjusted mortgage interest rate, an allowance for depreciation or maintenance, including insurance costs, the property tax rate and an offsetting term that represents expected capital gains over the relevant holding period of a house.

[14] Cross-country studies covering a short time period have examined (e.g. Lang et al. 2020) mortgage loan characteristics including loan-to-value and loan-to-income ratios for some countries, but regular time-series data at the country level of such loan conditions have not yet been assembled for most countries.

ECB's bank lending survey which began in 2002, and from changes in NPL ratios and in the 'credit gap' (i.e. the deviation from a Hodrick-Prescott trend of credit extended by the banking system). These can all be classified as indicators of loose lending conditions.

Nevertheless, there are serious problems with several of the housing risk indicators, which also limits their usefulness as early warning indicators for financial crises. Two of the most important of these are credit growth and house price to income ratios. For example, relatively high growth in credit could be reflecting strong and sustainable economic growth rather than overly loose lending conditions. And, rather than suggesting overly loose lending conditions, high house prices relative to income could also be reflecting sustainably lower nominal and real interest rates and/or supply constraints that are unlikely to be quickly resolved.[15] To avoid misinterpreting indicators, empirical methods are required to distinguish benign from non-benign causes of raised indicators.

To a degree, the inclusion of a rich set of controls in early warning forecasting models for housing risk could help reduce the potential misinterpretations. These controls could include interest rates, income growth and land supply constraints (although these are not easily measurable). However, in cross-country studies, there is substantial institutional heterogeneity that is unaccounted for, so that assuming a homogeneous influence of the controls without a more structural interpretation is likely to be problematic.

A different, more structural methodology has been suggested by Muellbauer (2022), that encompasses all three of the above household 'stretch' indicators. This methodology can give improved estimates for an individual country of evolving loan standards, of potential over-valuation of house prices and of excessive levels of household debt. For example, for France, the latent variable approach[16] used in Chauvin and Muellbauer (2018) measured credible indicators of loan standards, i.e. non-price credit conditions (i.e. 'funding stretch'). These indicators for both consumer credit and for housing loan markets had remarkable forecasting power, jointly with several macroeconomic variables, for NPL ratios, both one and two years ahead. A similar approach for an emerging market country, South Africa, found similar forecasting performance of the latent variable measures of lending standards for the related credit impairment ratios of banks (Aron and Muellbauer, 2024). Muellbauer (2022) explains how these models, augmented by equations of the pass-through to borrowing rates from the policy rate and changing credit conditions, by an equation for residential investment, and an equation for the NPL ratio, can articulate most of the mechanisms by which macroprudential policy transmits to the economy through its impact on credit conditions. Aikman et al. (2021) also give an account of how the transmission mechanism of macroprudential policy works through house prices, consumption and residential investment.

---

[15] A trenchant critique by Svensson's (2024a, b) questions the use of the house price to income ratio as a measure of overvaluation. For Sweden, he argues that, once low interest rates are taken into account in his proposed user cost to income ratio, Swedish house prices would be judged *undervalued* in recent years. By contrast, use of the house price to income ratio would imply a substantial overvaluation. However, as argued by Goodhart and Muellbauer (2024), no single, simple indicator of overvaluation is appropriate. Instead, a model-based approach, as outlined in Box 1, is preferable to assess the degree of overvaluation.

[16] The latent variable is effectively a function of a set of dummies or splines common to multiple equations, potentially appearing both as an intercept (i.e. as a shift in the mean) and as an interaction effect with selected economic variables. The latent variable serves to capture the difficult-to-measure episodes of financial deregulation and changes in market structure, and changes in macroprudential policy settings. This approach is quite different from a factor analysis of a set of credit indicators, which extracts the common information but without controlling for the influence of other drivers.

While the French model is based on a six-equation system, it is probable that a stripped-down two-equation version consisting of a house price equation and a mortgage debt equation, with a possible ancillary equation for income expectations,[17] could achieve a reasonable measure of evolving mortgage credit conditions, see Appendix for details. In addition to capturing 'funding stretch', a considerable benefit from such an approach would be improved measures of house price over-valuation ('collateral stretch') over those currently used in the risk dashboards by improving the specification of the house price equation. As well as controlling for changing loan standards, it is helpful to include extrapolative expectations of house price appreciation in the house price equation, which often induces over-valuation. The mortgage debt equation could provide important insights into 'household stretch'. Empirical evidence for a number of countries[18] suggests that cash flow, as reflected in the debt-service ratio, is a major consideration for households in managing debt. The controls for other drivers such as (typically slow-moving) demography and (sometimes fast-moving) lending standards, contribute to understanding the sustainability of household debt and how quickly deleveraging could occur after negative shocks. Another benefit is that the latent variable method provides an innovative technique for testing for the effects on lending standards of changes in macroprudential instrument settings, see Section 4.

The proposal above to estimate stripped-down two-equation models for each country separately could be handicapped by short samples for some countries. Using panels for groups of economies with common characteristics[19], and/or Bayesian methods, could compensate for limited time series data for some economies, but still allow for country-specific estimates of changing loan standards and extrapolative expectations of house price appreciation. In the Euro area, the Bank Lending Survey of credit conditions provides useful information beginning in 2003 on the time-profile of loosening and tightening of bank credit.[20] Information on other time-varying indicators such as on the average duration of new mortgage loans and on distributions of loan-to-income and loan-to-value ratios, where granular data have become available in recent years, and on changes in macroprudential settings, can also help identify the time-profile of the latent variables. The 'house prices at risk' approach to monitoring housing-related risks developed at the IMF (IMF, 2019, ch. 2) should also benefit from this latent variable method of improving the measurement of previous lending standards and of obtaining better estimates of over-valuation.

The discussion so far has been focused on aggregate indicators, but there are distributional as well as spatial aspects of household vulnerability. To complement evidence-based research on aggregate data, analysis is needed of granular household distributional data. To illustrate the point, suppose there is a uniform fall in house prices in all locations. For a given distribution of loan-to-value ratios, those with highest LTVs will be the first to experience negative equity. As house prices fall further, there will be a non-linear rise of numbers in negative equity, and in the aggregate size of the negative equity

[17] Economists regard income growth expectations embedded in the concept of permanent income as relevant for modelling consumption. For similar reasons, they should also be relevant for explain the demand for housing and hence house prices.
[18] For France, UK, Germany, Canada, and South Africa.
[19] This means that estimates from countries with long time series data can be applied to countries with shorter data histories, but similar structural characteristics. Specifying some parameters as functions of structural characteristics, which vary across countries, is another way in which the panel approach can help overcome missing data problems.
[20] However, these indicators do not cover non-bank credit providers, which have become more prominent in recent years. There is also the possibility that they may not cleanly capture changes in non-price credit conditions if some respondents regard a rise in lending rates induced by a higher policy rate as a tightening of non-price credit conditions.

positions. There will be a similar non-linear rise in the default risk.[21] The distributions of LTVs, debt-service ratios and the incidence of unemployment among mortgage borrowers, will affect the overall household vulnerability and its ensuing impact on mortgage lenders. To complicate matters, changes in house prices are never uniform across locations and by mortgage type (for owner-occupation or investor landlords). There are several sources for granular data including the Household Finance and Consumption Survey (HFCS) in Europe, the US Survey of Consumer Finances (SCF), data from lenders on stocks and flows of lending, and spatial house price data. Some of the literature using such data is discussed in Section 5.4 below.

4. Housing-related macroprudential tools: usage and effectiveness.

4.1 Housing-related macroprudential tools.

Macroprudential tools in the context of housing can broadly be divided into three groups. The first is the group of borrowing based measures (BBMs). The second are lender-based (or capital-based) measures with a strong sectoral impact on housing and other real estate. The third are measures with a broad-based impact across the economy, but including housing and other real estate. BBMs come in various forms, such as limits on loan-to-value (LTV), loan-to-income (LTI) and debt-service ratios (DSTIs). Strictly speaking, the latter require a comprehensive picture of a borrower's entire loan commitments and not just the housing loan. There are also 'stressed' DSTIs, where the lender is required to ensure that the borrower can cope with, for example, a 3 percent rise in the mortgage interest rate. Such limits, often termed 'speed limits', can be imposed across the board, but more often have been applied with escape clauses, CGFS (2023). For example, ceilings might be less stringent on first-time buyers or more stringent on buy-to-let investors, or lenders might be allowed to exempt a given fraction of loans from these limits. A BBM where the lender is required to limit the growth rate of the loan book above given LTI or LTV ceilings, is like a mix of a lender-based and a borrower-based measure. Speed limits like this deal with the frequent objection to BBMs that they interfere in private contracting: lenders can contract with whom they choose, subject to additional limits on their overall loan book. Other BBMs include restrictions on interest-only loans, such as an outright ban, and amortisation requirements. The latter can take the form of, for example, requiring that loans in certain LTI or LTV classes are required to repay at least a minimum percentage of the loan every year. According to LoDuca et al (2023), eight EU countries used limits on interest-only loans and/or amortisation.

For housing-related BBMs to be a policy option, regulators need legislative permission for their use and need to access granular data from lenders to monitor that lenders are adhering to the measures, and to assess their effectiveness. A minimum requirement is that each lender provides distributional data on LTVs, LTIs and DSTIs. For example, LTVs percentiles could be classified into under 75, 75-80, 80-85, etc. up to over 110, and analogous intervals for LTIs and DSTIs. Limited information is also required on joint distributions of high LTV, high LTI loans to monitor high-risk lending. Ideally, LTI and DSTI information should include all household debt and not just housing-related debt, as the latter could impact the ability to service housing debt. Even when legislative permission is lacking, and regulators can only make recommendations, such data can be an important regulatory tool. Note that in some countries with credit registers, or as in the UK, with a census of all regulated mortgages, far more

[21] Aron and Muellbauer (2016) adapted this idea to estimate negative housing equity in the UK and found it to be highly relevant in explaining mortgage payment arrears and foreclosures.

detailed loan-level data are available, enabling more comprehensive evidence-based research on the dynamics of default.

Capital-based tools include adjusting the risk weights on particular types of credit such as mortgage loans. Another tool is the countercyclical capital buffer (CCyB), which is tightened in boom phases and relaxed during a crisis to soften its impact and to support post-crisis credit flows. In principle, a sectoral CCyB could be designed to mitigate housing related risk. The Basel Committee for Bank Supervision (2018) argued the case for including such tools in the Basel III supervision framework and in 2019 published guiding principles for jurisdictions that wish to apply time-varying risk weights. These are not part of the formal Basel III framework and so do not have the same regulatory status as the countercyclical capital buffer at a global level, but have been applied to real estate in some countries, e.g. Slovenia.

An example of the third type of regulatory tool, potentially with time-varying macroprudential applicability, is the liquidity coverage ratio (LCR). The LCR aims to ensure that banks maintain a liquidity buffer on their balance sheets, which can be liquidated quickly during a period of liquidity stress. The net stable funding ratio (NSFR), concerning the ratio of illiquid assets relative to stable funding limits overreliance on short-term wholesale funding, encourages better assessment of funding risk across all on- and off-balance sheet items, and promotes funding stability. While neither is specifically housing-related, they can help reduce financial crisis risk, with benefits for the housing sector.

4.2 The effectiveness of macroprudential tools (housing tools and some others).

There is now a large literature on the effectiveness of different tools on intermediate targets such as curbing credit growth, household indebtedness, and house price growth. A review of the literature up to 2019 is given by Duca et al. (2021), with an associated online appendix containing a tabular summary of different studies. Some of this literature and more recent literature is discussed below under macro- and micro-categories. The studies on effectiveness of macroprudential policy cover the typical tools applied to housing and credit markets, but also non-housing macroprudential tools such as capital ratios on systemically important banks. Potentially, diagnostic tools such as stress testing could affect the behaviour of financial institutions, with macroprudential implications. This is a potential area for future research.

All studies face a common endogeneity problem of policy because macroprudential measures tend to be enacted when credit and house price growth are high. But such growth also depends on other factors. For example, if tightening occurs amid high credit growth owing to optimism about future income, this could underestimate the effect of tighter LTV or DSTI caps on credit growth in empirical models excluding income expectations. Researchers have used rich sets of controls and lags or creative application of instrumental variable estimation techniques to try to circumvent this problem. However, it is important to be aware that there may nevertheless be a tendency to understate policy effectiveness. A second problem lies in lack of data in most countries on the voluntary lending criteria banks were using before regulatory limits were introduced. The effects of new limits on LTVs, LTIs and DSTIs could be large or small, depending on what fraction of loans were *already* under the announced new limits.

4.2.1 Studies using macro-data.

Panel studies using macro-data suffer from endogeneity and the unknown deviation of new macroprudential limits from previous voluntary lending criteria, discussed above. There are two further problems. The first is linked with the institutional differences across countries, and the second arises from differences in the nature of shocks than can trigger crises, both discussed above. The implication of neglecting institutional differences and the different nature of shocks across countries, is that panel studies where the only form of country heterogeneity, apart from a small set of country-level economic controls, is in the country fixed effect, will distort the estimates of the impact of macroprudential policy. One example which illustrates both is a downturn triggered by a rise in interest rates outside the control of the central bank which has an immediate effect on debt-service ratios of existing borrowers in floating rate environments but not in fixed rate ones. A precautionary earlier tightening in debt-to-income ratios will be more effective than one for LTVs in such a context. A crisis involving a heavy contraction of credit availability will be less serious in floating rate environments when central banks can lower the policy rate – compare the US and the UK in 2008-10. Therefore, conclusions about the relative effectiveness of restrictions on LTVs vs. on debt-service-to-income or loan-to-income, need to be treated with considerable caution.

Before the assembly of the cross-country database discussed by Alam et al. (2019, 2024), there was little information on the intensity of measures, so that zero/one dummies were used in most studies. More recently, while more information has been assembled, there can be comparability problems across countries, and as noted above, intensity also depends on how different from pre-existing loan standards. Regulators differ in the concept of income used to measure ratios to income. For example, the income of second or third earners in a mortgage-applying household may be given different weights in different countries. Different rules often apply according to the regularity of income or types of employment. LTVs can also suffer problems of comparability as valuation practices can differ between countries, and even within countries, and the time difference can vary between the lenders' valuation and the transaction price.

Despite these issues, some tentative conclusions have been reached from the international macro evidence (see Duca et al. (2021), and the meta-studies by Araujo et al (2020) and Biljanovska et al (2023)). Tighter LTV limits do curb household leverage and credit growth in most countries, especially those with more volatile house prices. The effects on house price growth of tighter LTV and DSTI limits are more heterogeneous across studies. There is evidence that leakage can be an issue such as where tighter limits on banks may be partially circumvented by non-bank financial institutions.[22] The studies also find that combinations of policies tend to be more effective than individual policies. For example, tighter LTV caps are often offset by lenders relaxing DSTI or LTI criteria, hence the effectiveness of this policy would be enhanced by applying joint action on both types of tools (for practical examples, see ESRB (2022)).

4.2.2 Studies using micro-data.

Biljanovska et al. (2023), is a comprehensive summary of the state of knowledge on the effectiveness of macroprudential measures for cross-country panel macro-data and microdata, based on a meta-analysis of studies. The authors argue that the evidence supports the effectiveness of such measures,

[22] This is prevented by many European regulatory authorities through applying limits to all mortgage lenders and not just banks.

especially sectoral and borrower-based measures, in containing credit and house price growth. Where micro-level data were available, levels of statistical significance were generally higher, a conclusion also reached by Araujo et al. (2020). The evidence also points to relatively mild short-term effects of policy to reducing economic growth, while the resilience of economies to shocks over the medium term tends to be strengthened.

These broad conclusions are consistent with those of the micro-macro approach of Gross and Poblacion (2017) and Jurca et al (2020), discussed further in section 5.3.3. First, BBMs can noticeably improve household and bank resilience to macroeconomic downturns, in particular when multiple measures are applied; second, those measures tend to complement each other, as the impact of individual instruments is transmitted via different channels; and thirdly, the pre-emptive implementation of borrower-based measures is warranted as early action forestalls the accumulation of risks.

There is significant evidence for non-linearities in the effectiveness of BBMs. For example, evidence from Romanian loan-level data studied by Nier et al (2019) found that limiting the DSTI at origination to below 50 percent had a sharp effect in reducing defaults, while lowering the ceiling further had little effect. Kelly and O'Toole (2018) found a similar non-linear effect for a sample of mortgage loans for the UK buy-to-let market, estimating a "double trigger" default model linking originating debt service and loan-to-value ratios to ex post default. There are suggestions from some of the early literature of stronger effects from tightening than from loosening measures. This is plausible as loosening typically occurs after a downturn in which the asset position of banks has deteriorated from rising loan defaults and lower profitability. The banks' more cautious lending policies may then override looser regulatory constraints, making the latter less effective. However, loosening the CCyB can then be helpful in relaxing the lending policies of banks.[23]

4.2.3 Implications from the CGFS (2023) study.

Studies of panel data across many countries are subject to serious qualifications, for the reasons discussed above. There is scope for improving on existing studies by including more and better controls for country heterogeneity. Meanwhile, there are important lessons to be gleaned from a qualitative comparative study of 14 countries, based on the interaction of leading experts in each country, CGFS (2023). The reflection of common experiences during 12 years from 2011 to 2022 is a strength of this study, given that the countries faced broadly similar shocks of extraordinarily low post-GFC nominal interest rates, followed by the global pandemic and the post-pandemic inflation shock.

There are four main conclusions from the study. First, consistency across diverse housing-related government policies is stressed, an issue an issue we return to in section 6. The second conclusion is that governance frameworks strongly influence the effectiveness of different tools, which affects the choices among available tools targeting housing-related risks. In this sample of countries, in instances where a single body is ultimately responsible for financial stability, there has been greater proactive usage of tools in addressing housing risks and more transparency in regularly reviewing policy. Clear objectives and a clear legal basis for a full range of macroprudential tools helps target risks more effectively. Operational independence of the macroprudential regulator, and access to reliable, up-to-date data to adequately assess risks, also promote effectiveness. Since the supervisors of banks and other financial institutions have granular information and levers to enforce compliance, good cooperation between the macroprudential authorities and the supervisory authorities enhances the

[23] Meeks (2017) showed the obverse, that tighter capital requirements raise mortgage spreads and lower mortgage volumes, as well as affecting house prices and arrears.

effectiveness of macroprudential policy. Since information barriers will impede effectiveness, situating the microprudential and macroprudential authorities in the same institution, e.g. a central bank, can help to reduce policy lags and inaction.

The report's third broad conclusion is to recommend guardrails to serve as *automatic* stabilisers to safeguard resilience in housing market upswings. There are long lags between lax lending standards and subsequent financial vulnerabilities. Hence, the early timing of macroprudential interventions is key to crisis prevention. Hence, inaction bias from uncertainty, or implementation delays because of defects in governance, are costly perennial problems. An interesting focus of CGFS (2023) is on tools that meet policy objectives, but without the need for frequent adjustment as risks evolve. These include guardrails such as floors on loss-given-default parameters, minimum risk weights, banks' exposure limits on residential real estate, as well as minimum banks' capital requirements on housing portfolios (which is effectively a sectoral CCyB). Building in future conditionality *ex ante* with respect to the release of capital, or tying risk weights to debt-to-income ratios, could help enhance the automatic stabiliser properties of capital-based measures.

In a housing upswing, when house price rises outpace the rise in incomes, the CGFS (2023) argues that income-based limits, like LTIs, are better placed than LTV limits[24] to automatically tighten. This is because household incomes are far less cyclical than house prices. It is worth drawing a further distinction on income-based limits as stabilisers. DSTIs act similarly as automatic stabilizers to LTIs when their definition is based on an invariant interest rate, but, when they are based on a current (varying) interest rate, they are far less satisfactory than LTIs as automatic stabilisers. This is an important point to appreciate because this can amplify the effect of lower interest rates in housing market upswings.

To illustrate this point, we take a practical example from France, where most housing loans are granted at a fixed rate for extended periods. In this environment, DSTI limits based on the current interest rate are far more common than in environments where housing loans are on floating rates. While this seems to make sense as households are protected against future rises in interest rates, such limits relax credit on new borrowers when nominal interest rates fall. Chauvin and Muellbauer (2018) find very large responses of housing debt and house prices in France to falls in nominal interest rates on housing loans, given a 40 percent recommended ceiling on DSTIs from the late 1990s to 2008. Much of the rise in real house prices in France in this period can be attributed to a combination of lower nominal interest rates and credit liberalisation, for example, in the form of longer loan durations. If one of the aims of macroprudential policy is to limit rises in real house prices or in house price- or debt-to-income ratios, DSTIs based on current interest rates do *not* have desirable automatic stabilisation properties.

Turning to environments where mortgage loans are mostly on floating rates (e.g. Sweden and the UK), DSTI limits on new mortgage applications[25] based on an invariant precautionary target interest rate

[24] With a fixed LTV ceiling, as house prices rise, so the maximum debt permitted rises in *proportion* to housing value, rather than becoming a more stringent limit.

[25] With a fixed rate mortgage loan, the effect of a debt-service-to-income limit and a loan-to-income limit might be thought to be logically identical. However, when 'debt' includes all household debt but 'loan' refers only to a mortgage, they are then clearly different. Moreover, while the DSTI definition of debt looks more comprehensive, by extending the repayment period – in the extreme, indefinitely, with an interest-only mortgage - the cash-flow cost of debt service can be reduced. This means that unless additional restrictions on the length of a mortgage or some other amortisation requirement, such as repaying a minimum fraction of the outstanding debt every period (as for example in Sweden), are introduced, DSTI limits are subject to leakages of this type.

have the advantage of not relaxing credit when interest rates fall, or tightening credit when interest rates rise. DSTI limits based on the current interest rate are not commonly used as macroprudential instruments in floating rate environments as they result in volatile credit flows for new mortgages when interest rates change.

Several micro-data studies have found strong empirical evidence for a link between high DSTIs at origination of a mortgage and subsequent default risk. However, this evidence is context-dependent. Where mortgage loans are mostly on floating rates or on or short-term fixes, post-origination rises in interest rates increase default risks. Aron and Muellbauer (2016) find a strong effect from a higher aggregate interest rate service to income ratio[26] to raised aggregate payment delinquencies and foreclosures in the UK. This finding reflects the fact that high accumulated debt relative to income increases default risk, compounded by rises in interest rates on the debt. Drehmann and Juselius (2013) find that the debt-service to income ratio has useful forecasting properties for financial crises in a panel study of 26 countries. However, they do not differentiate between adjustable and fixed-rate regimes, which should affect the size and speed of transmission to default risk.

The last of the four main conclusions from the report argues that transparency about costs and benefits of macroprudential policies should help public acceptance of such policies. This stresses the importance of research into the welfare and distributional effects of these policies. This is the topic of the next section.

5. Assessing the welfare consequences of macroprudential policies.

Clear communication about the cost-benefit trade-off of macroprudential policy can foster long-term support for macroprudential policies, CGFS (2023): "candid communication about costs, benefits, uncertainties regarding their measurement and how they informed policy decisions helps to maintain support even as memories of housing crises fade." This is an important reason why comprehensive assessments of the welfare consequences of macroprudential policies are needed and why the findings should be in the public domain.

As the CGFS report points out, the benefits and costs of macroprudential policy differ in terms of time horizons, tangibility and whom they affect. Costs from implementing a restrictive macroprudential policy reducing aggregate demand, for consumption, residential investment and investment by SMEs (that depends on home equity collateral), tend to materialise fairly quickly. Beyond the short run, lower levels of house-building could constrain the medium-run labour market choices of workers because of constraints on mobility. The short-term consequence for aggregate demand and the short-term distributional effects are relatively easily recognized. For example, income-based restrictions (on LTIs and DSTIs) disproportionately affect lower income buyers of homes, while LTV-based restrictions impact more heavily on first-time buyers without collateral backing from families. The costs can also be mitigated by allowing lenders to flexibility use their private information about the credit-worthiness of borrowers not to have to impose blanket restrictions. The medium-term benefits include avoiding over-heating of the economy, but need to be implemented in good time. Establishing the benefits requires simulation of counter-factuals, and are therefore more uncertain. In what follows, recent

[26] This is defined as the product of the mortgage interest rate and mortgage debt scaled by average income. It is similar to a DSTI but excludes the repayment of debt element.

research into the conceptual and quantitative foundations for evaluating the welfare and distributional consequences of different macroprudential policies is reviewed.

5.1 The Growth-at-Risk framework.

The substantial literature on the causes of financial crises primarily treats these crises as discrete, zero or one, events. The following examples all use a discrete definition of financial crises and examine drivers linked to housing markets, such as credit growth and debt-service ratios. Schularick and Taylor (2012) use a comprehensive dataset spanning over a century and multiple countries to analyse the relationship between credit growth and financial crises.[27] Drehmann and Juselius (2014) show that the credit-to-GDP gap - the deviation of the credit-to-GDP ratio from its long-term trend - outperforms other indicators in predicting banking crises, particularly when combined with measures of asset price bubbles and other financial imbalances. Drehmann, Juselius and Korinek (2017) show that adding information on the debt-service ratio further improves the predictability of banking crises. Jorda, Schularick and Taylor (2016) document the global rise of debt collateralised on housing wealth and show that, especially in more recent history, the predictive power of the growth of mortgage credit relatively to non-mortgage credit has increased.

However, focusing on crisis prediction in this way suffers from two problems. Not everyone agrees on the classification criterion for what defines a financial crisis, and such crises are relatively rare events. With sparse observations, it is harder to draw robust evidence-based conclusions. More recently, the focus has shifted to Growth-at-Risk (GaR) given the link between severe downturns in GDP and financial crises. This avoids controversies about classification, and since GDP is a continuous variable there are many more observations for analysis. GaR quantifies the impact of financial conditions on the distribution of future economic growth, particularly on the lower tail of the distribution to capture downside risks. The GaR framework uses quantile regressions to estimate the conditional distribution of future GDP growth based on current financial conditions. Financial conditions are measured by a factor model based on ingredients from money, debt and equity markets.

Adrian, Boyarchenko, and Giannone (2019) have formalized the GaR concept in their influential paper, "Vulnerable Growth," where they demonstrated that tighter financial conditions increase the likelihood of severe economic downturns. Aikman et al (2019) replace the relatively near-term perspective of Adrian et al. (2019) with horizons up to 5 years ahead. With data on 16 advanced countries back to 1980, they demonstrate that higher levels of credit, house price growth and the current account deficit, and lower levels of bank capitalisation, increase medium-term downside risks to GDP. They also find that financial conditions have no effect beyond a one-year horizon, as do Duprey and Ueberfeldt (2020) for Canada. See the chapter in this *Handbook* by Nina Boyarchenko for a summary of the insights from this literature.

The most obvious cost-benefit criterion to evaluate macroprudential policy is the expected discounted sum of aggregate real GDP over some horizon. The costs of macroprudential policy are the short-term reductions in GDP that could be caused while the benefits are the avoidance of more severe GDP losses in the longer term. Given the weights attached to different GDP outcomes, the GaR framework is ideally suited to estimating the net aggregate benefits or costs of macroprudential actions.

[27] They estimate a probabilistic model that specifies the log-odds ratio of a financial crisis occurring in country i in year t, denoted with the binary variable S_{it}, which takes the value 1 or 0.

A spate of papers has used the GaR framework to quantify the impact of macroprudential policies on downside risks to GDP, e.g. Franta and Gambacorta (2020), Galan (2020), Chavleishvili et al. (2021), further discussed below, and Fernández-Gallardo et al. (2023). Franta and Gambacorta (2020) examine the impact of LTV restrictions and rules on loan-loss provisioning on GaR for 56 countries from 1980 to 2012. They conclude that tighter LTV limits narrow the whole distribution of GDP outcomes, while tighter loan-loss provisions mainly reduce the severity of a potential crisis. Galan (2020) analyses data from 28 EU countries from 1970 to 2018 and compares timing and effectiveness of capital- and borrower-based measures.[28] He concludes that capital-based measures are slower to act in the upswing of the cycle, taking about two years to become effective, while late-cycle BBM tightening can still have some benefits. However, in the downturn, releasing capital-based measures is more quickly effective than loosening BBMs. Fernandez-Gallardo et al. (2023) examine both GDP-at-risk and credit-at-risk for 12 advanced economies from 1990 to 2017, using a narrative-identification strategy to measure exogenous changes in an index of macroprudential policy based on 11 components. They conclude that tighter policy reduces tail risk on both sides of the GDP distribution, but particularly reduces the upper tail of the credit growth distribution and that this is a major channel through which GDP at risk is affected.

The search for a simple quantitative target for macroprudential policy to parallel inflation targeting for monetary policy has led Cecchetti and Schoenholtz (2018) to propose the simple objective of setting macroprudential policy to limit risk of a more than x% fall in GDP over a set horizon to no more than z%. Aikman (2022) proposes a 3 year horizon and 5% for both x and z as a plausible targets that a government could set the macroprudential authority. The x% target is more robust than it might seem at first sight as the factors driving a 4% or a 6% decline in GDP will be very similar to those driving a 5% decline. The z% target reflects the degree of risk aversion the government wishes to impose on the authority, and that is a more subjective matter. This approach depends on good models for GaR, but that is not so very different from inflation targeting, which is really inflation *forecast* targeting and relies on good models for inflation over the relevant policy horizon[29]. This proposal has much to be said for it in terms of simplicity and ability to communicate both between the professional research staff and the decision makers within the macroprudential authority, and the accountability of the authority and its ability to communicate with the wider community. However, it does not fully address the wider questions of what are the costs and benefits of macroprudential policy and what deeper welfare criteria should apply. This is the topic of the next subsection.

5.2 Aggregate cost-benefit versus using wider welfare criteria.

The specific financial stability mandate of macroprudential authorities suggests an additional precautionary objective to maximising the expected discounted sum of aggregate real GDP. This objective is to penalise large down-side risk.

Chavleishvili et al. (2021) propose an objective function for evaluating the impact of macroprudential policies on future GDP. In addition to considering the discounted sum of expected GDP over some horizon, they add a penalty for the expected growth shortfall based on multivariate GaR estimates.[30]

[28] In contrast, two related papers focus on bank capital ratios as the only macroprudential instrument (Aikman et al., 2019), or use a single index of macroprudential measures for Canada (Duprey and Ueberfeldt, 2020).
[29] One difference, however, is in forecast evaluation, simpler for inflation where outcomes and forecasts can be straightforwardly compared.
[30] Suarez (2021) proposes instead penalising quadratic deviations of GaR from expected growth of GDP. This is less satisfactory, as positive and negative deviations are equally penalised.

The weight on the penalty function reflects the degree of aversion to downside risk of the policy maker. In an application to euro area data, they find that macroprudential policy leaning against the financial cycle – tightening when financial exuberance is rising – has net benefits, even with zero risk aversion (no penalty function). Moreover, the benefits increase with greater risk aversion. In principle, historical information on the impact of macroprudential policies and other controls on GaR, derived from studies such as those cited above, could be used to choose ex-ante, evidence-based macroprudential settings that maximise the objective function.

In practice, including a penalty in the objective function raises a set of issues. The first concerns the weight assigned to the penalty function. The fact that a macroprudential authority exists with a financial stability mandate implies that the weight should be strictly positive. Secondly, macroprudential policies are not the only policies with growth implications. This kind of objective function makes explicit the need for coordination of macroprudential and monetary policy.[31] Then, indeed, the omission of a low inflation component in the objective function proposed by Chavleishvili et al. (2021) is a problem[32]. It might be argued that in the context of a monetary union with macroprudential policy fully devolved to the country level, that the monetary policy path should be taken as exogenous when each macroprudential authority sets its policy path. However, this case has a number of weaknesses.[33] suggesting that one cannot get away from a more general objective function incorporating average growth, downside growth at risk and an inflation objective. Central bank independence is consistent with the need to insulate such an objective function from short-term electoral considerations. Hence, using such a more general welfare framework to develop policy settings should carefully examine the robustness of its conclusions to different relative weights attached to the three policy goals.

5.3 Distributional implications of macroprudential policy.

It is widely recognised that aggregate GDP is far from being a wholly satisfactory welfare measure, for example because it ignores distributional implications.[34] An early IMF paper, Arregui et al. (2013) explains clearly the main methodological issues for assessing cost-benefit trade-offs for aggregate GDP, but it does not address distributional issues.[35] However, the democratic principle of one person, one vote points to social preferences preferring outcomes with lower levels of economic inequality.

A growth-at-risk element in the objective function does, to an extent, capture preferences for lower inequality. The distributional objective is not explicitly in the objective function but is there implicitly. Sharp downturns in GDP are typically associated with worse economic consequences for those with the most limited resources, and greater job and income insecurity. A positive weight on this component of the objective function will favour less unequal economic outcomes. Those macroprudential authorities

[31] Brandao-Marques et al. (2020) have taken this a stage further by examining costs and benefits using the GaR approach in an integrated policy framework encompassing macroprudential, monetary, forex interventions, and capital flow management policies.
[32] Aikman et al. (2023) incorporate both inflation and stability objectives in a quadratic variant of the objective function with a weight on the stability objective that varies with stability risk aversion.
[33] The first weakness is that individual macroprudential policy can cause cross-country spill-overs, which argues for cross-country coordination. Moreover, monetary policy decided at the ECB should take into account cross-country macroprudential settings, given that these have implications for country-level output and therefore for inflation. This should give further impetus to cross-country coordination.
[34] The GDP measure also excludes non-market externalities such as loss of biodiversity and global heating, and excludes sources of well-being that lie outside of markets such as social cohesion and healthiness.
[35] Typically, applications of this framework, such as by Reichenbachas (2020) to Lithuania, tend to ignore distributional issues.

that emphasise borrower resilience in addition to lender resilience are implicitly guarding against household vulnerability and rising inequality.[36] The relative weights that a macroprudential authority places on borrower and lender resilience could affect the emphasis placed on mitigating the risks in commercial real estate (CRE) as compared to residential housing markets. This could have a distributional impact. A serious downturn in CRE is likely to have more immediate effects on wealthy investors and pension funds than on poorer households. A greater weight on borrower resilience would imply macroprudential policy steered more towards preventing serious downturns in residential property markets than on CRE.[37]

5.3.1 A panel study of distributional implications.

One *macro-study* that attempts to address the distributional implications of macroprudential policies is by Frost and van Stralen (2018), using panel regressions for 69 countries over the 2000–2013 period. This study suggests that macroprudential policy, in the form of loan-to-value (LTV) and debt-to-income (DTI) limits, widens inequality. They find a positive association between the use of loan-to-value (LTV) and debt-to-income (DTI) limits and a higher Gini of net (after tax-and-benefit) income inequality. They are careful not to imply a causal association.[38] For example, if credit booms are associated with widening inequality, the policy choice of tighter BBMs to limit the associated risks could explain their findings of a positive association. After the GFC, countries with bigger housing booms typically suffered worse recessions, in which income inequality would have increased. Had the application of BBMs and other policies been more effective in preventing those booms, the findings might well have been reversed.

5.3.2 Country studies with granular data.

Inequality has several potential dimensions. Income inequality will differ according to whether only cash income is considered or whether income is defined to include the imputed rent of owner-occupiers. Income and wealth inequality within and between groups can be compared across many categories, such as renters vs. owners of housing, by age groups or gender or family types, by regions and other spatial dimensions, or across groups with shared characteristics such as educational level, region and occupation.

Where there are good granular data, modern modelling techniques provide the capacity for simulations, enabling a comprehensive examination of the impact on the various dimensions of inequality of BBMs and capital- based measures. There have been several *micro-based studies* of distributional effects of macroprudential policies, almost all covering BBM, which generally find that in the short-term BBMs have negative effects on lower income borrowers and would be first-time buyers of homes. See the chapter in this *Handbook* by Jose-Luis Peydró, Francesc Rodriguez-Tous, Jagdish Tripathy, and Arzu

[36] However, there are cases where policies that restrict the choices of some households to protect them against risks that, in hindsight, did not emerge, can increase inequality.
[37] However, as Duca et al. (2021) explain, US commercial real estate was strongly implicated in the 2008-10 financial crisis, with large spillover effects onto households via the banking crisis. In 2023-24, the downturn in the office sector of CRE, as the result of increased working from home as well as higher interest rates, could have negative implications for US regional banks and their ability to extend credit, Duca and Ling (2024), with potential spillover effects on households and small businesses. This means that even with a strong relative weight on borrower relative to lender vulnerability, CRE-related risks should be no means be neglected.
[38] Konstantinou et al. (2022) find a similar result for former transition economies when they do not control for endogeneity, but little association when they do.

Uluc for a survey of these studies. However, these studies neglect the longer-term consequences of macroprudential policies, which in many cases may reduce inequality.

The following seven country studies exemplify the micro-approach and span the following countries: Israel, Ireland, Norway, Portugal, South Korea and the UK. Using granular data for Israel, Tzur-Ilan (2017) finds that tighter LTV ceilings induced borrowers to buy homes in lower price locations, further from city centres, though apparently did not reduce overall access to mortgage credit. A study of the impact of tighter LTV and LTI constraints in Ireland, imposed in 2015 with supervisory loan level data, finds that mortgage credit is reallocated from low-to high-income borrowers and from urban to rural counties (Acharya et al., 2020). This reallocation weakens the feedback loop between credit and house prices and slows down house price growth in "hot" housing markets. In Norway, the imposition of an LTV ceiling locked some first-time buyers (FTBs) out of owner-occupation (Aastveit et al., 2020). These FTBs did not have access to parental or grandparental support, showing how family support can compensate for tighter LTV requirements and rising house price to income ratios. Some successful FTBs, forced to put down larger deposits, may have depleted their liquid asset holdings, making them more vulnerable to income shocks.[39] For Portugal, Felix et al. (2021) investigated, with credit register data, the effect of a tighter LTV restriction introduced in 2018. They document the short-term impact on newly constrained households in terms of buying cheaper houses and lowering debt to income ratios, but also paying somewhat higher spreads on their mortgages. Overall, the post GFC ultra-low policy rates and tighter down-payment constraints will have widened wealth inequality between the haves and the have-nots, especially younger ones. In general, the consequences for household vulnerability will depend on the functioning of the private rental sector, on access to social housing and on the social safety net.

Turning to South Korea, Park and Kim (2023) find empirical evidence that suggests that the imposition of LTV ceilings had a significant negative impact on the wealth of low-net-worth households in 2017-19. The two years that followed the tightening of the LTV ceiling coincided with a steep increase in house prices in South Korea, especially in and around the capital, indicating that the policy by itself did not prevent these increases. It is plausible that the reduced ability of the poorest-quintile households to acquire homes in those localities severely inhibited their capability to gain wealth at this time. This channel suggests that the impact of stricter LTV ceilings on households depends crucially on the movement in house prices in the aftermath of the policy. This indicates that timing is important and that BBMs coordinated with other policies to limit housing booms are likely to be more effective in preventing increases in wealth inequality.

A second Irish study by Higgins (2024) reaches broadly similar conclusions to the first Irish study (Acharya et al., 2020). Lower income borrowers tended to respond to the LTI constraint by buying cheaper (either smaller houses or houses in lower priced locations) after the policy change. Higher income borrowers, more likely to be above the loan-to-value threshold, responded primarily by reducing the LTV of the mortgage. He finds that houses prices fell after the policy change in postcodes where a higher fraction of borrowers were above the loan-to-income threshold before the policy. A UK study assesses the effects of a 15 percent-limit imposed in 2014 on lenders — not households — for the share of high loan-to-income ratio (LTI) mortgage flows (Peydro et al., 2024). Credit to low-income borrowers then contracted in local-areas more exposed to newly constrained lenders, lowering house price growth in those locations. Although there were adverse short-term consequences, in the longer

[39] However, this argument is weakened by the fact that home equity withdrawal is widely available in Norway. Home-owners with positive equity can therefore easily access credit to buffer negative income shocks.

run, however, with rising interest rates in 2022-23, mortgage defaults were lower. It is likely that low income borrowers would have benefited from this.

These studies are concerned with relatively short-term distributional consequences for households. They neglect wider consequences for the financial system, for example via potential loan defaults. They also ignore the impact on aggregate house prices and aggregate credit growth over the medium term. The associated risks could also have distributional consequences.

Macroprudential authorities *are* sensitive to the distributional consequences of borrower-based measures and design them carefully. CGFS (2023) documents a widespread use of flexibility margins for BBMs.[40] For example, some countries impose tighter LTV limits on buy-to-let investors and repeat home-buyers rather than on first-time buyers. Moreover, the use of combinations of BBM tools, reduces the need to set one tool very restrictively. Capital-based policies, such as tightening sectoral CCyBs or risk weights on mortgages, have somewhat more diffuse effects on households via the choices made by lenders when allocating potentially smaller loan levels. These choices can including raising interest rates on loans. Unfortunately, the restricted availability of granular and timely data can limit the ability of macroprudential authorities to choose the most effective evidence-based basket of policies to reduce the short-term negative effects on lower income borrowers and first-time buyers and enhance the positive medium-term effects.

5.3.3 The integrated micro-macro approach.

One attempt to consider both the short-term consequences of macroprudential policy and longer-term outcomes is the integrated *micro-macro-approach*, based on granular micro data and macro data. In the empirical literature, the integrated micro-macro approach of Gross and Población (2017), Jurca et al. (2020) Georgescu and Vila Marin (2021) and Gregor (2024), also allows issues of inequality to be addressed. This approach provides an important advance by integrating the banking sector with micro household and labour market data. The *macro-element* potentially captures economy-wide effects resulting from shifts in macroprudential settings including the application of BBMs. The *micro-element* of the approach allows detailed distributional effects to be simulated. The micro-macro model generates probabilities of default and the size of losses, given default, and links these with bank balance sheets.

The findings of Jurca et al. (2020) are for Slovakia, and it is doubtful how directly applicable these are to countries with different characteristics, e.g. floating rate mortgages, less concentrated banking sectors, more mature mortgage markets and different macroeconomic histories. In Gross and Población (2017), simulations are carried out for seven European countries, each with different institutional structures which are also not explicitly accounted for. Moreover, the econometric method used to model each country's macroeconomy does not take account feedback mechanisms, for example, from house prices to consumption and to residential construction, let alone the resultant differences in feedbacks due to institutional differences. The macroeconometric model used in Jurca et al. (2020) also does not incorporate these feedbacks, limiting the potential amplification of shocks.

[40] In Belgium, France, Ireland, Luxemburg, New Zealand and the UK, flexibility margins affected up to 35 percent of new lending (CGFS, 2023, Table A.4). For example, in 2014 the UK FPC introduced a flow limit restricting the proportion of mortgages extended at LTI ratios of 4.5 or higher to 15% of a lender's new mortgage lending. In France, the new DSTI limit of 35% introduced in 2020 allowed 20% of new loans to be outside this limit, while limited flexibility was also permitted for the maximum loan duration of 25 years. Though effective earlier, these limits were legally enforced only in January 2022.

Gross and Poblacion (2017), Jurca et al (2020) for Slovakia and Gregor (2024) for Czechia focus on the implication for banks' default probabilities and losses given default, rather than on the distributional implications for households, though those are within the scope of the methodology.

A study which uses a similar methodology and does examine distributional issues is that of Georgescu and Vila Marin (2021). This study uses data from the euro area Households Finance and Consumption Survey (HFCS), to examine the effects of BBMs on income and wealth inequality. They find that BBMs can increase inequality at introduction, but can dampen the increase in inequality under adverse macroeconomic conditions. They conduct counterfactual simulations under different macroeconomic and macroprudential policy scenarios for Ireland, Italy, Netherlands and Portugal. Simulation results suggest that BBMs have a moderate negative welfare impact in terms of wealth inequality and a negligible impact on income inequality. Giannoulakis et al. (2023) use a similar simulation model which allows the examination of combinations of instruments to examine the resilience effects for households in different parts of the income and wealth distribution. The focus here is more on the benefits, including for banks, of improved risk profiles of these households than on the short-term impact of constraints on their access to housing. As the macro-environment is treated as exogenous in these studies, transmission onto the macro-economy through changing loan standards (affected by macroprudential policy settings), is absent. The feedback from the macro-economy onto welfare and distributions of income and wealth is therefore missing. In other words, some of the system dynamics or general equilibrium effects are neglected.

5.4 The importance of general equilibrium for assessing distributional and welfare consequences.

Many, including politicians, do not understand 'system dynamics' (or 'general equilibrium', in conventional speech). For example, many think it 'obvious' that mortgage interest tax relief helps first-time buyers onto the housing ladder. This is not the case in a general equilibrium setting, where for the US at least, Sommer and Sullivan 2018 conclude: "Eliminating the mortgage interest deduction causes house prices to decline, increases homeownership, decreases mortgage debt, and improves welfare".

The media and politicians worry that tighter BBMs (that is, lower LTV or DSTI ceilings, and higher amortisation requirements) might reduce access to owner-occupation, increase inequality and lower welfare. However, a systems approach could well indicate that these conclusions are wrong, at least in the medium run. For example, tighter BBMs could lower house prices, debt and gearing, and reduce the tendency for house prices to overshoot. Similarly, the easing of mortgage credit conditions, as in the UK from the late 1990s to 2007, see Turner Review 2009, might be thought to have increased the access of young people to owner occupation. Instead, in the UK, owner-occupation for younger households (that is, headed by someone aged 30-34) actually *fell* after credit conditions eased from 1997-2007 as affordability deteriorated, but then rose slightly after 2014 with tighter BBMs, see Resolution Foundation (2023).

Studies that concentrate on the first-round and partial equilibrium effects of BBMs (reviewed in section 5.3.2), but disregard the medium-term, system-wide impact of BBMs, risk reinforcing the potential misconceptions of the media and politicians.

Dynamic stochastic *general equilibrium* models have been specifically designed to address general equilibrium questions. Versions of these models with credit frictions could be regarded as appropriate for answering welfare questions about macroprudential policy in a general equilibrium setting. However, as

Box 2 explains, the current literature suffers from serious limitations.

Box 2: Limitations of the DSGE framework for analysing general equilibrium, distributional and welfare implications of macroprudential policy.

The DSGE literature is based on a framework of two representative agents, those of saver and borrower households. The current literature cannot meet the challenges of a realistic representation of housing and credit markets, and therefore of the implications of macroprudential policy.

A widely-cited paper by Clerc et al. (2015) extends the DSGE model with credit constraints introduced by Iacoviello (2005). They add a banking sector to the model which intermediates flows between borrowers and savers. They add a layer of entrepreneurs outside the household sector, and frictions in the form of costly state verification and defaults by entrepreneurs. They analyse the aggregate welfare gains in consumption-equivalence terms from introducing capital requirements on banks. A related paper by Mendicino et al. (2018) calibrate a similar model to Euro area data and also examine the impact of capital requirements on the relative welfare of savers and borrowers. There have been several applications of this approach to different countries, following the lead of these two papers.

However, there are severe limitations to the above approach. The approach makes the extreme assumption of instant market clearing of house prices. It also assumes that there is no extrapolative element in households' expectations of house price gains. Both of these assumptions are contradicted by comprehensive empirical evidence summarized in the survey of international house price cycles of Duca et al. (2021). Further, the assumption that households are infinitely-lived limits enormously the study of distributional effects. This includes the possibility of analysing crucial inter-generational effects and the differences between households with, and without, accumulated family wealth. Finally, these models assume arbitrary and extreme differences in preference parameters such as the elasticity of intertemporal substitution between savers and borrowers. This counters the intuition that preference distributions over individuals should be roughly bell-shaped.

Within the DSGE framework, the heterogeneous agent model of Garriga and Hedlund (2020) offers a better way forward, though without a full general equilibrium treatment. It includes tenure choice between owning and renting, a rich portfolio choice, long-term defaultable mortgages, and endogenously illiquid housing (i.e. the illiquidity of housing varies over time) induced by search frictions.

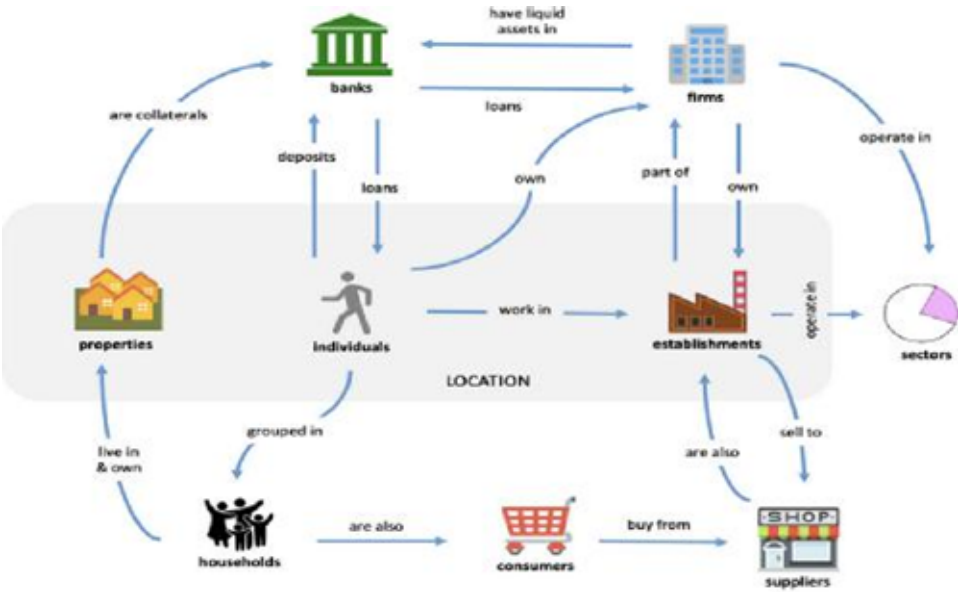
5.5 The agent-based approach for assessing distributional and welfare consequences.

The microstudies of the distributional effects of macroprudential policies reviewed in section 5.3.2, miss the behavioural responses and wider transmission effects operating through the macroeconomic links shown in Figure 1.[41] Even the integrated micro-macro approaches reviewed in section 5.3.3 do not fully capture the system dynamics arising from these links. Underlying the macro perspective of Figure 1, is a detailed micro-structure. Complementing Figure 1 is a figure drawn from Kaszowska-Mojsa et al. (2024), which portrays the connections between individual agents – households, workers, firms, banks-

[41] A partial exception is Cesnak et al. (2021) who provide detailed distributional information on how BBMs in Slovakia have affects households with different ages and incomes, but also estimate the substantial effects of BBMs on house prices in Slovakia. However, further feedbacks from house prices on the economy are outside the scope of the study.

corresponding to the macroeconomic linkages, see Figure 2.

Figure 2: Sectoral and microeconomic interactions between economic agents.



Source: Kaszowska-Mojsa et al. (2024).

How these sectoral and microeconomic interactions operate in different countries, and how they are affected by macroprudential policies, will vary a great deal with the institutional context of each country. However, the effects of macroprudential policies like BBMs are not solely tied to institutional features and market conditions but also to the personal attributes of households. Households may perceive their consumption set as being restricted by regulations, but these constraints could also contribute to smoothing consumption over the business cycle, thus resulting in moderate downturns and reduced volatility. There may be varied effects of BBMs on different groups of households with specific characteristics and in specific situations e.g., in the labour market in a given phase of the economic and financial cycle. Currently, only the Agent-Based Modelling (ABM) simulation method, with fully heterogeneous agents and based on empirical data, allows analyses at such a finely disaggregated level. This method probably has the best potential for assessing the medium-run distributional and welfare consequences of different macroprudential choices under different scenarios. However, this is not to underestimate the work needed to develop plausible heuristic rules followed by individual agents and checking model simulations against available data at various levels of aggregation.

Agent-based models that incorporate housing have their origins in pioneering studies of the housing bubble in metropolitan Washington D.C. using household and loan-level data, see Geanakoplos et al. (2012) and Axtell et al. (2014). This was followed by an application to the UK in Baptista et al. (2016), and slightly extended in Carro et al. (2023). Important features are the transitions between owner-occupation, renting and drivers of default. However, the approach is limited by the omission of a residential construction sector, the restriction to the assumption of fixed-rate mortgages and the omission of linkages between house prices and consumption.

At the time of writing, the only other UK-based ABM paper is Tarne et al. (2022), which extends the Baptista et al. (2016) approach to include a consumption channel, though still assuming only fixed-rate loans, and includes a useful treatment of the important buy-to-let market. They consider the effects of

macroprudential settings in the form of LTV restrictions for buy-to-let investors, first-time and repeat buyers on inequality and consumption volatility. They find that restrictions on buy-to-let investors are likely to reduce inequality and consumption volatility, while tighter restrictions on first-time buyers can increase inequality.[42] In assessing housing cycle dynamics, their model implies that in the UK, contrary to the evidence, the downswings are longer than upswings.[43]

Another key study in this limited literature, by Mero et al. (2023), significantly extends previous studies. They apply the ABM approach to Hungarian micro-data, and include both fixed and floating rate loan markets, and they endogenise the construction sector. They find that tighter BBMs disproportionally affect households in the lower parts of the income distribution. However, in treating the macroeconomic environment as exogenous, this limits the possibility of tracking amplification with the model (see Figure 1 above). The spatial resolution of the model is notable and makes it possible to analyse the regional impact of credit restrictions and building cost rises.

A significant step towards widespread practical implementation of ABMs with the housing market articulated into owners, renters and landlords, and connected with credit provision, is Wiese et al. (2024). For 38 OECD economies, this paper calibrates an ABM with macrodata and microdata on households and individuals with details on consumption, wealth, and debt, as well as Compustat microdata on firms and banks with balance sheets and income statements. The paper demonstrates useful forecasting performance of macro aggregates making the approach suitable for developing policy models both for monetary policy and for macroprudential policy with both macro and distributional implications.

To date, the most comprehensive ABM, based on granular, including spatial, data for Polish households, employees, firms, banks and the fiscal authority, and capturing most completely the sectoral and individual linkages illustrated in Figure 2, is by Kaszowska-Mojsa et al. (2024). This model has the flexibility to enable the construction of intricate scenarios and to evaluate counterfactual outcomes associated with various BBMs. For example, combinations of BBMs can be designed to limit negative distributional impacts of various types. Since these types of models can replicate the economy, the financial system and society up to a 1:1 scale, they require substantial computational power, but with the advantage of the complete heterogeneity of the agents. All households differ in terms of, inter alia: net worth (or other measures of wealth), income, indebtedness, tenure status, and consumption and savings patterns. Individuals can be of different ages, genders, and with different education and occupations, all derived from micro-data. Similarly, companies and banks are diversified based on empirical data. Behavioural rules not only vary across entities but can also adapt to evolving market situations, sectoral and macroeconomic conditions.

In principle, such an ABM can simulate the effect of different macroprudential policies on changes in income distributions, and also the impact of different macroprudential combinations of tools and their calibrations on the financial system and the economy – including on the labour market, entrepreneurship, wealth, income and indebtedness. All the dimensions of inequality discussed in Section 5.3.2 can be examined, moreover, in the form of joint distributions. For example, one application of the model by Kaszowska-Mojsa et al. (2024) is to examine the differential impact of different policy mixes on income inequality between and within regions. Simulations with the model for Poland suggest that (sub-optimal)

[42] Carro et al. (2023) also examine the spillover effects of loan restrictions in the UK on potential owner-occupiers on BTL investors. Carro (2023) applies a similar model to the Spanish housing market to analyse the greater amplitude of the Spanish house price cycle.

[43] One reason for this conclusion could be the fixed-rate assumption, which limits the effectiveness of a monetary policy response in the event of a downturn.

macroprudential policy settings, especially on LTV limits adopted in Poland after 2014, resulted in a medium-run increase in the Gini measure of income inequality. In principle, the model could be used to compare distributional consequences of alternative policy settings, for example, with greater escape clauses for lenders.

While much progress is evident in the development of ABM models that could be useful for assessing outcomes of housing-related macroprudential policies, more research needs to be done. The heuristics that describe behavioural rules of each agent can sometimes seem overly simple. Utility-maximizing behaviour, with realistic constraints and limited information, can sometimes give useful insights into plausible formulation of behavioural rules. To an extent, micro-empirical evidence was used by Kaszowska-Mojsa et al. (2024) in calibrating behavioural rules, and as more time-varying granular data become available, the evidence base will improve. Simulations of ABM models to generate aggregate data need to be checked for realism against econometric studies of macro-data. There can also be problems with the survey data, for example, with non-response and biased response in surveys of income and wealth, although these are present just as much with the integrated micro-macro approach, discussed in section 5.3.3.

6. Coordination of housing-related macroprudential policies with other housing policies.

Macroprudential regulators should not have to carry the entire burden of trying to stabilise housing markets and guard against household vulnerabilities. The successful mitigation of the boom-bust cycles in housing markets that have destabilised financial systems in the past requires consistency across housing-related policies across a range of different government departments (CGFS, 2023). This is in line with the view of OECD (2021), which explains the many interactions of housing with the economy. These include the impact on the environment, on inequality between people and regions, labour mobility, location and travel patterns and productivity, as well as housing affordability and financial stability. Many aspects of policy across different government departments may affect housing choices. The OECD calls for a more holistic policy across government with multi-pronged benefits, including reducing financial stability risks and the scale of many of the shocks likely to be faced by households, as well as improving the resilience of households in the face of shocks. Such policies reduce the scale of the tasks faced by macroprudential authorities.

Rigorous micro-prudential and market conduct regulation is required to promote the resilience of households and SMEs, for example by limiting predatory lending practices, mis-selling and other kinds of market abuse by banks and other lenders. Rigorous micro supervision that discourages the mis-alignment of incentives between, on the one hand, mortgage originators and sales teams, and the risk- control sections at lenders, on the other, could have done much to moderate the sub-prime lending crisis in the US, for example, by preventing 'NINJA' (no income, no job) loans. It is important also to have a mortgage lending protocol with appropriate warnings and advice channels to protect borrowers with payment arrears. This would avoid rapid foreclosures and the potential amplification of housing market downturns, as occurred in the US, see Guren and McQuade (2020). Frameworks that encourage coordination between macroprudential authorities and bank supervisors and market conduct authorities, ease the task of the former.

Co-operation is needed between governments and financial regulators to reduce housing market distortions, and the supply-demand imbalances induced by tax, planning and land supply policies. Options outside the

control of financial regulators include eliminating or limiting the mortgage interest tax deduction, which increases household leverage and was also found highly regressive by OECD (2021). Proportional or progressive property taxes, linked to market values, would contribute to stabilising house prices as well as reducing inequality. Since land ownership tends to be even more unequal than home ownership, and land prices are far more volatile than prices of structures, split rate taxes to tax land more heavily than buildings serve the same purpose, see Muellbauer (2023). Such tax reforms would reduce the need for macroprudential authorities to use BBMs to restrict access to credit in order to stabilise house prices. As, in the short-run, these restrictions can *increase* inequality for lower income households and first-time buyers, valid concerns about increased inequality are better met by tax reform.

Reforming land use zoning or planning to increase housing supply would improve access to housing. Land value capture[44], see OECD/Lincoln Institute of Land Policy (2022), could fund infrastructure and subsidised housing, improving housing access and permitting the repurposing of government revenue to meet other social goals. A larger pool of affordable social housing and an improved social safety net would reduce household vulnerability to shocks. Reducing transfer taxes would improve the flexibility of both labour and housing markets, giving more choice options to households facing shocks, again reducing household vulnerability.

7. Conclusions.

This chapter has emphasised the crucial importance of institutional heterogeneity in understanding the nature of risks to lender and borrower resilience stemming from the ways finance, housing and the rest of the real economy interact. As Section 2 explained, whether home equity withdrawal is easily available or not, and differences in the responsiveness of residential investment to house prices, have a substantial influence on the amplification of shocks through house prices to the wider economy. Where property taxes are unrelated to recent market valuations and where generous tax deductibility of mortgages has encouraged high levels of household gearing, house prices are likely to be more volatile. Moreover, the structure of the financial system where vulnerabilities can arise from high levels of interconnectedness and duration mismatch can have serious implications for the depth of a potential crisis. Furthermore, institutional differences interact with differences in the source of shock. For example, shocks to interest rates have larger and speedier consequences in floating than in fixed rate mortgage markets. But if shocks originate elsewhere, and the central bank can lower the policy rate, this will ameliorate the effect of negative shocks far more in floating rate markets than where mortgages are at long-duration fixes. These differences also affect the strength and speed of transmission of macroprudential measures.

These institutional differences need to be taken into account in assessing risks. This suggests that one size does not fit all. In other words, cruder indicators of house price overvaluation such as the house price to income ratio and recent growth rates of house prices, can be much more misleading for some countries and macro-environments than others. The same applies to credit to GDP or household debt to income ratios and their growth rates as measures of recent lending standards or of household over-indebtedness. Section 3 argued for a combination of better model-based measures of over-valuation, over-indebtedness and lending standards that takes into account the institutional circumstances of each

[44] The OECD defines land value capture (LVC) as the set of policy instruments that allow governments to capture the land value uplift generated by public interventions, such as infrastructure investments or administrative action (OECD 2022).

country, and good granular distributional data since risks tend to be concentrated in the tails of distributions.

There is a large literature of panel and country studies attempting to measure the effectiveness of different macroprudential tools. As discussed in section 4, there are multiple difficulties facing such studies based on aggregate data. These include the endogeneity bias that tends to bias downwards estimates of effectiveness and typical lack of information on the credit allocation rules being followed by lenders at the point at which macroprudential measures are enacted. If the new constraints are not much more severe than existing practice, then their effectiveness could be small. Moreover, multi-country panel studies, before the database assembled by Alam et al (2019, 2024), typically did not have information on the intensity of measures, resorting therefore to simple dummies. But even with better measures, differences in institutions and in the nature of shocks and in the broader economic environment, are unlikely to be well captured by country or time fixed effects. In other words, homogeneity of slope coefficients almost always imposed in panel studies is an implausible assumption and this necessitates exercising considerable caution in interpreting the results.

The very different qualitative approach adopted by CGFS (2023) on the post-GFC comparative experiences of macroprudential policies of 14 countries, drawing on leading practitioners in each country, is therefore very welcome. It led to four key conclusions, beginning with the need to align housing-related macroprudential policies with other housing-related policies by governments, for example on the structure of taxation and land-use zoning or planning, further discussed in section 6 above. The second key conclusion concentrated on governance frameworks, arguing that they "affect the ability to use the best tools to meet specific objectives, the speed at which policies can be implemented to mitigate risks, and the scope of tools to limit potential leakages. For example, collective experience shows that policies have been better targeted at risks when macroprudential authorities have a clear mandate, operational independence and a legal basis to direct policy across the full range of macroprudential tools."

Virtually all studies agree that early macroprudential action to head off developing risks is important for effectiveness. Inaction bias is therefore a serious problem. This is addressed in the third conclusion of the CGFS report, which argues that inaction bias can be reduced "by prioritising tools that meet objectives without requiring adjustment. Guardrails, such as floors on loss-given-default parameters, minimum risk weights or appropriately designed income-based borrowing limits, help maintain resilience during housing market upswings and periods of sharp interest rate swings." It points to the automatic stabilising function of some income-based tools, discussed in section 4 above.

Long-term public support for macroprudential policy is important for effectiveness. The final conclusion of the report argues that "Candid communication about costs, benefits, uncertainties regarding their measurement and how they informed policy decisions helps to maintain support even as memories of housing crises fade. "Conceptual and empirical research on measuring the welfare and distributional effect of macroprudential policies is reviewed in section 5 above. It argues that the growth-at-risk (GaR) framework, explained in section 5.1, is well suited to exploring costs and benefits as measured by aggregate or per capita GDP as it makes it possible to associate probabilities with different potential outcomes over relevant policy horizons, e.g. 5 years. However, expected GDP does not take account of the mandate of macroprudential authorities to avoid serious downside risks, implying an objective function, which adds a penalty for the expected growth shortfall based on multivariate GaR estimates. The weight on the penalty function reflects the degree of aversion to downside risk of the policy maker.

Especially where the macroprudential function sits in the central bank alongside monetary policy with a low inflation objective, this suggests a yet more general objective function including the inflation objective, highlighting the need for coordination between monetary and macroprudential policies. However, for those looking for a simple macroprudential objective to parallel a 2 percent target for inflation, given to many monetary policy committees, the GaR approach offers the following option: give the macroprudential authority the target of limiting the probability of, say a 5 percent or more, decline in GDP over the next 5 years to no more than z percent. The lower is z, the more averse is the target to downside risk. This does require reliable and well-documented models for GaR, but arguably, inflation forecast targeting also requires good forecasting models of inflation.

Macroprudential (and monetary) policies have important distributional effects, which often generate public controversy. The visible short-term effects on those whose access to credit may be restricted by macroprudential measures often tend to be seen as widening the generational divide between young and older households. Reliable granular data are required to measure those impacts and compare different types of policies, whether borrower- or capital based and with or without escape clauses. But the first-round effects that are the focus of many studies risk neglect system-wide effects. The pioneering work by Gross and Poblacion (2017), combining micro and macro data, was an important step towards a more comprehensive analysis. Inevitably, the estimates of the impact of macroprudential measures on aggregate house prices are less well-founded than the first-round impacts on borrowers, and feedbacks on the wider economy have so far been neglected in this literature. A fuller analysis needs to articulate the many channels of transmission, including on rental markets, tenure choices, portfolio decisions, house prices, migration and employment decisions at a spatial level, and the balance sheets of banks and other financial institutions and hence their ability and willingness to extend credit. The agent-based modelling approach, pioneered in the housing context by Geanakoplos et al. (2012) has been most fully and persuasively articulated by Kaszowska-Mojsa et al. (2024) as explained in section 5. Most citizens and many politicians do not understand “general equilibrium” or the way policies play out across the economy over a number of years. Developing such models and increasing public understanding based on their findings, would be likely not only to improve the quality of and support for macroprudential policies, but to highlight the other intervention points for public policy. These include property taxation, tax relief on interest payments, building social housing, the supply of land and land use planning. Such policies would complement or even reduce the need for macroprudential policies.

References

Aastveit, K., Juelsrud, R., Wold, E. (2002) 'Mortgage Regulation and Financial Vulnerability at the Household Level.' *Norges Bank Working Paper*, No. 6/20, pp. 1–48.

Abraham, J.M. and Hendershott, P.H. (1996) 'Bubbles in Metropolitan Housing Markets.' *Journal of Housing Research* 7(2), pp. 191–207.

Adrian, T., Boyarchenko, N. and Giannone, D. (2019). 'Vulnerable Growth.' *American Economic Review* 109 (4), pp. 1263-89.

Adrian, T. 2017. 'Macroprudential Policy and Financial Vulnerabilities', speech to the European Systemic Risk Board Annual Conference, European Central Bank, Frankfurt.

Adrian, T., Covitz, D. and Liang, N. (2015) 'Financial Stability Monitoring.' *Annual Review of Financial Economics* 7, pp. 357-95.

Acharya, V., Bergant, K., Crosignani, M., Eisert, T. and McCann, F. (2022) 'The Anatomy of the Transmission of Macroprudential Policies.' *Journal of Finance*, 77 (5), pp. 2533-2575

Aikman, D., Bridges, J., Hacioglu Hoke, S., O'Neill, C., Raja, A. (2019) 'Credit, Capital and Crises: A GDP-at-Risk Approach.' *Bank of England Working Paper*, No. 824, pp. 1–64, Bank of England.

Aikman, D. Bluwstein, K. and Karmakar, S. (2021) 'A tail of three occasionally-binding constraints: a modelling approach to GDP-at-Risk.' *Bank of England Working Paper*, No. 931, Bank of England.

Aikman, D. Kelly, R., McCann, F., and Yao, F. (2021) 'The macroeconomic channels of macroprudential mortgage policies.' *Financial Stability Notes*, Central Bank of Ireland, October 5th 2021.

Aikman, D. (2022) 'Improving the Accountability of the Financial Policy Committee.' appendix to letter to the Treasury Select Committee, https://macroprudentialmatters.com/improving-the-accountability-of-the-financial-policy-committee/

Aikman, D., Giese, J., Kapadia, S. and McLeay, M. (2023). "Targeting Financial Stability: Macroprudential or Monetary Policy?," *International Journal of Central Banking*\, 19(1), pp. 159-242,

Alam, Z., Alter, A., Eiseman, J., Gelos, G., Kang, H., Narita, M., Nier, E. and Wang, N. (2019) 'Digging Deeper--Evidence on the Effects of Macroprudential Policies from a New Database.' *IMF Working Papers* 2019/066, International Monetary Fund. (revised version in *Journal of Money, Credit and Banking*, 22 January 2024).

Anundsen, A.K. (2021) 'House price bubbles in Nordic countries?' *Nordic Economic Policy Review*, pp. 13-34.

Araujo, J., Patnam, M., Popescu, A., Valencia, F., Yao, W. (2020) 'Effects of Macroprudential Policy: Evidence from over 6,000 Estimates.' *International Monetary Fund Working Paper*, 20/67, pp. 1–53.

Arregui, N., Benes, J., Krznar, I., Mitra, S., and Santos, A. (2013) 'Evaluating the Net Benefits of Macroprudential Policy: A Cookbook.' *International Monetary Fund Working Papers*, 2013/167, pp. 1–73.

Aron, J. and Muellbauer, J. (2016) 'Modelling and Forecasting Mortgage Delinquency and Foreclosure in the UK.' *Journal of Urban Economics*, 94, pp. 32–53. https://doi.org/10.1 016/j.jue.2016.03.005

Aron, J. and Muellbauer, J. (2016) 'Modelling and Forecasting Mortgage Delinquency and Foreclosure in the UK.' CEPR: *VoxEU.org,* 1 Aug 2016.

Aron, J. and Muellbauer, J. (2024) 'New models for South African consumption, house prices, and mortgage and non-mortgage debt: insights for financial stability and monetary transmission.' UNU-WIDER United Nations University World Institute for Development Economics Research, Helsinki (forthcoming).

Bank for International Settlements (BIS). (2017a) 'Real estate and financial stability.' BIS Papers, no. 91, Bank for International Settlements.

Bank for International Settlements (BIS). (2017b) 'Macroprudential frameworks, implementation and relationship with other Policies.' BIS Papers No 94, Monetary and Economic Department, Bank for International Settlements, December.

Basel Committee on Banking Supervision (BCBS). (2018) 'Towards a sectoral application of the countercyclical capital buffer: A literature review.' *BIS Working Paper* 32, March.

Basel Committee on Banking Supervision (BCBS). (2019) 'Guiding principles for the operationalisation of a sectoral countercyclical capital buffer", https://www.bis.org/bcbs/publ/d487.pdf, November.

Baptista, R., Farmer J.D., Hinterschweiger, M., Low, K., Tang, D., Uluc, A. (2016) 'Macroprudential policy in an agent-based model of the UK housing market.' *Bank of England Staff Working Paper*, No. 619, October 2016.

Bernanke, B. S. (2018) 'The Real Effects of Disrupted Credit: Evidence from the Global Financial Crisis.' *Brookings Papers on Economic Activity*, 49 (2), pp. 251-342.

Biljanovska, N., Chen, S., Gelos, G., Igan, D., Martinez Peria, M., Nier, E., Valencia, F. (2023) 'Macroprudential Policy Effects: Evidence and Open Questions.' *IMF Departmental Paper*, 2023 (002), pp. 1–42.

Bloor, C., McDonald, C. (2013) 'Estimating the Impacts of Restrictions on High LVR Lending.' *Reserve Bank of New Zealand Analytical Note*, No. AN2013/05, pp. 1–17.

Brandão-Marques, L., Gelos, G., Machiko Narita, M. and Nier, E. (2020) 'Leaning Against the Wind: A Cost-Benefit Analysis for an Integrated Policy Framework,' *IMF Working Papers* 2020/123, International Monetary Fund.

Brunnermeier, M.K. (2009) 'Deciphering the Liquidity and Credit Crunch 2007-2008.' *Journal of Economic Perspectives*, 23 (1), pp. 77–100**.**

Carro, A. (2023) 'Taming the housing roller coaster: The impact of macroprudential policy on the house price cycle.' *Journal of Economic Dynamics and Control*, 156, pp. 104753.

Carro, A. (2022) 'Could Spain be Less Different? Exploring the Effects of Macroprudential Policy on the House Price Cycle.' *Banco de España Working Paper*, No. 2230, pp. 7–48.

Causa, O., Pochelmann, J. (2020) 'Should I stay or should I go? Housing and residential mobility across OECD countries?' *Economics Department Working Papers*, No. 1626, pp. 1–71.

Cecchetti, S. and Schoenholtz, K.L.. (2018) 'GDP at Risk.' *VoxEU.org,* 11 Jan 2018.

Cerutti, E., Dagher, J. and Dell'Ariccia, G. (2017), 'Housing Finance and Real Estate Booms: A Cross-Country Perspective.' *Journal of Housing Economics*, 38: 1-13.

Cesnak, M., Klacso, J., Vasil, R. (2021) 'Analysis of the Impact of Borrower-Based Measures.' *National Bank of Slovakia Occasional Papers*, No. 3/2021, pp. 4–65.

Chauvin, V., Muellbauer, J. (2018) 'Consumption, household portfolios and the housing market in France.' *Economics and Statistics*, 58, pp. 157–178.

Chavleishvili, S., Kremer, M. and Lund-Thomsen, F. (2024) 'Quantifying financial stability risks for monetary policy,' *Research Bulletin*, 115, European Central Bank.

Stijn C. (2015) 'An Overview of Macroprudential Policy Tools.' *Annual Review of Financial Economics*, *Annual Reviews*, 7(1), pp. .397-422, December.

Clerc, L., Derviz, A., Mendicino, C., Moyen, S., Nikolov, K., Stracca, L., Suarez, J., and Vardoulakis, A. (2015) 'Capital Regulation in the Model with Three Layers of Default.' *International Journal of Central Banking*, 40, pp. 9–61.

CGFS (2023) 'Macroprudential policies to mitigate housing market risks.' CGFS Papers No 69, Report prepared by a CGFS Study Group chaired by Emmanuelle Assouan (Bank of France), Bank for International Settlements, December 2023.

Crowe, C., Dell'Ariccia, G., Igan, D., and Rabanal, P. (2013) 'How to Deal with Real Estate Booms: Lessons from Country Experiences.' *Journal of Financial Stability*, 9(3), pp. 300–19.

Dell'Ariccia, G., Igan, D., and Laeven, L. (2012) 'Credit booms and lending standards: Evidence from the subprime mortgage market.' *Journal of Money, Credit and Banking*, 44(2-3), pp. 367-384.

Drehmann, M. and Juselius, M. (2014) 'Evaluating Early Warning Indicators of Banking Crises: Satisfying Policy Requirements.' *International Journal of Forecasting*, 28(3), pp. 463-480.

Drehmann M., Juselius, M. and Korinek, A. (2017) 'Accounting for debt service: the painful legacy of credit booms.' *BIS Working Papers* 645, Bank for International Settlements.

Duca, J., Muellbauer, J., and Murphy, A. (2021a) 'What Drives House Price Cycles? International Experience and Policy Issues.' *Journal of Economic Literature*, American Economic Association, 59(3), pp. .773–864.

Duca, J., Muellbauer, J., and Murphy, A. (2021b) 'What drives house prices: Lessons from the literature.' *VoxEU.org,* 13 September 2021.

Duca, J., Muellbauer, J., and Murphy, A. (2016) 'How Mortgage Finance Reform Could Affect Housing.' *American Economic Review*, 106(5), pp. 620–624.

Duca, J. and Ling, D. (2024) 'Work-From-Home, COVID-19, and Online Retail Effects on Commercial Real Estate Prices.' ms., Oberlin College.

Duprey, T. and Ueberfeldt, A. (2020) 'Managing GDP Tail Risk.' *Bank of Canada Staff Working Paper*, 20-3.

ESRB (2022) 'Vulnerabilities in the residential real estate sectors of the EEA countries.' February, European Systemic Risk Board

Félix, S., Abreu, D., Oliveira, V., and Silva, F. (2021) 'The impact of a macroprudential borrower based measure on households' leverage and housing choices.' *Working Papers*, No. 202116, Banco de Portugal, Economics and Research Department, pp. 1–27.

Fernandez-Corugedo, E. and Muellbauer, J. (2006). "Consumer credit conditions in the United Kingdom." Bank of England Working Papers 314, Bank of England.

Fernandez-Gallardo, A. (2023) 'Preventing financial disasters: Macroprudential policy and financial crises.' *European Economic Review*, Elsevier, vol. 151(C).

Financial Services Authority (2009) 'The Turner Review. A regulatory response to the global banking crisis.' March 2009.

Franta, M. and Gambacorta, L. (2020) 'On the Effects of Macroprudential Policies on Growth-at-Risk.' *Economics Letters*, 196, pp. 109501.

Frost, J. and van Stralen, R. (2018) 'Macroprudential policy and income inequality.' *Journal of International Money and Finance*, *85*, pp. 278–290.

Fernández-Gallardo, Á., Lloyd, S. and Manuel, E. (2023) 'The transmission of macroprudential policy in the tails: evidence from a narrative app. roach,' *Bank of England Working Papers* 1027, Bank of England.

Galan, J.E. (2020) 'The Benefits Are at the Tail: Uncovering the Impact of Macroprudential Policy on Growth-at-Risk.' *Journal of Financial Stability*, online.

Garriga, C. and Hedlund, A. (2020) 'Mortgage Debt, Consumption, and Illiquid Housing Markets in the Great Recession.' *American Economic Review,* American Economic Association, 110(6), pp. 1603-1634, June.

Geanakoplos, J., Axtell, R., Farmer, J.D., Howitt, P., Conlee, B., Goldstein, J., Hendrey, M., Palmer, N. and Yang, Ch-Y. (2012) 'Getting at Systemic Risk via an Agent-Based Model of the Housing Market.' *American Economic Review*, 102 (3), pp. 53–58.

Georgescu, O-M. and Vila Martin, D. (2021) 'Do macroprudential measures increase inequality? Evidence from the euro area household survey.' *ECB Working Paper Series*, No. 2567, 'pp. 1–47.

Giannoulakis, S., Forletta, M., Gross, M, and Tereanu, E. (2023) 'The effectiveness of borrower-based macroprudential policies: a cross-country analysis using an integrated micro-macro simulation model.' Working Paper Series 2795, European Central Bank.

Goodhart, C. and Muellbauer, J. (2024) 'Svensson on house price overvaluation.' *VoxEU.org,* 5 April 2024.

Gregor, J., (2024), "A Stress Test Approach to the Calibration of Borrower-Based Measures: A Case Study of the Czech Republic", Working Papers, Czech National Bank

Gross, M. and Población, J. (2017). 'Assessing the efficacy of borrower-based macroprudential policy using an integrated micro-macro model for European households.' *Economic Modelling*, 61, pp. 510-528.

Guren, A.M. and McQuade, T.J. (2020) 'How Do Foreclosures Exacerbate Housing Downturns?' *The Review of Economic Studies*, 87(3), pp. 1331-1364.

Higgins, B.E. (2024) 'Mortgage borrowing limits and house prices: evidence from a policy change in Ireland.' Working Paper Series, No. 2909, European Central Bank.

Honkapohja, S. (2009) 'The 1990's financial crises in Nordic countries.' Research Discussion Papers, No. 5/2009, Bank of Finland.

Iacoviello, M. (2005) 'House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle,' *American Economic Review*, 95(3), pp. 739-764, June, American Economic Association.

Iacoviello, M. and Neri, S. (2010) 'Housing Market Spillovers: Evidence from an Estimated DSGE Model.' *American Economic Journal: Macroeconomics* 2(2), pp. 125-64.

IMF (2019) 'Downside risks to house prices.' Chapter 2, in *Global Financial Stability Report*: Vulnerabilities in a Maturing Credit Cycle, April, 2019.

Jarmulska, B., Bandoni, E., Lang, J.H., Lo Duca, M., Perales, C. and Rusnák, M. (2022) 'The analytical toolkit for the assessment of residential real estate vulnerabilities,' Macroprudential Bulletin, European Central Bank, 19.

Jorda, O. Schularick, M. and Taylor, A.M. (2016) 'The great mortgaging: housing finance, crises and business cycles.' *Economic Policy*, 31(85), pp. 107-152.

Jurca, P., Klacso, J., Tereanu, E., Forletta, M. and Gross, M. (2020) 'The Effectiveness of Borrower-Based Macroprudential Measures: A Quantitative Analysis for Slovakia.' *International Monetary Fund Working Paper*, WP/20/134, pp. 2–37.

Kaszowska-Mojsa, J., Włodarczyk, P., Santos, J.L. and Farmer, D. (2024) 'The effects of macroprudential policies on inequality.' *Institute for New Economic Thinking Working Paper*, University of Oxford (forthcoming).

Kearl, J.R. (1979) 'Inflation, Mortgages, and Housing.' *Journal of Political Economy* 87(5), pp. 1115-38.

Kelly, R., McCann, F. and O'Toole, C. (2018) 'Credit conditions, macroprudential policy and house prices.' *Journal of Housing Economics*, 41(issue C), pp. 153-167.

Konstantinou, P., Rizos, A. and Stratopoulou, A. (2022) 'Macroprudential policies and income inequality in former transition economies.' *Economic Change and Restructuring*, 55, pp. 1005–1062.

Korinek, A. and Simsek, A. (2016) 'Liquidity Trap and Excessive Leverage.' *American Economic Review*, 106 (3) pp. 699-738,

Kuchler, T., Piazzesi, M. and Stroebel, J. (2022) 'Housing Market Expectations.' CESifo Working Paper No. 9665, Munich, March.

Lang, J. H., Pirovano, M., Rusnák, M. and Schwarz, C. (2020), "Trends in residential real estate lending standards and implications for financial stability," Financial Stability Review, European Central Bank, vol. 1.

Maclennan, D., Muellbauer, J. and Stephens, M. (1998) 'Asymmetries in housing and financial market institutions and EMU.' *Oxford Review of Economic Policy*, 14(3), pp. 54-80.

Meeks, R. (2017). 'Capital regulation and the macroeconomy: Empirical evidence and macroprudential policy,' *European Economic Review*, 95(C), pp. 125-141.

Meen, G. P. 1990. 'The Measurement of Rationing and the Treatment of Structural Change in the UK Mortgage Market,' *Journal of Applied Econometrics*, 5(2), 167–87.

Mendicino, C., Nikolov, K.,, Suarez, J., and Supera, D. (2018) 'Bank Capital in the Short and in the Long Run.' Working Papers, CEMFI.

Mérô, B., Borsos, A., Hosszú, Z., Oláh, Z. and Vágó, N. (2023) 'Analysing Construction Cost Shocks with a High-Resolution Housing Market Agent-Based Model.' *Journal of Economic Dynamics and Control*, 155, October 2023, pp. 104738

Mian, A. and Sufi, A. (2014) 'House of Debt: How They (and You) Caused the Great Recession, and How We Can Prevent It from Happening Again.' University of Chicago Press.

Muellbauer, J. (2022) 'Real estate booms and busts: implications for monetary and macroprudential policy in Europe.' in *ECB Forum 2022 on Central Banking: Challenges for monetary policy in a rapidly changing world*, proceedings of the 2022 ECB Forum on Central Banking, pp. 142–244.

Muellbauer, J. (2023), 'Why we need a green land value tax and how to design it', in Dougherty, S. and H. Kim (eds.), *Bricks, Taxes and Spending: Solutions for Housing Equity across Levels of Government*, OECD Publishing, Paris. https://doi.org/10.1787/d7681f43-en.

Muellbauer, J. and Kaszowska-Mojsa, J. (2023) *The Effects of BBMs,* Report for Finansinspektionen, https://www.fi.se/contentassets/f1361dc803fe43c78da7532b0c3663ed/muellbauer-kaszowska-mojsa-the-effects-of-bbms.pdf

Nier, E., Popa, R., Shamloo, M. and Voinea, L. (2019) 'Debt Service and Default: Calibrating Macroprudential Policy Using Micro Data.' No 2019/182, IMF Working Papers, International Monetary Fund.

OECD. (2021) *Brick by Brick. Building Better Housing Policies.* OECD, May 31, 2021.

OECD/Lincoln Institute of Land Policy, PKU-Lincoln Institute Center (2022) *Global Compendium of Land Value Capture Policies*, OECD Regional Development Studies, OECD Publishing, Paris.

Park, S. and Kim, Y-H. (2023) 'The impact of macroprudential policy on inequality and implications for inclusive financial stability.' *Journal of Banking and Finance*, 146, January, pp. 106716.

Peydró, J-L, Rodriguez-Tous, F., Tripathy, J., and Arzu Uluc, A. (2024) 'Macroprudential Policy, Mortgage Cycles, and Distributional Effects: Evidence from the United Kingdom.' The *Review of Financial Studies*, Society for Financial Studies, 37(3), pp. 727-760.

Prasad, A., Elekdag, S., Jeasakul, P., Lafarguette, R., Alter, A., Xiaochen Feng, A. and Changchun Wang, C. (2019) 'Growth at Risk: Concept and Application in IMF Country Surveillance.' IMF Working Paper 19/36, International Monetary Fund.

Reichenbachas, T. (2020) 'Assessing the impact of macroprudential measures: The case of the LTV limit in Lithuania.' Lietuvos Bankas Working Papers Series, No. 80/2020, pp. 1–29.

Ryan, E., Jarmulska, B., De Nora, G., Fontana, A., Horan, A., Lang, J.H., Lo Duca, M.,Moldovan, C. and Rusnák, M**.** (2023) *ECB Financial Stability Review*, November 2023.

Resolution Foundation (2023) 'An intergenerational audit for the UK.' 13 November 2023. The Resolution Foundation.

Schularick, M. and Taylor, A.M. (2012) 'Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008.' *American Economic Review*, 102(2), pp. 1029-1061.

Shin, H. S. (2009). 'Reflections on Northern Rock: The Bank Run That Heralded the Global Financial Crisis,' *Journal of Economic Perspectives*, 23(1), pp. 101-119.

Sommer, K. and Sullivan, P. (2018) 'Implications of US Tax Policy for House Prices, Rents, and Homeownership.' *American Economic Review*, American Economic Association, 108(2), pp. 241-274, February.

Suarez, J. (2022) 'Growth-at-Risk and Macroprudential Policy Design.' *Journal of Financial Stability*, 60, June, pp. 101008.

Svensson, L.E.O. (2024a) 'Are Swedish house prices too high?' *VoxEU.org,* 28 March 2024.

Svensson, L.E.O. (2024b), 'Are Swedish House Prices Too High? Why the Price-to-Income Ratio is a Misleading Indicator.' *CEPR Discussion Paper* DP18580, Centre for Economic Policy Research, London.

Tarne, R., Bezemer D. and Theobald, T. (2022). 'The effect of borrower-specific loan-to-value policies on household debt, wealth inequality and consumption volatility: An agent-based analysis.' *Journal of Economics Dynamics and Control*, 144, November, pp. 104526.

Tzur-Ilan, N. (2019) 'The Real Consequences of LTV Limits on Housing Choices.' *Real Estate eJournal,* pp. 1-65.

Tereanu, E., Behn, M., Lang, J.H. and Lo Duca, M. (2022) 'The transmission and effectiveness of macroprudential policies for residential real estate.' *Macroprudential Bulletin*, No 19, ECB, Frankfurt am Main, October.

Wiese, S. , Kaszowska-Mojsa, J., Dyer, J., Moran, J., Pangallo, M., Lafond, F. , Muellbauer, J., Calinescua, A. , Farmer, J.D. (2024) 'Forecasting Macroeconomic Dynamics using a Calibrated Data-Driven Agent-based Model', *Institute for New Economic Thinking Working Paper*, University of Oxford (forthcoming).

Appendix

The house price equation

The theory background for the house price equation is an inverted log-linear demand function. The inverse demand approach to deriving a house price equation is based on the idea that while the demand for the stock of housing depends on real house prices, income and other demand shifters, the housing stock is relatively fixed in the short run, while house prices are highly endogenous. In the inverted demand function, real house prices are the dependent variable, *rhp*, driven by household demand factors, conditional on the lagged housing stock.

$$\ln rhp_t = h_{1t} + h_{2t} \ln nmr_t + h_{3t} \ln user_t + h_4(ln(y_t/hs_{t-1}) + h_{5t} E_t \ln(y_t^p/y_t)) + h_6\, demog_t + h_7 spillover_{t-1} + + h_8\, property\ tax_t \quad (1)$$

In this equation, the intercept term, h_{1t} captures shifts in demand, which should increase with mortgage credit conditions, represented by an index, *MCCI*. All time varying parameters are functions of the form:

$$h_{it} = h_{i0} + h_{i1}\, MCCI_t \quad (2)$$

The nominal effective mortgage rate, taking amortisation into account, is *nmr,* and the user cost term, measuring after tax interest rates and maintenance costs minus expected appreciation, is *user.* Both effects should be negative, and potentially could vary with *MCCI.* The possible time variation in these effects is captured by the time subscripts on the corresponding parameters. The parameter h_4, for the log ratio of income to the lagged housing stock[45] is expected to be positive; from theory, this is measuring minus the inverse of the price elasticity of demand for housing. The coefficient h_{5t} captures the relative effect of permanent to current income, analogous to a similar term in the consumption function. The expected sign is ambiguous as there are two offsetting influences. Consider the situation where future income flows are expected to be higher than current income. The demand for housing as a current consumption item, as 'shelter', would then suggest a positive coefficient. If, however, future income flows are expected to fall relative to current income, say because of retirement, then investing in housing is a means of saving for the future. This would imply the opposite sign.[46] In principle, either factor could vary with mortgage credit conditions, *MCCI*. The remaining drivers of the real house price are demography, spillover effects from other housing markets,[47] and the rate of property tax (unless incorporated into the user cost measure).

The role of demography is mixed. On the one hand, the proportion or changes in the proportion of households in the younger, first-time buyer age groups could be a factor influencing house prices, mainly derived from housing demand as a consumption good. However, the portfolio demand for housing among middle-aged and pre-retirement households is likely to be high. This suggests that the proportion of households in this age group could also be a positive factor for house prices. In principle, demography and the income distribution should interact, as the purchasing power of the different demographic groups, as well as their size, could be relevant. In practice, lack of data typically makes this impossible to test. This specification also omits potential balance sheet effects from other types of assets, given ambiguity about expected direction of effects and missing time-series data for many countries.

The household mortgage debt equation

In contrast to the vast literature on consumption, little systematic econometric work exists on household debt, either for mortgage or for non-mortgage debt (see the reviews in Fernandez-Corugedo and Muellbauer (2006), Meen (1990) and Muellbauer (2022)). The canonical rational expectations-life cycle model of the representative consumer has little to contribute to understanding the determination of aggregate household debt. That model features a single asset, so can explain only the evolution of aggregate net wealth. In practice, consumers have multiple motives for holding debt, and these differ between mortgage debt and non-mortgage debt (which consists of credit card debt, overdrafts, personal loans, and finance to acquire durables like cars and furniture). Both mortgage debt and consumer debt are expected to be driven by the purpose of the debts.

The potential motives for acquiring mortgage debt include for housing as a consumption item (i.e. to acquire a roof over one's head), and for investment in housing to support future consumption. Another motive concerns the buffer stock role of housing equity, e.g. using housing as collateral via access to

[45] This formulation imposes the constraint that the income elasticity of demand for housing in time series data is one. Relaxing this assumption would generate separate parameters for income and the housing stock.
[46] Note that house price expectations (of appreciation) are already embodied in the user cost term.
[47] Spillover effects from housing markets in other countries could have an impact on local house prices through the investment choices of foreigners. They can be represented by lagged log ratios of house prices in the country relative to those of other countries.

equity withdrawal. Increasing a mortgage can support spending in the event of a short-term need for cash, because of an income drop or a medical emergency. These multiple motives suggest that no simple theoretical model can adequately explain the demand for mortgages. Moreover, the impact of income growth expectations on acquiring a mortgage remains uncertain: the consumption aspect of housing suggests a positive effect, while the saving aspect – acquiring housing as an asset – suggests the opposite.

These motives translate into the drivers of the (log) mortgage debt to income ratio, and several could potentially vary with the *MCCI*. Since mortgage debt finances housing purchases, higher house prices should increase need for mortgages, though with the proviso that some potential first-time buyers might be priced out of the market. Paradoxically, mortgage access could be restricted through the credit market in periods where house prices are very high relative to average income, effectively constraining mortgage demand. The demand for mortgages should be affected by the level of interest rates, nominal and/or real, and by income, both current and expected, giving a role for permanent income. With a higher housing stock, a larger mortgage stock would be needed, suggesting the housing stock to income ratio as one of the drivers of the mortgage debt to income ratio. Demography plays a role since, in general, a higher proportion of young households in the population might be expected to raise the demand for mortgages. The rate of property tax could be relevant since high tax rates would increase the financial burden of taking on mortgage debt to acquire housing.[48]

These potential drivers give rise to a long-run solution as in equation (3). If we assume that the income elasticity of the demand for mortgages is one, the long-run equation is formulated in terms of the log mortgage debt to income ratio.

$$\ln(mdebt_t/y_t) = m_{1t} + m_{2t}\ln nmr_t + m_{3t}\ln user_t + m_{4t}E_t\ln(y_t^p/y_t) + m_{5t}\ln(hp_{t-1}/y_{t-1}) + m_6 ln(hs_{t-1}/y_t) + m_7 demog_t + m_8\, property\ tax_t \quad (3)$$

where $mdebt/y$ is the mortgage debt to income ratio. All time-varying parameters are linear functions of $MCCI$:

$$m_{it} = m_{i0} + m_{i1}\, MCCI_t \quad (4)$$

The variables are as defined above.

The possible time variation in the effects of the nominal interest rate, user cost, permanent income, house prices and liquid assets, via their interactions with *MCCI*, is captured by the time subscripts on the corresponding parameters. Credit market liberalisation could impact in several ways on these long-run relationships, broadly analogous to the impacts discussed for the consumption equation. Whether some of these subtle parameter shifts can be empirically detected in a relatively short sample is questionable, but requires testing. To illustrate, credit market liberalisation: (i) should raise the intercept m_{1t} , implying a higher level of mortgage debt, mainly from relaxation of the housing down-payment and debt-service constraints; (ii) could make the real interest rate coefficient, m_{3t} more negative, while

[48]Transactions costs are another potential factor discouraging the taking on of mortgage debt, as they reduce the available cash for a down-payment, see Chauvin and Muellbauer (2018) for evidence on France.

nominal interest rates become less binding with liberalisation, making m_{2t} less negative;[49] (iii) could cause an upward shift in m_{4t}, as liberalisation refocuses people's decisions away from the present and income expectations weigh more heavily; [50] (iv) should raise m_{5t}, if the down-payment constraint is relaxed through liberalisation, making even more pronounced the usual effect of higher house prices relative to income increasing the demand for mortgages.

A potential defect of this approach is that the dynamic version of equation (3) is for the net change of the stock, not distinguishing debt repayments from new issuance. One can argue that the drivers of each are likely to be rather different. Where good data exist, the dynamic version of equation (3) can be replaced by two equations, one for new issuance, where credit conditions are particularly relevant, and one for repayments. Where mortgage markets have been newly established, as in formerly centrally planned European transition economies, new issuance dominates the net change in the mortgage stock in early years, but the role of repayments gradually becomes more important. Distinguishing the two is then important for modelling. For more mature mortgage markets, refinancing of mortgages long before their scheduled duration, e.g. 25 or 30 years, is often a major part of repayment flows, and will also be sensitive to credit conditions, as well as interest rates. The decision whether to distinguish new issuance from repayments is then a matter of data availability and quality.

Finally, an equation for the mortgage credit conditions index $MCCI_t$, jointly estimated from the equations (1) to (4), needs to be specified. One possibility is through a stochastic trend on which only generic restrictions such as smoothness can be imposed. This has the disadvantage that prior knowledge, e.g. from bank lending surveys or other indicators discussed in Section 3.2, about whether credit conditions were tightened or loosened in a particular year cannot be imposed. The alternative is to specify $MCCI_t$ as a linear function of a set of dummy variables. For example, consider a dummy taking the value 1 from the first quarter of year J and zero before. Its 4-quarter moving average linearly smooths the jump from zero to one over 4 quarters. Moving averages of moving averages of such dummies can generate non-linear transitions from zero to one.[51] A positive coefficient on such a dummy indicates easier credit, a negative coefficient indicates tighter credit. In the reduction from a fairly general version of the $MCCI_t$ function, e.g. with one transition dummy for each year, successively setting to zero, coefficients that contradict prior information, and finally setting to zero insignificant coefficients is a useful way of finding a parsimonious specification.

[49] Real interest rates measured in the user cost term have more to do with intertemporal substitution and the best time to acquire a mortgage, while nominal interest rates are closely connected with current cash flows and the ability to finance a mortgage. However, as mortgage debt depends on house prices, there is an indirect user cost effect, which could eliminate the need for a separate direct effect in the mortgage debt equation.
[50] On the other hand, in some countries, broadening access to mortgage to lower income households who may have been more credit constrained and less financially sophisticated, could have the reverse implication.
[51] Chauvin and Muellbauer (2018) and Aron and Muellbauer (2024) use smooth transition dummies that follow an ogive or S-shape in transitioning from zero to one over 8 quarters.