

# Would macroprudential regulation have prevented the last crisis?

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**Abstract:** How well equipped are today's macroprudential regimes to deal with a re-run of the factors that led to the global financial crisis? We argue that a large proportion of the fall in U.S. GDP associated with the crisis can be explained by two factors: the fragility of financial sector—represented by the increase in leverage and reliance on short-term funding at non-bank financial intermediaries—and the build-up in indebtedness in the household sector. We describe and calibrate the policy interventions a macroprudential regulator would wish to make to address these vulnerabilities. And we compare and contrast how well placed two prominent macroprudential regulators—the U.S. Financial Stability Oversight Council and the U.K.'s Financial Policy Committee—are to implement these policy actions.

**JEL classification:** G01; G21; G23; G28.

**Keywords:** Financial crises; Macroprudential policy; Leverage; Short-term wholesale funding; Credit crunch; Household debt; Aggregate demand externality; Countercyclical capital buffer; Loan to value ratio; Loan to income ratio.

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## 1. Introduction

In March 2009, in the depths of the Global Financial Crisis, Ben Bernanke recounted problems with the existing regulatory framework in the United States and suggested how some defects could be remedied. One key proposal was to “consider whether the creation of an authority specifically charged with monitoring and addressing systemic risks would help protect the system from financial crises like the one we are currently experiencing”, (Bernanke (2009)).

The idea that the financial system needed to be regulated was not new. However, up to the crisis most regulation was ‘micro-prudential’: it focused on the safety and soundness of individual banks, other financial institutions or specific markets. The role of a ‘macroprudential’ authority differs in both its *field of vision* and its *objectives* (Borio (2003), Hanson, Kashyap and Stein (2011)). Its field of vision is financial system-wide: layering concerns over potential amplification mechanisms and spillovers onto an assessment of individual safety and soundness. Its objectives are macroeconomic: it is tasked with ensuring the financial system as a whole can continue to support the real economy in a tail event, absorbing rather than amplifying shocks. Taken together, that gives macroprudential regulation a broad scope, potentially encompassing the resilience of lenders and borrowers alike.

Given the success of the last big innovation in central banking—inflation-targeting—the working assumption was that the creation of macroprudential frameworks with the right objectives, incentives and policy tools would make financial stability an attainable goal. Governments across the world hence began setting up financial stability committees: such committees now exist in over 40 countries (Edge and Liang (2017)). This paper asks whether the macroprudential institutions as they have been designed over the past decade could prevent—or materially dampen—a re-run of the last crisis.

Gauging the necessary macroprudential policy interventions requires an account of the factors that made the last crisis as severe as it was. Our diagnosis centres on two overlapping, but independent vulnerabilities: the increase in leverage and short-term funding at non-bank financial intermediaries, and the build-up in indebtedness in the household sector. We describe and calibrate the policy interventions required to address

these vulnerabilities. And we compare and contrast how well equipped two prominent macroprudential regulators—the U.S. Financial Stability Oversight Council (FSOC) and the U.K.’s Financial Policy Committee (FPC)—are to implement these policy actions.

In approaching this question, we assume the resilience of the financial system is as it was during the pre-crisis era. That is, we assume that Basel 3 and the associated reforms—to capital, liquidity, resolution, clearing, governance etc.—are not in place. At first blush, this might seem to stack the odds unfavourably against answering our essay question positively—after all, higher static bank capital requirements have been the authorities’ centrepiece response to ensuring the system is resilient to future shocks. With a more resilient banking system, so the argument goes, macroprudential regimes need to do less heavy-lifting, reducing the need for a powerful institutional framework.

In response, we invite the reader to interpret our thought-experiment as exploring how today’s macroprudential regimes might respond if a similar resilience ‘gap’ were to open up again in future. How well equipped are they to tackle such a gap? Do they have the analytical framework, the tools and the mandate to make a difference? Given that future threats to financial stability may well come from sources different to those of the last crisis, the test we pose is not very tough. Today’s macroprudential frameworks have been formed having seen the scenario we are revisiting, whereas the challenges facing macroprudential regulators in future will likely be new.

To preview our conclusions, we find that the U.S. FSOC would likely make little difference were we to experience a re-run of the factors that caused the last crisis. It has no macroprudential levers under its direct control, and not all its members have mandates to protect financial stability. A macroprudential regulator modelled on the U.K.’s FPC stands a better chance. It has the necessary mandate and powers. But spotting the extent of the build-up in vulnerabilities would be challenging. And given the role played by loosely-regulated non-bank financial institutions prior to the crisis, to be successful, an FPC-type regime would require political backing to widen the perimeter of regulation to capture such institutions. More generally, such a regulator would have to be fairly aggressive in using its powers—given the novelty of these powers, we have some doubts over whether such forceful interventions would have been feasible.

The paper is structured as follows. Section 2 identifies the key fault lines that arose prior to the crisis, fault lines that a successful macroprudential regulator would have to address. Section 3 asks what macroprudential interventions would be necessary to address these fault lines to make the crisis less severe. Section 4 considers whether existing macroprudential authorities are equipped to take the necessary steps. Finally, our conclusion distills the key challenges for successful macroprudential regulation that emerge from this counterfactual exercise and suggests priorities for future framework development.

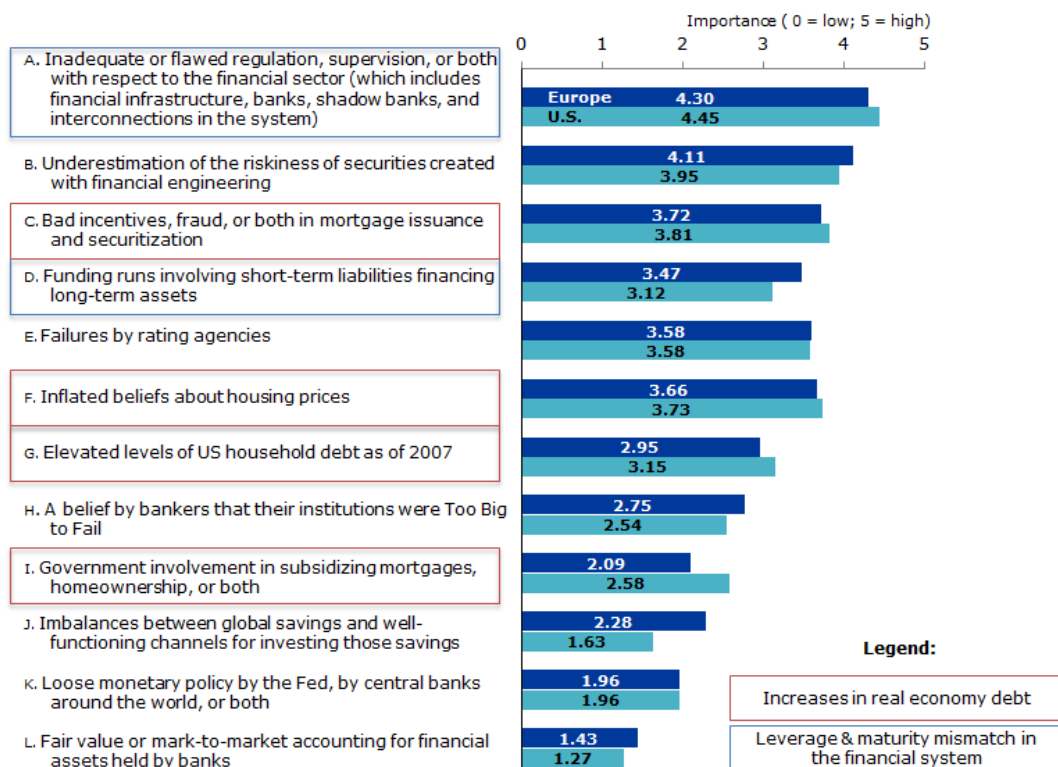
## **2. Fault-lines that led to the 2008 financial crisis**

Ten years on from the crisis, economists continue to debate and dispute its cause. Figure 1 provides a snapshot of the debate: it reports results from a survey of leading academic economists on the underlying factors that led to the crisis. Experts do not pretend that there was a single cause.

We argue that two broad factors were crucial to understanding why the crisis was so severe. The first concerns the fragilities in the financial system associated with excessive leverage and use of flighty short-term funding. The second is the unprecedented (by U.S. standards) lending boom to the household sector that began in the mid-2000s. We have boxed the individual causes listed in Figure 1 that fall into these two broad categories.

Our thesis, which we develop in the remainder of this section, is that these factors amplified the initial losses that occurred when housing prices fell, leading to a credit crunch in the financial system and large-scale deleveraging by households. This created an adverse feedback loop in which the credit crunch weakened the economy, leading banks to curtail lending further. Similarly, households cut spending, weakening the economy further. Having established this account, we then ask what macroprudential policy could do about it.

**Figure 1: The 2008 financial crisis did not have a single cause**



Source: Chicago Booth Initiative on Global Markets (igmchicago.org). Survey of academic economists in the United States and Europe, conducted in 2017. Answers are weighted by respondents' stated confidence. On the European panel, 37 of 49 panelists responded. On the US panel, 37 of 42 panelists responded.

## 2.1 Fragilities in the financial system

Vulnerabilities in the financial system built significantly in the years leading up to the global financial crisis (Brunnermeier (2009), Acharya et al. (2009), Duffie (2018)); such vulnerabilities meant that even relatively small losses on financial institutions' mortgage exposures were sufficient to trigger stability concerns for the entire financial system that ultimately spilled into the real economy.

Table 1 documents the solvency, liquidity and funding positions of different classes of financial institutions at two points prior to the global financial crisis: end-2001, a period when the U.S. economy was recovering from the strains caused by the collapse of the dot-com bubble; and end-2007, the beginning of the financial crisis. The total assets of the institutions we capture here increased from \$13 trillion to \$22 trillion between these dates.

We draw two conclusions from the table. First, the use of debt finance (‘leverage’) varied significantly across institutions. Broker-dealers (i.e., specialised investment banks, and the investment banking subsidiaries of larger banking groups) and government-sponsored agencies (GSEs) employed substantially more leverage than commercial banks and saving institutions. While the leverage of most institutions was stable or even fell in the years leading up to the crisis, it increased materially at broker-dealers. The assets of broker-dealers increased from 28 to 45 times their equity between 2001 and 2007, meaning that a roughly 2% decline in the value of their assets would have been sufficient to wipe out broker-dealers’ equity in its entirety.

**Table 1: Size and structure of the leveraged financial system**

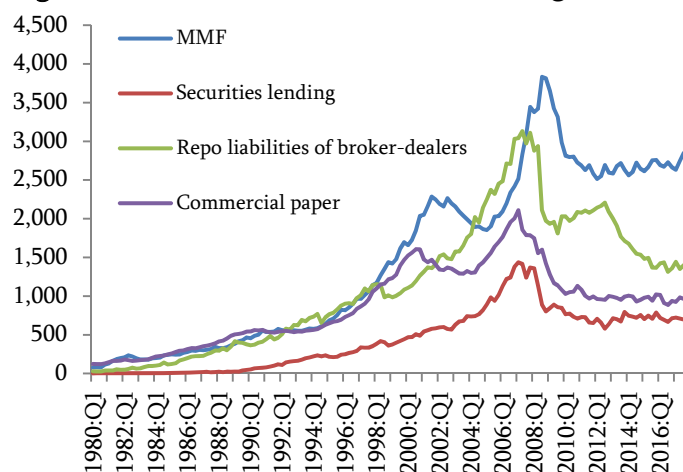
Size, leverage, and liquidity risk of leveraged financial institutions								
	2001Q4				2007Q4			
	Assets (\$bn)	Leverage	Liquid assets	Short-term funding	Assets (\$bn)	Leverage	Liquid assets	Short-term funding
Commercial banks	6,552	11.0	6.6%	26.5%	11,182	9.8	4.6%	33.2%
<i>of which: large institutions</i>	2,291	12.2	6.7%	32.9%	5,422	11.8	4.6%	37.5%
Savings Inst.	1,317	11.6	3.0%	18.2%	1,852	9.1	2.3%	22.6%
Credit Unions	456				699			
Brokers	2,376	28	2.4%	57.3%	4,686	45	0.4%	63.4%
GSEs	1,417	42.3	0.2%		1,677	23.7	0.7%	
Hedge funds (AUM)	539				1,868			
<b>Total</b>	<b>12,657</b>				<b>21,964</b>			

*Notes:* “Leverage” is defined as total assets divided by (book) equity. “Liquid assets” refers to the ratio of cash and Treasury securities to total assets. For brokers, “short-term funding” refers to repo funding relative to total assets. For deposit-takers, it refers to (estimated) uninsured domestic deposits and foreign deposits relative to total assets. While deposits are typically short-term liabilities many types of deposits, including insured deposits in particular, are ‘behaviourally stable’ and were not withdrawn during the crisis (see Martin et al. (2018)). *Sources:* Financial Accounts of the U.S., Call Reports, FDIC, Adrian et al. (2017a), Annual Reports of Fannie Mae and Freddie Mac, HFR Industry Reports (see Annex).

Second, in addition to their increasing leverage, broker-dealers were traditionally highly reliant on short-term wholesale funding.<sup>1</sup> Much of this funding was collateralised and took the form of repurchase agreements ('repos'). The repo liabilities of broker-dealers increased from \$1.4 trillion in 2001 to \$3.0 trillion in 2007.<sup>2</sup> Moreover, an increasing fraction of repos was backed by low quality collateral. For instance, in the most reliably measured portion of the repo market, the so-called 'tri-party' repo market that is intermediated by large banks, repos backed by non-U.S. Treasury collateral increased by over 50% between 2004 and 2007, compared to 15% for repos backed by U.S. Treasury collateral.<sup>3</sup>

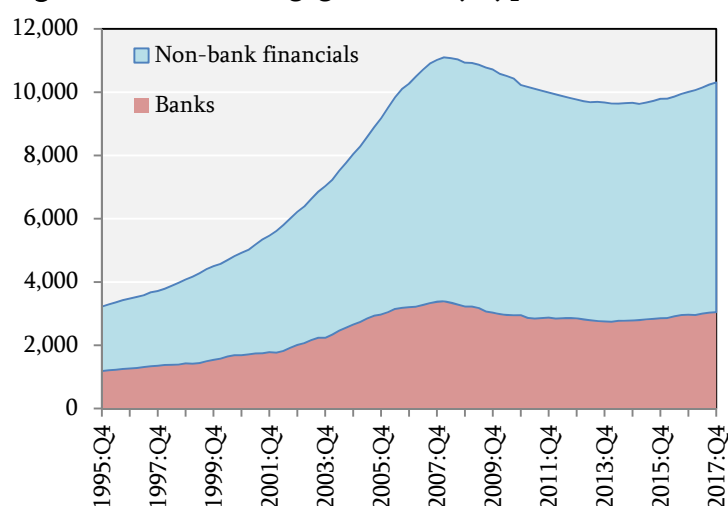
As Figure 2 illustrates, other forms of short-term funding also experienced rapid growth over this period. Commercial paper issuance (CP, another form of short-term debt) increased sharply, reflecting the increasing importance of structured investment vehicles (SIVs) that invested in long-term assets including mortgage-backed securities and funded these by issuing short-term asset-backed commercial paper (ABCP), a specific type of CP. By the end of 2006, ABCP accounted for almost 60% of all outstanding CP.

**Figure 2:** Reliance on short-term funding (\$bn)



Source: Financial Accounts of the U.S., based on Adrian et al. (2017)

**Figure 3:** Home mortgage credit by type of lender (\$bn)



Source: Financial Accounts of the U.S.. Non-bank financials includes life insurance companies, private pension funds, State and local govt. retirement funds, Government-sponsored enterprises, Agency- and GSE-backed mortgage pools, ABS issuers, Finance companies, and REITs.

<sup>1</sup> See Rosengren (2014) for evidence on the long-run trends in broker-dealers' size and their reliance on repo funding.

<sup>2</sup> Total repo liabilities for all types of institutions recorded in the Financial Accounts of the U.S. data for end-2001 and 2007 are \$2.2tn and \$4.8tn, respectively. None of these numbers were readily available in the run-up to the crisis, as broker-dealers repo liabilities were only reported on a netted basis (see Eichner et al. (2013) and Holmquist and Gallin (2014)).

<sup>3</sup> See SIFMA 2010 Repo Fact Sheet.

The growth in repos and CP coincided with an increase in the size of money market mutual funds (MMFs), which purchased much of the repos and CP issued. MMFs were allowed to invest in assets with a weighted average maturity of up to 90 days, but offered investors the ability to withdraw their money at a day's notice at a fixed value of \$1.00 per share. Moreover, MMFs did not have any capital that would shield these short-term investors from losses. The resulting fragility was exacerbated by other structural weaknesses in the design of MMFs, which, in a crisis, meant investors who withdrew their funds first were fully paid while later claims might not be, providing incentives to 'run' on the fund.

The growth in the repo market was accompanied by a similar increase in securities lending—the process via which insurance companies and other institutional investors lend securities to other investors for a fee, allowing investors to take short positions. Insurance companies such as American International Group (AIG) invested the cash proceeds from their securities lending operations in longer-term, illiquid assets (Adrian et al. (2014)), exposing themselves to considerable liquidity risk. On the day of Lehman's bankruptcy alone, as it was facing a ratings downgrade of its own, AIG had to return \$5.2bn of cash as counterparties refused to roll over securities lending deals (AIG, 2008, p. 4) and required government assistance the next day.

There were also less visible sources of liquidity risk. For example, both commercial and investment banks had provided extensive lines of credit to corporate borrowers. In the crisis, borrowers feared that these credit lines might not be renewed, prompting some to draw on them pre-emptively. Ivashina and Scharfstein (2010) identify media reports on prominent draw-downs totalling \$27bn. Aggregate statistics suggest that, in 2008 alone, above-average drawdowns on syndicated loan commitments may have accounted for \$119bn of additional credit that banks were forced to extend. Investment banks had also provided liquidity insurance to SIVs and similar types of conduits. As part of this insurance, investment banks had promised to step in to provide backstop funding if firms could not place their CP. Due to similar guarantees, Citigroup alone was exposed to \$25bn of liquidity risk if one particular segment of the CP market was to dry up.<sup>4</sup>

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<sup>4</sup> See Financial Crisis Inquiry Commission (2011). The number refers to the amount of liquidity insurance that Citigroup had sold to a special kind of (SIV-like) "Collateralised Debt Obligation" (CDO) conduits that invested in a range of (already structured) long-term mortgage-backed securities, and issued a mix of commercial paper and long-term securities.



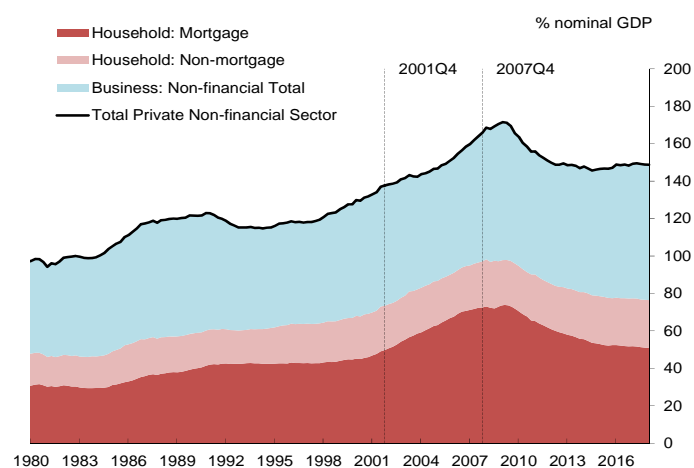
A defining characteristic of the period was that many of the vulnerabilities that built up occurred outside the traditional commercial banking system (i.e. insured deposit-taking institutions). At the same time, non-banks became an increasingly important source of credit for the real economy: between 2001 and 2007, non-bank financials accounted for over 70% of the total growth in home mortgage credit (Figure 3).

Collectively these observations suggest that the macroprudential regulator would have needed to have a way to change both the propensity to rely on debt financing and the maturity of the funding, for banks and non-banks.

## 2.2 The build-up in household debt

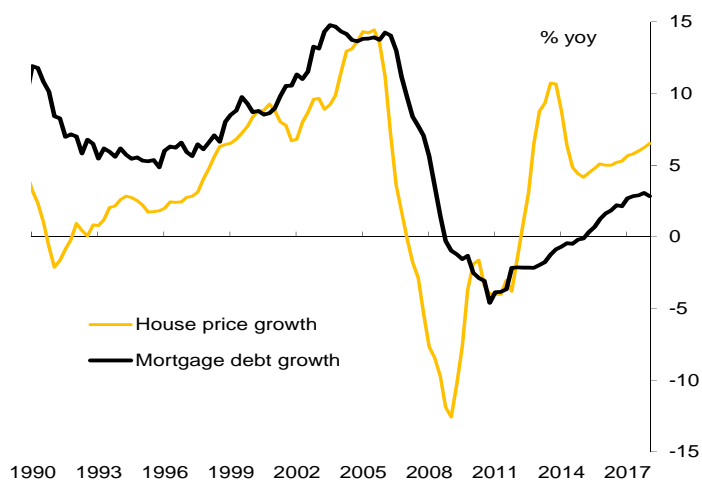
Alongside the pronounced build-up in leverage and maturity transformation in the financial system, there was a rapid build-up in debt in the real economy, concentrated in household mortgages. Mortgage debt doubled in the six years before the crisis, and by 2007 reached 72% of GDP (Figure 4).

**Figure 4:** U.S. private non-financial debt to GDP



Source: Debt data from Financial Accounts of the U.S., Table D.3.; GDP data from U.S. Bureau of Economic Analysis.

**Figure 5:** Mortgage debt and house prices



Source: Financial Accounts of the U.S. and S&P/Case-Shiller U.S. National Home Price Index

The increase in mortgage debt was accompanied by a house price boom (Figure 5). House prices rose by two-thirds in the five years to their peak in early 2006, more than twice as fast as household disposable income. Ongoing rapid house price appreciation was embedded in expectations (Gennaioli and Schleifer 2018). The aggregate loan-to-value

ratio on the stock of U.S. housing remained broadly flat during this period, meaning that for each 1% increase in house values, homeowners also increased their mortgage debt by around 1%.

This happened via two channels. First, existing homeowners extracted housing equity by taking out additional debt: commercial banks' home equity lines of credit (HELOCs) that allow households to take out additional loans secured against an existing property more than tripled from \$154bn in 2001 to \$486bn (3.3% of GDP) by 2007, and total cash-out refinancing<sup>5</sup> amounted to a cash flow injection for households of \$135bn a year (Brown et al. (2013)). Mian and Sufi (2011) estimate that existing home owners borrowed \$0.25 on average for every \$1 increase in home-equity value during the housing boom, enough to account for over half of the increase in debt for home owners between 2002 and 2006. Second, new homeowners took out larger mortgages in order to purchase more expensive homes.

Table 2 makes three important points about the nature of the debt build-up that will inform our subsequent macroprudential analysis. Panel A shows the magnitudes of the overall increase in debt. Mortgage debt doubled between 2001Q4 and 2007Q4, while corporate debt grew broadly in line with GDP growth over the period.

Panel B shows that aggregate measures of debt sustainability worsened somewhat between 2004 and 2007. But the moves were not particularly alarming in the context of surging household debt. The proportion of income spent servicing mortgage debt (which includes both interest and principal repayments) rose from 6.0% in 2004 to 7.2%, while the broader financial obligation ratio (which includes other recurring obligations such as rent payments and auto lease payments) drifted up from 16.8% to 18.1%. Mortgages continued to perform—the overall delinquency rate remained low and stable until around late 2006.

Panel C reveals that there were, however, clear signs that lending standards were being loosened. Senior loan officers reported easing standards between 2004Q1 and 2006Q3.

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<sup>5</sup> Cash-out refinancing deals are economically similar to HELOCs. But rather than taking out an additional loan, households repay their existing mortgage and take out a new, bigger mortgage on the same property.

**Table 2: U.S. household debt and its characteristics**

PANEL A: Household Debt and House Price Boom 2001-2007					
	2001Q4	2004Q4	2007Q4	2017Q4	
Level of indebtedness: \$ trn; (% GDP in parenthesis) <sup>(a)</sup>					
Private non-financial sector debt	\$14.7 (137.6%)	\$18.4 (146.5%)	\$24.4 (165.8%)	\$29.4 (148.8%)	
of which: PNFC	\$6.9 (64.2%)	\$7.6 (60.1%)	\$10.1 (68.8%)	\$14.3 (72.2%)	
of which: Household	\$7.9 (73.4%)	\$10.9 (86.4%)	\$14.3 (97.1%)	\$15.1 (76.6%)	
of which: Non-Mortgage	\$2.5 (23.7%)	\$3 (23.9%)	\$3.6 (24.6%)	\$5.1 (25.6%)	
of which: Mortgage	\$5.3 (49.7%)	\$7.9 (62.5%)	\$10.6 (72.4%)	\$10.1 (51%)	
of which: HELOC <sup>†</sup>	\$0.2 (1.4%)	\$0.4 (3.2%)	\$0.5 (3.3%)	\$0.4 (1.9%)	
House prices <sup>(b)</sup>					
Annual growth	6.7%	13.7%	-5.3%	6.2%	
Cumulative growth since 2000Q1	14%	56%	70.7%	93.5%	
Loan to value ratio (Mortgage debt / Housing assets) <sup>(a)</sup>					
Household sector	35.8%	37.6%	45.7%	36.1%	
PANEL B: Aggregate Debt serviceability and Delinquency					
	2001Q4	2004Q4	2006Q4	2007Q4	2017Q4
Debt serviceability <sup>(c)</sup>					
Total Household DSR	12.6%	12.2%	12.9%	13.2%	10.3%
of which mortgage	5.9%	6%	6.9%	7.2%	4.4%
Financial Obligation Ratio*	17.7%	16.8%	17.6%	18.1%	15.9%
Delinquency <sup>(d)</sup> (>90 days delinquent (%))					
Household total	-	2.3%	2.3%	3.6%	3.1%
Mortgages	-	1.1%	1.3%	2.9%	1.3%
PANEL C The heavily-indebted tail and marginal borrowers					
	2001Q4	2004Q4	2006Q4	2007Q4	2017Q4
Credit quality <sup>(d)</sup> : (Mortgage credit score at origination):					
Median	724	715	707	726	755
10th Percentile	594	588	578	597	645
Senior Loan Officer Opinion Survey <sup>(e)</sup> :	2.9	-3.4	-4.2	-	-
Heavily-indebted tail: <sup>(f)</sup>	2001	2004	-	2007	2016
LTV > 90%	9.5%	9.4%	-	9.4%	10.6%
Debt to income >4x	6%	11%	-	13.2%	10.7%
DSR > 40%	16.9%	17.3%	-	20.2%	13.9%
Marginal borrowers: <sup>(g)</sup>	2003	2004	2005	2006	2007H1
Subprime					
Originations (# million)	1.1	1.7	1.9	1.4	0.2
Median combined LTV (%)	90%	95%	100%	100%	100%
Proportion on “teaser” rates (%)	68%	77%	81%	77%	68%
“Near-prime:” Alt-A pools					
Originations (# million)	0.3	0.7	1.1	0.9	0.3
Median combined LTV (%)	90%	90%	90%	95%	95%
Proportion interest only (%)	16%	37%	40%	44%	52%

*Sources:* (a) Financial accounts of the U.S. and U.S. Bureau of Economic Analysis <sup>†</sup>Revolving home equity loans, all commercial banks (b) S&P/Case-Shiller (c) Federal Reserve Board’s Household Debt Service and Financial Obligations Ratios release \*The Financial Obligation ratio gives the proportion of income spent servicing debt (including both interest and principal repayments) and also includes other recurring obligations such as rent payments and auto lease payments. (d) New York Fed Consumer Credit Panel/Equifax: Household Debt and Credit Report 2018Q1 (e) Federal Reserve Board’s Senior Loan Officer Opinion Survey on Bank Lending Practices (4-quarter average of net percentage of banks tightening standards for mortgage loans) (f) Survey of Consumer Finance and authors own calculations. Shares reported are based on the sub-sample of those surveyed that had some mortgage debt on their primary residence. (g) Mayer et al. (2009), Table 1 and 2.

The average credit score for newly-originated mortgages drifted down from 2001 onwards, as did the credit scores for borrowers at the bottom 10% of the distribution. Digging further into the borrowing patterns for particularly risky borrowers reveals that the share of the stock of mortgagors with debt of over four times their income more than doubled between 2001 and 2007 from 6% to 13%.<sup>6</sup> The share with debt service burdens over 40% of income also rose, albeit less strongly, held down by falling mortgage spreads.<sup>7</sup> The number of subprime originations nearly doubled between 2003 and 2005, 80% of which were made with short-term “teaser” rates (Mayer et al. (2009)). “Near-prime” mortgages also increased rapidly. The private label securitisation market was an important driver of these frothy credit supply conditions (Keys et al. (2010)).

In summary, the years running up to the Great Recession saw an unprecedented surge in U.S. household debt. That boom was accompanied and reinforced by soaring property prices. Aggressive credit supply expansion, compounded by financial innovation, provided the undercurrent for an unsustainable cycle. Household balance sheets became increasingly vulnerable to a shock as more credit was extended to highly indebted households.

### *2.3 The ‘feedback loop’: credit crunch, deleveraging and economic contraction*

We complete our narrative with an attempt to quantify the importance of the aforementioned factors in contributing to the economic contraction that began in 2007Q4. We estimate that there was an 8.5% shortfall in the level of GDP per capita by 2010Q4 relative to a simple extrapolation of long-run trend from 2007Q4.<sup>8</sup>

Our hypothesis is two-fold. First, the fragility of the financial system meant that the downturn in the housing market led to solvency and funding liquidity problems for intermediaries, making lenders unwilling or unable to make new loans. This resulted in a

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<sup>6</sup> Data on the heavily indebted tail of borrowers in Panel C of Table 2 are from the Survey of Consumer Finance (SCF). Shares reported are based on the sub-sample of those surveyed that had some mortgage debt on their primary residence.

<sup>7</sup> For evidence of reduced mortgage interest rates, see for example Chomsisengphet and Pennington-Cross (2007).

<sup>8</sup> This extrapolation uses the 20-year average growth rate for GDP per capita between 1988 and 2007 which was 2% (the 10-year trend is the same). This simple extrapolation does not take into account the unwinding of any initial output gap in 2007. But the output gap estimated by the Congressional Budget Office at end-2007 was small (only +0.3pp) and so would not materially affect the large shortfall by end-2010. As a cross-check, an extrapolation of the 10 or 20 year trend starting from 2003 would have actually suggested a *negative* output gap in 2007.

‘credit crunch’ in the real economy, which in turn had an adverse effect on real activity. Second, heavily-indebted households de-levered by sharply reducing their non-housing consumption when house prices fell. This resulted in an aggregate demand externality, whereby a sharp contraction in spending led to a spiral of job losses and further spending cuts, as the economy struggled to reallocate resources.

We analyse estimates of the effects of the credit crunch and the household deleveraging channels separately, though these effects are obviously intertwined and confidence intervals for the magnitudes of each are wide. Our best estimates suggest that, taken together, they can account for around two-thirds to three-quarters of the contraction in output that occurred. That is, absent the credit crunch and the deleveraging by households, the cumulative fall in GDP growth during the recession would have been two-thirds to three-quarters smaller. The precise impact is not material to our argument and even if one worries that there could be some double counting, that is not critical. Rather, our claim is that these channels had a substantial bearing on the costs of the crisis. And therefore in order to be successful, macroprudential policy would have had to address both vulnerabilities.

### **Estimates of the impact of the credit crunch**

Figure 6 illustrates the sharp and persistent decline in the growth of commercial bank lending to households and companies that began in the second half of 2009. There is compelling evidence that this contraction in credit initially reflected tightening supply conditions, which adversely affected real economic activity.<sup>9</sup>

We think that this credit crunch reflected both the high leverage of financial institutions going into the crisis, and their reliance on short-term funding. The high leverage meant that small write-downs were enough to trigger solvency concerns, and the reliance on short-term funding exposed them to the risk of a funding loss or the requirement to pay higher funding costs, which further stretched their ability to continue lending. We do not attempt to distinguish between these two drivers of the credit crunch as they are closely interlinked.

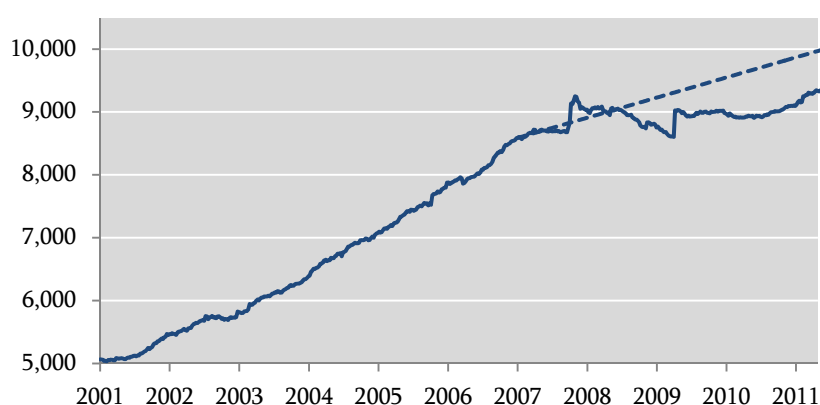
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<sup>9</sup> See inter alia Chodorow-Reich (2014), Almeida et al. (2009), Duygan-Bump et al. (2015), Iyer et al. (2013) and Ivashina and Scharfstein (2010).

In general, attempts to quantify the effect of the credit crunch on economic output face a trade-off between achieving a clean separation of demand versus supply factors and capturing the many channels through which it could operate. In the spirit of robustness, we take an eclectic approach here and draw from a range of studies that locate themselves at different points on this trade-off. Table 3 summarises the approaches we consider.

One of the most influential empirical papers on the credit crunch is Chodorow-Reich (2014). This study finds that the credit crunch can account for a 3% decline in the level of employment by small and medium-sized companies—amounting to slightly less than a third of the overall fall in employment in the year following the Lehman bankruptcy. This is best viewed as a tightly-estimated lower bound for the real economy impact of the credit crunch—it does not account for any effect there may have been on larger firms (which were also required to reduce their borrowing); nor does it account for effects resulting from the tightening in shadow bank credit, e.g. firms’ reduced ability to obtain funding by issuing commercial paper to MMFs.

**Figure 6:** Credit provided by US commercial banks in \$bn



*Source:* Financial Accounts of the U.S.. Pre-crisis trend (dashed line) is based on the average annual increase in nominal bank credit between 1987 and 2007. Assuming a linear trend rather than a constant growth rate is a conservative assumption and may understate the growth in credit if lending had continued along its pre-crisis trend.

Other approaches provide us with more direct estimates of the wider macroeconomic effects of the credit crunch, but with less clean identification. One is by Greenlaw et al. (2008), which assumes that financial intermediaries have simple leverage targets that they attempt to restore following losses that deplete their equity capital. Because banks and

shadow banks are so highly levered, the required contraction in their balance sheets is a multiple of the initial losses incurred. The resulting fall in bank lending is translated, using a simple regression, into a corresponding spending decline.

**Table 3:** Summary of approaches for estimating macroeconomic effect of credit crunch

Study	Impact on	Absolute effect	Notes
<b>Chodorow-Reich (2014)</b>	Employment	2.4% - 3.3% decline in SME employment	Micro study that looks at the impact of banks' financial difficulties on small and mid-sized firms that rely on credit from that bank.
<b>Leverage targets (based on an Greenlaw et al. (2008))</b>	GDP	Fall in GDP by 2.9%	Calculates how much credit lenders need to withdraw in order to absorb losses while still meeting certain leverage targets. Covers banks and shadow banks.
<b>Bassett et al. (2014)</b>	GDP	Pronounced tightening in lending, leading to fall in GDP by 1.6-2.4%.	Uses an econometric model to study impact of tightening lending standards on GDP. Measure of tightening is based on response to SLOOS survey.
<b>Guerrieri et al. (2015)</b>	GDP	Fall in GDP by 1% - 3%	Based on 5 macroeconomic models with financial frictions. Range excludes highest and lowest estimates.
<b>Hall (2012)</b>	Employment	6 pp increase in 'comprehensive unemployment rate' <sup>10</sup>	Based on a macroeconomic model with financial frictions.

*Notes:* For details of the assumptions underlying our estimate of “Absolute Effects”, see **Annex**.

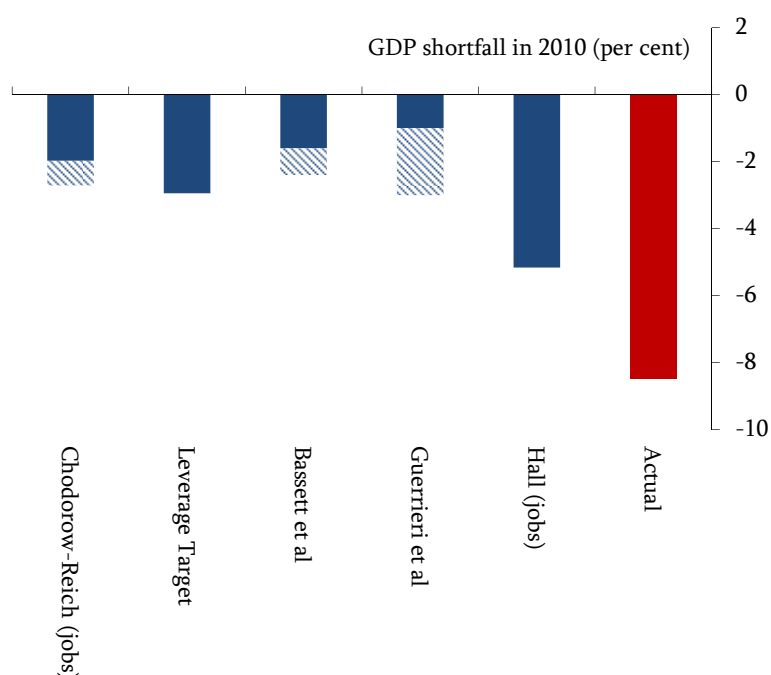
Updating this approach with what we now know about total mortgage-related losses during the crisis and using a conservative estimate of how financial institutions reacted to these losses,<sup>11</sup> this approach predicts a \$2 trillion reduction in credit supplied to the real

<sup>10</sup> The 'comprehensive unemployment rate' used in Hall (2012) includes changes in labour-force participation or hours worked per employee.

<sup>11</sup> Our estimate assumes that financial institutions keep their leverage target constant during the crisis, rather than reducing their leverage targets, which would generate further amplification of the shock to capital, as in Greenlaw et al. (2008).

economy.<sup>12</sup> We would expect this in turn to have reduced the level of GDP by 2.9%.<sup>13</sup> This is around one-third of the estimated 8.5% shortfall in the level of GDP by end-2010. The Greenlaw et al. (2008) approach is highly sensitive its specific assumptions. We therefore compare it to other available macroeconomic approaches. Bassett et al. (2014) find that a measure of credit supply disturbances based on responses to the Federal Reserve’s Senior Loan Officer Opinion Survey can account for 19-28% of the fall in GDP relative to its trend—like the Chodorow-Reich (2014) study, this estimate does not account for the tightening in credit conditions that occurred outside the banking system. Taking a very different approach, Guerrieri et al. (2015) and Hall (2012) survey the predictions from dynamic general equilibrium models with banking frictions. In response to bank capital shocks of the magnitude observed in the crisis, these models can account for 10-60 percent of the effects of the crisis.

**Figure 7:** Estimated impact of the credit crunch on US GDP in 2010



*Notes:* Solid bars depict minimum estimates, dashed bars depict maximum estimates. The results in Chodorow-Reich (2014) and Hall (2012) look at the impact of the credit crunch on employment. In order to map these estimates into GDP space and compare the results to the other studies we use a simple version of Okun’s law that suggests that a 2 percentage point fall in GDP growth relative to its trend maps across into a 1 percentage point increase in the unemployment rate (see eg Bernanke (2012)). For details of the assumptions see **Annex**.

<sup>12</sup> The predicted \$2tn reduction in total (bank and shadow-bank) credit to the real economy compares to a shortfall in lending by commercial banks to the real economy (relative to the conservative estimate of long-run trend growth in Figure 6) of \$0.6tn by the end of 2010. Given that in 2007, bank credit accounted for around one third of total credit to the private non-financial sector this is broadly in line with the prediction by the Greenlaw et al. approach.

<sup>13</sup> This calculation does not take into account any additional amplification that might have arisen from financial intermediaries’ liquidity problems. For instance, as previously-granted credit lines were drawn, the space for new loans would have been reduced further.

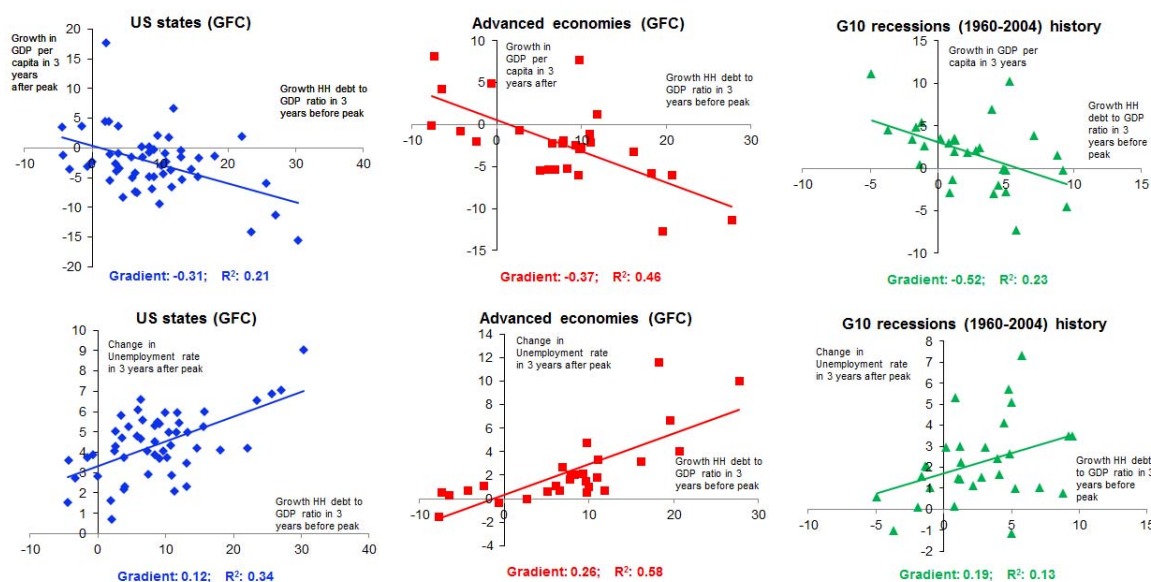


Figure 7 summarises what these various approaches tell us about the likely impact of the credit crunch. Taking the unweighted average across all of these studies, the credit crunch can explain around 35 percent of the decline in GDP.

### Estimates of the impact of the household deleveraging channel

Figure 8 illustrates the strong relationship that exists between household debt growth in the years preceding economic downturns and the severity of the subsequent downturn.<sup>14</sup> This reduced-form relationship is remarkably stable: it holds across U.S. states and advanced economies countries during the global financial crisis, and also for G10 countries over a longer sample period.

**Figure 8:** Household debt growth in the boom and the economic severity of the subsequent bust: across states, countries and time for GDP and unemployment



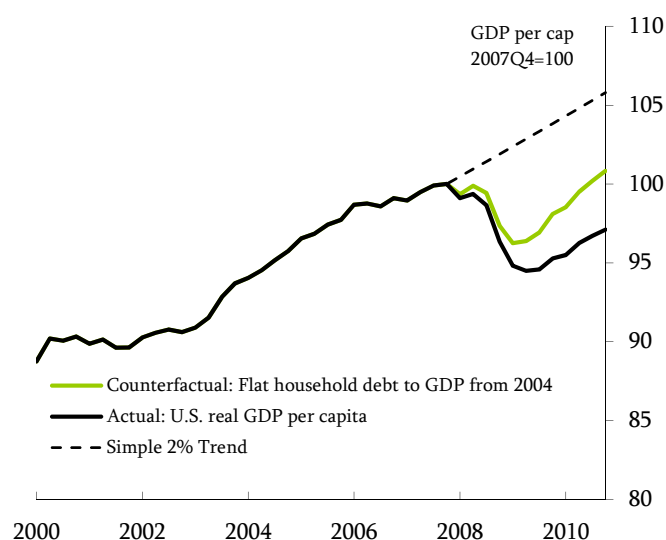
*Notes:* State level household debt statistics (left hand panel) from Federal Reserve Bank of New York; GDP data from Bureau of Economic Analysis (BEA); unemployment data from Bureau of Labour Statistics. Change in household debt to GDP ratio from 2004 to 2007 on x-axis, economic performance from 2007 to 2010 on y-axis. International data (middle and right panels) uses Bridges et al. (2017) dataset: household debt data from Bank of International Settlements “Long series on total credit and domestic bank credit to the private non-financial sector”; real GDP and unemployment data from the OECD, the Global Financial Database and national statistics websites. Middle panel shows experience across 27 advanced economies in the Global Financial Crisis, using same dates as U.S. state panel. Right hand panel is for recession episodes in G10 countries from 1960 to 2004 (i.e. Great Recession not included). A recession is defined as two consecutive quarters of negative real GDP growth, with at least eight quarters between consecutive peaks or troughs.

<sup>14</sup> See inter alia King (1994), Glick and Lansing (2010), Martin and Philippon (2017), Mian and Sufi (2010), and Mian et al. (2017) which document similar relationships.

What does this imply for the impact of household debt on the severity of the great recession? The regression line implies that each percentage point increase in the household debt to GDP ratio reduces GDP per capita by 0.3-0.5 per cent in a downturn. This suggests the 11.5 percentage point increase in U.S. household debt to GDP that occurred between 2004 and 2007 can explain between 3.5 - 5.8 percentage points of the decline in GDP. This is around half the GDP shortfall relative to trend.

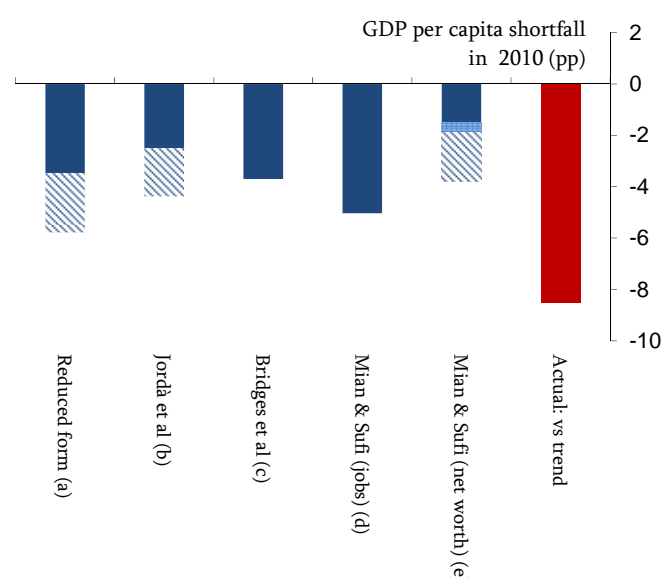
Jordà et al. (2013, 2016) refine this approach by controlling for a range of other macroeconomic factors and country-specific effects. Their estimates imply that around 40% of the GDP shortfall in the bust can be attributed to the build-up in household debt in the preceding years.<sup>15</sup> Bridges et al. (2017) find effects of comparable magnitude. Using their estimates, Figure 9 illustrates a counterfactual path for GDP per capita through the recession generated by holding household debt constant (relative to GDP) from 2004 onwards.<sup>16</sup> This corroborates the notion that household debt was a key driver of the severity of the recession.

**Figure 9:** Counterfactual path of US GDP per capita if household credit boom ended in 2004



*Notes:* Counterfactual assuming no increase in the household credit to GDP ratio from 2004-7. Suggests a 3.7pp stronger path for GDP per capita from 2007-10, accounting for around 45% of the fall relative to trend. Based on Bridges et al. (2017). The trend line of 2% is an extrapolation of the average annual growth rate of GDP per capita in the 20 years to 2007 – see footnote 8 for details.

**Figure 10:** Estimates of the impact of the household debt boom on the severity of the U.S. recession



*Notes:* Solid bars depict minimum estimates, dashed bars depict maximum estimates. (a)-(e) For details of the assumptions in Figure 10, see **Annex**.

<sup>15</sup> See **Annex** for details of the assumptions used in deriving this 40% estimate, presented in Figure 10.

<sup>16</sup> This experiment focusses on the recession path from 2007 – it does not consider the impact of weaker credit growth on the path of GDP per capita in the final phases of the credit boom.

Other papers in the literature attempt to disentangle this channel from effects attributable to the credit crunch, or other ways in which household debt may have affected economic output.<sup>17</sup> Mian and Sufi (2010) argue that the timing of the recession is suggestive of an important household-demand channel: U.S. counties that experienced a large increase in household leverage from 2002 to 2006 showed a sharp relative decline in durable consumption starting in the third quarter of 2006, before the first tremors of the liquidity crisis hit the financial system.<sup>18</sup>

Mian and Sufi (2012) document a significantly larger fall in non-tradeable sector employment from 2007 to 2009 within U.S. counties that had the highest household debt-to-income ratios in 2006. Extrapolating these differential effects to aggregate employment, the authors estimate that the decline in aggregate demand driven by household balance sheet shocks accounts for almost 4 million of the lost jobs from 2007 to 2009. Translating that into a GDP effect, using a simple Okun's law relationship can explain around 60% of the shortfall in activity in the downturn.<sup>19</sup>

Gertler and Gilchrist (2018) examine the relationship at state-level between house prices, mortgage debt and employment, along with a measure of banking distress. Their regression analysis attributes more of the explanatory power for the decline in employment to the banking distress variable than the mortgage debt measure. As they note, however, the reduced form nature of their analysis means that the total effects that they estimate are the result of a number of potential propagation mechanisms, so that one cannot completely separate the effects of a credit crunch from deleveraging.

As a further cross-check on the magnitude of the household deleveraging effect, we quantify the effect that avoiding the debt-driven increase in house prices would have had on the subsequent fall in prices (and households' reaction to this fall). Suppose that both the mortgage debt to GDP ratio and the average loan to value ratio on the housing stock had remained flat at their end-2003 levels. If we assume the trough in house prices in

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<sup>17</sup> For example, foreclosures of homes or cars might have had a negative impact on the productivity of the labour force. Similarly, the increase in household leverage may have led to a growth in the leverage of the financial sector, which ultimately contributed to the credit crunch.

<sup>18</sup> Brunnermeier (2009) provides an 'event logbook' for the unfolding crisis – it starts in February 2007 with an increase in subprime defaults, followed by UBS shutting down its internal hedge fund, Dillon Read on May 4, 2007.

<sup>19</sup> See **Annex** for details of the assumptions used in deriving this 60% estimate, presented in Figure 10.

2009 was unchanged, housing wealth would have had much less far to fall in our experiment.<sup>20</sup> The fall would have been just under \$3 trillion, less than a half of the \$6.5 trillion decline experienced in reality. Estimates of households' propensity to consume from housing wealth suggest that, with this smaller housing wealth shock, the fall in GDP would have been around 1.5 percentage points lower—explaining 17% of the deviation from pre-crisis trend.<sup>21</sup>

This estimate misses two amplifying channels that were likely to have been important for the overall macroeconomic consequences of household debt. First, in our scenario, fewer heavily-indebted households would have meant fewer foreclosures and, in turn, a less severe house price trough. Second, the initial reduction in spending driven by the housing market was likely subject to a significant “multiplier effect” during the recession, as weak demand begot further job losses and a downward spiral, as the economy struggled to reallocate resources. For example, in our scenario if we assume that foreclosures were halved and that the spending multiplier was two, then the feedback loop between falling house prices, housing wealth and consumption can explain around 45 percent of the subpar performance of GDP that followed the crisis.<sup>22</sup>

Figure 10 summarises the various estimates of the importance of the household debt channel surveyed in this section. Taking the unweighted average across all of these studies suggests the household debt deleveraging channel can account for just under half of the decline in GDP that occurred.

### **3. What could a macroprudential regulator have done to address the build-up in these vulnerabilities?**

The previous section established the contribution of the credit crunch and household deleveraging channels to the severity of the recession. We argue that a macroprudential

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<sup>20</sup> Again, we do not consider the impact of less growth in housing wealth on the path of GDP prior to the crisis: our focus is on the severity of the downturn.

<sup>21</sup> MPC estimates are from Mian et al. (2013).

<sup>22</sup> Illustrative estimates of these amplifying effects are based on a closely related counterfactual experiment in Mian and Sufi (2014), which assumes a 10% reduction in the house price crash brought about by widespread use of “shared responsibility mortgages.” Their experiment paints a prominent role for the household debt channel: “had such mortgages been in place when house prices collapsed, the Great Recession in the United States would not have been “Great” at all. It would have been a garden-variety downturn with many fewer jobs lost.” See **Annex** for details of the estimates used.

regulator would have needed to address vulnerabilities in both the financial system and in household balance sheets to have materially improved the post-crisis performance of the economy. In this section, we start by asking whether it would have been possible to identify the imbalances documented above in real time. We then consider the specific policies that a macroprudential regulator could have introduced in principle to address whatever had been detected—in doing we, we abstract from institutional frictions in implementing such policies, which we discuss in the next section.

### *3.1 Identifying the build-up in risk in real time*

Identifying necessary policy interventions would have required spotting emerging risks in advance. Our thought experiment does not assume “perfect foresight”. Rather we ask whether a regulator with a clear macroprudential remit could have spotted building vulnerabilities prior to the crisis.

Table 4 summarises how often some key words associated with building fragilities were mentioned in Federal Open Market Committee (FOMC) transcripts through the 2000s. Recognizing that the Fed did not have a macroprudential remit or supervisory responsibility for some important parts of the financial system, we draw three conclusions from this. First, the build-up in household debt was evident from the early 2000s, though recognition of risks associated with the subprime sector came much later. Second, the house price bubble was noticed a bit later (2005), but still well ahead of the crisis. Third, there was some awareness of the fragilities in the financial system (e.g. because of its reliance on repo), but the FOMC did not spot all of the fault-lines within the system (e.g. the reliance on commercial paper).

Identifying the debt build-up for households was relatively straightforward. The Bank for International Settlements (e.g. Borio and White (2004)) was already sounding alarms about the risks from credit build-ups in 2004, and this issue was mentioned regularly by the FOMC (see Table 4). The IMF’s Global Financial Stability Report in April 2005 had a chapter on the state of household balance sheets in advanced economies. Hence, it seems likely to us that policymakers were aware of the aggregate trends in household debt. It is less obvious that the kind of granular information on the amount of credit flowing to risky borrowers and heavily indebted borrowers noted in Table 2 was being picked up

(Eichner et al. (2013) make a similar point). It is striking that the word “subprime” was mentioned 314 times in the FOMC’s 2007 transcripts, but only 27 times in all the transcripts from 2000 to 2006.

**Table 4:** Financial stability terms appearing in FOMC discussions in the 2000s

	2001	2002	2003	2004	2005	2006	2007
<i>General</i>							
“Financial stability”	0	1	2	9	5	9	13
<i>Financial System:</i>							
“Bank”	502	429	449	302	284	309	1024
“Capital” / “Leverage”	454	308	340	208	183	177	402
“Shadow” / “Broker” / “Money market”	17	21	40	10	17	28	59
“Fund” / “Liquid” / “Repo”	1226	962	1150	1058	932	1110	1779
“Commercial paper” / “Securitization”	23	22	15	3	14	2	133
<i>Housing Market</i>							
“House price”	2	23	4	41	160	85	83
“Bubble”	6	15	14	19	114	4	8
“Loan” / “Lend” / “Debt” / “Credit” / “Borrow”	413	442	452	269	409	251	1563
“Mortgage”	84	100	96	67	176	118	481
“SubPrime”	0	3	1	0	8	15	314
“LTV” / “Heloc” / “Teaser”/“Alt-A”	2	1	1	0	40	0	45

*Notes:* For each year, transcripts of the eight FOMC meetings and any Conference Calls were searched. All transcripts available here: [https://www.federalreserve.gov/monetarypolicy/fomc\\_historical\\_year.htm](https://www.federalreserve.gov/monetarypolicy/fomc_historical_year.htm) A simple count of all words containing the stem words listed in the table above was conducted.

The impact of this debt boom on the sustainability of house prices was not immediately obvious to policymakers. But by June 2005, the FOMC was discussing evidence that houses may be up to 20% overvalued, leading to the spike in transcript references to “house price”, “bubble” and words associated with mortgage lending.<sup>23</sup> This assessment turned out to be pretty accurate: by the end of the crisis, house prices were 13% below their June 2005 level, and the peak-to-through fall during the crisis was 20%.<sup>24</sup>

While the FOMC had accurate information on the potential fall in house prices, it did not anticipate the effect this would have on the resilience of the wider financial system. The technology to stress test the banking system that has been developed since the crisis would have helped identify this impact. We argue that feeding a 20% house price fall

<sup>23</sup> See 2005 FOMC minutes: <https://www.federalreserve.gov/monetarypolicy/files/FOMC20050630meeting.pdf>.

<sup>24</sup> Based on the Case-Shiller U.S. National Home Price Index. The peak-to-through fall is defined as the fall between February 2007 and the end of the recession in June 2009. Between the end of the recession in June 2009 and February 2012 house prices fell further, bringing the overall peak-to-through fall to 26%.

into a well-designed stress test in 2005 would have revealed many of the fault lines that explained the depth of the crisis and would have helped calibrate additional prudential measures. The evidence in Hirtle et al. (2016) supports our claim: the authors demonstrate that, as early as 2004, a simple top-down stress-testing framework would have predicted that a macroeconomic scenario like the one in 2007/8 would have led to a significant capital shortfall in the U.S. banking system.

However, to reveal the full extent of the fragilities that existed, stress tests would have had to include certain non-banks and markets: dealer banks; commercial paper, repo and derivative markets; SIVs and conduits. We think that it would have been especially difficult to fully understand the funding flows across the system prior to the crisis. We offer two pieces of evidence supporting this view. First, some funding flows were not being measured at all. The most important missing data relates to repo transactions. For example, the repo positions of broker-dealers were only measured on a ‘net’ basis, which significantly understated the liquidity risks they were exposed to.<sup>25</sup> In addition, the pre-crisis FOMC transcripts demonstrate a lack of awareness regarding risks associated with commercial paper markets.

Second, even if the macroprudential regulator had understood that it had woeful data, building a map of funding interconnections would have been challenging and time consuming. The Office of Financial Research (OFR) formed an advisory Committee in December 2012. That group made a recommendation in August 2013 that the OFR construct a funding map. An OFR working paper issued in May 2014 provides an overview of how such a map could be constructed (Aguiar et al. (2014)). Even at that point, there were many identified data gaps that would have hamstrung the effort (see section 6 of their paper). So we are more cautious in what we expect on this front.

### *3.2 Tools and actions to reduce leverage*

To address the build-up in system-wide leverage, an empowered macroprudential authority can raise capital requirements. Basel III has created the countercyclical capital

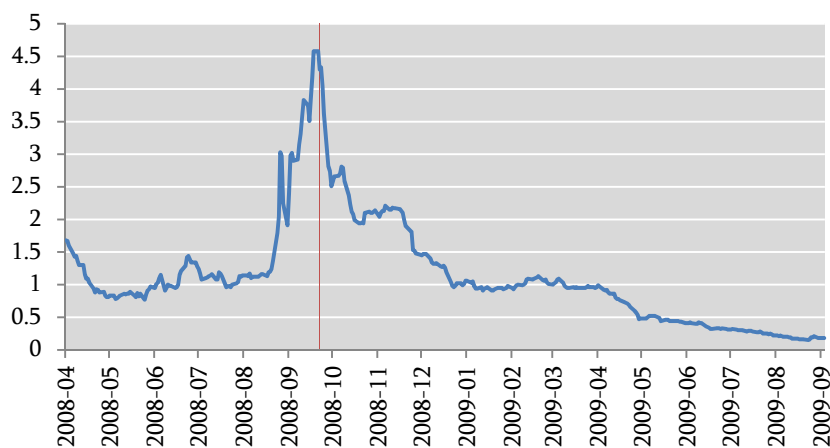
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<sup>25</sup> Pre-crisis netting arrangements were misleading in two ways. First, netting was permitted across different institutions, thereby unrealistically cancelling some exposures. Second, gross amounts borrowed may have been backed by lower quality collateral than any ‘offsetting’ lending transactions, meaning that netting even at the individual institution level could have obscured risks.

buffer (CCyB), a time-varying macroprudential tool that allows macroprudential regulators to do exactly this. We argue that were a re-run of the conditions prior to the crisis to occur, a macroprudential regulator would seek to deploy such a tool to build additional loss-absorbing capacity as it observes increasing macro-financial risks.

How much additional capital would U.S. banks have needed to be resilient given the scale of the credit bubble that was building in this period? One estimate of the required capital injection is provided by the scale of government capital support that occurred at the height of the crisis via the Troubled Asset Relief Program (TARP). Under this scheme, the U.S. Treasury invested \$200 billion in the preferred stock of fifteen large U.S. banks to enhance market confidence in the banking system, and thereby increase its capacity to lend.<sup>26</sup> While establishing cause and effect is difficult, there is evidence that this intervention—together with the Supervisory Capital Assessment Program (SCAP) stress tests that followed it—was transformative in improving market participants’ views as to the solvency of the U.S. banking system. Following its announcement, for instance, banks’ unsecured borrowing spreads declined sharply (Figure 11).

**Figure 11:** Spread between three-month LIBOR and Treasury bill yield



*Source:* Federal Reserve Bank of St. Louis. Red line shows day TARP was announced (14 October 2008)

<sup>26</sup> Our sample includes the fifteen bank holding companies and broker-dealers that received the largest TARP injections (Citigroup, Bank of America, JP Morgan Chase, Wells Fargo, Goldman Sachs, Morgan Stanley, PNC Financial Services Group, U.S. Bancorp, SunTrust, Capital One Financial, Regions Financial Corporation, Fifth Third Bancorp, BB&T, Bank of New York Mellon, Key Corp ). The TARP program also provided capital to other, smaller banks. These are not included in the numbers we use.



What level of the CCyB would have delivered an equivalent level of resilience as achieved by the TARP? The CCyB is typically expressed as a percentage of a firm’s assets, weighted by their riskiness and an additional “domestic lending conversion factor”.<sup>27</sup> One simple estimate of the necessary CCyB rate is hence:

$$\text{Required CCyB} = \frac{\$200 \text{ billion}}{\text{Risk weighted assets}} * \text{Domestic lending conversion factor}$$

As of 2005, the fifteen large banks that we focus on had total risk-weighted assets of approximately \$8.4 trillion—the denominator of the expression above.<sup>28</sup> The average “domestic lending conversion factor” was around 75 percent.<sup>29</sup> Using these parameters, we estimate that a CCyB of 3 percent would have provided an equivalent level of resilience as the \$200 billion TARP (Table 5). In effect, this would have brought forward the capital raising that ultimately proved necessary, substituting public provision of capital for private sector resources.

We conservatively estimate that setting a CCyB of 4.7 percent would in addition have mitigated any credit crunch effects that TARP on its own was unable to avoid by allowing banks to continue lending in line with historical credit growth rates.<sup>30</sup> An alternative way of estimating the CCyB that would have mitigated a credit crunch is to add the capital that banks raised privately on the back of the 2009 SCAP – a stress test that was explicitly designed to ensure that banks had enough capital to avoid deleveraging – to the \$200bn of TARP.<sup>31</sup> This thought experiment suggests a CCyB of around 4.2% could have prevented a credit crunch.

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<sup>27</sup> Under the Basel III framework, the CCyB for each bank is computed as a weighted average of the CCyBs across the jurisdictions in which the bank operates, with weights set according to risk-weighted private sector credit exposure by jurisdiction. Because large U.S. banks have global assets, an increase in the U.S. CCyB will not pass through one-for-one into their capital requirements.

<sup>28</sup> This number is estimated using published accounts and an average risk-weight of 67.5% - see New York Fed Quarterly Trends for Consolidated US Banking Organizations. Number includes the assets of firms that did not themselves receive TARP, but that in the course of 2008 were acquired by one of the fifteen TARP-recipients we focus on (Countrywide Financial, Merrill Lynch, Wachovia, Bear Stearns, Washington Mutual, National City Corp).

<sup>29</sup> See Avraham et al. (2012).

<sup>30</sup> A CCyB of 4.7 percent would have ensured that banks would have had sufficient capital to continue growing their balance sheets in line with the long-run average growth rate (see Annex for further details).

<sup>31</sup> The SCAP results were published in May 2009, and banks had six months to raise any required capital in private markets. There was an explicit ‘back-stop’ option to obtain capital from the U.S. Treasury if necessary. Over this period, the banks in our sample raised approximately \$70bn of capital in order to meet these requirements and did not make use of the option to obtain additional government funding.

**Table 5:** CCyB rate that would have been necessary to avoid TARP

Calculation		
<b>Replacing bail-outs</b>		
Total capital injections		\$198bn
Total risk-weighted assets (RWAs)		\$8,409bn
Bailout in % of RWAs	$\$198\text{bn} / \$8,409\text{bn}$	2.4%
Domestic assets in % of total assets		76%
Required CCyB rate	$2.4\% / 76\%$	3.1%
<b>Replacing bail-outs and supporting additional lending</b>		
Additional RWAs if credit growth had continued along pre-crisis trend		\$1,050bn
Assumed stressed target capital ratio		10%
Additional capital to support credit growth	$\$1,050\text{bn} \times 10\%$	\$105bn
Required CCyB rate	$3.1\% + \$105\text{bn} / (\$8,409\text{bn} \times 76\%)$	4.7%

*Sources:* US Treasury, Published Accounts, New York Fed Quarterly Trends for Consolidated US Banking Organizations, Financial Accounts of the U.S., Avraham et al. (2012).

To put this into context, Hirtle (2016) finds that between 2005 and the collapse of Lehman Brothers in 2008, dividend payments of large bank holding companies amounted to \$162bn, and total share buy-backs amounted to an additional \$131bn. Indeed, dividend payments and share buy-backs amounted to \$49bn and \$18bn, respectively, between mid-2007 and the failure of Lehman.<sup>32</sup> Collectively, these figures suggest that banks had ample capacity to meet such higher capital requirements through a combination of new issuance and additional retentions.

Finally, among the 15 institutions that we consider are some of the broker-dealers. These institutions were not subject to standard prudential requirements.<sup>33</sup> So as a first step, a macroprudential authority would have needed to bring these firms inside the regulatory perimeter. If a macroprudential authority had subjected *all* U.S. broker-dealers to the

<sup>32</sup> By mid-2007, New Century Financial Corporation, a leading subprime mortgage lender, had already failed, and Bear Stearns and BNP Paribas had started halting redemptions on a number of their investment funds.

<sup>33</sup> In 2010, the SEC had created the voluntary “Consolidated Supervised Entities” program to regulate large investment bank holding companies. However, this regime was primarily intended to satisfy foreign regulators (see Financial Crisis Inquiry Commission (2011)). It was generally seen as being insufficiently robust and was terminated following the failure of Lehman Brothers in 2008.

same capital standards as the banks, this alone would have added over \$280bn of capital to the system.<sup>34</sup>

### *3.3. Tools and actions to reduce funding mismatches*

During the crisis, the Federal Reserve set up a range of new liquidity facilities and provided around \$1.5tn of liquidity to the financial system.<sup>35</sup> This was equivalent to 9% of commercial banks' and broker-dealers' assets. To scale the macroprudential policy intervention that would be required were such a build-up in risks to re-occur, we posit that requiring firms to replace \$1.5tn of their short-term funding with longer-term debt would have reduced liquidity outflows in the crisis sufficiently to avoid a need for extraordinary central bank liquidity facilities. This is likely to be an over-estimate of the scale of appropriate policy intervention because some public provision of liquidity is likely to be efficient.

Data in Lallour and Mio (2016) suggests that applying the Net Stable Funding Ratio (NSFR)—a Basel III requirement that limits liquidity transformation—to relevant financial groups would have had a very similar effect: applying the NSFR to 12 of the largest US banking and investment banking groups at a consolidated level would have led to an increase in long-term funding of \$1.4tn by end-2007.<sup>36</sup>

What impact would such an intervention have on the real economy? While a \$1.5tn increase in the supply of long-term debt would have affected equilibrium yields, we think such an intervention would have increased firms' average funding costs by less than 9 basis points.<sup>37</sup> Conservative estimates suggest that this would have increased lending

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<sup>34</sup> This is based on the assumption that bringing broker-dealers into the scope of regulation would have reduced their leverage from 45 to 12 – the level of large commercial banks (see Table 1). This would have added  $4,686/12 - 4,686/45 =$  \$286bn of capital to the system.

<sup>35</sup> This includes Discount Window Funding, the Term Auction Facility, the Primary Dealer Credit Facility, the Term Securities Lending Facility, the Term Asset-Backed Securities Loan Facility, the Commercial Paper Funding Facility, and the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility. See Fleming (2012).

<sup>36</sup> The estimates in Mio and Lallour (2016) are based on end-2006 balance sheet data. To make them comparable to the size of the Fed's liquidity interventions we scaled them up to reflect the average growth of the relevant groups' balance sheets between 2006 and 2007.

<sup>37</sup> This is based on the conservative assumption of a 100 basis point difference between the spreads on short-term funding and long-term (5 year) debt. To put this into context, the average difference between the cost of repo funding and 5 year corporate bond spreads in 2006 was around 70 basis points.

spreads by less than 18 basis points, and would have reduced the pre-crisis level of GDP by less than 0.19 per cent.<sup>38</sup>

### *3.4 Tools and actions to reduce build-up in household debt*

By increasing the cost of credit for borrowers, it is plausible that higher capital and liquidity requirements might also help reduce household debt growth and house prices. We postulate, however, that the impact of implementing such measures in a boom is likely to be small (for evidence on the impact of raising capital requirements in an upswing, see Bahaj et al. (2016)). For that reason, we argue that a macroprudential regulator determined to reduce the build-up in household debt would need to take additional actions.

According to the IMF, the most commonly-applied tools to restrain build-ups in household debt are limits on loan to value ratios (LTV), affordability criteria, and loan to income (LTI) ratios. By making borrowers' less vulnerable to shocks, the introduction of such tools is intended to reduce the volatility in household consumption. We argue that the imposition of LTI limits on new mortgages and affordability criteria that ensure borrowers can continue to service their debt in the event of an increase in interest rates would have been influential in curtailing the unsustainable build-up in debt and the aggregate demand externalities that resulted in the recession.

As a simple illustration, we consider how LTI limits would have affected loan-level mortgage origination through the 2000s.<sup>39</sup> **Table 6** reports, for varying LTI limits, the number of mortgages that would have breached the limit, and the total impact on gross lending had these loans been reduced in size (e.g. because households opted for cheaper properties) so that they just conformed to the limit.

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<sup>38</sup> The estimated impact on lending spreads is based on the assumption that the increase in funding costs is fully passed on to borrowers by increasing spreads on loans (which represented c50% of total assets), and that financial institutions' cost of equity remains the same despite of the more stable funding base. The impact on GDP is estimated based on multipliers in Firestone et al. (2017).

<sup>39</sup> With thanks to Matthieu Chavaz for assistance, we use annual data resulting from the 1975 Home Mortgage Disclosure Act (HMDA). This covers the vast majority of mortgages originated, since it requires all financial institutions (exempting very small or rural-only lenders) to report their entire mortgage origination activity to the FFIEC. From this dataset, we analyse mortgages for house purchase by owner-occupiers where both loan size and income is reported.

**Table 6:** Impact of different loan to income limits on gross mortgage lending for house purchase

Impact on number of mortgages originated (million)						Impact on value of mortgages originated (\$ billion)				
		Impact of loan-to-income limit of:					Impact of loan-to-income limit of:			
	Actual number	2x	3x	4x	5x	Actual value	2x	3x	4x	5x
2000	4.3	2.1	0.6	0.1	0.0	560.1	89.2	19.1	6.0	3.8
2001	4.3	2.3	0.7	0.2	0.0	599.5	105.2	23.1	5.0	1.9
2002	4.4	2.5	0.9	0.2	0.1	712.3	168.6	62.6	32.3	24.9
2003	4.7	2.9	1.3	0.4	0.1	783.2	189.8	59.0	16.2	6.1
2004	5.3	3.2	1.5	0.5	0.1	939.4	246.0	82.0	21.8	6.1
2005	5.9	3.4	1.7	0.5	0.1	1,090.0	288.9	95.9	23.8	6.1
2006	5.4	3.0	1.4	0.4	0.1	1,003.2	246.2	75.2	18.8	6.1
2007	3.9	2.4	1.2	0.4	0.1	785.9	204.5	67.9	17.7	4.8
Cum. total: 2000-2007	38.3	21.7	9.2	2.7	0.7	6,473.7	1,538.5	484.8	141.5	59.8

Sources: Home Mortgage Disclosure Act (HMDA) data – see footnote 38.

This exercise reveals, for example, that a LTI limit of four times income would have had a noticeable impact on mortgage origination through the 2000s: 2.7 million of the 38 million mortgages originated would have had to be reduced in size, with a total impact on gross lending over the period of \$142bn.<sup>40</sup> But to put that in context, this would have left the mortgage stock on the eve of the crisis only around 1.3% lower than the \$10.6tn observed.<sup>41</sup>

This naive experiment is likely to significantly understate the impact of LTI limits on the mortgage stock, however. First, it assumes all affected borrowers receive a loan at the largest size possible given the limit—in reality, some borrowers would likely be shifted further below the limit and some might be excluded altogether.

One group of borrowers that would likely have been particularly affected are those that could not certify their income. Mayer et al. (2009) document that 3.3 million “Alt-A” mortgages were originated between 2003 and mid-2007, with 71% of those loans having

<sup>40</sup> This is likely an underestimate of the impact because the sample includes second liens or “piggyback” mortgages separately. In reality, LTI limits would take into account the *combined* LTI for first and second liens loans together. From 2004 onwards, it is possible to split second liens loans out of the data: from 2004 to 2007, they accounted for 3.5 million (17%) of total loans in the sample, but a relatively small \$185bn (5%) of the total value originated.

<sup>41</sup> This simply assumes that the reduction in gross lending for house purchase flows directly through to a lower stock of debt outstanding in 2007. This direct mapping may be biased upwards to the extent that the same individual moved more than once during the 2000-2007 period sampled.

low or no documentation. In addition, they estimate that there were 6.4 million subprime loans and that 35% of those had low or no documentation. Many of these loans would likely have been curtailed by an LTI limit. Presumably, some would be denied altogether. Plausible adjustments to account for the impact on these borrowers would substantially reduce the amount of lending that could occur. For example, the low or no documentation loans identified by Mayer et al. (2009) amount to 4.6 million originations from 2003 to mid-2007 (around a quarter of total originations). Assuming a proportionate share in the total *value* of originations would suggest around \$850bn of low or no documentation loans originated over that period. If only *one in six* of these loans were turned down altogether, that would generate a similar dollar reduction in lending to the entire effect of a four times LTI limit estimated above.

Furthermore, a macroprudential authority aiming to shore up household balance sheet resilience would have also implemented an accompanying affordability test.<sup>42</sup> This too could have had a material impact on the surge in marginal borrowers taking advantage of weak underwriting standards in the latter stages of the credit boom. For example, of 6.4 million subprime loans originated from 2003 to mid-2007, Mayer et al. (2009) document that 76% were so-called short-term hybrid loans with initial “teaser” rates. An affordability test that required mortgagors to be resilient to an interest rate stress would likely have significantly curtailed this lending, even for borrowers with complete documentation.

Finally, the impact of a LTI limit and accompanying underwriting standards in reducing the debt-deleveraging channel would likely have been greater than aggregate lending relationships suggest because it has a *targeted* impact on the most vulnerable borrowers. A large body of evidence suggests that the heavily indebted tail of borrowers has the largest marginal propensity to cut their consumption following a housing shock.

International evidence (summarised in Bank of England (2017)) finds a strong link between households’ LTI ratio and the fall in their consumption in the last crisis.<sup>43 44</sup>

Those studies suggest that borrowers with an LTI above 4 cut back spending around three

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<sup>42</sup> See Bank of England (2007) for a discussion of the complementarities between LTI limits and affordability tests.

<sup>43</sup> This draws on studies Bunn and Rostom (2015) for the UK, Andersen et al. (2014) for Denmark and Fagereng and Halvorsen (2016) for Norway).

<sup>44</sup> For the U.S. the focus has been on borrowers with high loan to *value* ratio. Mian et al. (2013) find that highly leveraged households have an MPC out of housing wealth around three times larger than less leveraged borrowers. Dynan (2012) finds a similar effect.

times as much as those with LTIs between 2 and 3. This could have led to material aggregate effects on the size of the Great Recession. Even the conservative estimate in Table 6 shows that by 2007 a LTI limit of four through the 2000s would have shifted 2.7 million households away from the highest marginal propensity to consume bucket.

#### 4. Could the macroprudential frameworks set up since the crisis implement such policies?

Edge and Liang (2017) survey the powers of the various macroprudential frameworks that have been created since the crisis.<sup>45</sup> Of the 58 countries surveyed, 41 have set up multi-agency financial stability committees (FSCs).<sup>46</sup> One striking finding is that only eleven of these committees have direct control over any macroprudential policy tools or are able to issue “comply or explain” recommendations that other authorities are formally obliged to respond to. The remaining cases rely on the voluntary cooperation of other regulators to achieve their policy aims. IMF (2018) report a similar finding.<sup>47</sup>

**Table 7:** Survey data on usage of macroprudential tools

	<b>Bank-focused tools</b> (positive CCyB, forward-looking provisions, caps on credit growth)	<b>Household-focused tools</b> (loan-to-income or debt-service-to-income limits)	<b>Both</b>
All Advanced Economies (18)	44% of countries	33% of countries	22% of countries
Advanced Economies with FSCs with (semi) hard powers (5)	60% of countries	40% of countries	40% of countries
Other Advanced Economies (13)	38% of countries	31% of countries	15% of countries

*Notes:* We consider the 19 advanced economies covered in Edge and Liang (2017), minus South Korea, for which no data on tool usage is available. Based on country classification in Edge and Liang (2017) and survey responses on tool usage in IMF (2018) that consider tools in use at the date of the survey. Results for the UK have been adjusted to account for measures that had been agreed but were not binding yet at the date of the survey.

<sup>45</sup> See Forbes (2018) for an excellent survey of how various macroprudential tools have been deployed in different countries.

<sup>46</sup> We focus on multi-agency committees to abstract from countries where the FSC is just an internal sub-committee within an existing agency.

<sup>47</sup> For the same set of countries, a survey conducted by IMF (2018) suggests that 23 countries have FSCs and one or more authorities with the power to issue macroprudential directions or “comply or explain” recommendations. But in a number of these cases the powers rest with an authority other than the FSC.

Restricting the sample to advanced economies, there is evidence that countries that have set up multi-agency FSCs with some form of power are considerably more likely to take macroprudential actions than other countries, in which such actions have to be taken by other authorities (Table 7). For instance, 60% of countries with high-powered FSCs have taken bank-focused policy actions and 40% have taken actions to limit household indebtedness; this compares to 38% and 31% respectively for countries without powerful FSCs. Put differently, the “treatment effect” of setting up a powerful FSC appears to be a 10 – 20 percentage point increase in the likelihood of the country implementing certain types of macroprudential actions.

This evidence is only suggestive and is based on a small sample. There may also be some reverse causality at play, with more interventionist countries being more likely to set up a powerful FSC. On the other hand, we include some FSCs that have relatively weak “comply or explain” powers in our “treatment group”, which should bias our estimates of the effect of an FSC with independent powers on countries’ propensity to take macroprudential actions downwards, leading us to understate the potency of powerful FSCs.

Our key takeaway from this table is that while many countries have taken macroprudential actions without having a designated FSC, institutional frameworks do matter: FSCs with independent tools appear to be more willing to act than e.g. government agencies that are exposed to short-term political pressures.

If we line up the multi-agency FSCs in order of the powers at the direct disposal of the committee, two cases stand out at opposite ends of the spectrum: the U.K.’s FPC, with its wide-ranging toolkit to achieve its mandate to protect and enhance the resilience of the U.K.’s financial system; and the U.S. FSOC, with few powers under its direct control, despite its mandate to identify and respond to emerging threats to financial stability.

In the remainder of this section, we compare and contrast the powers of the FSOC and FPC, as well as the institutional frameworks in which they operate, and we assess how well placed each is to implement the package of macroprudential measures identified in section 3.



#### *4.1 The U.S. Financial Stability Oversight Council (FSOC)*

##### **Institutional set-up**

The FSOC was set up in 2010 as part of the Dodd-Frank Act, and its membership of ten voting members consists of the heads of existing regulatory agencies, including the Federal Reserve, Federal Deposit Insurance Corporation, Securities Exchange Commission, alongside the Treasury Secretary and one independent member with insurance expertise. It also has five non-voting members, including the Director of the Office of Financial Research, who serve in an advisory capacity. It is chaired by the Treasury Secretary, and decisions are taken by a simple majority rule.

The FSOC has an overall mandate to identify and respond to risks to U.S. financial stability that could arise from the distress or failure of large, interconnected bank holding companies or nonbank financial companies. It is also charged with promoting market discipline by eliminating expectations that investors will be shielded from losses by the government. It is designed to facilitate information sharing between relevant regulatory agencies. Its only binding tool is the power to designate non-bank financial institutions deemed to be systemically important for enhanced supervision; it does not have the authority to act independently, and has no time-varying macroprudential powers under its control.

For other policy interventions, the FSOC relies on issuing recommendations to other regulators, not all of whom have an explicit financial stability objective (Kohn (2014)). The FSOC's limited powers explain why the Dodd-Frank Act puts relatively little emphasis on the Council's public accountability. The FSOC's annual report is targeted at a small expert audience, and its members are not individually accountable for their actions: testimony to Congress is only provided by the Chairperson.

##### **What could the FSOC do about a re-run of the factors that led to the last crisis?**

Given its limited powers, there is nothing the FSOC could do unilaterally to curtail a build-up of vulnerabilities in the financial system, or to address vulnerabilities associated with household indebtedness. While it is plausible the Council could identify certain non-bank financial institutions for enhanced supervision and recommend certain structural reforms to buttress stability (e.g. to the structure money market funds, or to

leverage limits for broker-dealers), the likelihood of these recommendations catalysing policy action is doubtful given the lack of a shared financial stability objective on the part of member agencies. Similarly, no federal regulator has clear jurisdiction over household debt limits, making it doubtful that an FSOC recommendation in this space would be carried through.

Recent case studies back up this pessimistic assessment. First, consider the efforts to reform the MMFs. The runs on the MMFs in the week after the Lehman failure were viewed by virtually all observers as revealing a fundamental vulnerability in the structure of these institutions (Squam Lake Group (2011)). It took the FSOC until November of 2012 to propose any recommendations for how to reform MMFs. The FSOC (unanimously) suggested three options for reform. These included making the shares in MMFs have a floating rather than fixed value, mandating a 1% capital requirement along with a requirement that large withdrawals could be delayed, or mandating a 3% capital requirement that might be combined with other options. The FSOC warned that proposals based on gating withdrawals create incentives to run. Following heavy resistance, including criticisms that MMFs were outside of the FSOC's remit, the FSOC did not issue a final recommendation (Cochran et al. (2015)).

The SEC, as primary regulator, rejected the idea of capital requirements and opted to request comments on two alternatives, a floating value option and one based on gates. It ultimately passed (on a 3 to 2 vote) the floating value option. This took effect in October 2016, but only applies to a sub-set of MMFs.<sup>48</sup>

A second case involves the long-running debate over attempts to reform housing finance in the United States. As detailed in Rajan (2010), there has been bipartisan support for using the GSEs to support the housing market, with an emphasis in the years before the crisis in making housing more affordable for lower income borrowers. Alan Greenspan, while he was Fed Chair and at the peak of his influence on public policy, repeatedly testified in favour of restraining the GSEs' ability to purchase private label mortgage back

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<sup>48</sup> One of the dissenting commissioners (Piwowar (2014)) stated "As a threshold matter, there is no evidence that money market funds themselves pose any threat to the stability of the U.S. financial system." He went on to say that if banks were overly reliant on MMF funding the banking regulators should deal with that. Concluding "only the imposition of a gate would stop redemptions, thus ending any run on a money market fund and obviating the need for any future taxpayer bailouts."

securities to no avail (e.g. Greenspan (2005)). The Dodd Frank Act did ban certain types of mortgages, such as interest only mortgages or those with negative amortization. But left the question of minimum down payment restrictions to a group of six regulators involved in housing. These regulators ultimately opted against requiring any minimum down payment requirement. Further, Dodd Frank gave no agency the ability impose loan to income requirements. Hence, the FSOC does not even have a primary regulator to which a recommendation could be directed.

Problems associated with the FSOC's lack of power would be mitigated if other authorities had both the tools and incentives to act in its place. The Fed's powers are the most wide-reaching in certain respects.<sup>49</sup> Maintaining the stability of the financial system and containing the systemic risk that may arise in financial markets has long been central to its mission (Kohn (2006)). And its powers include a requirement to conduct annual stress tests for large bank holding companies and the nonbank financial companies it supervises; it sets the CCyB for bank holding companies, up to a ceiling of 2.5% of risk-weighted assets; it can impose liquidity requirements on the largest and most complex financial institutions; and it can set minimum margin requirements.

Nonetheless, the Fed lacks authority over many parts of the financial system and has no tools that can be used to tackle some of the factors (e.g. household debt vulnerabilities) that we have identified as critical. A June 2015 "war game" exercise conducted by four Reserve Bank presidents concluded that the Fed had insufficient macroprudential powers to address a build-up in risks that resembled the global financial crisis (see Adrian et al. (2017)). Moreover, Fed officials have cast doubt on whether it is within its mandate to set monetary policy to act against a build-up in financial stability risks.

The circumscribed committee structure of the FSOC reflects a political choice to limit the remit of financial regulation. Our analysis of the crisis suggests that this choice comes at the cost of being limited in its ability to respond to certain types of vulnerabilities, notably developments outside the commercial banking system where international agreements have concentrated.

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<sup>49</sup> Some of the Fed's powers have been curtailed by Congress since the crisis, however. In particular, its ability to provide emergency lending to non-banks under Section 13-3 of the Federal Reserve Act has been heavily restricted.

## 4.2 *The U.K.'s Financial Stability Committee (FPC)*

### **Institutional set-up**

The U.K.'s FPC operates within a significantly different structure. Established in 2013, it has twelve voting members: the Governor of the Bank of England, four Deputy Governors, the Executive Director for Financial Stability, the CEO of the U.K.'s Financial Conduct Authority, and five independent external members.<sup>50</sup> Most of the Governors of the Bank of England also sit on the U.K.'s monetary policy and micro-prudential policy committees, which facilitates policy coordination. But the large external membership, combined with the fact that decisions are taken primarily by consensus, means that external members have a strong voice.

The FPC has a wide-ranging toolkit. It unilaterally sets the CCyB for all banks, building societies and large investment firms operating in the U.K., a countercyclical leverage buffer for large banks, and it can vary sectoral risk weights for certain exposure classes; it can impose binding limits on households' borrowing capacity via loan-to-value and loan-to-income restrictions; and it advises on the scenarios used in the U.K.'s bank stress-tests. In addition, the FPC can issue "comply or explain" recommendations to other regulators, and can recommend to the government that it be granted additional powers where necessary. Finally, it makes an annual assessment on whether the perimeters of prudential regulation are drawn appropriately. Past recommendations to other regulators have been invariably accepted. And the FPC has successfully petitioned the government for additional powers. In short, this is the most muscular macroprudential regulator in the world.

This extensive set of explicit and implicit powers is accompanied by a strong accountability framework. FPC members are personally accountable to Parliament and typically provide testimony at least once a year. These testimonies follow the release of the FPC's bi-annual Financial Stability Report, which is increasingly designed to reach a wide audience and increase public support for the FPC's actions.

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<sup>50</sup> A representative of the Treasury attends the FPC's meetings as a non-voting member.

### **What could an FPC-like regulator do about the factors preceded the last crisis?**

The FPC's powers to increase capital requirements via the CCyB, sectoral capital requirements and countercyclical leverage buffers provide it with an effective means for enhancing the resilience of the banking system prior to the crisis.<sup>51 52</sup> To calibrate these interventions, it seems plausible to us that, faced with evidence of mounting vulnerabilities throughout the early-to-mid 2000s, the FPC would have commissioned a severe stress test of the banking system. While such an exercise may not have uncovered all the channels via which losses eventually transpired (e.g. we doubt it would have been feasible to understand the full extent of losses that materialised on the "AAA" tranches of CDOs<sup>53</sup>), it would have exposed the fragile solvency position of the banking system at this point—thus signalling the need for higher capital.

This stress test and the corresponding additional capital requirements would not have applied to broker-dealers as a matter of course. To expand the scope of these policy interventions, a regulator modelled on the FPC would need to recommend changes to the regulatory perimeter, changes which Congress may not have granted given the political climate of the time. This highlights limits on what even the more powerful macroprudential regulators might achieve.

Turning to the real economy, the FPC's tools to limit the extension of certain mortgages with high loan-to-income and loan-to-value ratios provide it with a means of guarding against vulnerabilities associated with household indebtedness. The FPC has demonstrated its willingness to use such powers: the loan-to-income limit considered above is similar to the policy measures that the FPC put in place in 2014.

## **5. Conclusion**

Returning to the title of this paper, could macroprudential policy have prevented the last crisis? Our answer is "perhaps". Despite the challenges in spotting and responding to

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<sup>51</sup> There is no ceiling on the CCyB rate that the FPC can set for U.K. banks. However, CCyB rates above 2.5% are not automatically "reciprocated", i.e. do not automatically apply to the U.K. exposures of foreign banks.

<sup>52</sup> The FPC does not have powers to direct changes in banks' liquidity or funding requirements. But it could issue comply-or-explain recommendations to the microprudential regulator to implement such changes.

<sup>53</sup> That said, a paper written prior to the collapse in senior tranche CDO valuations argued that these assets were significantly overvalued given the likely states of the economy when defaults might occur, i.e. given the systematic nature of the risks being borne by investors (Coval et al. (2009)).

build-ups of risk in real time, our analysis suggests a macroprudential regime with a suitably strong mandate, coupled with powers to adjust financial system leverage and maturity/liquidity transformation and to limit household sector indebtedness, could have significantly ameliorated the macroeconomic fall-out from the collapse of the real estate bubble.

Are today's macroprudential regimes sufficiently well-equipped to do this? We argue the U.S. FSOC is not set-up for this purpose. It has no macroprudential levers under its direct control, and not all its members have mandates to protect financial stability. A macroprudential regulator modelled on the U.K.'s FPC would have the necessary mandate and powers. But given the role played by loosely-regulated non-bank financial institutions prior to the crisis, to be successful, an FPC-type regime in the U.S. would have required political backing to widen the perimeter of regulation to capture such institutions and then acted aggressively.

Our thought experiment raises a number of questions for the future developments of macroprudential policy regimes. First, how much faith should we have in a macroprudential regulator's ability to identify problems and act in real-time? The fact that even in hindsight we believe it would have been hard to handle this crisis makes us humble (see also Tarullo (2014)). Despite the large effort being devoted to risk assessment at macroprudential regulators and central banks globally, we are doubtful that such efforts will be completely successful. So policy frameworks should be calibrated with some built-in "slack" to account for the fact that elevated risks may not always be obvious in real time.

Second, how wide should the remit of a macroprudential regulator be? The evidence presented in this paper suggests that ensuring the resilience of lenders might not be sufficient to avoid costly crises, and that actions targeted at preventing build-ups in household debt might also be required. While many countries have implemented policies aimed at preventing excessive levels of household debt, they remain controversial. Preventing a willing borrower and lender from consummating a mortgage contract where neither party is likely to default, for fear of the macroeconomic spillovers such contracts might create, is a more interventionist conception of macroprudential policy than one

focused on ensuring the banking system remains resilient.<sup>54</sup> It is not clear whether such interventions should be left to technical committees or to democratically-elected governments (Balls et al. (2016), Tucker (2018)). This issue may help explain the stark differences observed to date in macroprudential frameworks across countries.

Third, which specific powers does a macroprudential regulator require, and how actively should it be in using these? Our thought experiment demonstrates that even now, some macroprudential regulators might not have the tools necessary to prevent the last crisis. Instead, many regulators must rely on making non-binding recommendations to other regulators. This is problematic in two respects. If other regulators have conflicting incentives, the ability of the macroprudential regulator to achieve its mandate may be severely curtailed. As we have seen in the case of the FSOC, this is not just a hypothetical problem.

A less obvious cost of arming a macroprudential regulator with only soft powers is that it divorces the responsibility for identifying and addressing risks. A financial stability committee that lacks the authority to address risks will be tempted to see risks everywhere—identifying them is costless and a useful way to hedge one's bets. Whereas we might expect a committee that has the power to act to be more careful in identifying risks, as it may be expected to act on its own advice, and doing so will be controversial. This means that the warnings of a more powerful financial stability committee might be more targeted and informative.<sup>55</sup>

Assuming it is equipped with the requisite tools, it also remains unclear how forcefully a macroprudential regulator should intervene when it spots emerging problems. Our simple calculations in this paper demonstrate the rough scale of intervention that would have been necessary to prevent the last crisis. These actions would have had non-negligible effects on economic activity in non-crisis periods, as well as wide distributional effects. Ideally, elected governments would specify the risk tolerance that a

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<sup>54</sup> As an example of the issues involved, in Illinois in 2006 three counties implemented a pilot programme to limit the extension of subprime mortgages. This was highly effective in reducing subprime originations. But the programme was deeply unpopular and was later repealed by unanimous consent. For an analysis of this policy, see Agarwal et al. (2014).

<sup>55</sup> We would like to thank Sir Jon Cunliffe for suggesting this point to us.

macroprudential authority should work towards (e.g. the acceptable level of “GDP-at-risk”).<sup>56</sup> To the extent that government cannot articulate such specific, quantitative targets in these terms, how sustainable is a model where such decisions are taken by technical committees rather than elected politicians?

Finally, fourth, how do societies ensure that macroprudential regulators have the power to take meaningful actions, but are also sufficiently accountable to sustain legitimacy in the long-run? Crises are infrequent, so the success of a macroprudential authority is hard to verify. Does the fact that there has not been a financial crisis during the past 5 years constitute strong evidence that the U.K. and U.S. regimes have been effective? Probably not. This “verifiability problem” is more pronounced than comparable problems faced by monetary policy makers (Broadbent (2018)). It means that extending the remit or granting additional powers to an independent macroprudential regulators comes with accountability challenges. The U.K.’s FPC addresses these by putting a lot of emphasis on communicating its actions to Parliament and the wider public. But while helpful, this does not fully address the fundamental problem.

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<sup>56</sup> See Adrian et al. (2016), IMF (2018a) and Aikman et al. (2018).



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## Annex: estimates and underlying assumptions

### A1. Notes on Table 1:

The largest banks are identified using the Federal Reserve's data release on Large Commercial Banks. For 2001 we use a threshold of \$150bn in total assets. For 2007 this is inflated using the consumer price index (\$180bn). All data for these banks is taken from call reports. Liquid assets are defined as "cash and amounts due from banks" plus US Treasury securities. Short-term funding is defined as uninsured domestic and foreign deposits. Uninsured domestic deposits are estimated using data on total domestic deposits, and data on the average ratio of insured domestic deposits to total domestic deposits for all FDIC insured institutions.

Data on commercial banks and savings institutions is based on aggregate FDIC data. Liquid assets and short-term funding are defined in the same way as above.

Data on credit unions is based on the Financial Accounts of the U.S..

Data on broker-dealers on the Financial Accounts of the U.S.. We estimate leverage based on Adrian et al. (2017a). Liquid assets are defined in the same way as above. Short-term funding is defined as repo funding.

Data on GSEs is based on published accounts. Liquid assets are defined as "cash and amounts due from banks" only.

Hedge fund's assets under management are based on HFR Industry Reports.

### A2. Notes on Table 3 and Figure 7:

**(a) Bar 1: Chodorow-Reich (2014):** Chodorow-Reich (2014) estimates that the credit crunch could account for 34-47% of the 7% fall in total employment by enterprises with less than 1,000 employees. Given that the employment decline in these firms accounted for two thirds of the aggregate employment decline, the impact of the credit crunch on small and medium-sized companies can explain between one fifth and one third of the overall decline in employment.

In order to translate this result into GDP space and compare the results to other studies we use a version of Okun's law (see eg Bernanke (2012)) that suggests that a 2 percentage point fall in annual GDP growth relative to its trend maps across into a 1 percentage point increase in the unemployment rate. Given that the unemployment rate increased by 4.3 percentage points between end-2007 and end-2009, this relationship suggests that the effects identified in Chodorow-Reich (2014) can account for a fall in GDP relative to trend by approximately 2.0 to 2.7 percentage points.

**(b) Bar 2: Greenlaw et al. (2008):** Greenlaw et al. (2008) assessed the potential impact of deleveraging by (shadow) banks on the US economy before the costs of the crisis was

fully known. They assumed that following a given loss, (shadow) banks would deleverage in order to return to a certain desirable level of leverage. We updated the underlying assumptions to reflect things we learned as the crisis unfolded:

- According to IMF (2010), mortgage-related write-downs of US banks were \$680bn by the end of 2009 – significantly higher than the \$250bn of system-wide losses assumed in Greenlaw et al.
- Using data from Greenlaw et al., we scale these losses up to account for losses in the shadow banking sector. This gives us system-wide write-downs of \$890bn.
- We assume that financial institutions aimed to keep their leverage constant. This differs from Greenlaw et al., who assumed a 5% reduction in leverage targets. Not assuming any reduction in leverage targets is a conservative assumption that reduces the predicted size of the credit crunch.
- Data in IMF (2010) suggests that US financial institutions covered 48.4% of the identified write-downs by issuing new equity. This is remarkably close to the 50% assumed in Greenlaw et al.
- Based on these numbers, we estimate that the financial system had to withdraw \$4.6tn of funding in order to meet its leverage target. Greenlaw et al. suggest that this translates into a  $(\$4.6\text{tn} \times 0.43) = \$2\text{tn}$  reduction in credit to the real economy.

A simple instrumental variable regression in Greenlaw et al. suggest that a \$2tn (6.3%) hit to the provision of credit to the domestic nonfinancial sector would have reduced annual GDP growth in the crisis by 2.9 percentage points. However, the table below shows that this estimate is sensitive to assumed leverage targets.

10% reduction	5% reduction	Constant	5% increase	10% increase
-4.1%	-3.5%	-2.9%	-2.4%	-1.8%

**(c) Bar 3: Bassett et al. (2014):** Bassett et al. (2014) use a VAR to study the impact of tightening in lending standards on GDP. The measure of tightening that they use is based on a measure of responses to the Federal Reserve’s Senior Loan Officers Survey that controls for any macroeconomic and bank-specific factors that may affect both loan officers’ responses and loan demand.

They find that a one standard deviation shock to their measure of credit tightening reduces real GDP by around 0.8% two to three years after the shock. Using the same measure of tightening, they find that in 2008 we saw a 2-3 standard deviation shock to credit supply. This suggests that the credit crunch may have explained a 1.6 - 2.4% fall in real GDP.

**(d) Bar 4: Guerrieri et al. (2015):** Guerrieri et al. (2015) survey the predictions from five dynamic general equilibrium models with banking frictions developed by Federal Reserve Board staff. In order to calibrate a negative capital shock to the banking system, the authors use results for the Comprehensive Capital Analysis and Review (CCAR) of 2013.



The scenario of the 2013 CCAR was designed to be comparable to the Great Recession. In response to the bank capital shocks of the magnitude observed in the crisis, these models predict the following falls in GDP:

Model	Impact of shock to banking system on GDP
Iacoviello Model	-6%
Covas / Driscoll Model	-3%
Kiley/Sim Model	-2.5%
Queralto Model	-1%
Guerrieri / Jahan-Parvar Model	-0.45%

In Table 3 and Figure 7 we exclude the results from the studies that found the highest (6%) and lowest (0.45%) impact on GDP, which leaves us with a range of 1 - 3% of GDP.

**(e) Bar 5: Hall (2012):** Hall (2012) calibrates a dynamic general equilibrium model to replicate the global financial crisis in the U.S.. The paper uses the model to describe a counterfactual economy over the period 2009 through 2020 in which the same increase in financial frictions occurred but no household deleveraging took place. The paper finds that in this counterfactual, the “comprehensive unemployment rate”(which includes changes in labour-force participation or hours worked per employee) increases by around 6 percentage points between end-2007 and end-2010 – compared to an actual increase in the comprehensive unemployment rate of around 10 percent. That is financial frictions account for around 60% of the increase in unemployment, or an increase in the standard unemployment rate by 2.6 percentage points. Using our simple version of Okun’s law, this suggests that the credit crunch can explain a 5.2% fall in GDP relative to the level implied by its long-run trend.

### A3. Notes on Figure 10:

**(a) Bar 1: Reduced form:** This bar shows a range of -3.5 to -5.8pp. It is derived from Figure 8, which presents the reduced form relationship between the cumulative growth in the household debt to GDP ratio in the three years *before* a recession and the subsequent cumulative growth in real GDP per capita three years *after* the recession begins. The gradient of the simple regression line through this scatter plot for different U.S. States in the Great Recession suggests that each additional 1pp increase in the household debt to GDP ratio in the run-up to the crisis was associated with a 0.3pp larger reduction in GDP per capita in the downturn. Similarly, this “gradient” was 0.4pp amongst different advanced economies in the Great Recession and 0.5pp amongst G10 economies in historical recessions between 1960 and 2004. Taking this 0.3-0.5pp gradient range and multiplying through by the 11.5 percentage point increase in the U.S. household debt to GDP ratio that occurred between 2004 and 2007 can explain between 3.5 - 5.8 percentage points of the shortfall in GDP per capita from end-2007 to end-2010.

**(b) Bar 2: Jordà et al.:** This bar shows a range of -2.5 to -4.4pp. The lower estimate is taken directly from a counterfactual experiment presented in Figure 4 of Jordà et al. (2013). It shows the impact of total non-financial sector excess credit growth in the U.S. in the 2001-2007 boom on the subsequent decline in GDP per capita. An excess credit measure of 3.75 is reported, reflecting the average annual increase in the credit to GDP ratio during the boom relative to the sample average. Note that this includes a substantial contribution from non-bank credit growth. To approximate the GDP per capita impact, this 3.75 excess credit measure is multiplied through by the marginal impact derived from the authors' local projections. To avoid over-focus on one point estimate on the impulse response, the average of the Year 2, 3 and 4 coefficients is taken to give the end-2010 impact. These coefficients are -0.7, -0.4 and -0.9 respectively (see Table 6, Jordà et al. (2013)), averaging the coefficients gives -0.67 and so an impact of:  $-0.67 \times 3.75 = -2.5\text{pp}$ .

The second estimate repeats the exercise, but using estimates from Jordà et al. (2016), which focusses on the role of *mortgage* credit in driving recession severity. On this basis, we calculate an excess credit measure of 3.4 for U.S. from 2001-2007 (given by the average annual increase in the mortgage credit to GDP ratio 2001-2007 less the long-run average increase since 1950). This is multiplied through by the average of the Year 2, 3 and 4 coefficients presented in Table 9 of Jordà et al. (2016), which is -1.3 and so gives an impact of:  $-1.3 \times 3.4 = -4.4\text{pp}$ .

**(c) Bar 3: Bridges et al.:** This bar shows an impact of -3.7pp. In Table 5 of Bridges et al. (2017) the impact of the 3 year change in the household credit to GDP ratio on the GDP per capita shortfall 3 years into the recession is estimated to be -0.32. Given the household debt to GDP ratio rose by 11.5pp in the 3 years running up to the Great Recession, this estimate can account for  $11.5 \times -0.32 = -3.7\text{pp}$ .

**(d) Bar 4: Mian & Sufi (jobs):** This bar shows an impact of -5pp. Mian and Sufi (2012) exploit the differential effects on employment in the non-tradable versus tradable sectors across counties with different debt to income ratios to identify a demand channel associated with household balance sheet shocks. The authors extrapolate this to an aggregate demand effect, assuming a proportionate impact on tradable and non-tradable employment economy-wide. They estimate that 3.92 million of the lost jobs from 2007 to 2009 were attributable to this channel. This accounts for 2.5pp of the 4.3pp increase in the unemployment rate over that period. In line with the approach taken for Figure 7 (see Annex A2 above), we translate this impact into GDP space using an Okun coefficient of two: this gives an impact of  $2.5 \times 2 = 5\text{pp}$ .

**(e) Bar 4: Mian & Sufi (net worth):** This bar shows a total impact of -3.8pp, decomposed into a -1.5pp initial net worth effect, a -0.4pp contribution from foreclosures and a -1.9pp impact from the spending multiplier associated with the first two effects. The overall scenario draws inspiration from a comparable exercise in Mian and Sufi (2014).

Step i): Housing wealth shock: We size the housing wealth shock relative to a counterfactual where the mortgage debt to GDP ratio remains flat at its end 2003 level of

59%, rather than rising to 71% by end-2006. We assume there is no change in nominal GDP: all of the adjustment is through lower mortgage debt. We also assume that the average loan to value ratio of the housing stock remains flat at its end 2003 level of 38% (reflecting our observation that mortgage debt and house prices moved in lock-step through the 2000s boom). This counterfactual leaves housing wealth with \$3.6 trillion less far to fall to an unchanged trough in end 2009.

Step ii): Consumption impact: Applying a marginal propensity to consume out of housing wealth of 0.06 (the mid-point of the range estimated by Mian et al. (2013)), this counterfactual would have reduced the consumption shock by  $3600 \times 0.06 = \$216\text{bn}$  or 1.5% of nominal GDP at the time. This 1.5pp contribution is assumed to apply to real GDP per capita as well as nominal GDP.

Step iii): Foreclosure amplification: The -0.4pp contribution from reduced foreclosures is illustrative. It simply assumes that by curtailing the last 3 years of the credit boom and reducing the size of the correction, household balance sheets remain significantly more resilient in the crisis. We therefore assume that the peak foreclosure rate is halved, which we assume reduces the observed fall in house prices by around 5% (this scales by half the foreclosure effect described in a related experiment in Mian and Sufi (2014), Chapter 12 pp174-179). The result is a further reduction in the housing wealth shock of \$1 trillion dollars which, given an MPC of 0.06, translates to a saving of 0.4% of nominal GDP.

Step iv): Spending multiplier: The spending multiplier impact of -1.9pp simply follows the Mian and Sufi (2014) experiment described above and assumes a spending multiplier effect of 2x, for illustrative purposes. This part of the effect is shaded separately in Figure 10 and can be discounted or scaled accordingly, given the appropriate size of spending multipliers is not well-established. As Mian and Sufi (2014) note, an illustrative multiplier of two is arguably conservative for a consumption (rather than fiscal) contraction and one which occurred during a recession (when spending multipliers are typically larger).

**(f) Bar 5: Actual vs trend:** By end-2010, the total deviation of GDP per capita from an extrapolation of its pre-crisis trend from end-2007 is -8 ½ %. This calculation is explained in the main text: footnote 8.

#### **A4. Notes on Table 5:**

In order to consider by how much the relevant banks' balance sheets might have grown between Q4 2007 and Q4 2009 absent any credit crunch, we look at the average growth rate of commercial bank credit over this horizon (1%) and compare it to the growth rate in the 20 years before (1987 –2007). Over this period average annual bank credit growth was 7%.

We next calculate by how much relevant institutions' balance sheets would have increased if they had grown by 7% rather than 1% over two consecutive years. That is, we assume these banks would have been asked to contribute "their share" to lifting up overall credit growth (c. \$1,050bn of risk-weighted assets).

Assuming that in the counterfactual the *rate* of credit growth would have remained at its 1987-2007 average is a more conservative assumption than assuming that the linear trend in Figure 6 would have continued. This may overstate the CCyB that would have been necessary to prevent a credit crunch.