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Macroeconomic Implications of Financial Imperfections: A Survey

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Abstract

This paper surveys the theoretical and empirical literature on the macroeconomic implications of financial imperfections. It focuses on two major channels through which financial imperfections can affect macroeconomic outcomes. The first channel, which operates through the demand side of finance and is captured by financial accelerator-type mechanisms, describes how changes in borrowers' balance sheets can affect their access to finance and thereby amplify and propagate economic and financial shocks. The second channel, which is associated with the supply side of finance, emphasises the implications of changes in financial intermediaries' balance sheets for the supply of credit, liquidity and asset prices, and, consequently, for macroeconomic outcomes. These channels have been shown to be important in explaining the linkages between the real economy and the financial sector. That said, many questions remain.

Keywords

Asset prices, balance sheets, credit, financial accelerator, financial intermediation, financial linkages, international linkages, leverage, liquidity, macro-financial linkages, output, real-financial linkages.

JEL Classification

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"...They [economists] turned a blind eye to the limitations of human rationality that often lead to bubbles and busts; to the problems of institutions that run amok; to the imperfections of markets – especially financial markets – that can cause the economy's operating system to undergo sudden, unpredictable crashes ..."
Paul Krugman (2009a)

""Hello, Paul, where have you been for the last 30 years?"... Pretty much all we have been doing for 30 years is introducing flaws, frictions and new behaviors... The long literature on financial crises and banking ... has also been doing exactly the same...."
John H. Cochrane (2011)

"I believe that during the last financial crisis, macroeconomists (and I include myself among them) failed the country, and indeed the world. In September 2008, central bankers were in desperate need of a playbook that offered a systematic plan of attack to deal with fast evolving circumstances. Macroeconomics should have been able to provide that playbook. It could not..."
Narayana Kocherlakota (2010)

"... What does concern me of my discipline, however, is that its current core – by which I mainly mean the so-called dynamic stochastic general equilibrium (DSGE) approach – has become so mesmerized with its own internal logic... This is dangerous for both methodological and policy reasons... To be fair to our field, an enormous amount of work at the intersection of macroeconomics and corporate finance has been chasing many of the issues that played a central role during the current crisis... However, much of this literature belongs to the periphery of macroeconomics rather than to its core..."
Ricardo Caballero (2010)

"One can safely argue that there is a hole in our knowledge of macro financial interactions; one might also argue more controversially that economists have filled this hole with rocks as opposed to diamonds; but it is harder to argue that the hole is empty."
Ricardo Reis (2017)

"The financial crisis ... made it clear that the basic model, and even its DSGE cousins, had other serious problems, that the financial sector was much more central to macroeconomics than had been assumed..."
Olivier Blanchard (2017a)

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1. Introduction

The Great Financial Crisis (GFC) of 2007–09 confirmed the vital importance of advancing our understanding of macro-financial linkages. The GFC was a bitter reminder of how sharp fluctuations in asset prices, credit and capital flows can have a dramatic impact on the financial position of households, corporations and sovereign nations.[1] These fluctuations were amplified by macro-financial linkages, bringing the global financial system to the brink of collapse and leading to the deepest contraction in world output in more than half a century. Moreover, these linkages have resulted in unprecedented challenges for fiscal, monetary and financial sector policies.

Macro-financial linkages centre on the two-way interactions between the real economy and the financial sector. Shocks arising in the real economy can be propagated through financial markets, thereby amplifying business cycles. Conversely, financial markets can be the source of shocks, which, in turn, can lead to more pronounced macroeconomic fluctuations. The global dimensions of these linkages can result in cross-border spillovers through both real and financial channels.

The crisis has led to a lively debate over the state of research on the role of financial market imperfections in explaining macroeconomic fluctuations. Some argue that the crisis showed that the profession did not pay sufficient attention to these linkages. Others, by contrast, claim that they have been recognised for a long time and that substantial progress has been made in understanding them. But most acknowledge that financial market imperfections can often intensify fluctuations in the financial and real sectors. Yet, the absence of a unifying framework to study the two-way interactions between the financial sector and the real economy has limited the practical applications of existing knowledge and impeded the formulation of policies.[2]

This debate can be seen as a natural extension of the long-standing discussion about the importance of financial market developments for the real economy (as described in detail in Appendix I).[3] The diverging paths followed by the fields of macroeconomics and finance are

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[1] A large literature documents the various macro-financial linkages that have contributed to the devastating impact of the GFC. Some of the important books on the topic include Krugman (2009b), Sorkin (2009), Wessel (2009), Lewis (2010), Kose and Prasad (2010), Paulson (2010), Gorton (2012), Turner (2012), Bernanke (2013), Blinder (2013), Claessens et al (2014), Geithner (2014), Mian and Sufi (2014a), Wolf (2014), Farmer (2016), King (2016) and Taylor (2016). Lo (2012) reviews a set of 21 books on the GFC.

[2] We presented some quotes reflecting the flavour of this debate at the beginning of the survey. Krugman (2009a) criticises the macroeconomics literature for its failure to recognise the strong relationship between the financial sector and the real economy, while Cochrane (2011, 2017) responds critically to Krugman's views. Caballero (2010), Kocherlakota (2010), Taylor (2011), Romer (2016) and Reis (2017) provide varying assessments of research on macroeconomics. Blanchard (2017a) stresses the need for a broader class of macroeconomic models.

[3] Early surveys of the literature on macro-financial linkages include Gertler (1988), Bernanke (1993), Lowe and Rohling (1993) and Bernanke et al (1996). Mankiw (2006) and Blanchard (2000, 2009) offer more general reviews of the state of macroeconomics before the crisis. Recent (but more selective) updates on macro-financial linkages include Gilchrist and Zakrajšek (2008), Matsuyama (2008), Solimano (2010), BCBS (2011, 2012), Caprio (2011), Gertler and Kiyotaki (2011), Quadrini (2011), Borio (2014) and Morley (2016), as well as papers in Friedman and Woodford (2011). Work related to macro-financial linkages includes: Cochrane (2006) on financial markets and the real economy; Brunnermeier (2001) and Cochrane (2005) on asset pricing; and Tirole (2006) on the role and impact

at the root of recent debates (Figure A1). The literature has exhibited an oscillating pattern between integration and separation of financial and real economy issues. Early studies often considered developments in the real economy and financial sector jointly but they resorted to mostly qualitative approaches. Later studies, however, emphasised the separation of the real sector from the financial sector and subscribed to the idea that the financial sector was no more than a "veil" to the real economy. The corporate finance and asset pricing literatures largely adopted the "efficient markets" paradigm. An influential branch of the macroeconomic literature (following the real business cycle (RBC) approach) mostly focused on models that do not account for financial imperfections and their potential role in shaping macro-financial linkages.[4]

Although progress has been slower than hoped for, the literature has been making a more concerted effort over the past three decades to analyse the interactions between financial markets and the real economy. A number of studies have emphasised the critical roles played by financial factors for the real economy. Starting with Bernanke and Gertler (1989) – followed by Carlstrom and Fuerst (1997), Kiyotaki and Moore (1997) and others – rigorous analytical models have been developed. These models have been used for a variety of purposes, including the analysis of the impact of monetary and fiscal policies on the real economy and financial markets.

This paper surveys the rapidly expanding literature on the implications of financial market imperfections for macroeconomic outcomes. It attempts to contribute to the research programme in at least four dimensions. First, it presents a broad perspective on theoretical and empirical studies on the implications of financial market imperfections for macroeconomic outcomes. Second, it emphasises the global dimensions of these linkages in light of the rapid growth of international financial transactions and their critical role in the transmission of cross-border shocks. Third, it summarises the main empirical features of the linkages between the financial sector and the real economy. Finally, it attempts to identify gaps in the literature in order to provide guidance for future studies.

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of financial imperfections on corporate finance and other economic variables. Crowe et al (2010) and Nowotny et al (2014) present collections of papers on macro-financial linkages. Brunnermeier et al (2013) provide an analytical review of the literature on macro models with financial frictions. On the supply side, Adrian and Shin (2010b) survey the literature on the changing role of financial institutions and the growing importance of the shadow banking system. Gorton and Metrick (2013) and Pozsar et al (2013) review the role of securitisation and shadow banking; Brunnermeier and Oehmke (2013) and Scherbina and Schlusche (2014) review the literature on asset price bubbles; and Forbes (2012) reviews the literature on asset price contagion. Blanchard (2017a) looks at the state of macroeconomics, focusing on the need to include distortions other than nominal price rigidities, including financial frictions. Kocherlakota (2016) shows how the predictions of real business cycle models significantly change in the presence of small nominal rigidities and argues that these types of models are not useful tools for analysis of business cycles. For a recent discussion of the need to incorporate financial frictions, labour market frictions and household heterogeneity in benchmark macroeconomic models, see Ghironi (2017). Obstfeld and Taylor (2017) consider the importance of finance in the context of the international monetary system. The literature on law and finance also relates to the broad theme of macro-financial linkages (see La Porta et al (2013) for a recent review) but more from a longer-run developmental perspective.

[4] Claessens and Kose (2017) review research on the interactions between asset prices and macroeconomic outcomes in models without financial market imperfections. In these studies, changes in financial variables, such as asset prices, are associated with individual consumption and investment decisions but there are no aggregate feedback mechanisms from financial to real variables and little scope for macro-financial linkages.

The survey focuses on two main channels through which financial market imperfections can lead to macro-financial linkages. The first channel, largely operating through the demand side of finance, describes how changes in borrowers' balance sheets can amplify macroeconomic fluctuations. The central idea underlying this channel is best captured by the *financial accelerator* – an extensively studied propagation mechanism in a wide range of models. The second channel, associated with the supply side of finance, emphasises the importance of balance sheets of banks and other financial institutions in lending and liquidity provision for the real economy.

Given the large number of studies on the macroeconomic implications of financial imperfections, a survey on the topic comes with a number of caveats. First, for presentational purposes, we use the rough distinction between the demand and supply sides of finance, reviewing each separately and analysing how they can lead to macro-financial linkages. The demand and supply sides are of course interrelated as transactions are endogenous outcomes, especially when they are considered in a general equilibrium framework. Nevertheless, this rough demarcation allows us to classify many studies in a simple manner. Second, our objective is to provide intuitive explanations of how financial frictions can lead to macro-financial linkages. Hence, rather than delving into the details of certain models, we explain the general ideas describing the workings of models and then summarise the relevant empirical evidence for specific channels. In order to present a coherent review of this large body of work, each section provides a self-contained summary of the specific literature.

Third, macro-financial linkages ultimately originate at the microeconomic level. Hence, whenever possible, we draw lessons from the theoretical and empirical work on the microeconomic factors that are relevant for the behaviour of macroeconomic and financial aggregates. Fourth, while many of the papers we review have policy relevance, we largely stay away from directly addressing policy issues, including those related to monetary, macroprudential, regulatory and crisis management policies. Finally, while we did our best to include all the major studies on the topic, it is probably unavoidable that a survey of such a rich literature would miss some contributions.

Section 2 presents a brief review of the basic microeconomic mechanisms that could lead to financial market imperfections on the demand side. It starts with a conceptual discussion of how imperfections (financial frictions) stemming from information asymmetries and enforcement difficulties affect the amount and costs of external financing available to firms and households.[5] Financial frictions can lead to deviations from the predictions of the standard complete market models in terms of how (real and financial) resources are allocated.[6] Models incorporating financial frictions typically predict that access to external finance becomes easier and the premium charged for such financial transactions decreases with the strength of borrowers balance sheets and net worth. This can lead to the amplification of (monetary, financial and real) shocks as changes in net worth affect access to finance – and the use of that finance – and subsequently influence consumption and investment.

The section also reviews the empirical evidence on the importance of financial market imperfections on the demand side. Studies have employed microeconomic (firm, household, and sector-level) data to examine the role of imperfections in explaining the behaviour of

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[5] Some of the pioneering papers on financial frictions include Akerlof (1970), Jensen and Meckling (1976), Townsend (1979), Stiglitz and Weiss (1981), Bulow and Rogoff (1989) and Hart and Moore (1994).

[6] Throughout this paper, the terms "financial market imperfections" and "financial frictions" are used interchangeably. Financial frictions – in conjunction with a country's legal, regulatory and tax system – influence the design and evolution of financial contracts, markets and intermediaries.

households, firms and sectors over the business cycle. Some also analyse the importance of imperfections in driving macroeconomic outcomes during specific episodes. Most studies find that these imperfections tend to affect small firms and households the most, especially during times of financial stress. Although many studies provide supporting evidence concerning the roles played by imperfections, there is also a debate about their aggregate quantitative importance.

Section 3 reviews general equilibrium models that feature amplification mechanisms operating through the demand side. These models show how financial accelerator-type effects can arise when small shocks are propagated and amplified across the real economy through their impact on access to finance. In these models, the interactions between access to external financing and firms' or households' net worth or cash flows (or relevant asset prices) serve as transmission mechanisms between the financial sector and the real economy. Small, temporary shocks can amplify and spill over to other segments of the economy and generate large, persistent fluctuations in consumption, investment and output.

The past two decades have witnessed significant growth in research featuring financial accelerator mechanisms. This research programme, which often uses dynamic stochastic general equilibrium (DSGE) models, emphasises the important role played by shocks to external financing and asset prices in amplifying business cycles. For example, it models that changes in asset prices and net worth significantly influence household borrowing and spending through their impact on households' access to finance and the cost of such finance. More recent work highlights how financial frictions can affect the allocation of resources across a number of dimensions (firm heterogeneity, project choice, technological change, housing market structure and the functioning of labour markets). Section 3 also reviews how the financial accelerator mechanism has been incorporated into the analysis of the transmission of monetary policy to the real economy.

Section 4 looks at studies on the macroeconomic implications of financial imperfections in the context of open economies. As is the cases for a household or firm, imperfections can have an impact on net worth and affect a country's ability to borrow. Research has considered the importance of various imperfections using different types of open economy models. It has found that, with contracts being more difficult to enforce and information asymmetries being more prominent across borders, imperfections can be important for macroeconomic outcomes in open economies. For example, the financial accelerator mechanism has been shown to be quantitatively important in explaining the real effects of financial stress in open economy models. Another strand of the literature examines the interactions between imperfections and exchange rates, and considers the transmission of shocks in open economies through changes in the external value of the collateral required for financing. Recent empirical work supports the importance of global shocks to credit markets in leading to large cross-border spillovers in real activity.

Sections 5 and 6 present a summary of the amplification channels that operate largely on the supply side of finance and the empirical evidence relating to the importance of these channels (for discussions of the main functions of the financial system, see Levine (1997, 2005) and Zingales (2015)). Some of the same financial sector imperfections that give rise to the financial accelerator mechanism also affect the operations of financial intermediaries and markets, ie the *supply side* of finance. Just as is the case for firms, financial institutions' operations are affected by their net worth. Furthermore, financial intermediaries and markets themselves are subject to various imperfections and related market failures. Importantly, interactions among financial market participants can lead to aggregate developments on the

supply side of finance. Together, these observations imply that the supply side can be a source of shocks, amplification and propagation, leading, in turn, to macro-financial linkages.[7]

Developments on the supply side can have a substantial influence on macroeconomic outcomes through various mechanisms that can be classified under three major groups, although there are significant overlaps between these groups. The first two groups focus on banks' special role in intermediation. The first includes the *bank lending* channel, a mechanism traditionally identified in the literature as being particularly relevant for the transmission of monetary policy. Notably, changes in the balance sheets of banks, especially their liquidity, can affect the overall supply of financing. The second and related group is associated with (changes in) *bank capital*. As capitalisation varies over the cycle, banks expand or cut back lending, leading to aggregate procyclical effects. Both mechanisms matter especially to those households and firms for which bank credit cannot easily be substituted for.

The third and most recent group of studies focuses on the financial system's overall leverage and liquidity. The GFC showed that *leverage* could build up to excessive levels during upturns and drop sharply in downturns. This has important implications for the supply of external financing, asset prices and, consequently, for the real economy. In addition, providing *liquidity* is an important function of the financial system. The aggregate supply of financing and liquidity to the private sector depends, however, on a complex set of interactions between financial institutions, notably (but not only) through the interbank and other financial markets. Fluctuations on the supply side can have a significant impact on macroeconomic outcomes, with cycles of growing leverage, ample liquidity and rising asset prices being followed by cycles of deleveraging and liquidity hoarding (especially during periods of financial stress). More generally, a wide range of factors, including balance sheet positions of households, non-financial enterprises and financial institutions, interactions between those agents and financial markets, and access to information and ability to process it, can affect asset prices and the supply of external financing.

Empirical work shows that supply side shocks can affect the evolution of external financing, asset prices and market liquidity, with the potential for feedback loops between real and financial markets. A number of recent studies focus specifically on the linkages arising from the first two supply side channels for the transmission mechanisms of monetary policy. They document that the supply side can influence macroeconomic outcomes through an amplification of credit supply and external financing during boom periods and deleveraging and liquidity hoarding during periods of financial stress. A more recent strand documents the role of such supply factors internationally.

Section 7 reviews recent empirical studies that analyse aggregate linkages between the real economy and the financial sector. Using long series of cross-country data, those studies report a number of salient facts about the features of business and financial cycles and about the interactions between the two. They document that financial cycles appear to play an important role in shaping recessions and recoveries. In particular, recessions associated with

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[7] Important contributions on the supply side include Diamond and Dybvig (1983), Gale and Hellwig (1985), Calomiris and Kahn (1991), Holmström and Tirole (1997), Allen and Gale (1998) and Diamond and Rajan (2001). More recent work includes Adrian and Shin (2008), Geanakoplos (2008) and Brunnermeier and Pedersen (2009), Danielsson et al (2011), Gertler and Karadi (2011), Gertler and Kiyotaki (2011), Goodhart et al (2012), He and Krishnamurthy (2012), Brunnermeier and Sannikov (2014, 2016), Begenau (2016), Gertler et al (2016), Begenau and Landvoigt (2017) and Piazzesi and Schneider (2017). Many recent models combine demand and supply side considerations (including banks, shadow banks and payment and collateral services).

financial disruptions are often longer and deeper than other recessions while, conversely, recoveries associated with rapid growth in credit and house prices tend to be relatively stronger. These results collectively point to the importance of the two-way linkages between financial markets and the real economy.

Section 8 concludes with a summary of the main messages, questions for future research and policy issues that would require further work.

2. Financial imperfections: the demand side

This section reviews the basic mechanisms through which financial market imperfections on the demand side can lead to macro-financial linkages. It starts with a conceptual discussion of how the state of borrowers' balance sheets affects their access to external financing at the microeconomic level, ie at the levels of households and corporations. This is followed by a summary of microeconomic and sectoral evidence supporting the importance of imperfections on the demand side. Although most demand side studies support the role of imperfections, their quantitative importance is still under debate.

A. Basic mechanisms

Financial market imperfections often stem from information asymmetries and enforcement problems. Due to information asymmetries, lenders and investors know less about the expected rate of return on prospective projects than firm managers or owners do. Moreover, lenders and investors do not know everything about borrowers; for example, whether they are well qualified, exerts sufficient effort or selects economically efficient projects (ie with positive net present value). Since the economic prospects of projects, the financial position of borrowers and the actual effort expended by borrowers cannot be observed perfectly *ex-ante,* adverse selection and moral hazard problems arise. Lenders and investors may also face difficulty in enforcing contracts *ex-post.* In part due to information asymmetries (eg to verify the exact state of affairs of borrowers such as the actual effort they exerted) but also as the legal and institutional frameworks may not allow for efficient *ex-post* settlements (eg as collateral is hard to repossess) lenders may have to incur large costs and therefore refrain from lending in the first place.

These information asymmetries lead to transaction costs and incomplete financial markets in the sense that not every worthwhile project is financed.[8] In order to choose worthwhile

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[8] As Quadrini (2011) notes in his review, the presence of financial frictions implies the absence of complete trade in certain risks, that is, models with financial frictions feature missing markets, thus limiting a full sharing of risk. Models (implicitly or explicitly) also assume heterogeneous agents since there would otherwise be no reason to trade claims inter-temporally or intra-temporally. The fact that markets are missing may be exogenously assumed or can arise from financial frictions, that is, forms of market incompleteness due to information asymmetries and limited enforcement. There has been an extensive theoretical literature on how such imperfections can lead to missing markets or incomplete contracts, including in financial markets. Seminal corporate finance papers include Akerlof (1970), Jaffee and Russell (1976), Jensen and Meckling (1976), Rothschild and Stiglitz (1976), Stiglitz and Weiss (1981) and Myers and Majluf (1984). Tirole (2006) provides a textbook treatment of the role of imperfections in corporate finance and discusses some of their macroeconomic implications. Meyers (2015) reviews capital structure theories and how they have been tested. Samphantharak and

projects, avoid adverse selection and prevent shirking, lenders and investors will have to incur transaction costs. In order to overcome monitoring problems, savers and principal investors have to rely on agents (such as banks) for monitoring to be done on their behalf or employ certain *ex-post* mechanisms (for example, costly state verification (Townsend (1979)). For this to happen, they need to incur additional costs. These costs and other imperfections create, in turn, a wedge between: i) what the expected value of a firm or project would be and how much external financing it could obtain with no agency costs (ie under perfect information or run by the principal); and ii) what the value of the firm would be under a particular external financing arrangement.[9] This wedge means a higher cost of external financing or can even lead lenders to ration the external financing they provide *ex-ante* (Stiglitz and Weiss (1981)).

Models incorporating these imperfections typically predict that access to external finance is related to the strength of borrowers balance sheets. Because of this link, most models do not only predict that access to finance differs from what is predicted by models without imperfections, but also that to the extent that financing is available, its amount depends on borrowers net worth – the value of assets less outstanding debt obligations – and the collateral value of easily saleable assets, especially liquid assets (eg cash). Net worth and collateral provides three types of assurance to investors. First, with skin in the game, borrowers have better incentives to select profitable projects and work hard to deliver successful results. Second, borrowers have assets to help repay the loan, ie the simple value of recoverable collateral. Third, collateral can help investors screen out quality borrowers from low quality ones or help trustworthy borrowers signal their quality (Bester (1987) and Besanko and Thakor (1987)).

Lenders may demand a premium over the risk-free rate to provide credit to borrowers. This "external finance premium," ie the difference between the cost of external funds and the opportunity cost of internal funds, covers the costs incurred by financial intermediaries in evaluating borrowers prospects and monitoring their actions. It can also be seen as compensating investors for the inefficiencies and risks induced by moral hazard and adverse selection. If borrowers have limited net worth, their access to external financing can be fully constrained, even if they have profitable investment projects. This is because lenders have little confidence in their incentives to perform (and the lenders cannot screen out good projects) and their ability to repay. This premium and constraint on external financing also imply that deadweight losses can arise because not all profitable projects can obtain financing.

Changes in borrowers' net worth then affect their access to finance. Shocks, such as fluctuations in asset prices or changes in economic prospects, influence the balance sheets of borrowers. Given financial imperfections, resulting changes in net worth affect the volume of external financing supplied and its cost. Specifically, as net worth rises, the volume of external financing increases while its cost declines to a level that is comparable to the implicit cost of internal funds. Conversely, as net worth declines, the volume of external financing falls while its cost increases.

The relationship between borrowers net worth and their access to external financing (and its cost) implies that the impact of shocks (monetary, real and financial) can be amplified. This is an expected outcome as borrowers adjust their investment or consumption

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Townsend (2009) discuss how finance affects household behaviour. Dewatripont and Tirole (1994) and Freixas and Rochet (1997) present early analytical overviews of imperfections as they affect financial institutions (see also Greenbaum et al (2016)).

[9] These imperfections also affect the formation of firms since a firm (as an organiser of activities) can be a mechanism to internalise some of those constraints (Coase (1937)). Aghion and Holden (2011) present a review of research on incomplete contracts and the theory of the firm.

plans in the face of changes in the volume and cost of external financing. However, the effects of financial imperfections can be asymmetric over the business cycle. In fact, when net worth is high (more likely to be the case during booms), the problems of adverse selection or moral hazard are less relevant (as lenders' collateral requirements are less binding). Conversely, with adverse shocks, net worth-related constraints can suddenly become much more significant. The asymmetric nature of shocks has been exploited by the empirical literature to show the relevance of macro-financial linkages.

The key mechanisms described above are also relevant to understanding the implications of changes in household balance sheets. As is the case for corporations, the borrowing potential of households also hinges on the strength of their balance sheets. This means that movements in asset (such as house or equity) prices can lead to changes in household borrowing and spending that are larger than what is suggested by conventional life-time wealth and consumption effects (Claessens and Kose (2017)). Since housing represents a large part of household net worth, movements in house prices can affect homeowners' access to financing and the external financing premium they face (Mian et al (2017)).

B. Empirical evidence

Numerous studies examine the empirical relevance of financial imperfections. Some employ microeconomic (firm-, household- and sector-level) data while others consider specific events or episodes. This section summarises the empirical evidence provided by microeconomic data (largely focusing on corporate investment and household consumption). Additional work that considers macroeconomic and time series evidence is presented in Section 7.

Research documents a strong association between firm cash flow and investment. Theory predicts that, in environments with no financial market imperfections, a corporation's current cash flow is immaterial to its investment decision. With imperfections, however, a corporation's cash flow can influence investment decisions because the corporation is subject to an external finance premium that stems from financing constraints. As the cash flow increases, so can investment because of the greater availability of internal funds and the lower cost of such funds relative to external funds. Many studies using panel data report that corporate cash flows are indeed correlated with investment decisions. This is especially true for firms that are smaller, do not pay dividends or have poor credit ratings, exactly those firms that are more likely to be subject to imperfections. The first influential paper that presents empirical evidence of this link, by Fazzari et al (1988), has been followed by many others.[10]

The empirical evidence on the link between internal cash flows and investment shows that imperfections play a significant role. Although other factors can also lead to such linkages, studies using various techniques to control for such factors have confirmed the relevance of imperfections.[11] One confounding factor is that firms' current cash flows can be correlated with future profitability. Since prospective returns are relevant to current investment decisions, this can generate a correlation (even without financial market frictions). Evidence shows, however, that imperfections remain important. For example, Blanchard et

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[10] Other studies include Hubbard (1998), Hoshi et al (1991), Whited (1992), Calomiris et al (1995), Gross (1995) and Hubbard et al (1995). Stein (2003) presents a survey of theoretical and empirical work regarding the determinants of firm-level investment dynamics.

[11] For example, Kaplan and Zingales (1997) criticise the approach taken by Fazzari et al (1988) because they do not control for the endogeneity of financing constraints. See further Kaplan and Zingales (2000) on why investment-cash flow sensitivities are not good indicators of financing constraints.

al (1994) find supporting evidence by analysing how firms adjust their investment in response to "cash windfalls". They argue that such windfalls are unrelated to future profitability.

Other research, using different approaches, also emphasise the importance of financial imperfections. Lamont (1997) analyses internal capital markets of oil companies and finds that, in response to a sudden drop in oil prices, these companies significantly reduce their non-oil investment compared with other companies. Since this approach controls for the profitability of investments, it provides evidence of the importance of cash flows for investment. A number of other studies, including those on the determinants of inventories and employment, also point to the critical role of imperfections.[12] Another strand of the literature uses information extracted from CEO's public statements and surveys to assess directly whether firms are credit-constrained (Graham and Harvey (2001)).

Imperfections are acutely important for small firms, particularly during times of financial stress. Because such firms have more limited access to financial markets (because they have less collateral or are less transparent to outside investors), imperfections are often more relevant to them (Petersen and Rajan (1995)). Fazzari et al (1988)) find that investment is indeed significantly more sensitive to current cash flows for new and small firms. In a related study, Gertler and Hubbard (1988) report an inverse relationship between firm size and sales variability that stems from imperfections. They also find that the effects of financial market frictions on investment are asymmetric, with larger impacts during downturns than during booms. Fort et al (2013) show that young (typically small) businesses are more sensitive to the cycle than older/larger businesses. Campello et al (2010) and other papers document the adverse implications of financial constraints during a financial crisis (see Peek and Rosengren (2016) for a comparison of supply side effects between the GFC and previous crises).

Other studies also examine the importance of internal cash flow and asset price movements for the investment undertaken by different classes of firms. Gilchrist and Himmelberg (1999), for example, document that internal cash flow is critical for investment, especially for firms that are small, have limited access to credit markets and have relatively weaker balance sheets. They find that investment is responsive to both fundamental and financial factors, as predicted by the theory relating to financial frictions. Their estimates show that financial factors increase the overall response of investment to an expansionary shock by about 25% over the first few years following the initial shock. Chaney et al (2012) and Gan (2007) find a significant impact of asset (real estate) prices on corporate investment in the United States and Japan (see also Lin et al (2011) for the role of ownership structures for financing constraints).

Studies also report that small firms are more likely to be credit-constrained during periods of contractionary monetary policy. Gertler and Gilchrist (1994) examine the behaviour of small and large manufacturing firms in the United States during five periods of contractionary monetary policy and one period of credit crunch. They document that small and large firms behave differently during these periods, with the former group reducing its debt and the latter one increasing it. Small firms experience larger declines in their inventories and sales than large firms (Figure 1). They conclude that because large firms have easier access to credit, the impact of adverse credit market shocks is less pronounced for them than it is for smaller firms. Sharpe (1994) provides similar supporting evidence and concludes that the cyclicality of a firm's labour force is inversely related to its size.

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[12] See for additional work, Cantor (1990), Blinder and Maccini (1991), Oliner and Rudebusch (1993), Carpenter et al (1994) and Guiso et al (2013).

The behaviour of households is similarly affected by financial market imperfections. Due to imperfections, including an inability to borrow against one's life time income, households can be subject to borrowing constraints and therefore undertake more precautionary saving. This can make household consumption highly sensitive to fluctuations in transitory income. A number of empirical studies suggest that changes in aggregate consumption are significantly correlated with lagged or predictable changes in income or credit growth (Flavin (1981), Campbell and Mankiw (1989, 1990) and Deaton (1992); see Jappelli and Pistaferri (2010) for a review). Ludvigson (1999) shows a statistically significant correlation between consumption growth and predictable credit growth.

Changes in house prices affect household borrowing and spending substantially through their impact on household net worth and cost of credit. Home equity is often a large part of household net worth. A variety of micro-based empirical studies document that household consumption is affected more by changes in house prices than what simple life-time consumption models would predict (Claessens and Kose (2017)). Lamont and Stein (1999) report that US households with weak balance sheets adjust their housing demand more strongly in the face of income shocks, consistent with a role for borrowing constraints. Other studies also show that households face an external finance premium, which is lower when their financial position is stronger (Almeida et al (2006)).

Financial imperfections associated with housing markets are shown to have implications beyond their impact on individual households. Using regional-level data for the United States, Mian and Sufi (2010) show that the local variation in house price appreciation in the 2000s, and related subprime expansion and securitisation, led to a disassociation of local mortgage credit from income as borrowing constraints became (excessively) relaxed. Credit extension was driven by expectations of house price appreciation but this was followed by a wave of mortgage defaults when prices started to decline (Figures 2 and 3). In the regions affected, this triggered subsequent large adjustments in durables consumption (proxied by auto sales) and a rapid increase in unemployment (Mian and Sufi (2014b) and Loutskina and Strahan (2015); see also Benmelech et al (2017) on the important role of credit supply shocks in the auto loan market during the GFC).

However, some question the potential role of imperfections in explaining the behaviour of households and firms. They argue that the close association between income and consumption may not be entirely due to imperfections. Others point out the general difficulty in separating real effects from balance sheet effects. Factors, such as the expected rate of return, while difficult to measure, also affect firm and household access to finance. Some consequently argue that changes in cash flows represent a set of factors that is different from the strength of balance sheets (Eberly et al (2008)). Carroll (1997), for example, suggests that the excess sensitivity of consumption growth to forecastable income growth is explained by non-linearities of the marginal utility function rather than by borrowing constraints.

The quantitative importance of financial frictions for small firms has been under scrutiny as well. Chari et al (2008) challenge the findings of Gertler and Gilchrist (1994) and report that the behaviour of small and large firms is not significantly different during US recessions than it is during other times. Kudlyak and Sánchez (2017) consider how the debt, sales and inventories of small and large firms evolved during the third quarter of 2008, a period of elevated financial stress. They report that large firms experienced bigger declines in sales and short-term debt than small ones (Table 1). They also document similar patterns for earlier recessions. Others argue that even if smaller firms tend to face significant external finance premia, the role of such firms in explaining business cycles may be small (Cummins et al (2006)). Srinivasan (1986) shows that small- and medium-size manufacturing firms depend

more on internal finance than large firms, potentially making the costs of external finance less relevant in the aggregate.

It has also been shown that large firms are affected by imperfections, especially during times of financial stress. Even relatively large firms, including publicly-listed corporations, have been shown to face external finance premia, as predicted by theories premised upon imperfections (see Levin and Natalucci (2005) and Levin et al (2004)). When large firms suffer from adverse shocks to their balance sheets, their investments are also negatively affected, especially during recessionary and stressed periods (Aguiar (2005) and Gilchrist and Sim (2007)). Almeida and Campello (2010) find that large firms can also face high external financial costs.

On balance, many studies confirm the role of imperfections for outcomes associated with the behaviour of firms and households. This is particularly true of studies based on microeconomic data. However, few studies cover the universe of firms or households and only a small number of studies analyse the aggregate quantitative importance of financial frictions in a rigorous fashion. Consequently, they are less clear about the aggregate impact of imperfections. The next section turns therefore to studies that focus on the aggregate impact of imperfections and how such imperfections give rise to the financial accelerator mechanism.

3. Financial imperfections in general equilibrium

This section describes how financial imperfections can lead to more pronounced macroeconomic fluctuations. It first introduces the financial accelerator mechanism through which financial imperfections amplify and propagate aggregate cyclical fluctuations. In general, equilibrium models featuring this mechanism display that real, monetary and financial shocks can have a magnified effect on the real economy because borrowers adjust their investment in response to changes in external financing. The section then presents a summary discussion of the empirical evidence on the quantitative importance of the various types of financial accelerator mechanism, mostly in the context of DSGE models.

A. The financial accelerator

How does the financial accelerator work? The relationships described above, between the amount of external financing and its cost (premium), on one hand, and the strength of borrowers' balance sheets and cash flow positions, on the other, lead to an *amplification* mechanism where small shocks can result in large economy-wide adjustments to investment and consumption. Since wealth is a state (or given) variable and economic agents cannot quickly (or optimally) adjust their investment/saving plans (as they face costs of doing so), this mechanism persists over time, causing short-lived shocks to real or financial variables to have longer-lasting effects on the real economy. This *propagation* mechanism can also have general equilibrium effects as individual agents' actions affect other agents' behaviour in a mutually reinforcing fashion (see Figures 4A and 4B).[13]

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[13] For surveys describing variants of the financial accelerator mechanism, see Antony and Broer (2010), BCBS (2011), Coric (2011) and Quadrini (2011).

The basic mechanism

Although narratives of the propagation mechanisms had been around for a long time, Bernanke and Gertler (1989) presented the first formal model featuring the financial accelerator mechanism.[14] In their model, a negative productivity shock weakens the cash flow and balance sheet positions of corporations. In turn, this reduces their access to external finance and increases the premium on such finance, as in standard corporate finance models. One of the innovations of their model is the use of a dynamic framework. In particular, they introduced an overlapping generations model in which only entrepreneurs could costlessly observe the returns on their individual projects. But outside lenders have to incur a fixed cost to observe those returns (this "costly state verification" mechanism was first developed by Townsend (1979, 1988)). As firms' balance sheets and cash flows worsen, they start facing limits on their access to external finance in ensuing periods. This, in turn, leads them to reduce investment even after the initial productivity shock dissipates, thus leading to a persistence of shocks at the firm level.

While movements in cash flows play a key role in driving changes in access to credit and corporate balance sheets more generally in the model developed by Bernanke and Gertler (1989), fluctuations in credit and asset prices can also play important roles in amplifying shocks over time. For example, Kiyotaki and Moore (1997) focus on the role of asset prices. In their analysis, declines in asset prices constrain the ability of corporations to obtain new loans, with subsequent effects on investment and ultimately on output. They show that by allowing for the endogenous determination of asset prices, a small negative shock leading to an asset price decline gets amplified as it reduces the value of collateral for all borrowers and thereby reduces the aggregate availability of loans. This further depresses demand for the asset and its price, which then further reduces access to external financing.

In these models, shocks persist and amplify over time and also spill over to other corporations or sectors. The interactions between credit limits and cash flows or asset prices become the transmission mechanism by which small or temporary shocks – whether from technology, or other real factors, policies or income distribution – can generate large, persistent fluctuations. In these models, durable assets play a dual role: not only are they factors of production but they also serve as collateral.

Many dimensions of the financial accelerator

A number of studies have shown how various types of financial imperfection can lead to different propagation and amplification mechanisms. Some models provide complementary explanations of how such mechanisms can operate. In most models, cash flows, asset prices and balance sheets tend to be depressed during recessions.[15] Although the mechanisms (and/or channels) vary – running from cash flow, default risk, capital allocation across firms, technological change and information asymmetry to the functioning of labour and housing

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[14] Earlier general equilibrium models often featured incomplete financial markets (rather than market imperfections). Farmer (1984), for example, presents a setting where a complete set of futures markets does not exist because traders have finite lives.

[15] Each model has its specific advantages and limitations. Some models assume that agents are short-lived, as in the overlapping generations model of Bernanke and Gertler (1990) and Suarez and Sussman (1997). The model by Kiyotaki and Moore (1997) is dynamic with long-lived agents but, as Suarez and Sussman (1997) highlight, it rules out price indexation as a way of insuring against unanticipated shocks.

markets – the overall impact of amplification on macroeconomic outcomes is quite similar. Appendix II presents a summary of these mechanisms.[16]

B. Quantitative importance of the financial accelerator

Research, using a variety of approaches, documents the quantitative importance of the financial accelerator mechanism. This sub-section looks at two distinct groups of studies. The first employs DSGE models to evaluate the quantitative importance of the financial accelerator for the business cycle. The second group considers the role of the financial accelerator mechanism within the context of monetary policy. The sub-section concludes with a discussion of studies that challenge the quantitative importance of the financial accelerator.

Studies employing DSGE models

In one of the first DSGE models with financial market imperfections, Carlstrom and Fuerst (1997) show the importance of endogenous agency costs in accounting for business cycles. They employ a setup featuring a financial accelerator mechanism with long-lived entrepreneurs. Their model can replicate the empirical observation that output growth displays a hump-shaped behaviour in response to negative shocks as households delay their investment decisions until agency costs are at their lowest (several periods after the initial shock).

Bernanke et al (1999) represent the seminal DSGE model involving the financial accelerator. They show that endogenous fluctuations in balance sheets can propagate the impact of relatively small exogenous disturbances and lead to larger and longer-lasting effects on the real economy. Looking at how monetary policy shocks can get amplified, they find that the impact on investment of a 25 basis point decline in interest rates is almost doubled by the financial accelerator because the reduction is reinforced by an additional decline in the external finance premium. The initial response of output to such an interest rate decline is also about 50% greater due to financial accelerator effects. It is also more persistent because of agency problems between borrowers and lenders.

DSGE models and their many variants show how adding imperfections can help explain business cycles. Models including imperfections on the demand side – featuring external finance premia, balance sheet constraints on borrowing and liquidity shortages – are able to replicate to a significant degree the behaviour of key macroeconomic variables. Christiano et al (2008), for example, show that financial factors play an important role in explaining business cycles during the past two decades in the United States and Europe. Von Heideken (2009) documents that the financial accelerator greatly improves the ability of standard models, even those with an elaborate set of real and nominal frictions, to mimic the main features of business cycles in the United States and the euro area. Using the Bernanke et al (1999) financial accelerator framework, Nolan and Thoenissen (2009) show that shocks to the efficiency of the financial sector play an important role in explaining business cycles in the United States.[17]

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[16] See also Bernanke and Gertler (2000) and Cecchetti et al (2000) for a discussion of different mechanisms, including those working through asset prices.

[17] Other papers employing general equilibrium models (with the financial accelerator) discuss how financial institutions fit into broader real activity, including Christiano et al (2003), Christensen and Dib (2008) and De Graeve (2008).

DSGE models combining microeconomic and asset price data with macroeconomic variables, such as investment and consumption, further confirm the critical role of imperfections. Gilchrist et al (2009) demonstrate the quantitative importance of imperfections by examining credit spreads on the senior unsecured debt issued by a large panel of non-financial firms. Estimating a DSGE model that links balance sheet conditions to the real economy through movements in the external finance premium (using credit spreads as proxy), they show that rising external finance premia are related to subsequent declines in investment and output. They also show that credit market shocks contributed significantly to US economic fluctuations during 1990–2008. In related studies, Gerali et al (2010) and Atta-Mensah and Dib (2008) incorporate credit risk into standard DSGE models and quantify the role of frictions in business cycle fluctuations.

Studies using DSGE models have also shown how endogenous developments in housing markets can magnify and transmit shocks. Aoki et al (2004) quantify the effects of shocks to housing investment, housing prices and consumption in a model in which houses serve as collateral to reduce borrowing-related agency costs. Campbell and Hercowitz (2009) investigate the impact of mortgage market deregulation in a calibrated general equilibrium framework with borrowing-constrained households. Iacoviello (2005) constructs a model in which households' collateral constraints are connected to real estate, and finds that collateral and accelerator effects are critical in replicating the changes in consumption resulting from movements in house prices.[18] Aspachs-Bracons and Rabanal (2010) report that, while labour market frictions are critical in accounting for the main features of housing cycles in Spain, financial frictions associated with collateral constraints appear less important.

Using a framework in which house prices and business investment are linked, recent studies show how credit constraints affect macroeconomic fluctuations. For example, Liu et al (2013) study the close relationship between land prices and business investment. They focus on land prices because most of the fluctuations in house prices are driven by land prices rather than by the cost of construction (Davis and Heathcote (2007)). They introduce land as a collateral asset in firms' credit constraints and identify a shock that drives most of the observed fluctuations in land prices. Since firms are credit-constrained by land value, a shock to housing demand originating in the household sector triggers competing demands for land between the household and business sectors. This sets off a financial spiral that drives large fluctuations in land prices and strong comovements between land prices and investment, consumption and hours worked.

Some other studies, using DSGE models, analyse the importance of disturbances in housing markets in explaining certain features of business cycles. Monacelli (2009) shows that a borrowing constraint, where durables play the role of collateral asset, improves on a standard New Keynesian model's ability to match the positive comovement of durable and non-durable spending and the large response of durable spending to shocks. Davis and Heathcote (2005) show how a multi-sector growth model – with housing affecting household borrowing and spending – matches many empirical facts: consumption, residential investment

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[18] Guerrieri and Iacoviello (2013) present a model with collateral constraints that displays asymmetric responses to house price changes. In their model, collateral constraints become muted when housing wealth is high (shocks to house prices lead to small and positive changes in consumption and hours worked). However, collateral constraints become tight when housing wealth is low (shocks to house prices translate into negative and large changes in consumption and hours worked). Kannan et al (2012) consider the importance of credit constraints in driving the linkages between house prices and macroeconomic fluctuations. Iacoviello and Pavan (2013) and Iacoviello (2004, 2015) also consider the role of housing markets in explaining business cycles. Wachter et al (2014) present a collection of papers on the role of housing markets during the GFC.

and nonresidential investment comove and residential investment is more than twice as volatile as business investment.

Research also shows how disturbances in housing markets can have differential effects on the real economy depending on institutional and other country-specific features. Iacoviello and Minetti (2006b) show that the impact of house prices on borrowing constraints is stronger in countries with more liberalised credit markets. Iacoviello and Minetti (2008) explain the intensity of the broad credit channel of monetary policy with variables capturing the efficiency of housing finance and the type of institutions active in mortgage provision in four European countries. Cardarelli et al (2008) show how housing finance and house price shocks relate to business cycles in OECD countries and that spillovers from the housing sector to the rest of the economy are larger in economies where it is easier to access mortgage credit and use homes as collateral.

Financial accelerator and monetary policy

The financial accelerator mechanism is also critical in understanding one of the major channels of monetary policy transmission. In addition to the direct interest rate channel (ie the effect of interest rate changes on asset prices and, through related channels, consumption and investment), monetary policy affects the real economy through its impact on the balance sheets of corporations and households.[19] This so-called "balance sheet channel of monetary policy transmission" is closely related to the financial accelerator mechanism. Bernanke et al (1999) and Cordoba and Ripoll (2004a), for example, extend the Kiyotaki and Moore (1997) framework to environments with money and investigate the role of monetary policy.

Changes in monetary policy can have much larger effects on real macroeconomic aggregates than those resulting alone from traditional, direct interest rate and asset price channels. Interest rate movements affect the external finance premium and the severity of financing constraints faced by corporations and households because they influence cash flows and balance sheets, including net worth (through asset price effects). To illustrate, contractionary monetary policy is typically associated with a drop in asset prices and thus results in a decline in the net worth of corporations and households. This leads to an increase in their external finance premium and weakens their borrowing ability. This, in turn, constrains their spending on investment and consumption (Bernanke and Gertler (1995)).

The balance sheet channel of monetary transmission, also called the "broad credit channel", has been studied extensively. A number of papers consider different dimensions of this channel in various settings (see Boivin et al (2011) for a summary of this literature).[20] These papers typically find that monetary policy has an impact on the balance sheets of borrowers and on the distribution of income between borrowers and lenders. A change in policy rates can therefore have an effect on the real economy that is larger than what would be suggested by the direct channels alone. Section 5 discusses a similar channel but in relation

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[19] For a discussion of these other channels, see Claessens and Kose (2017). For a review of the relevance of the corporate finance literature for monetary policy, see Trichet (2006).

[20] See, for example, Faia and Monacelli (2007), Iacoviello and Minetti (2008), Christiano et al (2008), Carlstrom et al (2009), De Fiore and Tristani (2011), Eggertsson and Krugman (2012) and Cúrdia and Woodford (2016). Woodford (2011) reviews this abundant literature. Considering balance sheet effects, Taylor (2008) proposes a modified Taylor rule that adjusts the short-term interest rate to observed increases in credit spreads. Kannan et al (2012) provide evidence of how the inclusion of house price movements in the conduct of monetary policy can help stabilise the economy in the face of pressures in the housing market.

to the supply side: the bank lending channel, which refers to the effect of monetary policy on the supply of loans.

Debate about the importance of the financial accelerator mechanism

Some studies question the quantitative importance of the financial accelerator mechanism and suggest that other mechanisms might be more important. Chari et al (2007) analyse financial and other frictions with data for the US Great Depression and the 1982 recession. Their results suggest that labour wedges – differences between what firms are willing to pay given the marginal product of labour and what workers are willing to accept in wages given their marginal rate of substitution vis-à-vis leisure – account for most of the fluctuations (see also Buera and Moll (2015)).[21] Meier and Muller (2006) estimate a model with a financial accelerator for the United States, matching the impulse response functions after a monetary policy shock. They claim that financial frictions do not play a significant role. Bacchetta and Caminal (2000), using a stylistic model of credit markets, show that the impact of anticipated productivity and fiscal or saving shocks on output fluctuations is usually not amplified but may rather be dampened because of credit market imperfections.

Other researchers also argue that the quantitative relevance of imperfections associated with credit constraints, such as those studied by Kiyotaki and Moore (1997), can be small. For example, Kocherlakota (2000) shows that the degree of amplification provided by credit constraints depends crucially on the parameters of the economy. In a related paper, Cordoba and Ripoll (2004b) argue that the amplification mechanism in Kiyotaki and Moore (1997) relies heavily on their underlying assumptions. They consider a more standard setting and argue that while collateral constraints can help amplify small unexpected shocks to the real economy, their quantitative impact is small. In his review, Quadrini (2011) also highlights the generally weak amplification of collateral-based financial accelerator models as regards investment, suggesting instead to focus more closely on how financing constraints affect working capital rather than investment.

There has also been a vigorous debate about the importance of financial factors in explaining the Great Depression. While Calomiris (1993) and Bernanke (1995), in their review of various factors explaining the Great Depression, clearly come out favouring financial market imperfections, others do not. For example, Cole and Ohanian (2004) and Ohanian (2009) use general equilibrium models to show that labour policies can account for about 60% of the drop in economic activity in the 1930s and that these policies began to reverse when the economy resumed expansion in 1940. This suggests that financial factors did not play such a large role.[22] Chatterjee (2006) presents a short summary of recent studies, including those employing various types of general equilibrium model. A reflection of this intense debate can also be seen in the discussions on the sources of the post-GFC recession (eg Ohanian (2010), Woodford (2010) and Caballero (2010)).

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[21] Christiano and Davis (2006) claim that the result by Chari et al (2007) is not warranted if spillovers across wedges are taken into consideration (see also Justiniano et al (2010, 2011)). Ajello (2016) finds evidence that a significant fraction of US output and investment volatility is driven by shocks to financial intermediation spreads.

[22] Using a standard New Keynesian model, Eggertsson (2012) argues that the New Deal policies of the Great Depression were helpful in promoting the recovery. These policies were expansionary because they changed expectations (from deflationary to inflationary), thus eliminating the deflationary spiral of 1929–33. This made lending cheaper and stimulated demand.

4. Financial market imperfections in open economies

The macroeconomic implications of financial market imperfections have also been studied in the context of open economy models. Similar to the case of a corporation or household in a closed economy, a country's ability to borrow is affected by its net worth because of imperfections. Obstfeld and Rogoff (2002) argue that the relevance of imperfections is probably even stronger in an open economy context because contracts are harder to enforce and information asymmetries are greater than is the case in a closed economy setting. As a result, limited pledgeability of output and limited verifiability of borrowers' credit quality and actions influence access to international finance more than domestic finance.

The financial accelerator has been shown to be a quantitatively important mechanism in explaining the real effects of financial stress in open economy models. Gertler et al (2007) employ an open economy version of the model by Bernanke et al (1999) to analyse the behaviour of the Korean economy during the 1997–98 financial crisis. They report that the financial accelerator mechanism explains half of the reduction in output and that credit market frictions amplify the adverse effects of the crisis on investment.

Other research considers the relevance of imperfections in different open economy contexts. Aghion et al (2004), Aoki et al (2010) and Ferraris and Minetti (2013) use general equilibrium small open economy models with credit constraints to investigate the impact of various forms of financial liberalisation (of the capital account or credit markets) for fluctuations in output. Caballero and Krishnamurthy (1998, 2001), Paasche (2001) and Schneider and Tornell (2004) show that sharp fluctuations in credit and asset markets translate into boom-bust cycles in emerging market economies (EMEs) because of balance sheet constraints. Matsuyama (2005) finds that differences in financial market imperfections can lead to capital flowing from developing economies to advanced economies.

An important channel through which shocks can affect macroeconomic fluctuations is the external value of collateral required for financing. Mendoza (2010) constructs a small open DSGE model to examine the implications of a variety of shocks – including imported input prices, the "world interest rate" and productivity shocks – for real activity through collateral constraints. His model shows that when borrowing levels are high relative to asset values, shocks can be amplified (as in the debt-deflation mechanism of Fisher (1933)) and have a large impact on output as the collateral constraint cuts access to working capital financing (see Korinek and Mendoza (2014)). These findings help explain why the rapid slowdowns or reversals of capital inflows observed in EMEs ("sudden stops") are often followed by financial stress (see Claessens and Kose (2014)).[23]

Another strand of the literature examines the interactions between financial market imperfections and exchange rates. Krugman (1999) and Aghion et al (2000) show that the combination of imperfections and currency mismatches can lead to highly volatile business cycle fluctuations, especially in EMEs. Céspedes et al (2004) use the financial accelerator

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[23] Since some countries respond to these risks by building up foreign exchange reserves, such precautionary holdings of foreign, liquid assets could turn sudden stops into low-probability events nested within normal cycles, as observed in the data (Mendoza et al (2009), Borio and Disyatat (2011)). Bianchi (2011) studies the implications of credit constraints for overborrowing in a small open economy DSGE model and concludes that raising the cost of borrowing during tranquil times restores constrained efficiency and significantly reduces the incidence and severity of financial crises. Brunnermeier and Sannikov (2015) study a model in which short-term capital flows could be excessive and be a source of financial stress. Kalantzis (2015) study a two-sector model in which large capital inflows lead to financial crises.

construct of Bernanke et al (1999) in an open economy model, and find that a negative external shock can have a magnified impact on output because of the effects of a real devaluation on corporate sector balance sheets. In their model, devaluation lowers the real value of assets and adversely affects entrepreneurs' net worth. This leads to an increase in the cost of external credit and, in turn, further constrains investment, thereby amplifying the impact of the initial shock on the broader economy. Cook (2004), using a small open economy model calibrated to reflect the characteristics of East Asian EMEs, shows that a combination of currency mismatches and exchange rate depreciation can increase the cost of capital and reduce investment by adversely impacting firms' balance sheets.

Other studies consider the role of different types of financial market imperfection in general equilibrium multi-country settings. Backus et al (1994), Baxter and Crucini (1995), Heathcote and Perri (2002), Kose and Yi (2001, 2006) and many others have built multi-country models of international business cycles. Many such models, however, feature the assumption of financial autarky (ie countries cannot trade financial assets). Kehoe and Perri (2002) present a model in which the debt capacity of a country is tied to the value attributed by the country to its future access to international financial markets. They show that this mechanism can explain the cross-country output correlations observed in the data. Heathcote and Perri (2013) review the literature on various puzzles related to international risk sharing and allocative efficiency across countries and conclude that, even over the long run, allocations appear inefficient because of capital market imperfections.

The role of financial market imperfections in the transmission of business cycles has also been a fertile area of study. Gilchrist et al (2002) consider a model in which firms face credit constraints in borrowing both at home and abroad, which amplify the international transmission of shocks. Iacoviello and Minetti (2006a) develop a DSGE model where firms face a degree of slack with respect to credit constraints that differs according to whether they deal with domestic versus foreign creditors. They argue that this helps capture the observed comovements of output. Guerrieri et al (2012) examine the implications of default in a currency union with a model comprising banks that are capital constrained.

Recent research also examines the role of financial market imperfections in explaining the highly synchronised nature of the GFC. Perri and Quadrini (forthcoming) find that the recession that accompanied the GFC, and its global reach in particular, can be explained by shocks in credit markets. Using a two-country DSGE model, they show that positive shocks affect the real sector as they enhance the borrowing capacity of firms and thereby lead to higher employment and production, although at a lower level of labour productivity. They document that, when countries are financially integrated, country-specific shocks to credit markets affect employment and production in other countries by creating significant business cycle spillovers (see also Kalemli-Ozcan et al (2013) and Quadrini (2014)).[24] Moreover, credit

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[24] Devereux and Yetman (2010) and Dedola and Lombardo (2012) also examine how credit market shocks in DSGE models with financial market imperfections can generate international business cycle spillovers. Kollmann et al (2011) introduce a banking sector in an international business cycle model and study how shocks to this sector can generate global spillovers. Bacchetta and van Wincoop (2016) show that national business cycles can become highly synchronised when the world economy is hit by a global panic shock. Rose and Spiegel (2010, 2011) and Kamin and DeMarco (2012) examine this issue using empirical approaches.

shocks that are different from productivity shocks, tend to generate asymmetric business cycles (ie contractions that are sharper than expansions) and more volatile asset prices.[25]

Shocks originating in financial markets appear to be important in explaining global business cycles, especially during periods of global recessions. Helbling et al (2011) analyse the role of disturbances in global credit markets in explaining business cycles in G7 countries using a set of VAR models. Their results indicate that these disturbances can have a significant impact on output and other macroeconomic variables (Table 2). In their analysis, credit shocks, for example, account for roughly 11% of the variance of global GDP. In addition, they report that credit shocks account for about as large a share of fluctuations on their own as standard productivity shocks. Credit shocks explain almost 10% of the variance in global productivity and about 11% of the variations in inflation and interest rates. These shares are also close to those obtained for productivity shocks.

Helbling et al (2011) also undertake a series of counterfactual simulations to examine the evolution of global GDP during the GFC and report that credit shocks played an important role. Figure 5 shows the difference between the actual cumulative change in the demeaned global GDP factor and the cumulative change in the simulated value in the absence of a global credit shock during the period ranging from Q3 2007 to Q4 2009. The impact of the shock clearly intensified as the recession spread from the United States to other advanced economies. For example, without the credit shock, the global recession would have been about 10% milder, given the difference between actual and simulated cumulative growth in Q3 2009. The bottom panel of Figure 5 compares the contributions of credit and productivity shocks to cumulative global GDP growth based on counterfactual simulations. Credit shocks on their own accounted for a larger share of the cumulative decline in the global GDP factor than productivity shocks (for the role of shocks originating in credit markets, see also Huidrom (2014), Bassett et al (2014) and López-Salido et al (2017)).

5. Financial imperfections: the supply side

The process of financial intermediation arises in part from attempts to overcome imperfections, but it can itself also create amplification and propagation effects. The financial accelerator mechanism discussed in the previous sections explains how changes in borrowers' balance sheet and cash flow positions (and certain other features of borrowers) – the *demand side* of finance – can affect their access to financing and thereby lead to an amplification and propagation of shocks. Some of the same and other, similar imperfections also affect the operations of financial intermediaries and markets – the *supply side* of finance. Together, these imperfections imply that the supply side of finance can by itself be a source of shocks and propagation, leading to specific macro-financial linkages.

This section presents the three main supply side channels linking financial imperfections to the real economy. The first sub-section analyses the role of *bank lending* in shaping macroeconomic outcomes. Next, the implications of changes in *bank balance* sheets for the real economy are considered. The third one looks at how the channels associated with *leverage, liquidity* and other supply factors can affect real aggregates.

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[25] Some recent studies emphasise the importance of various imperfections associated with financial shocks, trade credit, and working capital in explaining the sharp decline of trade relative to output during the GFC (Amiti and Weinstein (2011), Chor and Manova (2012) and Bems et al (2013)).

A. Bank lending channel

The *bank lending* channel, also referred to as the *narrow credit* channel, arises from the special role played by banks in credit extension. As explained in the previous section, certain asymmetric information problems are more likely to be prevalent among households and small firms. This can limit their access to financial services, even when households have adequate income or when firms have projects with reasonably high risk-adjusted returns. Banks invest in information acquisition and monitoring and can thereby (partially) overcome the problems arising from information asymmetry (and other "contracting" problems).[26] However, during this process, some households and smaller firms may become bank-dependent in that they are unable to substitute with ease other forms of finance for bank loans (or whatever financial services they obtain from a bank). Larger firms, by contrast, may be less affected by such lock-in effects because they are less subject to information asymmetries and do not depend as much on banks. In addition to retained earnings, they can finance investment by issuing equities and bonds in capital markets or by raising other forms of external financing.[27]

Liquidity provision, which takes the form of credit lines and backup facilities (targeted at firms and including capital market instruments, such as commercial paper) is another reason for the special role of banks. Indeed, banks play a special role in maturity transformation and liquidity provision (see Diamond and Dybvig (1983) and Holmström and Tirole (1997)). The traditional function of a bank is to borrow short (eg collect households deposits) and lend long (eg extend loans to firms and mortgages to households). In doing so, a bank provides valuable external financing. Banks also provide liquidity services to firms and households. Through the raising of wholesale funds, for example, a bank can quickly make liquidity available to corporations. Although other financial institutions perform similar functions, the ability of banks to provide liquidity at short notice is not easily matched by other forms of financial intermediation.

The dependence of firms and households on banks for credit and liquidity has consequences for the real economy. Since some firms and households cannot easily substitute for bank loans and liquidity, banks play a central role in the propagation of economic fluctuations. Real and financial shocks affecting banks' ability to lend and provide liquidity then influence the real sector. Shocks can arise from changes in regulation, supervision, technology or preferences. For example, a regulatory change can require banks to keep higher reserves. If they cannot raise funds quickly, banks may need to adjust their lending, an adjustment that is more likely to affect bank-dependent borrowers, such as smaller firms and households. When faced with an adverse shock, a change in lending is also more likely for small banks because of their limited access to other forms of funding (such as certificates of deposit). Since such banks are also more likely to have a higher proportion of bank-dependent clients, it can again disproportionally affect smaller firms and households.

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[26] Many studies examine the special roles of banks (Freixas and Rochet (2008) and BCBS (2016) review the literature). For example, banks can screen potential borrowers, acquire information on firms' collateral (Rajan and Winton (1995) and Diamond and Rajan (2001)) or directly monitor borrowers' actions in order to prevent problems associated with moral hazard (Repullo and Suarez (2000) and Holmström and Tirole (1997)). Earlier contributions include Brunner and Meltzer (1963) and Bernanke (1983), and Rajan (1998) provides a comprehensive review of the functions of banks.

[27] Bernanke and Blinder (1988) provide a stylised discussion of the lending channel using an IS/LM type framework. Stein (1998) provides a "micro-founded" adverse selection model of bank asset and liability management that generates a lending channel. For an early overview of the theory and empirical evidence relating to the bank lending channel, see Kashyap and Stein (1994).

A number of studies have formally analysed the possible general equilibrium effects of the special role of banks. In Diamond and Rajan (2005), banks create value added because they have superior skills in assessing entrepreneurs' collateral and commit to using those skills on behalf of investors by issuing demand deposits.[28] Negative shocks can undermine this role, shrinking the common pool of liquidity and thereby creating spill-overs to other banks and exacerbating overall liquidity shortages. The interbank market, in particular the possibility that it may freeze, is crucial to their model. Other research develops models that also analyse the occurrence of interbank market freezes and the role of such freezes in inducing credit crunches (Freixas and Jorge (2008) and Bruche and Suarez (2010)). Diamond and Rajan (2011) construct a model showing that the possibility of future fire sales means that deep-pocketed investors are willing to buy bank assets only at a low price. With banks preferring to hold on to their assets, the credit crunch is exacerbated.[29]

The dependence of firms on bank financing influences how monetary policy is transmitted to the real economy through the *bank lending channel*.[30] Monetary policy actions can affect the ability of banks to lend since it influences the supply of funds that a bank has access to – by affecting the availability of deposit funds and its funding costs more generally – and consequently the amount of loans a bank can make. A monetary contraction, for example will act to increase bank's funding costs. This will then induce banks to reduce their supply of loans. The decline in the supply of loans, if not offset by firms and households obtaining other forms of financing, in turn, negatively impacts aggregate output because it constraints households' consumption and (small) firms' investment. The bank lending channel can thus explain why policy rate decisions affect the supply and cost of credit by more than the sole impact of the policy rate move (see Claessens and Kose (2017) for a discussion of the interest rate channel).

The credit and liquidity roles of banks also have implications for banks' organisation as well as their regulation and supervision (see BCBS (2016) for a review). A unique aspect of banks' maturity transformation and liquidity provision process is their use of demand deposits that are "redeemable" at par and on request.[31] This makes banks vulnerable to liquidity runs

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[28] Holmström and Tirole (1998) represents the pioneering study of the special role of banks in a general equilibrium environment. For models that endogenise the superior skills of banks in collecting entrepreneurs' collateral, see Habib and Johnsen (1999) and Araujo and Minetti (2007).

[29] Gorton and Huang (2004) show how, in an environment in which private investors make inefficient project choices (eg as they cannot accumulate the liquidity needed to buy the assets of distressed financial institutions), the government can provide liquidity and help mitigate such inefficient choices. Lorenzoni (2007) shows that competitive financial contracts can result in excessive borrowing *ex ante* and excessive volatility *ex post* in an economy with financial frictions and hit by aggregate shocks.

[30] Early surveys of the literature on the bank lending channel include Bernanke (1993), Bernanke and Gertler (1995), Cecchetti (1995), Hubbard (1995) and Peek and Rosengren (1995a). As discussed later, there are also studies highlighting the importance of risk-taking by banks in their lending decisions (eg Disyatat (2011) and Borio and Zhu (2012)).

[31] A number of studies (Calomiris and Kahn (1991), Kashyap et al (2002), Diamond and Rajan (2001) and Huberman and Repullo (2014)) explain why banks fund themselves with short maturities given those risks. These models generally rely on the disciplining features of short-term debt and the beneficial tension between making illiquid loans to borrowers and providing liquidity on demand to depositors. While other intermediaries, such as money market funds, are also vulnerable to runs, as seen during the GFC (Schmidt et al (2016) and Covitz et al (2013)), they generally do not lend and take short-term on-demand deposits at the same time. They are also thought to be "less special," in that their intermediation functions can be more easily replaced, although the GFC raised questions about such an assumption.

(Diamond and Dybvig (1983)). While banks also have access to wholesale funding, as the GFC has shown, this access can be subject to sudden withdrawals too (Gertler et al (2016)). These unique credit and liquidity provision functions and the possibility of runs have implications for the way banks are organised, governed and treated by the government (including through regulation and supervision). It also has implications for the provision of public safety nets and for crisis management.[32]

B. Bank capital channel

The health of a financial intermediary's balance sheet can influence its lending and other intermediation activities. Balance sheet positions, especially net worth, matter for financial intermediaries just as is the case for non-financial corporations. Net worth has an impact on financial intermediaries' access to funds and their liquidity positions and thereby affects their lending activities. Banks also need to satisfy capital adequacy requirements (whether market- or regulation-driven). Given the costs associated with raising new capital quickly on the open market, a bank's net worth depends over the short run on changes in the quality of its loan portfolio and the value of its other assets, including securities.

Consequently, changes in the value of a bank's assets will affect its access to and cost of funding and its ability to make new loans. A decline in loan quality, for example, or a fall in the value of tradable assets, can lead to a drop in a bank's capital. This can make its funding more costly or make its capital adequacy requirements binding, forcing the bank to shrink its loan book. When these shocks take place simultaneously at many banks, they can lead to systemic consequences, especially when alternative sources of external financing are limited.

These effects can be a source of aggregate cyclical fluctuations through what has been called *the bank capital channel* (Greenwald and Stiglitz (1993); see Borio and Zhu (2012) for further references). When many banks are affected by the same capital shock, aggregate effects can occur. For example, during a recession, the quality of bank loan portfolios tends to weaken, adversely impacting banks' balance sheets. In order to shore up their relative capital positions (as desired by the market or to satisfy regulatory requirements) – but unlikely to be able to raise capital quickly – banks may need to tighten their lending standards and reduce the volume of risky credit they provide.[33] Since borrowers who rely on banks for their external funding needs have a limited set of alternatives, this can lead to a slowdown in economic activity, or even a recession, with a higher proportion of non-performing loans and deteriorating bank balance sheets. The decline in bank lending induced by such a "capital crunch" can affect (and interact with) economic activity through various channels (see Bernanke and Lown (1991), Holmström and Tirole (1997), Repullo and Suarez (2000) and

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[32] Some of these issues are discussed further in Claessens and Kose (2014). Acharya et al (2011a, 2011b) model "freezes" in the market for bank assets. In their models, depending on the information environment and the nature of liquidation costs, small shocks can lead to sudden interruptions in financial institutions' ability to roll over their liabilities. Bank liquidity may also be countercyclical, that is, inefficiently high during booms but excessively low during crises, making interventions to resolve banking crises desirable ex post but not ex ante (Farhi and Tirole (2012)). See further Tirole (2011) for a review of various aspects of illiquidity and Holmström and Tirole (2011) for an extensive analysis of (private and public) forms of liquidity.

[33] Repullo and Suarez (2013) provide a model in which banks are subject to regulatory capital requirements and have limited access to equity markets. Gorton and Winton (2017) present a general equilibrium model to study the private and social costs of bank capital.

Van den Heuvel (2006, 2008)). With this mechanism, a strong link can arise between bank capital, the supply of bank financing and macroeconomic outcomes.

The interaction between bank capital and firm liquidity matters in various ways, especially when firms are locked into credit relationships with banks. Den Haan et al (2003) and Minetti (2007) show that a capital crunch can induce firms to abandon high quality projects or break up credit relationships. Thus, a capital crunch depresses not only the volume of investment but also its average productivity. Chen (2001) shows that a capital crunch can cause a drop in asset prices (eg real estate), which can, in turn, have feedback effects, including a contraction in bank capital. Minetti and Peng (2013) investigate the mechanics of the bank capital channel in an open economy model (calibrated for Argentina) and show that real interest rate shocks generate large fluctuations in output and real estate prices.

Some recent studies employing DSGE models help gauge the quantitative importance of the bank capital channel. Gertler and Kiyotaki (2011, 2015) and Gertler and Karadi (2011, 2013) develop models that exhibit moral hazard in the financial sector and thus provide a role for bank capital. They find that, under reasonable assumptions about efficiency costs, banks limit their deposit taking in response to a decline in net worth. These studies also explore how unconventional monetary policy (UMP) – specifically direct intervention in credit markets – can attenuate the bank capital channel. Christiano and Ikeda (2013) show how these and other models with financial frictions allow for quantitative analyses of the channels by which unconventional policies can affect financial and economic outcomes in times of financial stress. They find that the net welfare benefits of such intervention during a financial crisis is large and increases with the severity of a crisis.[34]

The bank capital channel also matters for the conduct of monetary policy. Monetary policy may have a limited impact (including through the bank lending channel) when shortfalls in bank capital constrain loan supply and already dampen economic activity. The potency of the bank capital channel also hinges on the degree to which non-bank financial institutions may be capital-constrained (or otherwise) themselves and the extent to which firms and households are bank-dependent (Gilchrist and Zakrajšek (2012)). Even well developed and adequately capitalised non-banks may not be able to offset a decline in banks' supply of loans since their financing can be imperfect substitutes for bank loans. This means that, in practice, central banks consider the state of all intermediaries' balance sheets (even though they tend to focus on those of banks).

C. Leverage and liquidity channels

Leverage, defined as the ratio of total assets to shareholder equity, has received much attention recently because of its role in the GFC. Fluctuations in the leverage of financial institutions (and other agents) relate to changes in asset prices through both simple accounting and the behaviour of agents. The basic accounting relationship between movements in asset values and changes in leverage is negative, ie rising asset prices boosts net worth and thereby makes measured leverage drop, ie leverage is countercyclical. Similar to the financial accelerator mechanism, this means that financial institutions and other agents

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[34] There is a large literature on the effectiveness of UMPs that uses various approaches, see Eggertsson and Woodford (2003), Krishnamurthy and Vissing-Jorgensen (2011), Farmer (2012), Woodford (2012), Bauer and Rudebusch (2014), Baumeister and Benati (2013), Swanson and Williams (2014), Arteta et al (2015, 2016), Farmer and Zabczyk (2016), and Borio and Zabai (2016).

can fund themselves easier in times of rising asset prices, and consequently lend more to others, even without raising their leverage.

In practice, as Adrian and Shin (2008) show, leverage is not countercyclical (or even acyclical), but procyclical, at least for broker-dealers; it increases when asset prices rise and falls when asset prices decline. And, in financial markets, as Geanakoplos (2010) shows, margins (or haircuts), which dictate the share of financing available for a unit of collateral, are procyclical too, ie lower during booms and higher in busts. While the exact mechanisms remain unclear, many attribute this procyclicality to perverse incentive structures, incomplete corporate governance arrangements, herding behaviour and other agency issues (see Borio et al (2001); Claessens and Kodres (2017)).

As leverage fluctuates, it affects the supply of financing. When leverage is high, supply can be expected to be more ample since it means that intermediaries face fewer constraints in credit extension. Conversely, when leverage is low, financing tends to be more constrained. When a number of financial institutions exhibit acylical or procyclical leverage rather than countercyclical leverage, aggregate financing and liquidity conditions are affected. This behaviour leads to a feedback effect: stronger balance sheets fuel greater demand for assets and this, in turn, raises asset prices and further strengthens balance sheets and demand for assets.

Consequently, since there is more, rather than less – as in other markets – buying of an asset when its price rises, leverage does not necessarily decrease during an asset price boom and can even increase (Drehmann and Juselius (2012) document that, while in practice increases in market values outstrip debt increases at the aggregate and sectoral level, there is procyclicality). Conversely, during a bust, the mechanism works in reverse, balance sheets weaken due to asset price drops, leverage decreases and pressures arise to curtail the supply of financing. In turn, this leads to additional declines in asset prices, possibly affecting a broader array of institutions and activities, further weakening balance sheets and reducing leverage. These reductions in leverage can also be associated with increases in asset price volatility, which is in part related to the arrival of adverse information (Fostel and Geanakoplos (2012)). Figures 6A and 6B summarise conceptually the mechanisms and dynamics of the leverage cycle during upward and downward phases.[35]

The leverage channel operates in ways that are very similar to the bank capital channel (see Adrian and Shin (2011a)). The difference is that the aggregate leverage channel is not limited to banks or related to the special nature of banking. Rather, it can operate at the level of the overall financial system, when the various actors (including hedge funds, institutional and other investors) experience limits on their ability to undertake transactions. It can also affect the so-called shadow banking system.[36]

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[35] The leverage cycle can relate to the presence of asset price bubbles, which can be rational or irrational. Either type can be welfare enhancing or reducing (see further Claessens and Kose (2017) on asset bubbles). Nuño and Thomas (2017) document that leverage has contributed more than equity to fluctuations in total assets and that it is positively correlated with assets and GDP but negatively correlated with equity (see also Halling et al (2016)). He and Krishnamurthy (2013) develop a model of financial intermediaries to study the linkage between risk premia and leverage.

[36] See Adrian and Ashcraft (2016) for an overview of the shadow banking system, its growth and functioning; Claessens et al (2012b) for a review of the functions performed by shadow banking systems; Gennaioli et al (2013), Gertler et al (2016) and Begenau and Landvoigt (2017) for analytical models of shadow banking; and Gorton and Ordoñez (2013) on how an economy can become fragile if it relies extensively on privately-produced safe assets, such as those generated by shadow banking. See further

The leverage channel can lead to more pronounced financial and business cycles, possibly associated with bubbles and other asset price anomalies. Because of the net worth and other related balance sheet channels, changes in leverage affect asset prices and influence the availability of external financing for all types of borrower. In other words, the degree of leverage becomes an indicator of the buoyancy of external financing and risk-taking. Through feedback effects, such as changes in asset prices, the leverage channel can then lead to stronger two-way linkages between the real and financial sectors. The leverage channel is also closely related to the overall state of liquidity, with asset prices possibly deviating from "fundamentals" over the leverage cycle (see Shleifer and Vishny (1997) and further Appendix III).[37]

Recent studies examine the interaction between leverage and boom-bust cycles through the lens of externalities. Lorenzoni (2008) and Jeanne and Korinek (2010) model how firms that set leverage during booms do not account for the impact that their leverage has on the price of collateral assets during busts (see also Dávilla and Korinek (2017)). Such externalities can, in turn, lead to excess leverage. Other studies emphasise the role of strategic interactions and complementarities among banks in pursing collectively risky strategies *ex ante* (Farhi and Tirole (2012)) and inducing credit crunches *ex post* (Rajan (1994) and Gorton and He (2008)).[38]

6. Evidence relating to the supply side channels

The supply side of finance can have a significant influence on macroeconomic outcomes through various mechanisms. Empirical evidence suggests that the behaviour of financial institutions can have an impact on the supply of external financing and overall liquidity. Studies also show that supply side factors can affect the evolution of asset prices, with the potential for virtuous and vicious feedback loops between real and financial markets. In addition, recent research documents that the supply side can influence macroeconomic outcomes through deleveraging and liquidity hoarding, especially during periods of financial stress. While it is hard to separate empirically the roles of different channels – liquidity shortfalls, for example, are often related to adverse shocks to capitalisation – this section attempts to survey the empirical literature relating to these three channels.

Gorton (2016) and Golec and Perotti (2017) for reviews of the literature on safe assets with a domestic focus and Gourinchas and Rey (2016) for an analysis of the role and effects of safe assets globally.

[37] Bruno and Shin (2015) study the dynamics linking monetary policy and bank leverage. They construct a model of the risk-taking channel of monetary policy in an international context. The model rests on a feedback loop between global banks' increased leverage and capital flows amid currency appreciation for capital recipient economies. It shows that adjustments to leverage act as a linchpin between fluctuations in risk-taking and monetary transmission.

[38] Other research aimed at understanding how externalities can carry the seeds of ensuing busts includes Dell'Ariccia and Marquez (2006) who show how lending standards tend to weaken during booms as adverse selection is less severe and lenders find it optimal to weaken screening and lending standards (with the objective of trading quality for market share). This leads to deteriorating portfolios, lower profits and a higher probability of a downward correction.

A. Bank lending channel

The bank lending channel has been extensively studied empirically, at least as regards the effect of changes in bank liquidity conditions. There is intense debate about whether this channel can be identified with macroeconomic data – given the difficulty of separating factors driving demand from those driving supply. Some studies look at credit market indicators, such as the ratio between bank lending and commercial paper, showing that tighter monetary policy leads to a decline of the ratio (Kashyap et al (1993) and Ludvigson (1998)). Oliner and Rudebusch (1996) argue that a change in the mix of finance can capture the bigger decline in the amount of credit granted to small firms compared with large firms. Others question the potency of the bank lending channel in relation to monetary policy, especially for the United States. Some studies argue that since banks can accumulate deposits by issuing money market liabilities, such as certificates of deposits, monetary policy has a limited impact on bank lending (see Romer and Romer (1989) and Ramey (1993)). A number of studies, though, find evidence supporting the relevance of the bank lending channel.[39]

Other work finds that the bank lending channel plays a role for small banks but has a limited overall impact. Kashyap and Stein (2000), using US bank data, find the impact of monetary policy on lending to be stronger for banks with less liquid balance sheets, with the pattern largely attributable to smaller banks. This evidence supports the bank lending channel since these banks are likely to have fewer external financing options. Others question this view (Bernanke (2007)). Given the growing depth and variety of capital markets, they argue that even small banks have gained access to a multitude of funding sources in addition to retail deposits. Moreover, even if the bank lending channel is important for smaller banks, these banks constitute only a minor share of total US lending. Consistently, Lown and Morgan (2002) report results suggesting that while bank lending may play an important role in macroeconomic fluctuations, the magnitude of the bank lending channel for monetary policy changes may be quite small.

Empirical evidence also suggests that the importance of the transmission channels varies by type of loans and changes over time. Recent studies of the bank lending channel attempt to establish which types of bank loan are more likely to be affected by nominal or real shocks. Den Haan et al (2007), employing a reduced-form VAR model to identify monetary policy shocks, find that after a monetary tightening, real estate and consumer loans decline sharply while commercial and industrial (C&I) loans respond positively and often significantly. By contrast, after a non-monetary negative shock, C&I loans decline sharply, while real estate and consumer loans display no decrease. Boivin et al (2011) report that US transmission channels have evolved over time due to structural changes in the economy, particularly in credit markets, and changes in the relationship between monetary policy and expectations formation. As a consequence, monetary policy innovations have had a more muted effect on real activity and inflation in recent decades relative to before 1980.

The potency of this channel also varies across countries and appears to be more influential in bank-dominated systems. In market-based systems, such as those of the United States and the United Kingdom, where the role of capital markets is relatively important, firms and households enjoy a variety of external financing alternatives whereas in bank-based systems, such as those of Germany and Japan, fewer options exist. This implies that the bank lending channel is expected to be more influential.

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[39] See Gertler and Gilchrist (1993, 1994), Friedman and Kuttner (1993), Kashyap and Stein (1995), Peek and Rosengren (1995b) and Kakes and Sturm (2002).

Evidence from outside the United States appears indeed to be more clearly supportive of the bank lending channel. Research relating to some European countries show that banks play a more prominent role in financial intermediation (see Ehrmann et al (2003) and Iacoviello and Minetti (2008)). Jiménez et al (2012) use Spanish data on loan applications and loans granted and find that tighter monetary conditions and worse economic conditions weaken loan extension (especially to firms). This is also the case for lending from banks with lower capital or liquidity ratios. Their results suggest that firms cannot offset the impact of credit restrictions by simply switching to other banks (or other forms of financing). The channel might be weakening over time though, as many financial systems have become more market-based (Altunbas et al (2010), Claessens (2016)).

B. Bank capital channel

A number of studies find empirical support for the bank capital channel, especially during periods of substantial capital shortage, leading to so-called credit crunches. For example, Lown and Morgan (2006) show for the United States that surveys of senior loan officers, which partly reflect supply conditions, provide significant explanatory power for US real activity. De Bondt et al (2010) show how similar lending surveys, especially those relating to enterprises, are a significant leading indicator of bank credit and real GDP growth in the euro area. Some studies report that credit losses at commercial banks had some, albeit not large, regional effects on the US recovery from the 1990–91 recession (Bernanke and Lown (1991), Hancock and Wilcox (1993, 1994), Berger and Udell (1994) and Peek and Rosengren (1994)).[40] These studies found multipliers, that is the effect of a 1% change in bank capital on the percent change in lending, ranged from 1.5 to 2.7. Ashcraft (2006) also found some small effects of variations in commercial bank loans on real activity in normal times. Gambacorta and Marques-Ibanez (2011) show that weaker banks in the United States and Europe restricted loan supply more strongly during the GFC than other banks.

Other studies document varying effects. Bayoumi and Melander (2008) employ a VAR model and report that an exogenous fall in the bank capital/asset ratio of one percentage point reduces real US GDP by some 1.5% through weaker credit availability. Moreover, an exogenous fall in demand of 1% of GDP is gradually magnified to about 2% through financial feedback effects. Greenlaw et al (2008) regress the log difference of GDP on the lagged four quarter (log) change of domestic non-financial debt, using as instruments TED spreads and lending standards. They find a change in credit growth of 1% to affect real GDP growth by about 0.34% in the short run and 0.47% in the long run. By contrast, Berrospide and Edge (2010), who update studies from the early 1990s using panel regression techniques, find a modest effect on lending: capital shortfalls affect the extension of new loans with a range of 0.7% to 1.2% and not significant changes in GDP growth (however, in a VAR setting they do find bank capital shocks to affect GDP growth up to 2.75%). Francis and Osborne (2010) also report a smaller effect for UK banks.

Effects can vary by bank capitalisation and by the state of the business/financial cycles. Bernanke (1992) and Meh and Moran (2010) find that the health of banks plays an important role during recessions and subsequent recoveries because bank capital can (or cannot) cushion shocks (see also Berger and Bouwman (2013)). Other studies also find a greater role for bank capital during periods of significant credit losses or outright shortages of bank capital. Some

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[40] Hancock and Wilcox (1994) investigate the impact of the bank capital channel on the US housing market and find significant effects of the early 1990s capital crunch on commercial and residential real estate activity.

report that during such periods, weakly capitalised banks limit their lending much more than highly capitalised banks (Peek and Rosengren (1995b) and Woo (2003)). In a related paper, Ashcraft (2005) finds, however, that it is the closure of commercial banks rather than shocks to their capital base that leads to large and persistent negative effects on real output. He reports a decline in real income growth of about 3% to 6% in counties where subsidiaries of failed US banks are located.

Sectoral and event-based studies provide more direct (and sometimes clearer causal) evidence linking bank capital to economic fluctuations. Calomiris and Mason (2004) find that bank loan supply shocks have an impact on local area income over the 1930–32 period, using as instrument variables measured at the end of 1929 (before the Great Depression produced changes in bank loan foreclosures and net worth). Peek and Rosengren (1997, 2000) find a response of up to 3% in semiannual lending growth by Japanese branches in the United States in response to a decline of one percentage point in the capital of parent banks, which, in turn, has consequences for real activity. Since they also use instrumental variables for lending (asset quality and bank capitalisation of Japanese parent banks as well as changes in land prices in Japan), they can claim evidence of causality (see also Haltenhof et al (2014)).

Firm-focused and other microeconomic research also lends support to the important role played by bank capital. In particular, loans from banks that have a weak capital base are more sensitive to changes in market interest rates than loans from better capitalised banks (Kishan and Opiela (2000, 2006) and Gambacorta (2005)). Conversely, bank capital matters for the conduct of monetary policy (Gambacorta and Shin, forthcoming). In addition, evidence suggests an inverse relationship between bank capital and the interest rate charged on loans, even after accounting for the characteristics of borrowers, banks and various contract terms (Hubbard et al (2002)). Using firm-specific data on the use of bank debt and public bond financing from 1990 to 2014, Becker and Ivashina (2014) show that the close link between bank credit supply and business cycle evolution is driven by external financing/supply effects and especially impacts small firms. Conversely, Laeven and Valencia (2013) and Giannetti and Simonov (2013) find important positive effects of bank recapitalisations on the growth of firms' real value added and borrowing.

Some recent studies with DSGE models have incorporated capital shortfall shocks to the supply of finance. Jermann and Quadrini (2012), after documenting the cyclical properties of US firms financial flows, show how adding financial shocks to a model with standard productivity shocks can much better explain movements in real and financial variables, including during periods of financial stress. Financial imperfection arises in their setup from the limited ability of firms to borrow (due to an enforcement constraint). Gilchrist and Zakrajšek (2011) show in a DSGE model how credit spreads for financial institutions, likely related to their soundness, significantly impact US business cycles during the period 1985–2010 (Figure 7).[41]

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[41] The potency of the bank capital channel also depends on accounting standards and the recognition of capital losses. In particular, the speed at which loan losses are recognised in banks' balance sheets and, consequently, their capital positions, determines in part the pace at which banks may amplify negative aggregate shocks by cutting back on lending. At the same time, the lack of prompt recognition of loan losses may distort banks' incentives, inducing them to direct funds to inefficient borrowers. Caballero et al (2008), for example, find evidence that the limited recognition of capital depletion in Japanese banks slowed Japan's recovery from the early 1990s recession.

C. Leverage and liquidity channels

Financial system leverage is often procyclical. There is much empirical evidence relating to leverage and liquidity mechanisms during booms, including the recent ones in advanced countries. During the early to mid-2000s, the rapid increase in asset prices in the United States and in other advanced countries led to more abundant liquidity and allowed for greater financial sector leverage. This, in turn, led to a greater supply of external financing and further asset price increases, creating a virtuous cycle, with increasing asset prices and higher collateral values. For the United States, Adrian and Shin (2008, 2011b) show that this procyclical behaviour of leverage was more prevalent among broker-dealers, while households, non-financial non-farm firms and commercial banks exhibited less or no cyclicality (Figure 8).

Some of these effects also operate in an international context. Shin (2012), Gourinchas (2011) and Rey (2015) highlight how changes in liquidity intermediated globally by banks (and interacting with global imbalances and monetary policy in key countries, notably the United States) can lead to more pronounced and synchronised national cycles, as witnessed very clearly before, during and after the GFC.[42]

There is also ample evidence pertaining to the leverage cycle during busts, which relates to the increase in margins (haircuts) charged on collateralised lending. In the fall of 2008, as the cycle swung down, asset prices declined and financial institutions incurred large capital losses. Funding and leverage constraints forced institutions to sell off (securitised) assets. Not just investment banks, but also commercial banks that relied less on core deposits and equity financing, had to cut back lending as their funding and balance sheet positions were strained (Cornet et al (2011)). These fire sales were associated with higher margins (or haircuts). Geanakoplos (2010) shows that haircuts on repurchase agreements (repos) increased from 10% at the end of 2006 to more than 40% when the GFC started (see also Gorton and Metrick (2010)). The sharp increase in haircuts meant that banks had less collateral to offer and had to absorb more losses. In turn, this forced banks and other financial institutions to shed assets, further depressing prices, which led to even greater capital and funding problems.[43]

Variations in the supply of external financing can also show up in the debt and equity issuance of non-financial firms. Covas and Den Haan (2011) document that most size-sorted categories of US firms display a procyclical issuance pattern of debt and equity, with the procyclicality decreasing with firm size.[44] Research also reports that initial public offering (IPO) markets can be "hot", with periods of heavy issuance or "cold", with a dearth of

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[42] See also Cerutti et al (2017a) on the role of global factors in driving capital flows and Cerutti et al (2015) on how dependence on specific lenders and investors can affect countries' exposure to such global factors. See also Cerutti et al (2017b) for a recent empirical assessment. Landau (2013) and Hartmann (2017) provide general reviews of global and international liquidity, as provided by the private sector or by central banks, and how it relates to the designs of the international monetary and financial systems.

[43] A fire sale spiral, as first pointed out by Stiglitz (1982) and Geanakoplos and Polemarchakis (1986), creates a negative externality and a possible rationale for regulation. Because each institution does not bear the full cost of its own actions, it will not fully take into account the price impact of its own fire sales on asset prices. See further Brunnermeier and Pedersen (2009), Gorton (2010) and Choi and Cook (2012) for models of fire sales. Brunnermeier and Oehmke (2013) review the related literature on bubbles.

[44] More generally, heterogeneity among firms (and households) and specific patterns of external financing are likely to be important factors in explaining why financial frictions can lead to relatively large effects on business cycles (Zetlin-Jones and Shourideh (2017)).

offerings (see Ritter (1984)). This cyclicality seems in part related to the state of investor supply. Helwege and Liang (2004) show that hot markets are largely driven by greater investor optimism rather than by changes in adverse selection costs, managerial optimism or technology. More generally, the supply of external financing, with related effects on asset prices, seems to vary for reasons that are unrelated to the real economy. While often not explicitly investigated, some of these variations seem to have large real consequences (see Titman (2013), for an overview of how various shocks to debt and equity markets and other market segments can affect real activity, among others, through corporate investment-related externalities).

The impact of procyclical leverage on the real economy can be especially perverse in times of stress, when financial institutions and markets cut back on financing and asset prices drop sharply. Almeida et al (2012) show how the GFC led to a reduction in investment for firms for which long-term debt happened to mature in the third quarter of 2007 (of several percentage points relative other firms). Using a DSGE model, Mendoza (2005) shows that as leverage drops from 15% to 11% during a crisis, a 2% wealth-neutral shock leads to about a 4% drop in consumption and investment and a 1.3% decline in output (see also Adrian et al (2012) and Adrian and Shin (2014)).

These variations seem to relate to countries' institutional environment. For example, countries, with market-based financial systems tend to exhibit greater cyclicality in leverage. In market-based systems, the effective use of collateralisation and the development of more sophisticated risk management and information-sharing mechanisms mean that leverage can be increased with greater ease. In bank-oriented systems, in contrast, leverage is more restricted, in part due to regulations. Consequently, leverage and asset price cycles more likely arise in market-based systems (IMF (2009)). As changes in leverage and liquidity within the financial system affect the real economy, shocks to asset prices can consequently have a greater real impact.

Because short-term collateralised borrowing is the chief tool used by financial institutions to adjust their leverage, the leverage channel relates to (and affects) monetary policy. Adrian and Shin (2008) show that repos and reverse repos transactions, in which borrowers provide securities as collateral, are used heavily to adjust leverage. Since the growth of repo transactions is closely associated with the ease or restrictiveness of monetary policy, a strong connection arises between monetary policy and liquidity. When monetary policy is "loose" ("tight"), there is more likely to be rapid (slow) growth in repos and financial market liquidity tends to be high (low). Furthermore, as Geanakoplos (2003) shows, not only does leverage display endogenous cycles but the interest rate becomes endogenous. With both leverage and interest rates adjusting, this can lead to further procyclical supply side behaviour (see Geanakoplos (2010) for a review).

Both monetary policy and macroeconomic conditions appear to affect the risk appetite of financial intermediaries and their supply of credit. Adrian et al (2010b) study the links between the growth of financial intermediaries' balance sheets, the macroeconomic risk premium and output in the United States. The empirical behaviour of the macroeconomic risk premium tracks closely that of the term spread of interest rates and of the premium charged to more risky credits. They also develop a measure of intermediary risk appetite using changes in balance sheet quantities. In response to shocks to risk appetite, the macroeconomic risk premium and output exhibit significant and persistent changes. Higher risk appetite is associated with a decline in the risk premium and a pick up in output (Figure

9).[45] Adrian and Duarte (2016) model how these interactions can make the financial system more vulnerable to negative shocks and lead to highly nonlinear dynamics that can adversely affect the real economy (see also Aikman et al (2016) for a review of the various possible links between financial vulnerabilities, monetary policy and macroeconomic developments).

However, the relationship between the monetary policy stance and risk-taking is complex. De Nicolò et al (2010) model how monetary policy easing can induce greater risk-taking through a search for yield. At the same time, they show that there can be another effect at work if financial intermediaries operate with limited liability. In their model, at least in the short run when bank capital is fixed, high charter-value (well capitalised) banks increase risk-taking if the policy rate is low and low charter-value (poorly capitalised) banks do the opposite as they try to preserve their capital. On balance, the effects of monetary policy on risk-taking depend on intermediaries' degree of limited liability and financial health. Empirical evidence, while still partial, supports these complex interactions. For example, empirical evidence for the United States by De Nicolò et al (2010) broadly supports the prediction that a low policy rate is associated with greater risk-taking by banks as the riskiness of their loans is higher when interest rates are lower (Figure 10).[46]

7. Aggregate macro-financial linkages

The previous sections documented that imperfections on the demand and supply sides of finance could be associated with pronounced fluctuations in the real economy. Complementary to this literature has been long standing research that provides important insights into the general patterns of aggregate macro-financial linkages (see the overview of this literature in Appendix IV). Since it is hard to identify the direction of causality between changes in financial markets and fluctuations in real activity, and whether demand or supply channels are the main factors, many of these studies have taken a largely agnostic approach.

Until recently, this research programme did not present a comprehensive perspective on business and financial cycles. This was for at least two major reasons. First, most studies consider only selected aspects of business and financial cycles. For example, many examined the implications of booms in asset prices or credit only rather than considering the full financial cycle. Second, research tended to focus on case studies or used small country samples.

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[45] See further Adrian et al (2016) on the relevance of leverage for macroeconomic modelling (and macro-financial linkages). They show that a parsimonious model using detrended dealer leverage as a "price-of-risk" variable performs well in time series and cross-sectional tests for a wide variety of equity and bond portfolios (at least better than models that use intermediary net worth as a state variable) and in comparison to benchmark asset pricing models.

[46] For the effects of monetary policy on risk-taking, including when interest rates are particularly low, see further Dell'Ariccia and Marquez (2013), Dell'Ariccia et al (2014), Jimenez et al (2014), Valencia (2014), Ioannidou et al (2015), and Borio and Hofmann (2017). Posen (2009), Bean et al (2010) and Bernanke (2010) argue otherwise. Adrian and Shin (2008, 2011a) and Adrian et al (2010a) analyse how the risk-taking channel works in the United States. Some other recent studies providing further microeconomic evidence for the presence of the risk-taking channel domestically and internationally include Maddaloni and Peydro (2011), Altunbas et al (2014), Bruno and Shin (2015, 2017), Morais et al (2015), Dell'Ariccia et al (2017), and Domanski, Shin and Sushko (2017). See also Rajan (2005) and Hanson and Stein (2015) for arguments and models linking low interest rates to search-for-yield motives for investors other than banks. For a review of studies of the effects of low interest rates on financial institutions profitability and capitalization and risk-taking, see European Systemic Risk Board (2016).

Although the literature on financial crises has employed broader samples, the identification of crises has often suffered from analytical drawbacks and the analysis has limited itself to a single phase of the cycle, the aftermath of a crisis.[47]

Some recent studies, however, document the major features of macro-financial linkages using rich cross-country databases covering a long period of time. In this section, we present a summary of the findings of this work.[48] The section begins with an overview of the methodology and data sets used in these studies. This is followed by a discussion of the stylised facts that emerge from the data. The last sub-section considers the main properties of the linkages between business and financial cycles.

A number of salient facts emerge about the features of business and financial cycles and their interactions over different phases. First, financial cycles are often more pronounced than business cycles, with financial downturns deeper and more intense than recessions. Second, financial cycles can build on each other and become amplified. For example, credit downturns that overlap with house price busts tend to be longer and deeper than other credit downturns. Third, financial cycles appear to play an important role in shaping recessions and recoveries. In particular, recessions associated with financial disruptions, notably house price busts, are often longer and deeper than other recessions. Conversely, recoveries associated with rapid growth in credit and house prices tend to be stronger than other recoveries.

A. Business and financial cycles

A number of methodologies have been developed to characterise business cycles. The findings reported in this section are based on the "classical" definition of a business cycle, which focuses on changes in levels of economic activity. The definition goes back to the pioneering work of Burns and Mitchell (1946) who laid the methodological foundations for the analysis of business cycles in the United States. Moreover, it constitutes the guiding principle of the Business Cycle Dating Committees of the National Bureau of Economic Research (NBER) and the Centre for Economic Policy Research (CEPR) in determining the turning points of US and European business cycles.[49]

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[47] Claessens and Kose (2014) review a number of studies that focus specifically on periods of financial stress and crisis and the behaviour of real and financial variables during such events. Reinhart and Rogoff (2008, 2009a, 2009b, 2014) review the characteristics of various types of financial crisis for many countries over a long period. Boissay et al (2016) analyse the links between credit booms, (interbank) liquidity and banking crises (see also Allen et al (2011)).

[48] The notion of financial cycles was empirically documented in early studies for smaller samples of countries and periods of time, such as Borio et al (1994) and Borio and Lowe (2002), and refined in subsequent work, including Drehmann et al (2012), Aikman et al (2015) and Juselius and Drehmann (2015). This section draws on Claessens et al (2009, 2011, 2012a) which provide detailed empirical analyses of the interactions between business and financial cycles.

[49] An alternative methodology would be to consider how economic activity fluctuates around a trend and then to identify a "growth cycle" as a deviation from this trend (Stock and Watson (1999)). While several studies have use detrended series (and their second moments, such as volatility and correlation) to study the various aspects of cycles, it is well known that the results of these studies have depended on the choice of detrending methodology (Canova (1998)). The advantage of turning points identified by using the classical methodology is that they are robust to the inclusion of newly available data. In other methodologies, the addition of new data can affect the estimated trend and thus the identification of a growth cycle. Fatas and Mihov (2013) analyse different approaches for the dating of recoveries using US data. See also Ng and Wright (2013) for a survey of business cycles facts and methodologies.

The classical dating methodology distinguishes three phases of cycles: recessions, expansions and recoveries. It assumes that a recession begins just after the economy reaches a peak and ends as it reaches a trough. An expansion begins just after a trough and ends at the next peak. A complete business cycle has two phases, recession (from peak to trough) and expansion (from trough to peak). Together with these two phases, recoveries from recessions have been studied. The recovery phase is the early part of an expansion and is usually defined as the time it takes for output to return from its lowest point to the level it reached just before the decline began. An alternative definition considers the increase in output four quarters after the trough. Given the complementary nature of these two definitions of the recovery phase, both of them are used here.

Financial cycles are identified by employing the same methodology. However, different terms are used to describe them: the recovery phase is called an "upturn" and the contraction a "downturn". These two phases provide rather well defined time windows for considering the evolution of financial cycles. In what follows, we study the main features of business and financial cycles, considering, in particular, their duration, amplitude and synchronisation.[50]

Business cycles

Recessions can be long, deep and costly. A typical recession lasts close to four quarters while a recovery last about five quarters (Figure 11).[51] The typical decline in output from peak to trough, the recession's amplitude, is about 3% for the full sample and the typical cumulative output loss amounts to about 5%. The amplitude of a recovery, defined as the increase in the first four quarters following the trough, is typically about 4%. Although most recessions (recoveries) are associated with moderate declines (increases) in output, there can be much larger changes in activity as well.

Business cycles in EMEs are more pronounced than those in advanced economies. In particular, the median decline in output during recessions is much larger in EMEs (4.9%) than in advanced economies (2.2%) and recoveries in EMEs are twice as strong as those in advanced countries. In terms of cumulative loss, recessions in EMEs are almost three times more costly than those in advanced economies. These findings suggest that macroeconomic developments, policy factors and institutional characteristics, including possibly the degree of financial frictions, potentially affect the evolution of business cycles in different countries.

Business cycles are highly synchronised across countries. For some observers, the global nature of the GFC, during which many economies experienced a recession at the same time, was surprising. However, this is not so unusual because recessions and recoveries are often synchronised across countries. Recessions in many advanced economies, for example, were concentrated in four periods over the past 40 years – the mid-1970s, the early 1980s, the early

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[50] The results reported in this section are based on a large database that comprises a total of 44 countries: 21 advanced OECD economies and 23 EMEs. For the former group, the data coverage ranges from Q1 1960 to Q4 2010 while for the latter it ranges from Q1 1978 to Q4 2010 (because quarterly data series are less consistently available prior to 1978). In order to study business cycles, GDP is used because that variable is the best available measure of economic activity. Financial cycles are studied considering three distinct but interdependent market segments: credit, housing and equity. See further Claessens et al (2012a).

[51] Claessens et al (2012a) identify 243 recessions and 245 recoveries. The number of recessions and recoveries differs slightly because of the timing of events. There are 804 complete financial cycles over the period Q1 1960 to Q4 2010. The sample features 253 downturns in credit, 183 in house prices and 443 in equity prices; and 220, 155 and 429 upturns in credit, house and equity prices, respectively. Since equity prices are more volatile than credit and house prices, they feature naturally more often in downturns and upturns than the other financial variables.

1990s and 2008–09 – and often coincided with global shocks, such as increases in oil prices and interest rates (Figure 12). Such synchronised recessions tend to be deeper than other types of recession.

Financial cycles

Financial cycles are often longer and more pronounced than business cycles, with financial downturns particularly deeper and longer than recessions. Downturns (upturns) of financial cycles tend to be longer than recessions (recoveries) (Figures 13 and 14). Episodes of house price downturns, in contrast, persist for about eight quarters and other financial downturns last around six quarters. A typical financial downturn corresponds to about a 6% decline in credit, 6%–7% fall in house prices and 30% decline in equity prices. Upturns are often longer than downturns, with the strength of upturns to differ across financial markets. Equity price upturns are the sharpest, some 26%. Financial cycles are also more intense than business cycles, ie financial variables adjust much more quickly than real ones, as shown by their slope coefficient. These findings are consistent with various studies documenting that asset prices are more volatile than economic fundamentals (see Shiller (1981, 2003) and Campbell (2003)).

The main features of financial downturns vary across EMEs and advanced economies. While not necessarily longer, financial downturns in EMEs are much sharper than in advanced countries. Credit contractions last about the same in both groups but are one-third deeper in EMEs. Equity downturns last as long in both groups but upturns are much shorter in EMEs. Comparisons between mean and medians show that the distributions of duration and amplitude of the phases of financial cycles are also more skewed to the right in EMEs than in advanced economies. These differences indicate that factors possibly related to the presence of financial frictions could affect financial cycles.

Financial cycles also tend to feed off of each other and become amplified. The likelihood of a credit downturn (or upturn) taking place goes up substantially if there is also a disruption (or boom) in house prices. There are also strong interactions between financial cycles. Credit downturns that overlap with house price busts tend to be longer and deeper than other credit downturns. Similarly, a typical credit upturn becomes 30% longer and twice as large when it coincides with a housing boom. This suggests that feedback effects play a role as disruptions in one market aggravate the problems in another, probably because of collateral constraints and complementarities between credit and housing finance. Moreover, globally synchronised financial downturns are often longer and deeper, especially for credit and equity markets. During highly synchronised equity market downturns, for example, prices drop by about 30% compared with some 18% for other downturns.

B. Linkages between business and financial cycles

Recent research using cross-country data has revealed important links between business and financial cycles. Claessens et al (2012a) use a comprehensive database for a large sample of advanced economies and EMEs over a long period of time to provide a broad empirical characterisation of macro-financial linkages. They report three main results. First, business cycles are more closely synchronised with credit and house price cycles than with equity price cycles. Second, financial cycles appear to play an important role in determining recessions and recoveries and shaping the features of business cycles more generally. In particular, recessions are more likely to coincide with financial disruptions while recoveries are more likely to be associated with booms. Third, recessions associated with some forms of financial disruption, notably house price busts, are often longer and deeper than other recessions. Conversely, recoveries associated with rapid growth in credit and house prices tend to be

stronger. These results collectively highlight the importance of macro-financial linkages, especially those involving developments in credit and housing markets, for the real economy.

Synchronisation and likelihood of cycles

Business cycles often move in tandem with financial cycles, especially with credit and house price cycles. One can study the degree of synchronisation between business and financial cycles by using the concordance statistic (Table 3).[52] Cycles in output and credit appear to be the most highly synchronised, with a median (mean) synchronisation of 0.81 (0.78). This means that cycles in output and credit are typically in the same phase about 80% of the time. The concordance statistic for cycles in output and house prices, 0.68 (0.64), is lower than that for output and credit but still slightly higher than that for output and equity prices, 0.58 (0.60). This reinforces the common finding that developments in credit and housing markets could be key in driving macro-financial linkages.

There are also differences in concordance between advanced economies and EMEs. Advanced economies typically display a higher degree of synchronisation of output, credit and house prices than EMEs. This may reflect the more developed nature of advanced country financial markets with the result that fluctuations in credit, house prices and other financial variables are more important to the real economy. It may also indicate that EMEs are more often affected by global shocks operation through international capital flows, including through actions of their residents (see for example Forbes and Warnock (2012) and Caballero and Simsek (2016)).

The likelihood of recessions and recoveries varies with the presence of financial disruptions or booms. The unconditional probability of being in a recession or a recovery in any given quarter is about 19%. However, if there is a financial disruption episode in the same quarter, the probability of a recession increases substantially, to 35% to 38%. Similarly, if a credit (house price) boom is already underway, the probability of experiencing a recovery rises to roughly 57% (43%). Rapid growth in equity prices is, however, not associated with greater likelihood of a recovery in the real economy.

Interactions between cycles

Recessions accompanied by financial disruptions tend to be longer and deeper than other recessions. In particular, recessions associated with asset price busts are significantly longer than recessions without such disruptions (Figure 15). Recessions with severe asset price busts as well as credit crunches result in significantly larger drops in output and, correspondingly, greater cumulative output losses relative to those without such episodes.[53]

A recession associated with one type of financial disruption is often accompanied by broader stress in other financial markets. For example, recessions accompanied by credit crunches result in a significant decline in credit as well as substantial drops in house and equity prices. One can also analyse recessions accompanied by combinations of credit crunches and asset busts. Although the number of such episodes is small, a recession associated with a

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[52] The concordance statistic provides a measure of the fraction of time that the two series are in the same phase of their respective cycles. The series are perfectly procyclical (countercyclical) if the concordance index is equal to unity (zero).

[53] For a deeper perspective, it is useful to consider additional measures of credit and asset prices. For example, some papers (Chari et al (2008) and Cohen-Cole et al (2008)) highlight the importance of going beyond aggregate measures (for example, by differentiating credit to corporations from credit to households) to study the dynamics of credit markets. Unfortunately, such disaggregated series are not available for a large number of countries over long periods.

credit crunch and an asset price bust often leads to a larger cumulative output loss than a recession with only a credit crunch or an asset price bust.

Just as recessions associated with financial disruptions are longer and deeper, recoveries associated with credit or house price booms are shorter and stronger. With respect to duration, recoveries coinciding with house price booms tend to be significantly shorter (Figure 16). Moreover, recoveries associated with credit and house price booms are often stronger and faster than those without such booms. By contrast, recoveries combined with booms in equity markets do not appear to be different from those without such episodes, confirming the somewhat limited role of equity markets in macro-financial linkages.

These stylised facts describing the aggregate linkages between business and financial cycles are also supported by the results of panel regressions incorporating a wide range of explanatory variables. In particular, changes in house prices tend to play a critical role in determining the duration and cost of recessions (Claessens et al (2012a)). The results are also consistent with the findings of recent empirical studies emphasising the importance of house price dynamics in shaping business cycles (Cecchetti (2008), Leamer (2007), IMF (2008), and Muellbauer (2007)).[54]

Why are recessions associated with house price busts more costly? First, housing represents a large share of wealth for most households and, consequently, price adjustments affect consumption and output more strongly (Claessens and Kose (2017)). By contrast, equity ownership is relatively less common and typically more highly concentrated among wealthy households who likely make much smaller adjustments to their consumption during the various phases of the financial cycle (and recessions and recoveries). Housing wealth has indeed been found to have a larger effect on consumption than equity wealth (Carroll et al (2011)). Second, equity prices are more volatile than house prices, implying that changes in house prices are more likely to be (perceived to be) permanent than those of equity prices (Cecchetti (2008) and Kishor (2007)). With more permanent wealth changes, households adjust their consumption more strongly when house prices increase (decline), leading to larger increases (declines) in output during recoveries (recessions) that are associated with house price booms (busts).

8. Conclusions

The GFC was a painful reminder of the importance of macro-financial linkages. These linkages centre on the two-way interactions between the real economy and the financial sector. Imperfections in financial markets can intensify these linkages and lead to gyrations in the financial sector and the real economy. Global dimensions of these linkages can result in spillovers across borders through both real and financial channels.

Research on macro-financial linkages has a long tradition, but has become a central topic only over the past three decades. This paper reviews this rich literature and presents a broad perspective on theoretical and empirical work. The survey considers the two channels – the

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[54] Analytical models also support this notion. Using the financial accelerator mechanism presented in Section 5, for example, some studies (Aoki et al (2004) and Iacoviello (2005)) use DSGE models to show specifically how endogenous developments in housing markets can magnify and transmit various types of shock to the real economy and find quantitatively large effects. Mian and Sufi (2010, 2014) provide empirical evidence at the regional level for the real economy effects of mortgage credit expansion in the United States.

demand and supply sides – through which financial imperfections can affect macroeconomic outcomes. The demand side channel, largely captured by financial accelerator-type mechanisms, describes how, through changes in the balance sheets of borrowers, financial markets can amplify macroeconomic fluctuations. The supply side channel emphasises the importance of changes in financial intermediaries' balance sheets for the availability of external financing and liquidity, the role of financial markets in the determination of asset prices and the implications of those factors for the real economy.

A summary

The literature has made significant progress in understanding the demand side of macro-financial linkages. Many models now feature amplification mechanisms operating through the demand side. These models show how a financial accelerator-type mechanism can lead to the propagation and amplification of small (real or financial) shocks across the real economy (through their impact on access to finance). A number of models that incorporate financial accelerator mechanisms show the importance of changes in asset prices and other financial shocks in driving movements in borrowers' net worth and access to finance, leading to fluctuations in aggregate activity.

These analytical findings are also supported by empirical studies. In particular, extensive evidence documents how the state of borrowers' balance sheets affects their access to external finance. Demand side imperfections in financial markets have been shown to lead to an amplification of shocks (monetary, real and financial) because changes in the net worth of borrowers affect their access to finance and, therefore, to consumption, investment and output. Empirical studies confirm that these imperfections tend to affect small firms and households particularly strongly, especially during periods of financial stress. Although most findings support the roles played by financial imperfections, there is nevertheless an ongoing debate about the quantitative importance of the financial accelerator.

The GFC has shifted attention to the critical role played by amplification channels operating through the supply side of finance. Earlier theoretical work on the bank lending channel analysed the possible general equilibrium effects arising from the special role of banks in financial intermediation. Empirical studies documented how the dependence of some firms on bank financing influences the transmission of monetary policy to the real economy. Since the GFC, there has been a broader recognition that the supply side of finance (beyond the specific role played by banks for some firms) can be a source of shocks, amplification and propagation.

This recognition has led to a number of studies on modelling the supply side of finance. Although the literature is still in its early stages, recent work has analysed the roles played by bank lending, bank capital and financial markets more generally – *inter alia* through their impact on asset prices, liquidity and leverage – in shaping macroeconomic outcomes. This work has brought out the critical role importance of the leverage channel in leading to more pronounced financial and business cycles. Related, given the importance of banks' credit and liquidity provisioning roles, studies have provided insights into how to consider and adapt banks' internal organisation, and their regulation and supervision in general equilibrium settings.

Recent empirical studies confirm that shocks associated with the supply side of finance can affect the evolution of external financing and asset prices, with the potential for feedback loops between real and financial markets. New tests of the bank lending channel based on variables, like the size of banks, types of loan, and certain other specific features of the

financial system, show its importance as a channel of monetary transmission. Other work shows that the potency of the bank capital channel varies over business and financial cycles (especially during credit crunches). Recent work also examines the procyclical nature of financial system leverage, asset prices and liquidity, providing evidence relating to their impact on real aggregates, especially in times of financial stress.

In addition, a number of empirical studies on aggregate macro-financial linkages document the importance of developments in financial markets for the real economy. In particular, cycles in various financial market segments (equity, housing and credit) appear to play an important role in shaping recessions and recoveries. Recessions associated with financial disruptions are often longer and deeper than other recessions while, conversely, recoveries associated with rapid growth in credit and house prices tend to be relatively stronger.

What next?

The topic of macro-financial linkages promises to remain an exciting area of research, given the many open questions and significant policy interest. A list of potential future areas of research, by no means exhaustive, is provided next.

Data issues. There are large data gaps. The lack of adequate time series data on important financial and macroeconomic variables has been a severe limitation for researchers. Although the prices of many traded assets are widely available (including for equities and bonds), gaps remain with respect to higher frequency and longer-dated series relating to the housing market and aggregate credit. Comprehensive cross-country databases pertaining to business and financial cycles have only recently been constructed. Researchers would also benefit from better access to granular data on external financing and credit, and on the balance sheets of firms, banks and other financial intermediaries. Such data are essential to the exploration of the links between the financial sector and the real economy and to the assessment of the systemic risks that can arise from these linkages (see the papers collected in Brunnermeier and Krishnamurthy (2014) on the general data needs required for research on macro-financial linkages).

Data deficiencies are especially significant at the international level. There is a dearth of information at the aggregate and granular levels about bilateral exposures – between two countries as well as between two financial institutions, the cross-border activities of banks, institutional investors, hedge funds and other market participants (see further Cerutti et al (2014), Borio (2013), Tarashev et al (2016) and Heath and Bese Goksu (2017)). Moreover, existing data sources are often not comparable because they are compiled under different regimes. While some recent data collection efforts have been underway, such as those under the G20 Data Gap Initiative (FSB-IMF (2016)), progress in this area has been slow, including on obtaining data on the world's largest financial institutions, the so-called global systemically important financial institutions (G-SIFIs).

Demand side channels. Although research on the demand side channels is much richer than that on the supply side, many questions remain open. DSGE models, including those with financial market imperfections and financial accelerator-type amplification mechanisms, have been widely used by policy institutions. Yet, when calibrated with reasonable parameters and tested with realistic shocks, the quantitative importance of the financial accelerator in explaining real activity appears to be limited. Models still face difficulties in accounting for heterogeneity among agents and for the asymmetries and non-linearities that arise from macro-financial linkages, especially when adverse shocks hit borrowers' net worth and curtail their access to external financing. Little attention has been devoted to the role of the debt

service ratio as leading indicators of household consumption (Juselius and Drehmann (2015) and Drehmann et al (2017)).[55]

Some fundamental aspects associated with the demand side channels are still being debated. For example, questions surrounding the quantitative importance of financial market imperfections for small firms should be answered, as some argue that there is little difference between small and large firms. While many empirical studies find that the effects of financial conditions vary by type of economic agent, including households, firms, financial intermediaries and sovereign entities, many of those do not present rigorous tests for specific financial imperfections. To illustrate, the GFC has highlighted the role of house prices in affecting consumption and broader macroeconomic outcomes, but the exact channels by which this takes place are not yet well established. Consequently, the implications of empirical findings for regulation, institutional reform or other policy design issues require additional work.

Supply side channels. Since the GFC, few question the relevance of supply side factors for macroeconomic outcomes. That said, the theoretical literature still falls short of providing realistic models. While some models show how supply side dynamics can lead to macro-financial linkages, they are still rudimentary in their treatment of the financial system. They tend to focus on banks rather than on the financial sector as a whole. And even when banks are included, their treatment is highly stylised. For example, many models simply assume the presence of banks, but do attempt to justify their existence, eg whether banks arise to overcome information asymmetries or because they are "special" in other ways.

Models often assume that banks are homogenous while in practice large banks operate very differently from small ones. There is often no distinction between liquidity and solvency risks, and the interaction between such risks is not always explicitly modelled. Moreover, the banks' choice of assets, including which sectors they lend to, is often imposed *a priori* rather than being endogenously determined. Models typically ignore many parts of the financial system (other than banking) and are unable to account for gross positions or intra-financial system transactions (such as interbank claims or transactions between banks and capital markets).[56]

A more realistic representation of the supply side of finance requires richer models that account for the heterogeneity of banks and capture the behaviour of other financial intermediaries. It also means modelling how banks, non-bank financial institutions and markets are linked to each other (such as through shadow banking activities) as well as how such institutions and markets are linked to the international financial system. Furthermore, more sophisticated approaches to modelling of the intricate linkages between financial imperfections, labour markets and real activity are sorely needed. Any advances in this area would require, among others, overcoming the general "linear" structure of DSGE models,

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[55] Several surveys discuss advances in the modelling of heterogeneous agents, news shocks, financial crises, bubbles and systemic risk (Heathcote et al (2009), Lorenzoni (2011, 2014), and Brunnermeier and Oehmke (2013)). Another strand of the literature uses *ad hoc* borrowing constraints to model financial imperfections in environments with a continuum of households (Huggett (1993), Aiyagari (1994), Krusell and Smith (1998)), which is particularly useful in studying distributional issues. Moll (2014) studies an environment in which financial frictions lead to misallocation of resources.

[56] See Acemoglu et al (2015) and Boissay et al (2016) for analysis focusing on effects of networks and links among financial institutions, including through the interbank market. See Freixas et al (2011) for analysis on monetary and prudential policies in the interbank markets. See Dou et al (2017) for a review of the role of macro-financial interactions in dynamics models used at central banks.

which has proved to be a hindrance to the analysis of financial turmoil given that "non-linear" effects, such as liquidity shortages, fire sales and deleveraging, are prevalent.

More empirical work is also needed on the roles of various asset markets, including credit, housing and equity markets. Empirical studies need to provide a better understanding of the potential role of supply side channels through the operations of bank, non-bank financial institutions and financial markets. The roles played by institutional and other factors (such as benchmark-based compensation contracts, competition among financial institutions and the states of general liquidity and capitalisation) in driving the leverage cycle of banks and other financial institutions are in great part a mystery. The roles of collateral and margin constraints during boom and fire sale periods need deeper analysis. Interbank markets, especially during periods of financial turmoil, are surprisingly little analysed. Research also needs to focus on identifying the best measures (price, quantity or a combination of both) that characterise the linkages between supply side financial market imperfections and macroeconomic outcomes. This could also help answer some basic questions, such as which quantitative variables are better in predicting fluctuations in macro-financial linkages and systemic risk.

Global implications of financial imperfections. The rapid spread of disruptions from US financial markets to other countries during the GFC has led to a number of questions about the cross-border transmission of real and financial shocks. Understanding the reasons for the collapse of global trade and financial flows during the height of the crisis and the implications of this for the real sector is likely to be a significant area of research. More work on the international spillovers of financial shocks, the roles played by multinational financial intermediaries and the synchronisation of business and financial cycles is also needed. On the theory front, open economy models could do a better job in assessing the cross-border implications of financial imperfections, considering the influence of both demand and supply side channels.

Policy challenges. As noted in the introduction, the GFC has generated an intense debate in the economics profession about the state of research on the importance of financial market imperfections in explaining macroeconomic fluctuations. Some argue that the crisis showed that the profession had not paid sufficient attention to these linkages. Others claim that these linkages had been recognised for a long time and that substantial progress had been made in understanding them. Our survey shows that the profession has indeed produced valuable research spanning a wide spectrum of issues. However, challenges remain, notably with respect to how the findings may best translate into policy. More research is required in order to arrive at a solid understanding of the issues and help guide policy decisions.[57]

Policy challenges stemming from the GFC require a much better integration of "core" research with empirical findings and the operational aspects of policy design. Since the GFC, many new regulations have been adopted (FSB (2017)). Questions remain, however, about what may be the "optimal" design of the financial system (Claessens (2016)). And related to this is the preferred design of the regulatory infrastructure, an issue that is not often formally

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[57] Bernanke (2010), Blanchard et al (2010, 2013), Caballero (2010), Kocherlakota (2010), Woodford (2010), Turner (2012), Claessens et al (2014), Kose and Terrones (2015), Blanchard and Summers (2017) and several papers in the Fall 2010 issue of the *Journal of Economic Perspectives* look at how the GFC may have influenced research, including the literature on the intersection between macroeconomics and finance. Blanchard et al (2012, 2016) and Akerlof et al (2014) discuss how economic policies have been reassessed by economists since the GFC. Gopinath (2017) provides a review of the recent macroeconomic policy-related work in international economics.

addressed when adopting new regulations (see Claessens and Kodres (2017) for a review). One set of questions, for example, relates to the best configuration of capital adequacy and liquidity requirements for commercial banks.[58] Other questions focus on how to best monitor and, perhaps, regulate the shadow banking system (see Claessens et al (2015) for a collection of papers on the subject).

The interactions between monetary policy and financial imperfections also require work. For example, the conduct monetary policy in the presence of financial frictions and the zero lower bound demands further analysis (eg Brunnermeier and Sannikov (2016) and Rogoff (2017)). A better assessment of the role played by monetary policy during a liquidity trap and the implications of UMPs are of strong policy interest (eg Korinek and Simsek (2016) and Del Negro et al (2017)). Related is the need for a better understanding of the role of financial factors in determining the real interest rate, including in the context of a possible global secular stagnation scenario. Some work on this has pointed at debt overhang in driving low interest rates, including for open economies.[59] While recent research has advanced our understanding of the basic issues, more work is warranted.

A broad area of further research involves the design of macroprudential policies (see Claessens (2015) and Adrian (2017) for analytical reviews and IMF-FSB-BIS (2016) for a review of policies). Following initial work at the BIS (see Galati and Moessner (2013)), there is now a widespread recognition of the importance of imperfections, externalities and specific market features as motivating factors for macroprudential policy.[60] While progress is being made, the conceptual frameworks underpinning proposals for specific policies still require much more work, particularly given the non-linearities involved (see Mendoza (2016)).

Furthermore, the empirical work to date has often used aggregate data, which does not always allow for specific policy recommendations incorporating all relevant trade-offs, notably the costs of macroprudential policies and the possibility of regulatory adaption and arbitrage. For example, empirical studies on how specific macroprudential policy tools, such as borrowing limits on housing finance or countercyclical capital buffers, may affect banks' overall risk-taking have been limited and their results are still preliminary (see Acharya et al (2017) and Auer and Ongena (2017) for early work). More research could help in guiding the design of macroprudential policies.

There is also a vigorous debate on the effectiveness of macroprudential policies and other regulatory measures to cope with large fluctuations in asset and credit markets, and whether monetary policy is perhaps also needed, as reflected in the contrasting views on the costs and benefits of "leaning against the wind" (compare Svensson (2016, 2017) and Adrian and Liang (2016)). More research on the linkages between monetary policy and asset price dynamics, and related financial systemic risks, is thus definitely needed. The global dimension of

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[58] See, for example, Dewatripont and Tirole (2012), Stein (2012), Goodhart et al (2013), Admati and Hellwig (2014), Fender and Lewrick (2016), Kara and Ozsoy (2016) and Kashyap et al (2017).

[59] See Eggertsson and Krugman (2012) and Eggertsson et al (2016); see also Borio (2017) on the possible role of monetary policy in affecting the real interest rate.

[60] See the early contributions by Crockett (2000), Borio (2003) and Knight (2006) (see also Clement (2010)). Subsequently, the BIS and other related entities have conducted much research on various aspects of macroprudential policy. The Committee on the Global Financial System (CGFS), for example, reported on operational aspects in 2010, 2011 and 2012 (CGFS (2010, 2012) and CGSG (2011)). An influential, post-GFC take was Brunnermeier et al (2009). Recent work on macroprudential policy includes Bianchi et al (2012, 2016), Farhi and Werning (2016) and Bianchi and Mendoza (forthcoming).

financial cycles is also an area that is subject to debate, with varying views of the quantitative importance of the global financial cycle (Rey (2015), Cerutti et al (2017b) and Ha et al (2017)). Related, more work on the global consequences of monetary policies is needed to help guide the design of such policies, including for small open economies, which often use a combination of exchange rate, foreign exchange reserves, macroprudential and capital flow management policies.[61] Future research also needs to focus on the interaction between financial policies and fiscal policy.

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[61] See Jeanne (2014, 2016), Pereira da Silva (2016) and Agénor et al (2017).

Appendix I. Research on macro-financial linkages: a brief history

Research on macro-financial linkages has a long history. The Great Depression created much interest in such linkages but this interest faded away over the next few decades. There has been a resurgence of interest since the early 1980s, with the introduction of rigorous general equilibrium models that have provided rich theoretical insights. Such insights have been complemented by the results of empirical studies at the macroeconomic and microeconomic levels. This appendix provides a brief review of the evolution of this literature (see Figure A1 for a schematic presentation).

The study of credit cycles, which precedes that of business cycles, goes back at least to Mills (1867) but, as just mentioned, the Great Depression was the primary motivation for the early qualitative work on the role of financial factors in shaping macroeconomic outcomes. Fisher (1933) provided a descriptive account of the relationship between the high leverage of borrowers and the severity of the downturn during the Great Depression. His "debt-deflation" mechanism was the first elegant narrative showing how a decline in net worth induced by a drop in prices, ie deflation, could lead borrowers to reduce their spending and investment, which, in turn, could cause activity to contract and result in a vicious cycle of falling output and deflation. Haberler (1937) reviewed early studies of business cycle fluctuations, focusing on the so-called monetary, over-investment, under-consumption, and psychological theories.

The literature that followed, however, turned its attention to the role of money, rather than credit, as the critical financial variable. While Keynes (1936) also brought out financial developments, eg as he discussed how the confidence of borrowers and lenders could changes in ways nor easily explained with economic models ('animal spirits"). He focussed more on the importance of money for the real economy. Armed with insights from the liquidity preference hypothesis, the early "Keynesian" models paid special attention to the mechanisms linking money to real activity, including the multiplier mechanism and the role of fiscal policy (Hicks (1937), Modigliani (1944) and Tobin (1958)). The "monetarist" school, on the other hand, insisted on the importance of monetary rather than real factors (Friedman (1956), Friedman and Schwartz (1963) and Tobin (1969)).

Later studies documented the critical role of financial intermediation in economic development and macroeconomic fluctuations but these did not lead to a fundamental shift in thinking. Gurley and Shaw (1955) showed that economic development and financial sophistication go hand in hand. Others, including Cameron (1961), Shaw (1973) and McKinnon (1973), also highlighted the importance of finance for development, contrasting among others the East Asian and Latin American experiences. Their main argument was that a country's overall "financial capacity," ie its financial system's ability to provide credit, was more relevant to the real economy than money. In the early stages of financial development, money could be important but it becomes less relevant in more developed systems, particularly as a measure of credit availability. Instead, banks increasingly use non-deposit sources of funding and non-bank intermediaries provide alternative sources of financing. This view, while also advanced by many financial historians (eg Goldsmith (1969)), did not prevail and research on finance and macroeconomics followed separate paths.

New analytical insights were gained during the 1950s with the applications of portfolio theory. A major breakthrough was the introduction of portfolio theory by Markowitz (1952), which inspired a large literature. However, it did not pay much attention to financial frictions. Tobin (1969) improved the understanding of how asset valuation, a key area of finance, affects investment. Through his concept of the "q" valuation ratio, he established a direct relationship between developments in equity markets and investment. With few exceptions,

however, these contributions paid little attention to the various forms of financial intermediation or to their imperfections.

The separation of finance and macroeconomics became increasingly pronounced after the introduction of the "irrelevance of financing structure" theorem of Modigliani and Miller (1958). The theorem provided a case for the independence of firm valuation and investment from financing structures and suggested more generally a decoupling of real economic activity from financial intermediation. A number of developments accelerated this separation. First, the Arrow-Debreu theorem (which shows that, in the presence of contingent claims that span every possible state of the world, allowing agents to insure against any event, it becomes much easier for agents to make choices), upon which Modigliani and Miller based their work. Second the methodological advances of the 1970s, notably with respect to asset pricing (Merton (1973)) and derivatives modelling (Black and Scholes (1973)). And, lastly, the emergence of the rational expectations paradigm (see below). Together they gave traction to the concept of "efficient financial markets" (Fama (1970, 1991)). This work put less emphasis on the role of banks as markets were thought to be able to efficiently provide most financial services (notably, of the twenty chapters in the *Handbook of the Economics of Finance* (2003), only one (Constantinides et al (2003)) was on financial intermediation).

The growing popularity of work based on the assumption of efficient and frictionless financial markets coincided with a shift in the macroeconomic literature. Researchers focused increasingly on the real side of the economy, using models with little role for financial variables (see Chari and Kehoe (2006) for a review). The precursor in macroeconomics to efficient financial markets was the rational expectations paradigm (Muth (1961) and Lucas (1976)), which assumes agent make choices consistent with models involving uncertainty and full information. It further reinforced the drive for quantitative models with fully optimising agents acting mostly in frictionless worlds. Although the widely used vector autoregression (VAR) models, first proposed by Sims (1972), partially shifted attention back to money as a key financial aggregate, at least in applied policy work, the broader literature concentrated mainly on real variables (Lucas (1975) and Kydland and Prescott (1982)). Research on monetary policy stressed the importance of central bank independence (Sargent and Wallace (1976)) and focused on inflation targeting (Bernanke and Mishkin (1997) and Clarida et al (1999)).

Contributions to the macroeconomic literature over this period paid little attention to financial intermediation. The class of so-called New Keynesian macroeconomic models (ie using microeconomic foundations that assume some price or wage "stickiness", leading to a slow adjustment of real variables to shocks) that emerged included various real and nominal frictions but did not properly account for financial imperfections (Smets and Wouters (2003)). Indeed, Gertler (1988) began his overview of the subject with a powerful observation: "*most of macroeconomic theory presumes that the financial system functions smoothly and smoothly enough to justify abstracting from financial considerations. This dictum applies to modern theory*" (see also Blanchard (1990)).

Some authors paid attention to the banking system, but mostly because it issued money, not because of its financial intermediation function. Bank runs (Diamond and Dybvig (1983)) and asset price bubbles (Blanchard and Watson (1982)) were studied but these did not become central to macroeconomic research. Minsky (1982, 1986) drew attention to the endogenous build-up of financial vulnerabilities. However, his work was largely qualitative and remained peripheral (see also Kindleberger (1996) and Borio and Lowe (2004)). Overall, the lack of interest in banking and finance seems to have been related to the less volatile nature of business cycle, especially after the mid-1980s, the era of the "Great Moderation" (Blanchard (2009)).
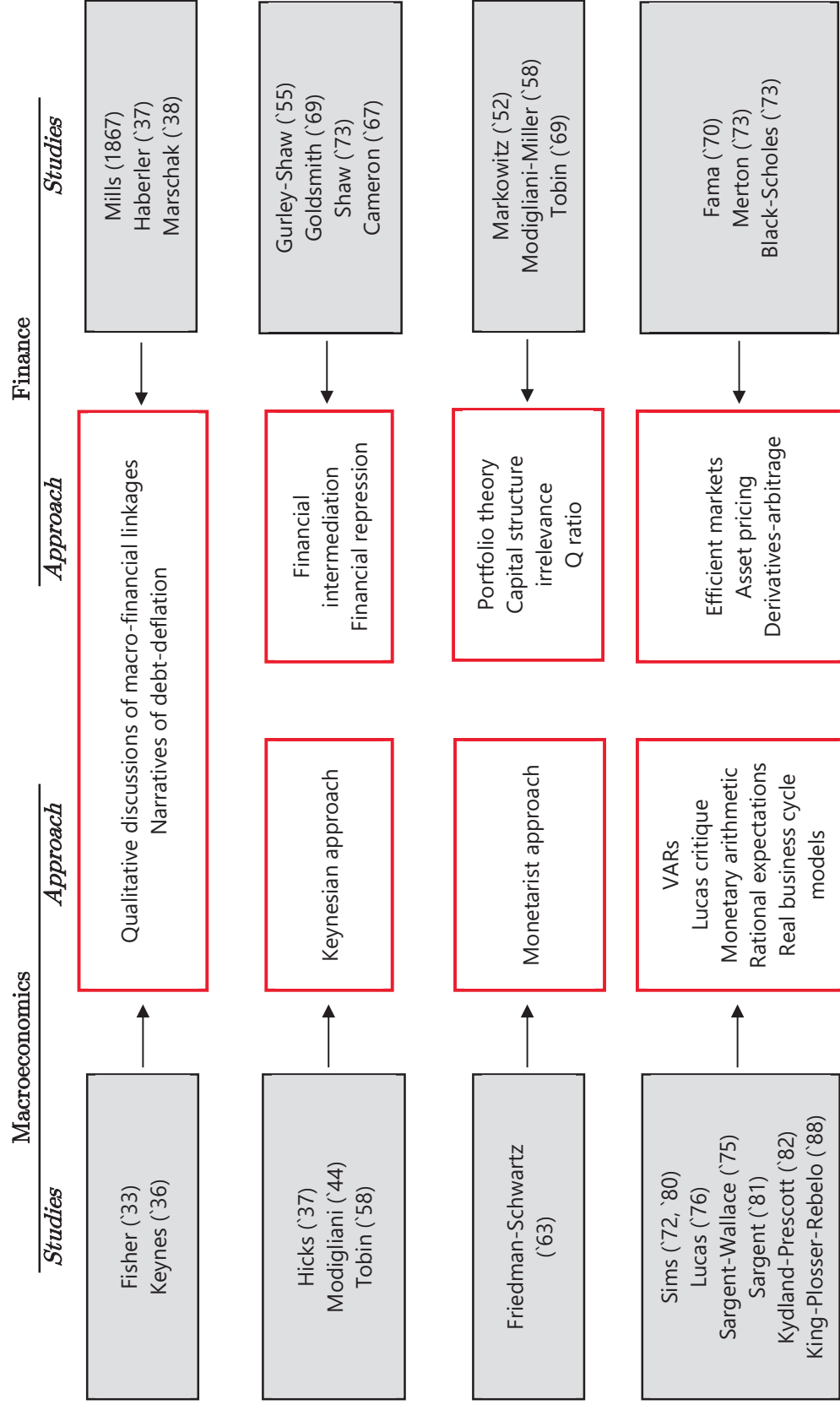
That said, interest in macro-financial linkages slowly picked up in the early 1970s. On the microeconomic theory front, research on the effects of asymmetric information and incentives, building on earlier work, notably Akerlof (1970), provided new insights. Many authors analysed the nature of optimal contracts with unobservable information, principal-agent problems or other imperfections (Jensen and Meckling (1976), Townsend (1979), Stiglitz and Weiss (1981), Williamson (1987)); including specifically for financial institutions (Gale and Hellwig (1985), Calomiris and Kahn (1991) and Holmström and Tirole (1997)). Following Shiller (1981), some researchers focused on deviations from the efficient markets hypothesis. Fazzari et al (1988) documented how corporate cash flows correlate with investment decisions, contradicting the q theory and providing evidence of financial imperfections.

Following work by pioneers in behavioural economics (eg Kahneman and Tversky (1979)), Thaler in a series of influential papers (eg De Bondt and Thaler (1985)) started the field of behavioural finance. This branch analyses how investor psychology, in conjunction with limits to arbitrage, can affect prices in financial markets. Building on Thaler's insights, Shleifer and Vishny (1997), drew attention to the limits to arbitrage in asset markets. Many contributions since then have showed how individuals' behaviour deviates from the standard paradigm (see Barberis and Thaler (2003), Thaler (2005) and Hirshleifer (2015) for reviews).
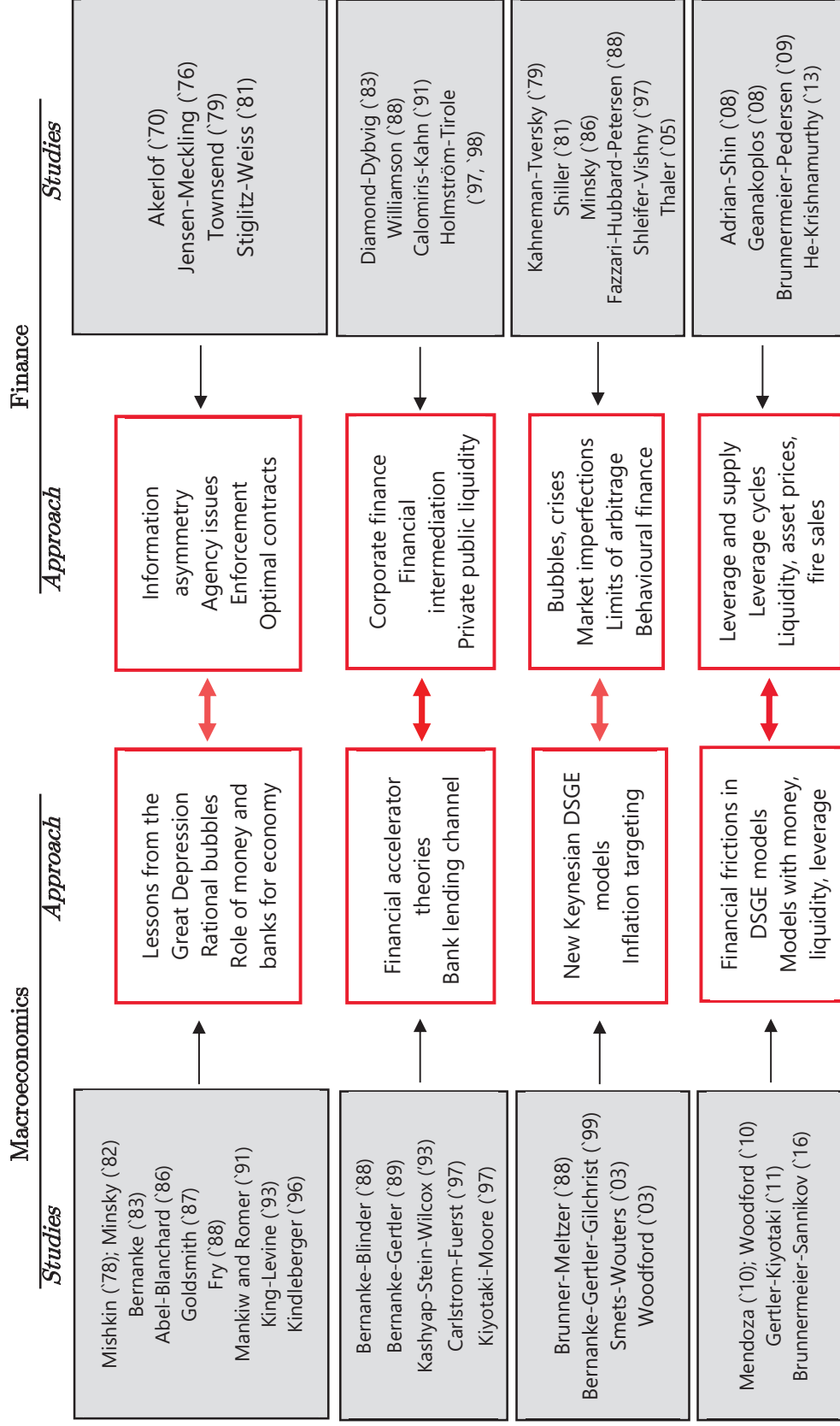
New empirical work also studied the importance of macro-financial linkages. Notably, Mishkin (1978) and Bernanke (1983) documented the critical role of financial factors in explaining the severity and persistence of the Great Depression. Mishkin argued that household balance sheet positions significantly impact consumer demand and Bernanke showed that a worsening of bank and corporate balance sheet positions leads to a more severe debt crisis. Other empirical studies put greater emphasis on the role of financial markets and institutions in shaping aggregate economic outcomes (Eckstein and Sinai (1986) and Brunner and Meltzer (1988)). Bernanke and Blinder (1988), Kashyap et al (1993) and others demonstrated the importance of the bank lending channel. A number of studies considered specific episodes of credit crunches in the United States and other countries and analysed the role of financial institutions in driving business cycles (Sinai (1992)). Importantly, with better data, the (causal) links between financial development and longer-term macroeconomic outcomes were documented (Goldsmith (1987), Fry (1988) and King and Levine (1993)).

Over the past three decades, more rigorous analytical models have investigated the linkages between financial markets and the real economy. Some of these focus on amplification mechanisms, collectively known as "the financial accelerator", which operates through the demand side of financial transactions (Bernanke and Gertler (1989), Carlstrom and Fuerst (1997), Kiyotaki and Moore (1997) and Bernanke et al (1999)). These models show how accelerator effects arise when small shocks, real or financial, are propagated and amplified across the real economy as they lead to changes in access to finance. More recent theoretical and empirical research has illustrated the importance of amplification channels operating on the supply side, including through financial institutions and markets (Brunnermeier and Pedersen (2009), Adrian and Shin (2008) and Geanakoplos (2008)). New models that include both demand and supply types of macro-financial linkage (Brunnermeier and Sannikov (2014), Gertler and Kiyotaki (2011), Williamson (2012) and Dávila and Korinek (2017)) have been developed.

Figure A1. Evolution of research on macro-financial linkages

Macroeconomics   **Finance**

Studies   *Approach*   *Approach*   *Studies*

Mishkin ('78); Minsky ('82)
Bernanke ('83)
Abel-Blanchard ('86)
Goldsmith ('87)
Fry ('88)
Mankiw and Romer ('91)
King-Levine ('93)
Kindleberger ('96)

→

Lessons from the
Great Depression
Rational bubbles
Role of money and
banks for economy

⇕

Information
asymmetry
Agency issues
Enforcement
Optimal contracts

→

Akerlof ('70)
Jensen-Meckling ('76)
Townsend ('79)
Stiglitz-Weiss ('81)

Bernanke-Blinder ('88)
Bernanke-Gertler ('89)
Kashyap-Stein-Wilcox ('93)
Carlstrom-Fuerst ('97)
Kiyotaki-Moore ('97)

→

Financial accelerator
theories
Bank lending channel

⇕

Corporate finance
Financial
intermediation
Private public liquidity

→

Diamond-Dybvig ('83)
Williamson ('88)
Calomiris-Kahn ('91)
Holmström-Tirole
('97, '98)

Brunner-Meltzer ('88)
Bernanke-Gertler-Gilchrist ('99)
Smets-Wouters ('03)
Woodford ('03)

→

New Keynesian DSGE
models
Inflation targeting

⇕

Bubbles, crises
Market imperfections
Limits of arbitrage
Behavioural finance

→

Kahneman-Tversky ('79)
Shiller ('81)
Minsky ('86)
Fazzari-Hubbard-Petersen ('88)
Shleifer-Vishny ('97)
Thaler ('05)

Mendoza ('10); Woodford ('10)
Gertler-Kiyotaki ('11)
Brunnermeier-Sannikov ('16)

→

Financial frictions in
DSGE models
Models with money,
liquidity, leverage

⇕

Leverage and supply
Leverage cycles
Liquidity, asset prices,
fire sales

→

Adrian-Shin ('08)
Geanakoplos ('08)
Brunnermeier-Pedersen ('09)
He-Krishnamurthy ('13)

Notes: This diagram presents a rough representation of the evolution of research on macro-financial linkages. Early interest in such linkages was triggered by the Great Depression. However, it remained largely qualitative. Although research became more analytical over time, it moved away from the analysis of financial market imperfections, especially over the period 1950–80. Since then, the literature has made significant progress in capturing the effects of microeconomic imperfections. More recently, it has combined theoretical insights from macroeconomics and finance in general equilibrium models. It has also produced many empirical studies at the micro- and macroeconomic levels. This diagram includes only a select set of studies because of space constraints. We summarize many other studies in the main text.

Appendix II. Financial accelerator mechanisms

Although there are many variants of the financial accelerator mechanism, they tend to describe similar channels of transmission and propagation. A number of theoretical studies show that the mechanism can play an important role in accentuating macroeconomic fluctuations. This appendix presents a summary of the various mechanisms found in the literature (see Quadrini (2011) for a systematic analytical review of the causes of financial frictions and the types of accelerator model; Gerke et al (2013) also compare the various models that feature a financial accelerator mechanism and collateral constraints).

One mechanism works through changes in cash flows that depend on the overall state of the economy. Greenwald and Stiglitz (1993) develop a dynamic model in which changes in corporate cash flows play a critical role in propagating financial market disturbances to real sector variables, including employment and inventories. Another mechanism acts through changes in the intensity of adverse selection in credit markets. Azariadis and Smith (1998) show that the presence of adverse selection can create indeterminacy, with the economy fluctuating between Walrasian and credit rationing regimes, and with cyclical downturns exhibiting declines in real interest rates and increases in credit rationing (see also Mankiw (1986)).

Changes in default probabilities over the cycle can also amplify cyclical fluctuations. During the upswing of a cycle, default probabilities decline, allowing investors to lend greater sums of money, as predicted by the Stiglitz-Weiss model (1981) of lending under asymmetric information and moral hazard. This fuels the upswing. On the downswing, the mechanism works in reverse, leading to sharp declines in available external financing. The general equilibrium implication of this mechanism is modelled by Suarez and Sussman (1997) using an overlapping generations model. In particular, during booms old entrepreneurs sell larger quantities and prices fall, implying that young entrepreneurs must rely to a greater extent on external sources of financing. Since external financing can generate excessive risk-taking, booms are often followed by higher failure rates. Fire sales by bankrupt corporations during such periods then lead to asset price declines, which, in turn, generate macroeconomic fluctuations.

The allocation of capital across heterogeneous firms can, in the presence of financial imperfections, also create procyclicality. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) focus on the impact of financial imperfections on aggregate investment and employment but neglect the effects of the reallocation of inputs across heterogeneous firms. Recent studies try to fill this gap. Eisfeldt and Rampini (2006) find that the costs of capital reallocation, such as those induced by financial frictions, need to be countercyclical to be consistent with the cyclical dynamics of capital reallocation and productivity dispersion. Moll (2014), in a model where entrepreneurs are subject to borrowing constraints and idiosyncratic productivity shocks, shows with plant-level panel data that financial frictions can explain aggregate productivity losses in two EMEs that are 20% larger than in the United States. In related research, Khan and Thomas (2013), using a DSGE model in which capital reallocation across firms is distorted by frictions, show that a shock can be amplified and propagated through disruptions to the distribution of capital across firms. Herrera et al (2011), in their study of US firms and the dynamic properties of gross credit flows relative to macroeconomic variables, find that financial frictions can impact aggregate productivity by hindering the inter-firm reallocation of credit.

Project choice and technological change can also lead to financial accelerator mechanisms. The literature on the accelerator often emphasises the impact of imperfections on the volume

of investment or consumption. However, imperfections can also propagate and amplify shocks by triggering changes in the quality and productivity of projects undertaken. Some studies argue that financial frictions that are made worse by recessions induce firms to switch to lower quality and lower productivity projects (Barlevy (2003)). Aghion et al (2010) show how recession-induced credit constraints can make firms choose short-term investments with low liquidity risk, making the share of long-term but more productive projects procyclical. In other studies, though, recessions have a cleansing effect, stimulating the adoption of more productive technologies. Araujo and Minetti (2011) document that, while firms collateral and credit relationships ease their access to credit and investment, such relationships can also inhibit restructuring activity (ie the transition to new and more productive technologies).

Financial imperfections affecting large firms also can result in accelerator-type effects. While the literature generally stresses that small firms are especially exposed to financial imperfections, frictions can also affect large firms. As is well documented in the corporate finance literature, large firms, especially those that are widely held, face more acute agency problems. Managers of large firms can have incentives to allocate cash inefficiently, for example, by empire building (Jensen and Meckling (1976) and Jensen (1986)). Dow et al (2005) integrate this problem into a dynamic equilibrium model and show how cash flow shocks can affect investment and be propagated over time.

Philippon (2006) models how managers tend to overinvest and how shareholders show greater tolerance for such behaviour more during booms, with the cyclical behaviour related to the quality of governance. Martin and Ventura (2011) consider a financial accelerator model in which bubbles in asset prices drive changes in borrowers' net worth and the tightness of credit constraints (see also Martin and Ventura (2015)). Note also that firm demand for external financing appears to deviate from the behaviour predicted by standard models (Baker and Wurgler (2013) survey theory and evidence on behavioural corporate finance).

Information asymmetries can be a source of asset price booms, bubbles and busts. Models à la Kiyotaki and Moore (1997) assume that agents participating in asset markets are equally informed. However, financial frictions can also generate confusion about the fundamental value of assets. When agents are asymmetrically informed about the fundamental value of assets, Yuan (2005) shows that credit constraints can contribute to uncertainty and exacerbate the volatility of asset prices. Iacoviello and Minetti (2010) show that opening an economy to foreign agents (such as lenders) that have less information about traded collateral assets, can lead to higher volatility of asset prices, credit and output. Gorton and Ordoñez (2013, 2014) show that when an economy relies on informationally-insensitive debt, a credit boom can follow during which firms with low quality collateral start borrowing. Since this is associated with a more fragile environment, a small shock can trigger a large change in the information set, leading to a drop in asset prices and a sharp decline in output and consumption. A distinct but related area of research explores the role of distortions, such as moral hazard or weak corporate governance, in generating asset price bubbles (Allen and Gale (2000) and Barlevy (2014)).

Moreover, financial imperfections can propagate adverse shocks through labour markets, for instance, by hindering the job search process. Motivated by the GFC, Sterk (2015) presents a business cycle model in which a fall in house prices reduces geographical mobility because credit-constrained homeowners experience a decline in their home equity, creating distortions in the labour market. The model can explain much of the joint cyclical fluctuations in US housing and labour market variables, including the events that took place in 2009. Andrés et al (2010) explore a similar propagation channel involving credit frictions and labour markets. They are able to explain the comovements of US house prices with output, investment and consumption. Burnside et al (2016) provide a model in which agents'

interactions create "fads" about asset price prospects. This process, in turn, generates boom-busts cycles or protracted booms that are similar to those observed for house prices.

Appendix III. Understanding liquidity and leverage cycles

Liquidity, a key concept for macroeconomic and financial developments, is difficult to define, in part as it is multi-faceted (see further Holmström and Tirole (2011) and Tirole (2011)). Liquidity is often considered in relation to the price of credit. It can correspondingly be measured by short-term interest rates, with lower rates being associated with ampler liquidity. While the underlying theoretical motivations are not always entirely clear, some studies also employ quantity-based measures – such as the aggregate quantity of money or "excess" money growth (money growth less nominal GDP growth). Both concepts tend to move in the same direction. They are also closely related to the monetary transmission channels of interest rates and asset prices.

Narrower definitions of liquidity in the finance literature relate to the tradability of specific assets while broader definitions refer to banks' role in liquidity provision. A liquid asset is said to have the following features: it can be sold rapidly, with minimal loss of value (close to the true present value of its discounted cash flows) within a short period of time (minutes or hours). Conversely, an illiquid asset is not readily saleable. This type of liquidity depends on various factors. For example, an asset can be illiquid because of uncertainty about its value or because there is no market in which it can easily be traded. Liquidity creation is also seen as a core function of banks (see Bouwman (2014) for a review of the literature on (private) liquidity creation by commercial banks and its regulation).

Recently, the literature has introduced new classifications of liquidity formally. Specifically, Brunnermeier and Pedersen (2009) categorise liquidity into two forms: *market* and *funding liquidity* (among practitioners these concepts had been familiar for some time; see for example Borio (2000, 2004)). *Market liquidity* is defined as the ease with which money can be raised by selling assets at reasonable prices. A liquid (or deep) market is one with willing buyers and sellers at all times for large quantities and with orders that are not strongly influencing prices (the probability that the next trade is executed at a price equal or close to the last one is high; see Vayanos and Wang (2013) for a review of the theoretical and empirical literature on market liquidity).

Funding liquidity describes the ease with which financial institutions, investors or arbitrageurs can obtain funding. It is high, ie markets are "awash with liquidity", when it is easy to raise money. Funding liquidity is affected by the strength of fund-seekers' balance sheets and cash flows. This strength is, in turn, affected by asset prices: when collateral values are high (and/or rising) and margins are low, funding liquidity can be ampler (as in the case of repos). As such, market and funding liquidity are closely related. And, there is a strong parallel to the financial accelerator mechanism of Kiyotaki and Moore (1997) that focuses on how changes in asset prices affect firms' ability to raise external financing.

Liquidity can be influenced by two distinct leverage spirals: the valuation and the margin/haircut spirals, both of which relate to the soundness and funding positions of financial institutions. The *valuation spiral* is driven by asset price effects. If many financial institutions suffer a similar shock – say a drop in the value of mortgage-backed securities – all of them have to cut back their asset positions. This depresses asset prices further, leading to an additional erosion of capital, which then forces institutions to cut back on their positions even more. With mark-to-market accounting rules and market discipline, leveraged financial institutions cannot defer these losses individually. Moreover, when markets are illiquid, selling assets depresses prices further.

The *margin/haircut spiral* can come on top of the *valuation spiral*. It arises when many institutions finance their asset positions with (short-term) borrowed money (repos) and have

to put up margins in cash or are imposed a discount (haircut) on the assets they provide as collateral. These margins/haircuts increase in times of price declines – as lenders want better protection – and thereby lead to a general tightening of lending conditions (margins and haircuts implicitly determine the maximum leverage that a financial institution can adopt). The *margin/haircut spiral* then reinforces the *valuation spiral* in forcing institutions to reduce their leverage.

These mutually reinforcing effects create virtuous or vicious cycles, with real economic impacts. Brunnermeier and Pedersen (2009), Adrian and Shin (2008, 2010a) and Geanakoplos (2010) point out how these mechanisms can affect liquidity and leverage, which, in turn, affect financial and economic cycles. During a virtuous cycle, these mechanisms can lead to rising asset prices (even bubbles). In a vicious cycle, they can create fire sales. Importantly, these cycles can be triggered by relatively small shocks. In particular, even a temporary lack of liquidity may create adverse effects for a highly leveraged financial institution. Liquidity shocks can also be aggravated through various channels, including the hoarding of funds, runs on financial institutions and network effects (via counterparty credit risk). Because of these spirals, small shocks can force the economy into a process of deleveraging and fire sales. This can have a substantial impact on the real economy, as happened during the Asian financial crisis of the late 1990s and the GFC (see Shleifer and Vishny (2011) for a review of the literature on fire sales and macroeconomics).

Appendix IV. Linkages between business and financial cycles: an overview of empirical studies

Using various methodologies and measures to proxy cycles, a number of studies have examined the features of business and financial cycles and the aggregate linkages between such cycles. They have pointed out the procyclical nature of financial markets and provided the broad patterns describing the linkages between business and financial cycles. This Appendix reviews these studies for the three most important market segments: credit, equity and housing.[62]

Credit market cycles and business cycles

The study of credit cycles has a history that goes back to Mills (1867) at least. Most of the early work in this area employed qualitative approaches and considered the extreme versions of these cycles: booms and busts (or crunches) (see Keynes (1936), Galbraith (1954), Shiller (1989, 2000) and Sinai (1993); Niehans (1992) reviews very early work on credit cycles (Juglar (1862)). A number of studies also consider specific credit crunches in the United States and other countries (see Wojnilower (1980, 1985), Owens and Schreft (1995), Cantor and Wenninger (1993) and Helbling et al (2011)). Using US data going back to 1875, Bordo and Haubrich (2010) document that credit disruptions appear to exacerbate cyclical downturns. A number of studies also consider the important role played by credit in driving business cycles. Using VAR models, Meeks (2012) examines the role of credit shocks in explaining US business cycles and finds that such shocks play an important role during financial crises but a somewhat smaller role during "normal" business cycles.

Recent studies apply a variety of quantitative approaches to cross-country data to analyse episodes of credit booms and crunches. Mendoza and Terrones (2008), for example, use a "thresholds method" to identify credit booms in 48 countries over the period 1960–2006. They find that booms generally coincide with above-trend growth in output, consumption and investment during the build-up phase and below-trend growth of those variables in the unwinding phase. During the build-up phase, a surge in private capital inflows is accompanied by a deterioration of current account positions (see also Gourinchas et al (2001), Schularick and Taylor (2012)). Other researchers (such as Castro and Kubota (2013) and Dell'Ariccia et al (2016)) also study the determinants of credit booms' length.

Cycles in asset (house and equity) prices and business cycles

Booms and busts in asset prices have also been a major area of research. Borio and Lowe (2002), using an aggregate index of asset price (equities, and residential and commercial property), define booms as periods during which asset prices deviate from their trends by specified amounts. They also consider the interaction between developments in asset prices and credit. They report that there are substantial declines in house prices and residential investment during housing busts (after episodes of booms) in 16 advanced economies. This

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[62] For additional references on the literature covering the linkages between business and financial cycles see Rebelo (2005), Claessens et al (2009, 2011, 2012a), Siregar and Lim (2011), Guarda and Jeanfils (2012), Hubrich et al (2013), Borio (2014), De Rezende (2014), Große Steffen (2015), Hubrich and Tetlow (2015), Kose and Terrones (2015), Hartmann et al (2015), Abbate (2016), Abildgren (2016), Jordà et al (2016, 2017), Bluwstein (2017) and Gandré (2017).

work builds on earlier contributions, including in Bank for International Settlements (1993), and Borio et al. (1994), and has since been deepened in a number of ways (see further Hofmann (2001) and Davis and Zhu (2004)). Similarly, Detken and Smets (2004) identify between 1970 and 2002 38 house price booms in 18 OECD countries on the basis of prices exceeding trend growth rates by at least 10% (see also Adalid and Detken (2007)). They emphasise the importance of joint fluctuations in house prices and credit over the boom-bust cycles in asset prices.

Others have focused on boom and bust episodes in house and equity prices. However, because they employed different methodologies and data sets, their findings have been difficult to compare. Bordo and Jeanne (2002) analysed episodes of booms and busts in house and equity prices for OECD countries and documented that more than one in every two house price booms ended up with a bust, against one for every six equity price booms. Using OECD data for 18 countries from 1970 to 2009, Burnside et al (2016) found that the amplitude of typical house price booms and busts was 54% and 29%, with a median length of four and five years, respectively. They also report that booms are not always followed by busts.

A number of other studies have borrowed methods widely employed in the business cycle literature to study financial cycles. Following Harding and Pagan (2002), rigorous approaches to documenting financial cycles have been used. For example, Pagan and Sossounov (2003) identify "bear" and "bull" phases in equity markets using formal methods of business cycle dating for US monthly data over the 1835–1997 period. They report that while the duration of bear markets is about 15 months, it is around 25 months for bull markets. Bear markets are characterised by about a 30% decline in equity prices and bull markets by about a 40% increase.

Ohn et al (2004) examine the "duration dependence" exhibited by bull and bear markets in the United States and report that both phases show positive dependence. Using the same methodology, Edwards et al (2003) find that the cyclical properties of equity prices in EMEs change following periods of financial liberalisation. Kaminsky and Schmukler (2008) report that equity price cycles in EMEs tend to become more volatile after liberalisation. Drehmann et al (2012) show that the length and amplitude of financial cycles have increased markedly since the mid-1980s and that cyclical peaks are very closely associated with financial crises.

Other research focuses on the cyclical properties of house prices. Although cyclicality is common, the duration and amplitude of housing cycles vary widely across geographical areas and time (Cunningham and Kolet (2011) and Hall et al (2006)). This, in turn, reflects variations in demand and supply conditions, the characteristics of housing finance and the sources of linkage between housing and real activity. Igan and Loungani (2012) study the characteristics of house price cycles in advanced economies and find that long-run price dynamics are mostly driven by local fundamental factors, such as demographics and construction costs, although movements in such fundamentals – and credit conditions – can create short-run deviations from equilibrium paths.

Some studies consider the linkages between business and asset price cycles (Breitung and Eickmeier (2014), Cicarelli et al (2016) and Prieto et al (2016)). A central finding of these studies is that house price cycles tend to have an especially close relationship with business cycles. Based on evidence for 27 countries, Cecchetti (2008) finds that housing booms worsen growth prospects while equity booms have little impact on the expected mean and variance of macroeconomic performance (although they do aggravate adverse outcomes). Cecchetti and Li (2008) study the impact of booms in equity and house prices on extreme fluctuations in output and the price level. They find that equity and housing booms are both associated with significantly worse growth and inflation prospects over a three-year horizon. Leamer (2007) finds that there are strong linkages between various aspects of housing market and

business cycles in the United States. Ha et al (2017) find evidence of global cycles specific to financial variables. They also find that shocks to house and equity prices have spillover effects on macroeconomic aggregates (see also Cotter et al (2017)).

Synchronisation of financial cycles

Some studies document the extent of cyclical synchronisation and lead-lag relationships in the financial markets of various countries. Goodhart and Hofmann (2008) analyse the degree of synchronisation between house prices and credit movements – where these two variables may comove because a change in housing wealth has collateral effects which affect both credit demand and supply or changes in credit supply affect house price fluctuations. They show that the effects of shocks to money and credit are stronger when house prices are booming. Borio and McGuire (2004) report that peaks in housing prices lag peaks in equity prices by up to two years, with the lag length negatively related to changes in short-term interest rates. Hirata et al (2012) analyse the synchronisation of house prices across countries and their interactions with other financial variables (see also Cesa-Bianchi (2013)). Using a dynamic factor model, Rey (2015) and Miranda-Agrippino and Rey (2015) find that a common factor drives a sizeable portion of variations in asset prices globally and capital flows. Cerutti et al (2017a), however, question the quantitative importance of global factors for capital flows.

Table 1. Behaviour of small and large firms during recessions and tight money periods

(in percent change)

	Sales		Inventories		Short-term Debt	
	Large	Small	Large	Small	Large	Small
2007-2009 Recession[1]	-24.62	-20.24	-14.18	-15.36	-38.24	-19.83
2001 Recession[2]	-14.64	-6.92	-12.65	-9.28	-35.95	-12.13
All Recessions pre-2001[3]	-7.59	-10.15	-5.67	-9.11	-24.48	-12.62
Tight Money Dates[4]	-5.5	-9.39	-3.3	-7.78	-14.15	-11.45

Source: Kudlyak and Sánchez (2017).
Note: The table shows the difference between the minimum value of the detrended series in an interval of 12 quarters following the episode and the peak value of the series.
[1] The peak of the recession is Q4 2007.
[2] The peak of the recession is Q1 2001.
[3] The peaks of the recessions covered are: Q4 1969, Q4 1973, Q1 1980, Q3 1981 and Q3 1990.
[4] The periods of tight money are Q2 1966, Q4 1968, Q2 1974, Q3 1978, Q4 1979, Q4 1988 and Q2 1994.

Table 2. Variance decomposition: VAR with global factors
(fraction of variance explained by respective shock, in percent)

Shocks	Forecast horizon (quarters)	GDP	Productivity	Inflation	Interest Rates	Credit	Credit Spread	Default Rates
Credit	1	8.9	6.5	6.8	9.9	14.6	9.2	15.7
	4	9.7	8.8	9.2	10.1	13.9	9.5	14.9
	8	10.6	10.3	10.6	10.5	12.5	10.9	14.2
	12	10.8	10.4	10.9	10.8	12.1	11.1	13.9
Productivity	1	9.3	7.1	23.5	9.1	9.1	8.5	10.7
	4	10.5	9.4	19.6	10.3	11.4	9.9	12.2
	8	12.1	11.0	16.6	11.8	13.3	11.4	12.5
	12	12.3	11.4	16.3	12.3	14.5	11.8	12.5

Source: Helbling et al (2011).

Note: The roles of credit and productivity shocks in explaining global business cycles are shown using a VAR model that includes the estimated global factor of each variable and US credit spreads and default rates. The table reports the fraction of the forecast error variance of these variables that is explained by global credit and productivity shocks for different forecast horizons. Though both shocks are identified simultaneously, the variance decompositions need not add up to 100% because other potentially unidentified shocks make up the rest of the variance. Credit is measured by the aggregate claims on the private sector of deposit money banks and is obtained from the International Financial Statistics (IFS) of the IMF. The default rate series correspond to the monthly rates for US speculative-grade corporate bonds rated by Moody s Investor Service. GDP data are chained volume series from the OECD. The interest rates correspond to nominal short-term government bill rates and are taken from IFS. Labour productivity is defined as real GDP per hours worked and is obtained from the OECD. Inflation corresponds to the change in each country s CPI. The sample includes G7 countries for the period Q1 1988 to Q4 2009.
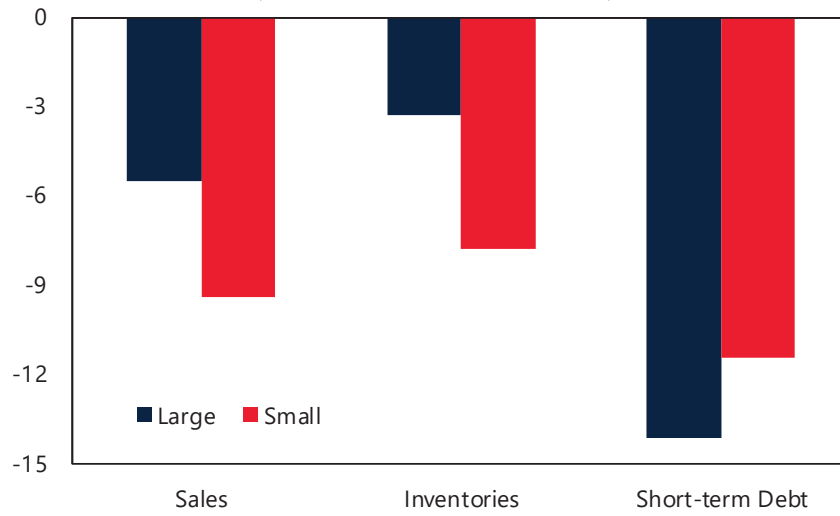
Table 3. Synchronisation of business and financial cycles
(concordance index)

	All Countries	Advanced Economies	Emerging Markets
Output and Credit Cycles			
Mean	0.78	0.82**	0.74
Median	0.81	0.83	0.76
Standard Deviation	0.10	0.06	1.13
Output and House Price Cycles			
Mean	0.64	0.67**	0.54
Median	0.68	0.70	0.50
Standard Deviation	0.12	0.15	0.15
Output and Equity Price Cycles			
Mean	0.59	0.57***	0.62
Median	0.58	0.57***	0.64
Standard Deviation	0.06	0.08	0.05

Note: Each cell represents the concordance statistic for the corresponding two cycles. Concordance is calculated as the fraction of time that two cycles are in the same phase. *** and ** imply significance at the 1% and 5% levels, respectively. Significance refers to the difference between advanced economy and emerging markets (means and medians only).
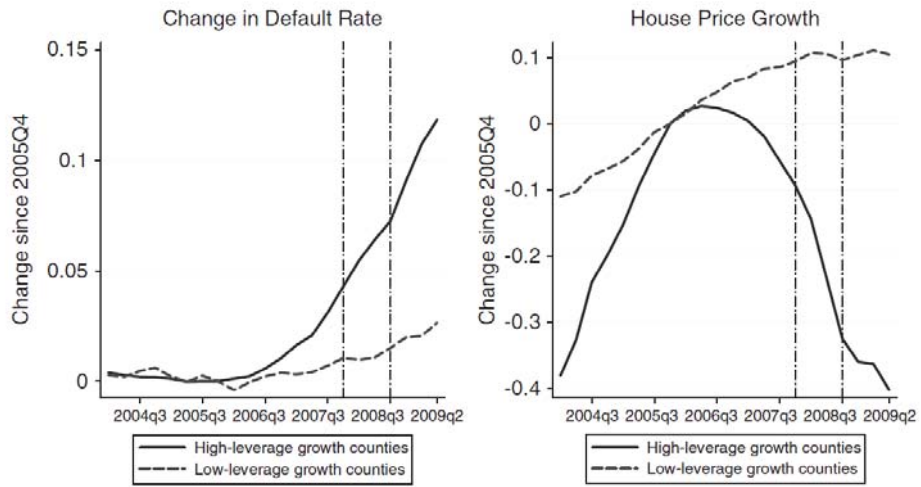
Figure 1. Behaviour of large and small firms
### (around periods of tight money)

Figure 2. Default rates and growth of house prices in countries with low and high leverage growth

Source: Mian and Sufi (2010).
Note: High-leverage growth counties are defined as the top 10% of counties in terms of the increase in the debt to income ratio from Q4 2002 to Q4 2006. Low-leverage growth counties are in the bottom 10% of the same measure. The left panel plots the change in the default rate for high- and low-leverage growth countries and the right panel plots the growth rate for high- and low-leverage growth countries.

Figure 3. Auto sales, new home building and unemployment rates in high- and low-leverage growth countries
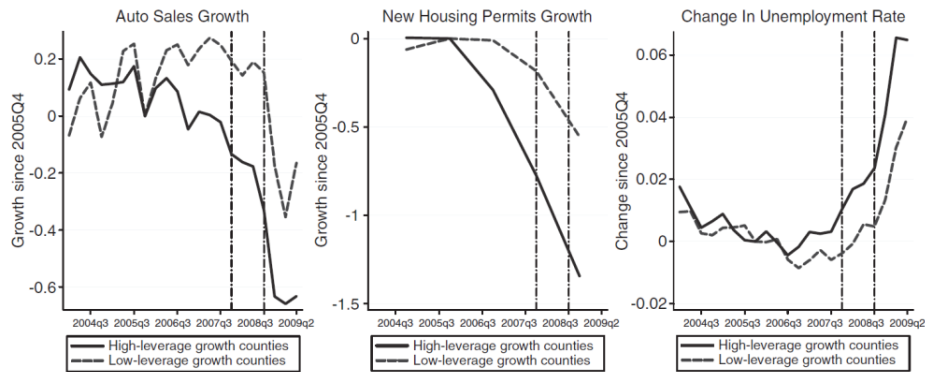
Source: Mian and Sufi (2010).
Note: High-leverage growth countries are defined as the top 10% of countries by the increase in the debt to income ratio from Q4 2002 to Q4 2006. Low-leverage growth countries are in the bottom 10% based on the same measure. The left panel plots the growth in auto sales, the middle panel plots the growth in new housing permits, and the right panel plots the change in the unemployment rate.

Figure 4A. Financial accelerator mechanism: demand side
(virtuous circle)
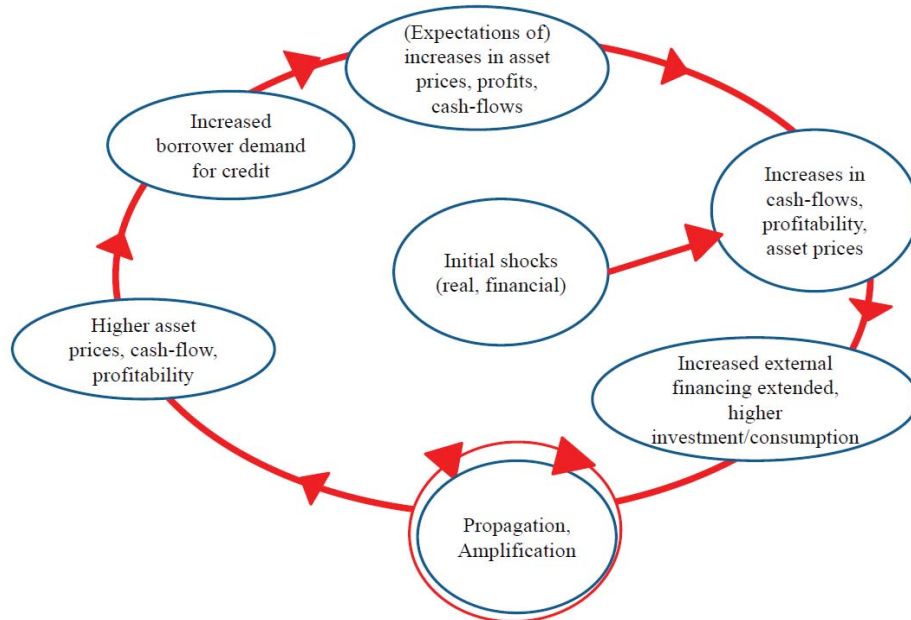
Note: The chart depicts the financial accelerator mechanism by which shocks to the economy may be amplified by changes in access to external financing, which then translates into changes in economic agents' investment and consumption spending. In turn, these changes are propagated and reinforced as asset prices and economic activity fluctuate, which then affects the demand and availability of external financing. This creates further feedback loops that are propagated through financial markets and the real economy.

Figure 4B. Financial accelerator mechanism: supply side
(virtuous circle)
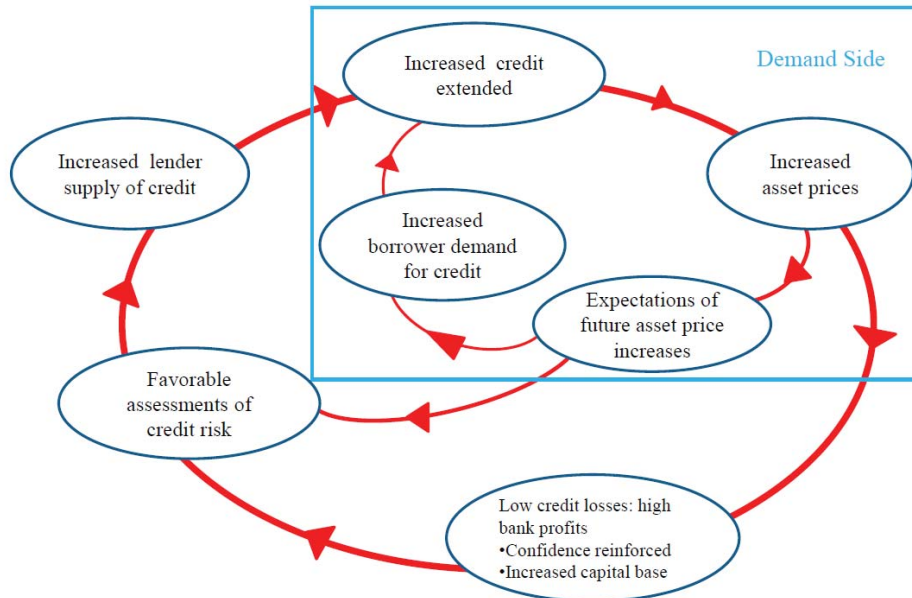
Note: The chart depicts both the demand (as in Figure 4A) and the supply sides of the financial accelerator mechanism. As financial institutions' balance sheets and profitability increase and asset prices rise, the assessment of economic prospects is viewed more positively and the supply of external financing expands. This then translates into changes in investment that enhance the feedback loops between financial markets and the real economy.

Figure 5. Evolution of global GDP: 2007:3–2009:4

A. Role of credit shock

### B. Contributions of credit and productivity shocks
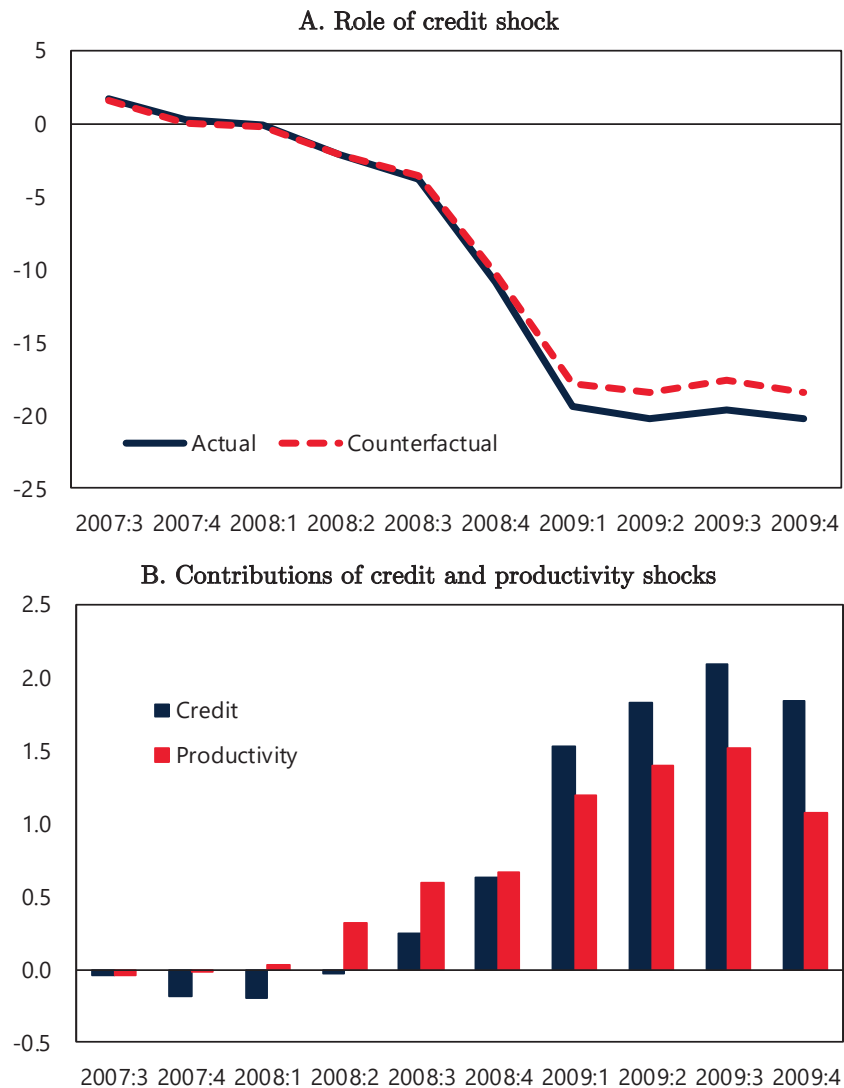
Source: Helbling et al (2011).

Note: Panel A compares the results of counterfactual simulations for the global GDP factor during the GFC. The solid line represents the actual global GDP factor and the dashed line represents the counterfactual when the global credit shock is set to zero during the period considered. Panel B compares the contributions of credit and productivity shocks to cumulative global GDP growth based on the counterfactual simulations. The bars represent the median difference. A positive (negative) bar captures how the decrease in the global GDP factor would have been smaller (greater) in the absence of the respective shocks. Credit is defined as the aggregate claims on the private sector by deposit money banks and is obtained from the IFS. Labour productivity is defined as real GDP per hours worked and is obtained from the OECD.

Figure 6A. Conceptual representation of liquidity and leverage cycles: gains
(virtuous circle)
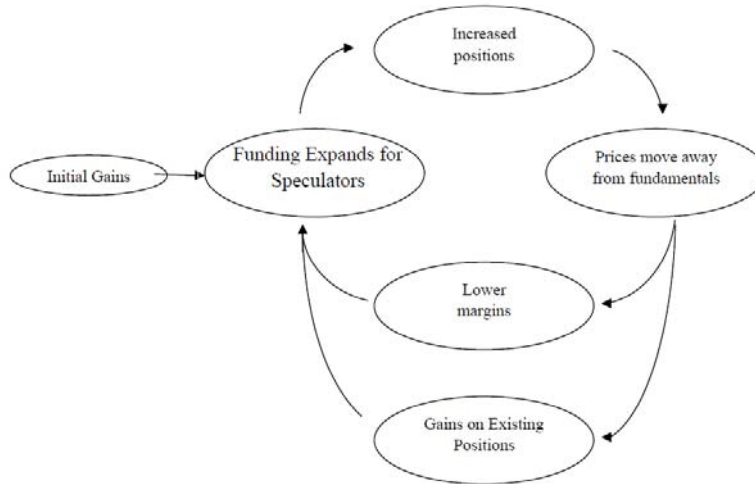
Source: Brunnermeier and Pedersen (2009).
Note: The figure depicts a situation where initial gains trigger a virtuous loop of increased asset prices and further gains. The underlying mechanism is similar to that of the financial accelerator where higher asset prices lead to increases in capitalisation, which then enhances the demand for assets, (further) driving up prices. The mechanism is in part reinforced by lower margins/haircuts on assets used as collateral, which allows for greater leverage.
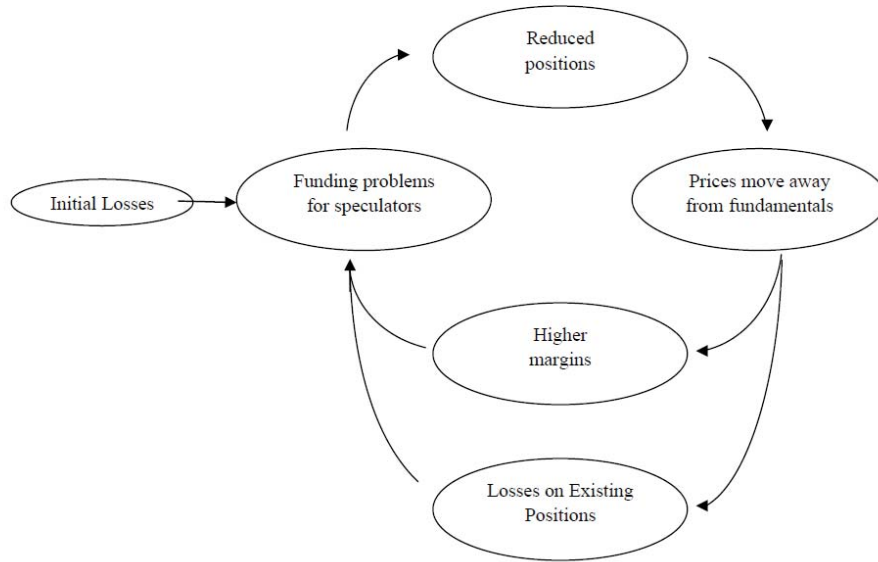
Figure 6B. Conceptual representation of liquidity and leverage cycles: losses
(vicious circle)

Source: Brunnermeier and Pedersen (2009).
Note: The figure depicts a situation where initial losses initiate a vicious circle of declining asset prices and losses. The underlying mechanism is that of a fire sale, which is essentially the forced sale of an asset at a dislocated, low price. It is in part triggered by an increase in the margins/haircuts on assets used as collateral, which allows for reduced leverage.

Figure 7. Macroeconomic implications of financial shocks
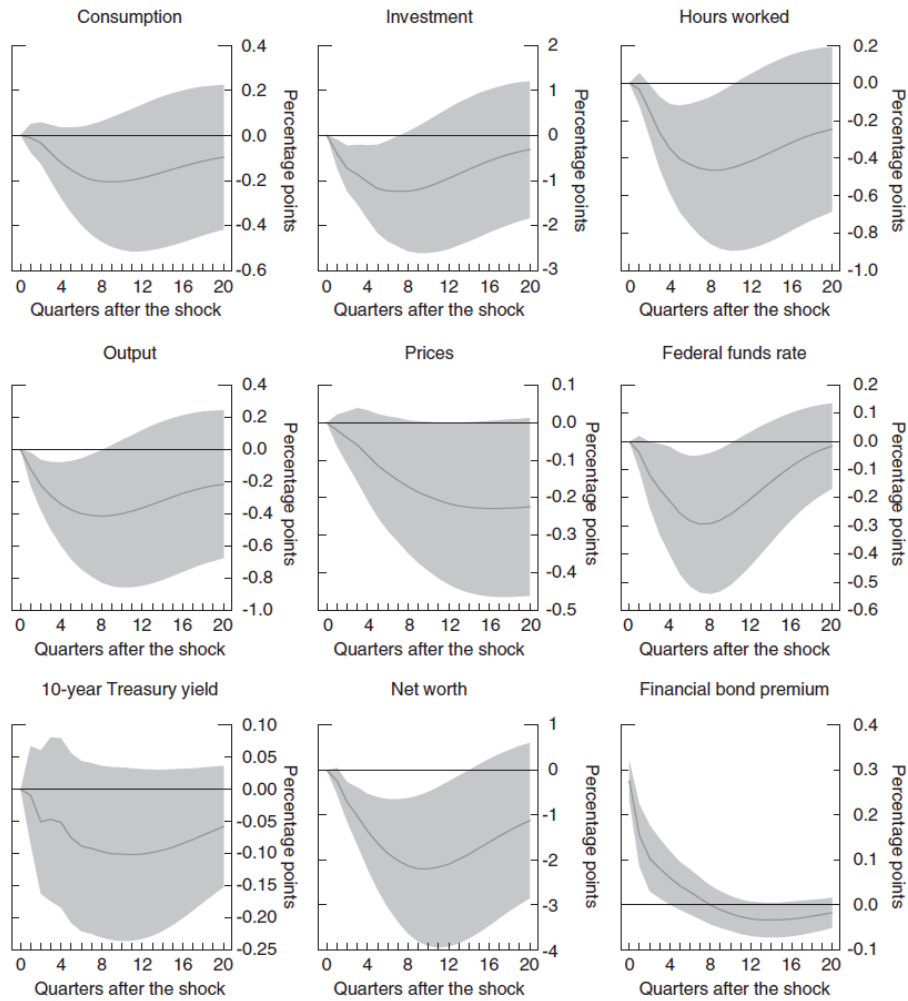
Note: The figure depicts the impulse response function of a nine variable VAR model to a one standard deviation orthogonalised shock to the financial bond premium over the period Q1 1985 to Q2 2010. Shaded bands denote 95% confidence intervals based on 1000 bootstrap replications.

Figure 8. Total assets and leverage

(leverage and asset growth move together for securities brokers and dealers)

A. Households

B. Non-financial non-farm corporations

C. Commercial banks

D. Securities brokers and dealers
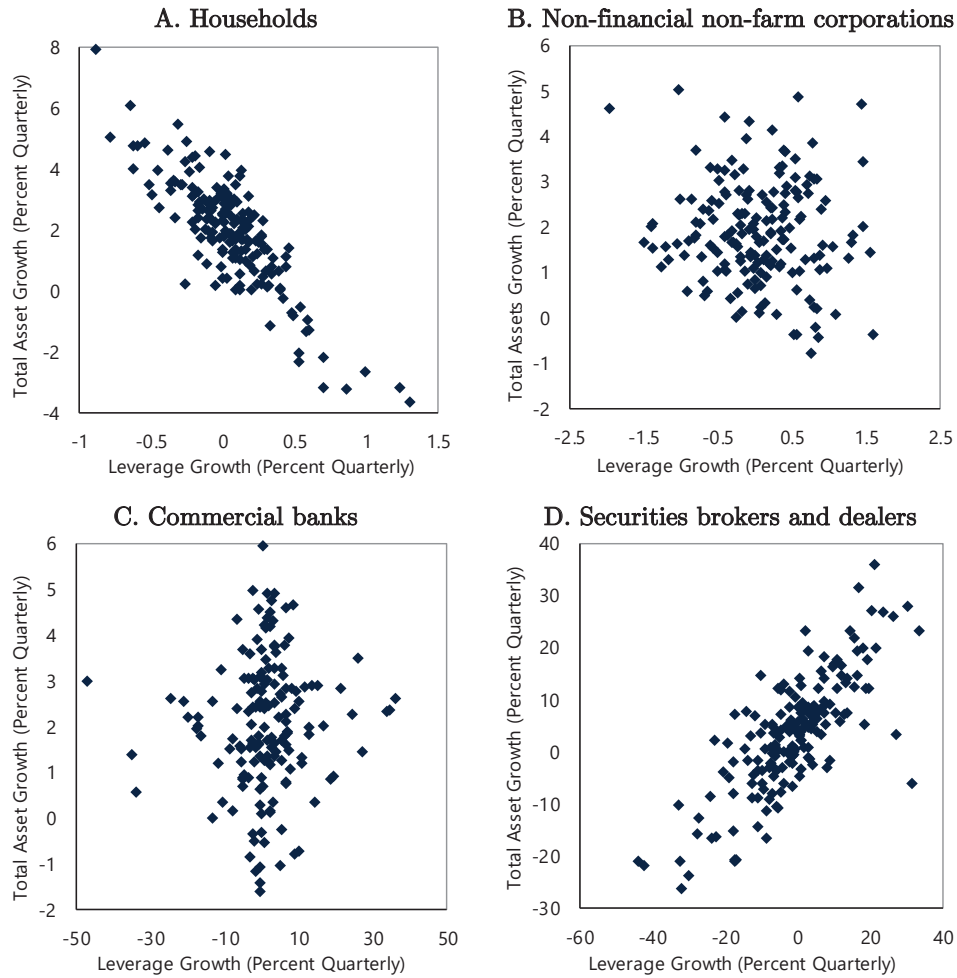
Source: Adrian and Shin (2008).
Note: Panel A plots the quarterly changes in total household assets to quarterly changes in household leverage as extracted from the US Financial Accounts (formerly called Flow of Funds). Panel B plots the change in leverage and change in total assets of non-financial, non-farm corporations drawn from the US Flow of Funds Accounts. Panel C plots the changes in leverage against the changes in the total assets of US commercial banks. Panel D plots the same for US securities brokers and dealers. The data are from 1963 to 2006.

Figure 9. Impulse responses to a risk appetite shock
(in percent)
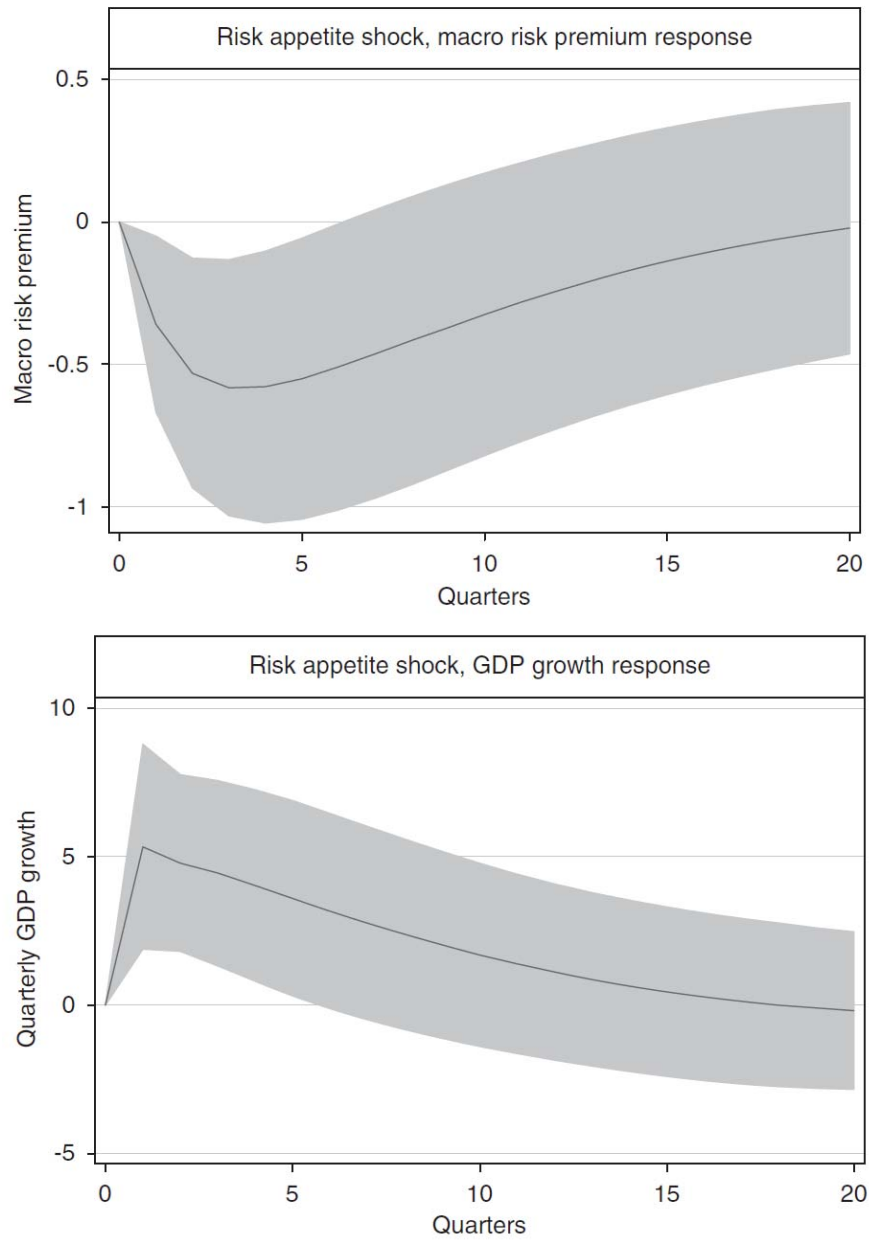
Source: Adrian et al (2010b).
Note: Stronger risk appetite leads to an expansion of intermediaries' balance sheets and a compression of credit spreads. The response of the macroeconomic risk premium peaks at four quarters and then subsequently reverts slowly towards zero. However, the significance of the risk appetite shock on the macroeconomic premium is fairly persistent and only becomes insignificant after about six quarters.

Figure 10. Monetary conditions and bank risk-taking
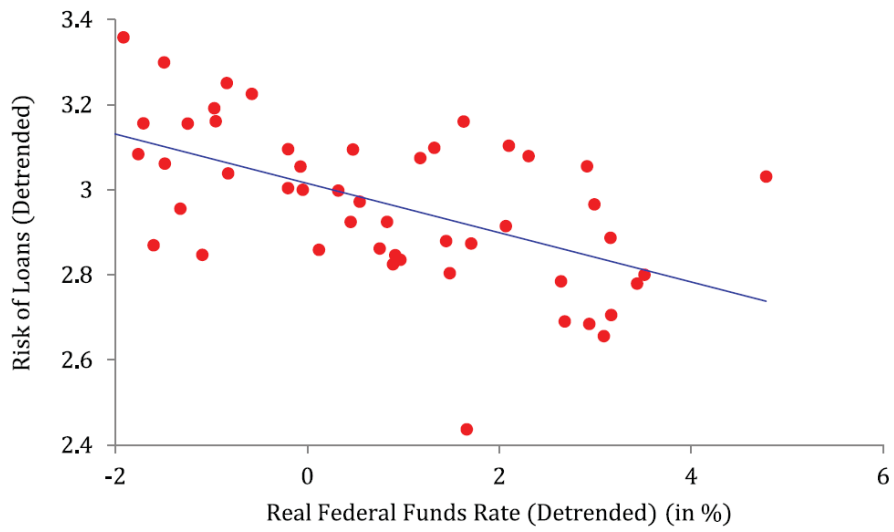
Source: Dell'Ariccia et al (2014).
Note: Simple OLS regression of a risk measure of bank lending and the real federal funds rate for all banks. The dependent variable is the risk of bank loans, which is based on an index ranging from 1 to 5. The measure is based on quarterly data over the period Q2 1997 to Q3 2009 and is taken from the Federal Reserve's Survey of Terms of Business Lending.

Figure 11. Recessions and recoveries: duration, amplitude and cumulative loss

Duration
(in quarters)

Amplitude
(in percent)

Cumulative loss from recessions
(in percent)
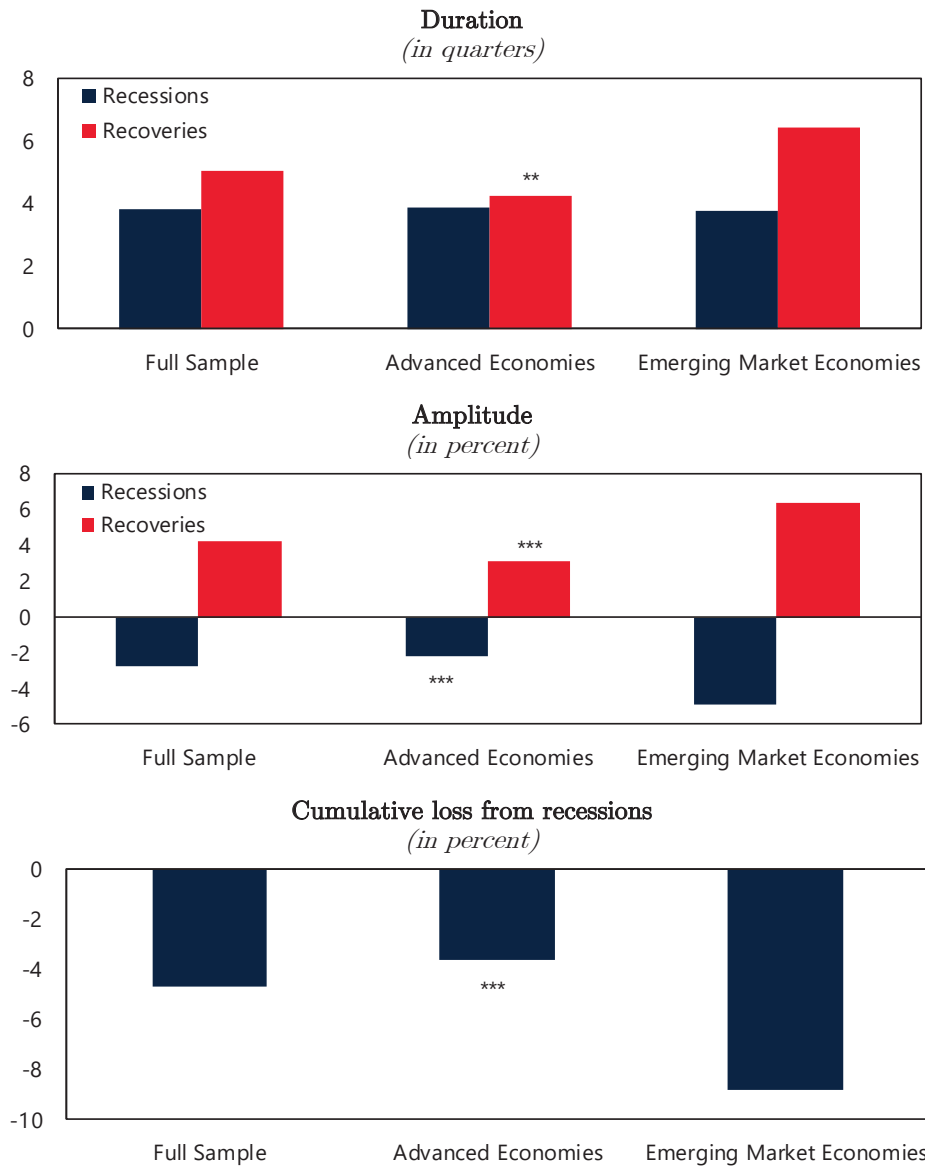
Source: Claessens et al (2012a).

Note: All the statistics except for those relating to duration correspond to sample medians. For duration, the means are shown. The duration of a recession is the number of quarters that have elapsed between the peak and the trough. The duration of a recovery is the time taken to attain the level of output reached at the previous peak. The amplitude of a recession is the decline in output from peak to trough. The amplitude of a recovery is the one-year change in output after the trough. The cumulative loss combines information about the duration and the amplitude to measure the overall cost of a recession. ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively. Significance refers to the difference between advanced economies and EMEs.

Figure 12. Synchronisation of recessions
(in percent)
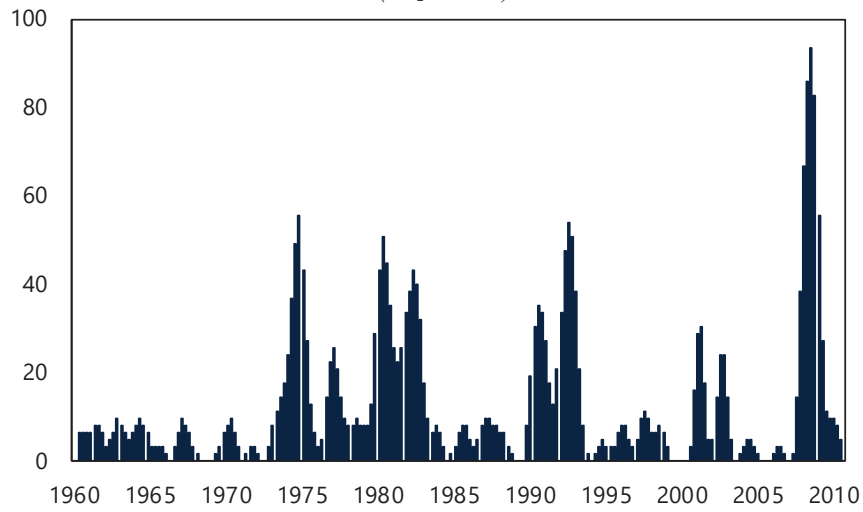
Source: Claessens et al (2012a).
Note: The share of countries experiencing a recession is presented. The figure includes completed as well as ongoing episodes. The sample contains quarterly data for 21 advanced economies over the period Q2 1960 to Q4 2010.

Figure 13. Financial downturns: duration, amplitude and slope

Duration
(in quarters)

Amplitude
(in percent)
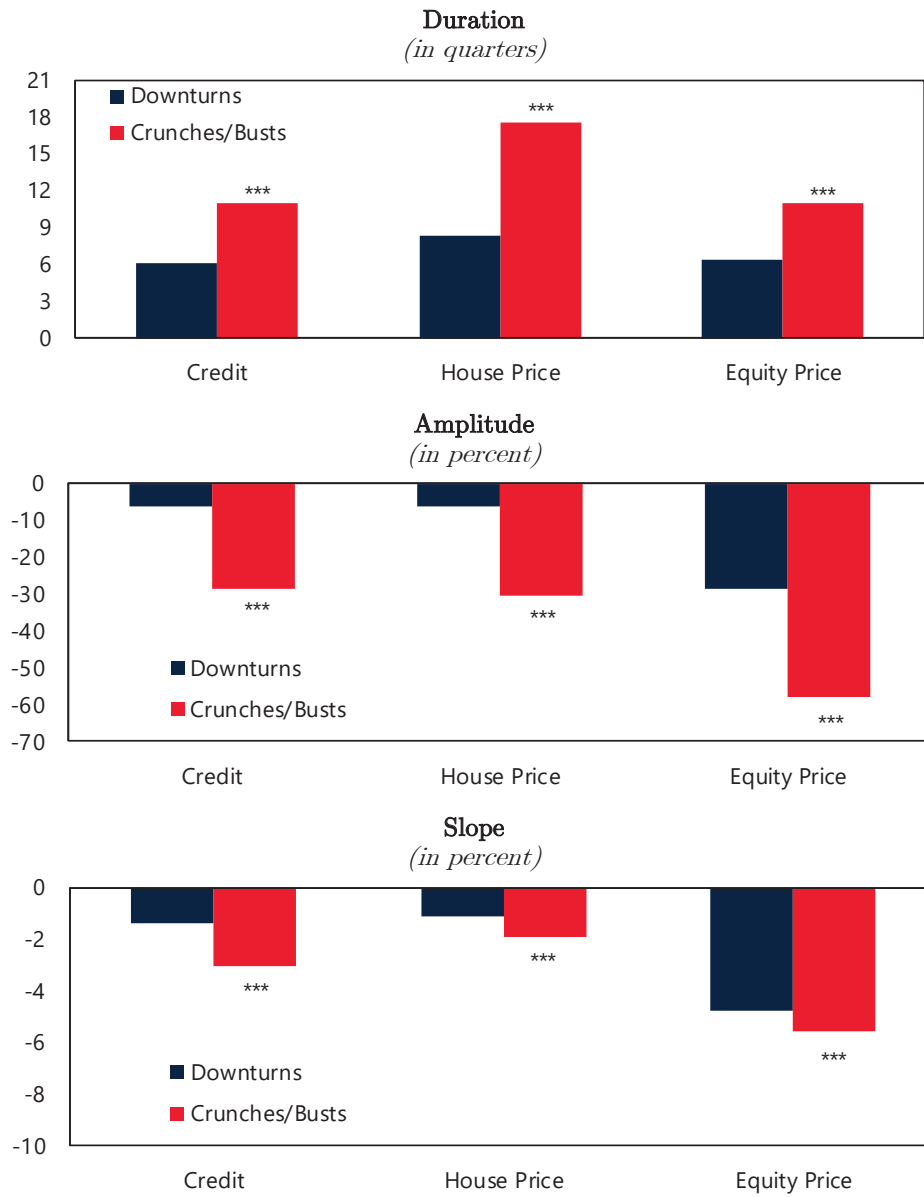
Slope
(in percent)

Source: Claessens et al (2012a).

Note: the amplitude and slope statistics correspond to sample medians. For duration, the means are shown. Duration is the number of quarters between peak and trough. Amplitude is based on the decline in each variable during the downturn. Slope is the amplitude divided by the duration. Busts (crunches) are the worst 25% of downturns calculated by the amplitude. ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively. Significance refers to the difference between busts (crunches) and other financial downturns.

Figure 14. Financial upturns: duration, amplitude and slope

Duration
(in quarters)

Amplitude
(in percent)
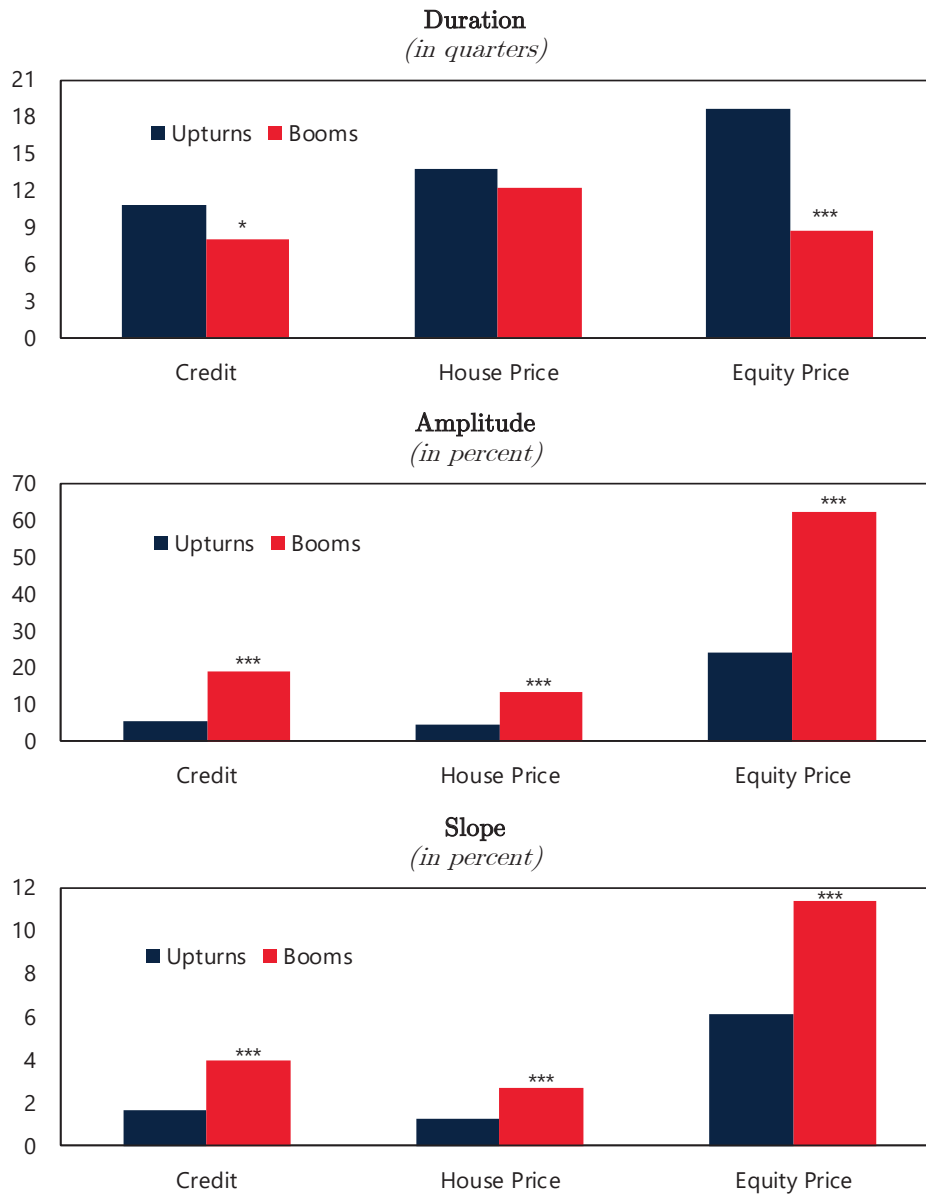
Slope
(in percent)

Source: Claessens et al (2012a).

Note: The amplitude and slope correspond to sample medians. For duration, the means are shown. Duration is the time it takes to attain the level of the previous peak. Amplitude is the change in one year after the trough of each variable. Slope is the amplitude from the trough to the period where the financial variable reaches its last peak, divided by duration. Booms are the top 25% of upturns calculated by the amplitude. ***, ** and * imply significance at the 1%, 5%, and 10% levels, respectively. Significance refers to the difference between financial booms and other financial upturns.

Figure 15. Recessions with financial disruptions: duration, amplitude and cumulative loss

Duration
(in quarters)

Credit Crunches — House Price Busts — Equity Price Busts

Legend: ■ Recessions associated with   ■ Recessions associated without

Amplitude
(in percent)

Credit Crunches — House Price Busts — Equity Price Busts

Legend: ■ Recessions associated with   ■ Recessions associated without

Cumulative loss
(in percent)

Credit Crunches — House Price Busts — Equity Price Busts

Legend: ■ Recessions associated with   ■ Recessions associated without

Source: Claessens et al (2012a).
Note: The amplitude and cumulative loss statistics correspond to sample medians. Duration corresponds to the sample mean. Disruptions are the worst 25% of downturns as represented by the amplitude. ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively. Significance refers to the 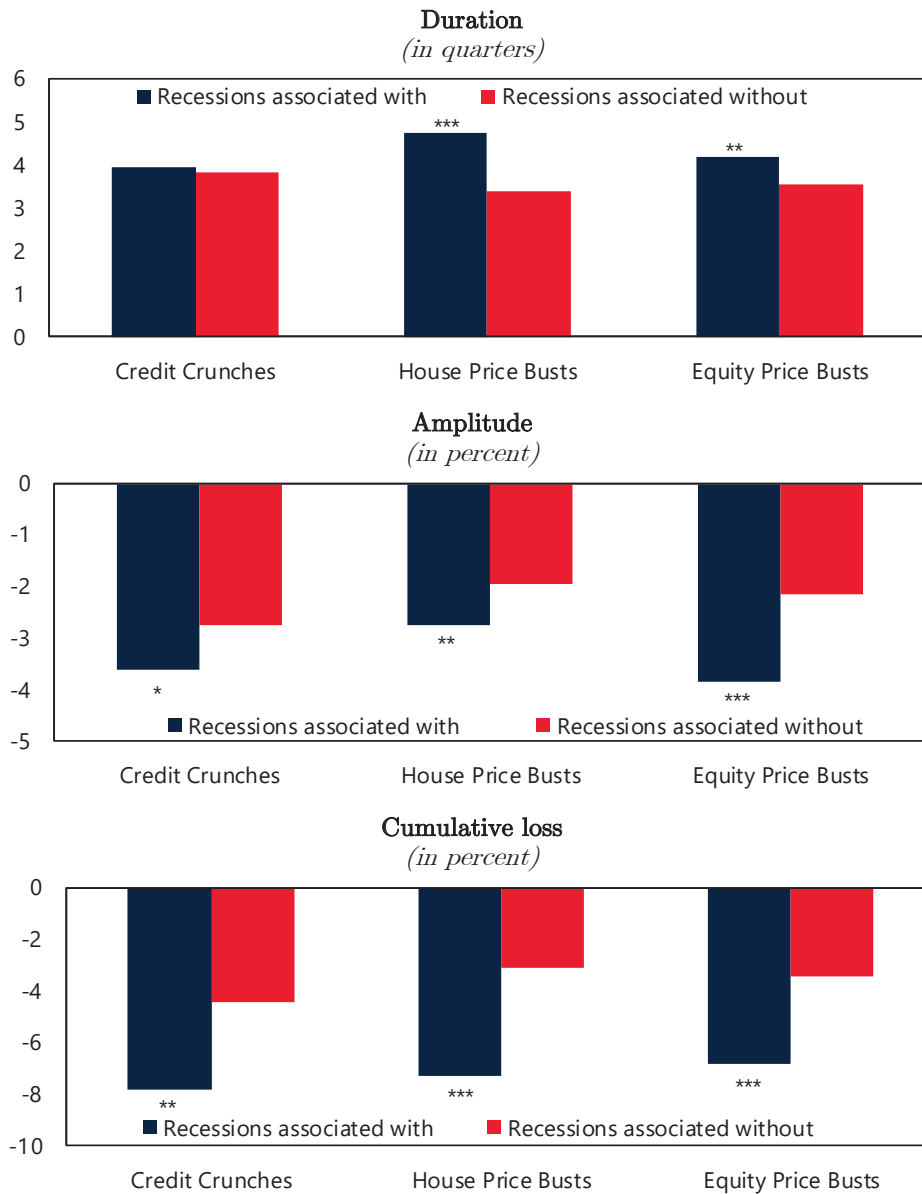difference between recessions with and without financial disruptions. For other definitions, see the notes to Figures 13 and 14.

Figure 16. Recoveries with financial booms:
duration, amplitude and slope

Duration
(in quarters)

■ Recoveries associated with　■ Recoveries associated without

Credit Booms　House Price Booms　Equity Price Booms

Amplitude
(in percent)

■ Recoveries associated with
■ Recoveries associated without

Credit Booms　House Price Booms　Equity Price Booms

Slope
(in percent)

■ Recoveries associated with
■ Recoveries associated without

Credit Booms　House Price Booms　Equity Price Booms
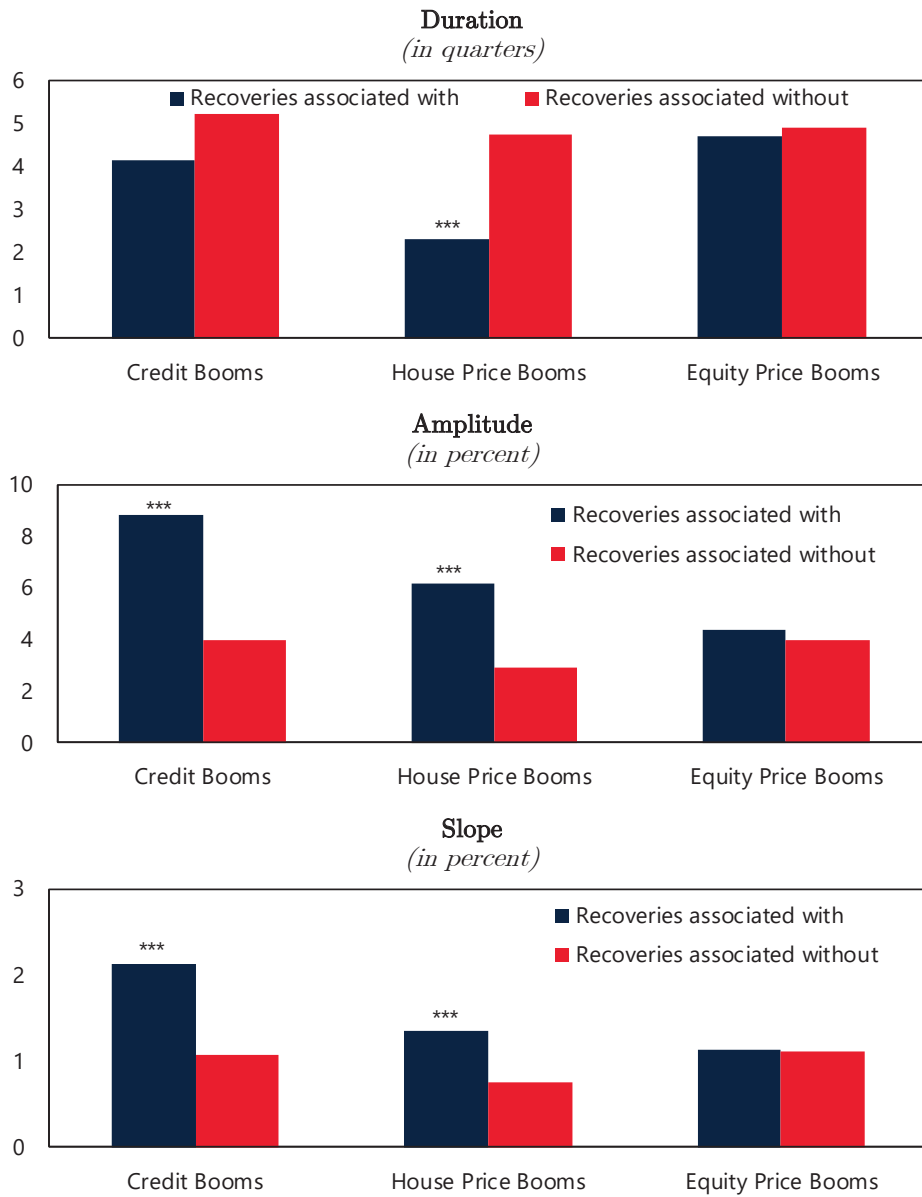
Source: Claessens et al (2012a).
Note: The amplitude and slope correspond to the sample medians. Duration corresponds to the sample means. Booms are the highest 25% of upturns by amplitude. ***, ** and * imply significance at the 1%, 5% and 10% levels, respectively. Significance refers to the difference between recoveries with and without booms. For other definitions, see the notes to Figures 13 and 14.

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