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Nina Boyarchenko, Giovanni Favara, and Moritz Schularick

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Financial Stability Considerations for Monetary Policy: Empirical Evidence and Challenges

Nina Boyarchenko, Giovanni Favara, and Moritz Schularick[1]

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Abstract

This paper reviews literature on the empirical relationship between vulnerabilities in the financial system and the macroeconomy, and how monetary policy affects that connection. Financial vulnerabilities build up over time, with both risk appetite and risk taking rising during economic expansions. To some extent, financial crises are predictable and have severe real economic consequences when they occur. Empirically it is difficult to link monetary policy to financial vulnerabilities, in part because financial cycles have long durations, making it difficult to separate effects of changes in monetary policy from other business cycle effects.

Keywords: Monetary Policy, Financial Stability, Financial Crises, Credit, Leverage, Liquidity, Asset Prices.
JEL Codes: E44, E52, E58, G2.

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I. Introduction

This paper reviews the literature on the empirical relationship between vulnerabilities in the financial system and the macroeconomy, and how monetary policy affects that connection. It discusses evidence from long time series and microeconomic studies that focus on links between asset valuations, financial intermediaries, monetary policy and the macroeconomy. In reviewing this literature, the paper focuses mostly on U.S.-based evidence – as the U.S. financial system is less bank-centric than in other countries – and on "net" vulnerabilities – that is, vulnerabilities that remain after taking into account the effects that supervisory, regulatory and macroprudential policies have on vulnerabilities.

We draw three main lessons from the empirical literature. First, financial vulnerabilities increase during economic expansions, with both risk appetite and risk taking rising. Financial cycles, however, are typically twice as long as business cycles, suggesting a potential mismatch in the evolution of financial vulnerabilities and variables targeted by central banks such as inflation and unemployment.

Second, financial crises are to some extent predictable and, once they occur, have severe real economic consequences. Financial cycles in which heightened risk taking in the form of increased leverage is coupled with high asset valuations are particularly pernicious and are associated with an increased probability of financial crises and a deterioration in the conditional distribution of real outcomes 1- to 3-years ahead. Such credit-fueled asset price booms typically feature compressed risk premiums due to either buoyant credit market sentiment or increased ability to take on risk by financial intermediaries.

Third, evidence on the link between monetary policy and financial vulnerabilities is limited, in part because financial cycles have long durations, and it is difficult to empirically separate changes in monetary policy from other business cycle effects. While there is some evidence that monetary policy affects asset valuations, investor risk appetite and household leverage, to date the empirical evidence does not point to quantitatively meaningful implications for financial vulnerabilities and the real economy. The limited evidence does not necessarily rule out a link between monetary policy induced financial vulnerabilities and the real economy; it can also mean that it is empirically difficult to identify a causal role of monetary policy.

A number of issues remain unresolved in the empirical literature relating monetary policy to financial vulnerabilities. First, the nonlinear interactions between monetary policy and financial stability are hard to estimate empirically. Second, separating the impact of accommodative monetary policy—as opposed to secular declines in the natural rate of interest—on the build-up of vulnerabilities is empirically difficult, since both imply low rates. Finally, a closely related issue is the extent to which the overall conduct of monetary policy—as a function of economic outcomes, possibly including financial vulnerabilities—rather than monetary policy surprises directly affects the build-up of vulnerabilities. For instance, the perceived systematic conduct of policy could affect financial vulnerabilities through their influence on households', firms', and investors' policy expectations and behavior.

These issues are likely to remain challenging empirically due to the paucity of changes in the conduct of monetary policy, the simultaneous impact of changing regulation—which limit researchers' ability to estimate with precision how monetary policy interacts with vulnerabilities over a business or financial cycle—and the rare nature of financial crises. While theoretical models could be used to shed light on the quantitative importance of this channel, the relative simplicity of models currently in the literature limits the generalization of their results, as discussed in Ajello et al. (2022).

The paper is organized as follows. Section II discusses how financial vulnerabilities evolve at business-cycle and lower frequencies. Section III reviews the empirical evidence on how financial vulnerabilities affect the real economy, both for the expected path of outcomes as well as the distribution of outcomes. Section IV surveys the empirical evidence on the channels via which monetary policy may lead to the buildup of financial vulnerabilities. Gaps in the empirical literature relating monetary policy to financial vulnerabilities are discussed in Section V.

II. Financial vulnerabilities

Financial vulnerabilities are generally procyclical but appear to have longer duration cycles than the typical business cycle. In particular, U.S. financial intermediary leverage, non-financial credit and asset prices are procyclical, consistent with models surveyed in Section II of Ajello et al. (2022) that feature a feedback loop between asset prices and financial intermediary leverage.

II.1 Financial vulnerabilities at the business cycle frequency

Financial vulnerabilities and the factors that drive them, such as risk-taking, are procyclical, rising in expansions and declining in recessions. However, the cyclicality of vulnerabilities of specific financial intermediaries may depend on their business models and the regulatory environment. The majority of the empirical evidence suggests that in recent decades book leverage is procyclical for most U.S. financial intermediaries, including broker-dealers, banks, and, to a lesser extent, insurance companies; one notable exception is the hedge fund sector, which appears to have countercyclical leverage.[2]

The composition of the financial sector and the cyclicality of individual subsectors of the financial sector in turn affects the cyclicality of credit provided to the nonfinancial sector of the economy. For example, deleveraging by banks often results in a reduction in bank loans but may be replaced by capital markets debt, such as corporate bonds and syndicated loans, which are primarily held by insurance companies and pension funds. Total credit extended to nonfinancial firms in the United States is procyclical but less so than that in Europe, perhaps reflecting the lower share of credit provided by the banking sector, which represents only a third of total credit provided to nonfinancial firms in the United States but is close to 80 percent in Europe (Boyarchenko and Mueller, 2020).

Total credit to nonfinancial firms is especially procyclical for riskier borrowers, with high-yield corporate bond issuance and issuance of leveraged loans increasing markedly during expansions (Greenwood and Hanson, 2013; Becker and Ivashina, 2016; López-Salido, Stein and Zakrajšek, 2017; Krishnamurty and Muir, 2017). Household credit growth in the United States is also procyclical, in large part driven by home-equity extraction (Mian, Sufi and Verner, 2017; Greenspan and Kennedy, 2008; Bartscher et al. 2021).

Unlike leverage, the cyclicality of liquidity and maturity transformation of financial intermediaries has received less attention in both the empirical and the theoretical literature.

[2] Adrian and Shin (2009, 2014), Adrian and Boyarchenko (2013), Adrian, Colla and Shin (2013), Adrian, Boyarchenko and Shin (2015), Beccalli, Boitani and Di Giuliantonio (2015), Boyarchenko and Mueller (2020), Chodorow-Reich, Haddad, and Ghent (2021), Ang, Gorovyy and van Inwegen (2011).

Instead, the literature has focused on measuring financial intermediaries' exposure to run risk associated with liquidity and maturity transformation.[3]

II.2 Financial vulnerabilities at lower frequencies

Financial cycles in credit and asset markets occur at lower frequencies than business cycles, with an estimated average cycle length of approximately 15 years.[4] The amplitudes of financial cycles, measured by the increase in leverage and asset prices from trough to peak, have increased markedly since the 1970s (Jordà, Schularick, and Taylor, 2013). One potential reason for this amplification is a strong and increasing international component of financial cycles that takes the form of a global financial cycle.[5]

II.3 Caveats

One caveat to the evidence on financial cycles discussed above is that such evidence is primarily based on long histories of aggregated data, yet the histories of the variables of interest are not long enough to evaluate the extent to which the financial cycle responds to regulatory, technological and other slow-moving changes in the structure of the economy.[6] It is thus possible that the financial cycles discussed above are driven by regulatory changes. For example, leverage for the banking sector, both in the U.S. and globally, exhibits a structural break after the global

[3] The literature has documented that "runnable" institutions include banks, broker-dealers, fixed income mutual funds, life insurance companies, and non-bank mortgage providers. See e.g., Ivashina and Scharfstein (2010), Acharya and Mora (2015), Kacperczyk and Schnabl (2013), Copeland, Martin and Walker (2010), Gorton and Metrick (2009), Duffie (2020), Bao, David and Han (2015), Sengupta and Xue (2020), Falato, Goldstein and Hortascu (2021), Koijen and Yogo (2017), Foley-Fisher, Heinrich, and Verani (2020), Kim et al. (2018).
[4] Drehmann et al. (2012) calculate that internationally the duration of financial cycles in credit and house prices has increased to 16 years in the past four decades, but exact number depend on filtering choices.
[5] International co-movement of risk premiums appears to be driven by the role of global banks as key investors in international markets (Jorda, Schularick, Taylor, and Ward, 2019; Aldasoro et al., 2020).
[6] Studies that rely on micro data, such as credit registries, are also likely not sufficient to overcome these empirical challenges, because micro data typically have short history, and are not available for nonbank financial intermediaries. In addition, studies that rely on such data are mostly focused on identifying the causal effect of, say, capital requirements on bank lending, not the aggregate impact of regulatory changes (Behn, Haselmann and Wachtel, 2016; Gropp et al, 2019; Fraisse, Lé, and Thesmar, 2020; De Jonghe, Dewachter and Ongena, 2020; Favara, Ivanov and Rezende, 2021).

financial crisis (GFC), potentially limiting our ability to understand the cyclicality of bank leverage in the post-GFC regulatory regime (Adrian, Boyarchenko and Shin, 2015).

III. Empirical evidence on financial vulnerabilities and real outcomes

This section relates financial vulnerabilities to risks to economic growth, as well as to the occurrence and severity of financial crises. Financial vulnerabilities that have a material impact on the real economy appear to emerge from the interplay of asset prices and credit growth—credit-fueled asset price booms that expose not only the financial system, but also households and firms, to a repricing of a large pool of leveraged assets and associated wealth losses (Jordà, Schularick and Taylor, 2015a). The triggers for the repricing can vary and may include exogenous shocks or sentiment reversals.

III.1 Financial vulnerabilities and economic crises

Accelerations in nonfinancial credit growth, measured as expansions of the ratio of credit to GDP or similar indicators relative to country-specific trends, are systematically associated with increasing risks of financial instability and subpar macroeconomic outcomes in international and U.S. long-run data (Borio and Lowe, 2002; Schularick and Taylor, 2012; Aikman, Haldane and Nelson, 2015; Mian, Sufi, and Verner, 2017; Greenwood et al., 2021). In addition, credit growth accelerations and looser-than-average financial conditions predict increased downside risks around the mean paths of real economic outcomes (Jordà, Schularick and Taylor, 2013; Adrian et al., 2019; Mian, Sufi, and Verner, 2017; Adrian et al., 2020). For instance, estimates suggest that the average annual crisis probability of about 4 to 5 percent increases to more than 25 percent if the most recent five-year credit growth is two standard deviations above the mean (Schularick and Taylor, 2012).[7]

Looking at the aftermath of non-financial credit booms across different forms of credit, household (especially mortgage) credit booms tend to be followed by worse real outcomes than business credit booms (Jordà, Schularick and Taylor, 2015b; Mian, Sufi and Verner, 2017; Jordà, Schularick and Taylor, 2020). The build-up of credit in the household sector predicts increased

[7] More recent estimates imply that the cumulative probability of entering a financial distress episode surges to 45 percent when equity price growth is in the top tercile of the distribution, and business credit growth is in the top quintile (Greenwood et al., 2021).

volatility and negative skewness of medium-term real economic outcomes, and negative tail events in GDP growth, consumption and investment (Schularick and Taylor, 2012; Jordà, Schularick and Taylor, 2013; Mian, Sufi and Verner, 2017; Greenwood et al., 2021; Richter, Schularick and Wachtel, 2021). Corporate credit booms have historically also been associated with heightened financial crisis risks in terms of bank failures and panics, but the consequences for the real economy are typically less severe (Mian, Sufi, Verner, 2017; Jordà, Kornejew, Schularick and Taylor, 2020; Mueller and Verner, 2020). Increases in financial sector leverage have also been associated with downside risks to medium-term growth (Boyarchenko, Giannone, and Kovner, 2020), and long-run cross-country data show that higher capitalization of the financial sector moderates the real effects of financial distress (Jordà, Richter, Schularick and Taylor, 2021; Gropp, Hakenes and Schnabel, 2011; Brunnermeier, Rother and Schnabel, 2020).

Financial vulnerabilities often build in benign macroeconomic environments when market participants become more willing to invest in riskier projects (Minsky, 1985; Kindleberger and Aliber, 2005).[8] Yet, risk premiums in credit and equity markets tend to be abnormally low during credit and financial booms (Krishnamurty and Muir, 2018; López-Salido, Stein and Zakrajsek, 2017).[9] Abnormally low risk premiums appear inconsistent with a positive price of risk, suggesting potential mispricing (Baron and Xiong, 2017).[10] Asset price increases during economic expansions are often followed by asset price crashes during crises, potentially triggering deleveraging spirals, exacerbating credit rationing and wealth losses.

III.2 Financial vulnerabilities and predicting negative tail outcomes

The build-up of credit and rising asset prices typically occur over a long period of time, resulting in some challenges in identifying credit booms and asset bubbles with sufficient confidence as they are occurring (Bernanke and Gertler, 2001; Pastor and Veronesi, 2006; O'Hara, 2008).

[8] More recently, Bordalo, Gennaioli and Shleifer (2018), and Greenwood et al. (2021) have taken up these ideas.
[9] Estimates from these studies suggest that the market pricing of credit risk is roughly 25 basis points below the normal level at a time when risks of financial distress rise sharply. In the equity market, Baron and Xiong (2017) and Fahlenbrach et al. (2018) show accumulations of risks on banks' balance sheets are not reflected in bank equity prices.
[10] For instance, investors do not seem to demand a compensation for the higher crash risk in bank shares during credit booms (Baron and Xiong, 2017). This evidence could be explained by the importance of adaptive expectations in financial markets and among financial intermediaries (Bordalo, Gennaioli, Shleifer, 2018; Richter and Zimmermann, 2020) or by time-varying intermediary balance sheet constraints (Geanakoplos 1997, Adrian and Boyarchenko, 2012).

Progress has been made in developing real time indicators of market sentiment, and early-warning signals of financial crises.[11] A different empirical approach to predicting negative tail outcomes, such as financial crises, focuses on assessing the risks to future real outcomes (Adrian, Giannone, and Boyarchenko, 2019). This approach finds that lower risk premiums and higher credit growth predicts higher median path of real outcomes and lower uncertainty around the median path in the short-run, but a lower median path and increased uncertainty around the median path in the medium-run, defined as two to three years out. This volatility paradox is a feature of theoretical models of non-linear, endogenous amplification of shocks—such as those discussed in Section III.2 of Ajello et al. (2022)—as low risk in the near term provides the opportunity for financial intermediaries to build up leverage.[12]

III.3 Caveats

While there has been some success in designing prediction models for financial crises, some caveats and open questions remain. With respect to definitions, there is no widely accepted definition of what constitutes a credit or an asset price boom. Credit booms are generally defined as large and persistent deviations of credit aggregates or asset prices from some historical average (Ordonez et al., 2020; Richter, Schularick and Wachtel, 2021). The existing literature has employed different techniques to establish trend or fundamental values (such as different time-series filters, reference to model-based fundamental values) and different approaches to measure deviations from such trends (using different thresholds and normalizations). The performance of early warning models is sensitive to such choices and summarizing the evidence across different methods and samples is difficult.[13]

[11] Gao and Martin (2021) propose a sentiment indicator to measure real time measures of market "bubbliness". Richter et al (2021) identify the markers of bad credit booms. See also Drehmann and Juselius (2014).
[12] Although much of this so-called "growth-at-risk" literature has focused on the relationship between financial conditions and the risks to future real GDP growth, the literature has documented a similar volatility paradox for unemployment (Kiley, 2018; Adams et al 2021) and to a lesser extent for inflation (Ghysels, Iania and Striaukas, 2018; Lopez-Salido and Loria 2020; Adams et al., 2021).
[13] The best forecasting performance for financial distress is often achieved by atheoretical data mining models, such as random forest and other learning-based classification tree methods (Ward, 2017; Fouliard, Howell, and Rey, 2021). The "black box" properties of these tools make them unattractive for policy decisions.

IV. Empirical evidence on the impact of monetary policy on financial vulnerabilities

The theoretical literature, summarized in Ajello et al. (2022), suggests that accommodative monetary policy has the potential to create financial vulnerabilities by raising asset valuations, compressing risk premiums, boosting leverage, as well as encouraging liquidity and maturity transformation. Theoretical models also suggest that monetary policy easing intended to counteract negative shocks in the shorter run may lead to vulnerabilities in the longer run.

Despite these theoretical predictions, the empirical literature thus far provides limited evidence that monetary policy creates vulnerabilities related to leverage or maturity and liquidity transformation. Instead, there is evidence that monetary policy affects asset valuations through risk premiums and that monetary policy easing may boost risk appetite. However, as discussed in Section III of this paper, stretched asset valuations, and compressed risk premiums need to be accompanied by the buildup of other financial vulnerabilities, such as excessive leverage, to affect the real economy meaningfully.

Estimates of elasticities of key financial vulnerabilities to monetary policy and other empirical facts surveyed in this section are summarized in the Table at the end of this paper.

IV.1 Asset valuations and Reach-for-yield

Asset valuations

The empirical literature broadly agrees that asset prices respond to unanticipated changes in monetary policy.[14] Elasticity estimates vary across empirical models, asset classes and sample periods, but on average unanticipated changes in monetary policy, conventional and unconventional, lead to significant changes in longer-term Treasury yields, stock prices and corporate bond spreads.[15] As reported in the Table at the end of this paper, the size of these changes is notable, but modest in magnitude relative to the typical volatility of these asset prices.

[14] Unanticipated changes in monetary policy means changes that financial markets do not expect ex-ante. Following Kuttner (2001), a large empirical literature uses an event study approach to identify the causal effects of monetary policy on asset prices.

[15] See, for example, Rigobon and Sack (2004), Bernanke and Kuttner (2005), Nakamura and Steinsson (2018). Hanson and Stein (2015), Gertler and Karadi (2015), Gilchrist, Lopez-Salido and Zakrajsek (2015), Gagnon et al. (2011), Krishnamurthy and Vissing-Jorgensen (2011), Swanson (2021), Lunsford (2020).

Event study-based evaluations find that monetary policy affects asset prices mostly through changes in risk premiums. For example, a surprise easing in the interest rate target and path is typically associated with a decline in longer-term nominal Treasury yields that is almost entirely attributable to a fall in the term premium (Krishnamurthy and Vissing-Jorgensen, 2011; Hanson and Stein, 2015; Gilchrist, Lopez-Salido and Zakrajsek, 2015). Likewise, a surprise easing results in a decline in credit risk premiums that is roughly equal to the total fall of corporate bond spreads, and an increase in the equity premium that drives most of the fall in stock prices (Bernanke and Kuttner, 2005; Gertler and Karadi, 2015; Gilchrist, Lopez-Salido and Zakrajsek, 2015). While reducing risk premiums is one of the key channels through which conventional and unconventional monetary policy support the economy, low risk premiums can become a source of financial vulnerability if they contribute to stretched asset valuations.

For house prices, empirical research shows that monetary policy easing boosts housing valuations. However, the contribution of monetary policy to housing price movements appears to be small relative to the average growth rate of house prices (Del Negro and Otrok, 2007; Jarocinski and Smets, 2008; Kuttner, 2014). Recent evidence also suggests that the effects of monetary policy on house prices may be non-linear, with house prices less responsive when prices are high and more responsive when prices are low (Paul, 2020).

Reach-for-yield

Evidence that accommodative monetary policy boosts risk appetite through a "reach-for-yield" channel is mixed in the United States, depending on the type of intermediary.[16]

Evidence of banks reaching for yield is inconclusive. Some studies find that low interest rates in the run-up to the GFC led to higher bank portfolio risk and more credit origination to riskier borrowers (Altunbas, Gambacorta, and Marques-Ibanez, 2010; Maddaloni and Peydro, 2014; Dell'Ariccia, Laeven and Suarez, 2017).[17] However, the estimated effects in these studies are not in general economically large. Furthermore, these findings are sensitive to the way monetary

[16] Reach-for-yield typically refers to the notion that investors and financial intermediaries have a higher propensity for bearing risk when interest rates are low (Rajan 2005; Adrian and Shin, 2009; Borio and Zhu, 2012; Diamond and Rajan, 2012; Feroli et al. 2014; Acharya and Naqvi, 2016; Campbell and Sigalov, 2020).
[17] Related research finds that U.S. banks charge risky borrowers lower loan spreads than safe borrowers in periods of monetary policy easing (Delis, Hasan, and Mylolonidis, 2017; Paligorova and Santos, 2017).

policy is measured, such as policy rate changes, monetary policy surprises, or residuals of standard monetary policy rules.[18] In addition, the evidence relating unconventional monetary policy surprises to bank risk-taking suggests that in the post-2009 period, the Federal Reserve's forward guidance and asset purchase programs had beneficial effects on banks without inducing excessive risk-taking (Chodorow-Reich, 2014).

Evidence for U.S. nonbank financial institutions (NBFIs) suggests some propensity to reach-for-yield. Money market funds, for example, responded to the Fed's commitment to keep interest rates at the zero lower bound in the post-GFC period by extending into riskier assets and holding less diverse portfolios (Chodorow-Reich, 2014; Di Maggio and Kacperczyk, 2017). Other financial intermediaries, including corporate bond mutual funds, pension funds, and insurance companies, have also responded to low levels of interest rates post crisis by holding riskier investment portfolios (Choi and Kronlund, 2019; Lu, Pritsker, Zlate, Anadu, and Bohn, 2019; Foley-Fisher, Heinrich and Verani, 2020).[19] To date there is no empirical evidence that these micro-level estimates have meaningful implications for financial stability.

IV.3 Financial Leverage, Liquidity and Maturity Transformation

Another channel through which monetary policy may generate vulnerabilities is by increasing financial intermediaries' leverage, as low rates make borrowing cheaper for banks and other financial intermediaries. As accommodative monetary policy boosts asset prices and the net worth of financial intermediaries rise through valuation effects, financial institutions may also expand their balance sheets in response to lower rates by increasing leverage.

For banks, estimates of the elasticity of deposit funding to changes in short-term rates are low, as banks appear to have market power over retail deposits (Driscoll and Judson, 2013; Drechsler, Savov, and Schnabl, 2021).[20] In contrast, there is evidence, albeit limited, suggesting that the cost of borrowing of broker dealers and other NBFIs is tightly linked to short-term interest rates

[18] Empirical evidence on Europe finds a stronger reach-for-yield effect in response to conventional monetary policy easing, especially if banks have low capital, interest rates have been low for an extended period, and banks' supervision is weak (Jimenez et al., 2014; Maddaloni and Peydro, 2011; Bonfim and Soares, 2018).
[19] Other NBFIs (notably REITs) reach-for-yield in response to U.S. unconventional monetary policy by increasing leverage rather than credit risk (Frame and Steiner, 2020).
[20] While the estimated average effect is small, the marginal increase of funding costs can be larger if banks raise marginal funds in rate sensitive markets.

(Adrian and Shin, 2010). Thus, a decline in the federal funds rate that, to a first approximation, reduces the cost of wholesale funding, may push NBFIs to increase leverage through higher short-term debt. However, whether these policy-induced effects are quantitatively important remains an open question.

The evidence based on aggregate leverage ratios indicates that a monetary policy easing leads to higher banks and broker dealers' leverage (assets-to-equity ratio) over a one-year horizon, but the estimated effects are not large (Miranda-Agrippino and Rey, 2020).[21] There is also international evidence that persistent monetary policy easing is associated with some increase in aggregate bank leverage, and that this effect is bigger at lower rates than higher ones (Cecchetti, Mancini-Griffoli and Narita, 2020).

Low rates can also lead to higher financial intermediary leverage if expansionary monetary policy reduces market volatility and intermediaries use value-at-risk (VaR) constraints to manage their risks (Adrian and Boyarchenko, 2012; Adrian and Shin, 2014; Stulz, 2016). To date, however, there is no empirical evidence studying the link between monetary policy and financial intermediary leverage through VaR constraints.[22]

Another potential channel through which monetary policy may contribute to the buildup of financial vulnerabilities is by changing the incentives of banks and NBFIs to engage in liquidity and maturity transformation, as monetary policy affects the opportunity cost of holding liquidity buffers and thus the willingness of these institutions to change the supply of credit. The evidence for banks suggests that monetary policy does not have a significant effect on total liquidity creation at banks (Berger and Bowman, 2017). In addition, changes in interest rates are estimated to have only moderate and transitory effects on bank earnings, suggesting that banks provide maturity transformation without much exposure to interest rate risk, thus posing little financial stability concerns (English, Van den Heuvel and Zakrajšek, 2018; Drechsler, Savov, and

[21] Coimbra and Rey (2020) present evidence that lower interest rates are associated with leverage increases at most levered banks.

[22] Coimbra, Kim and Rey (2021) show, however, through counterfactual analysis, that the accommodative monetary policy expansion following the GFC led the most levered banks to increase their value-at-risk.

Schnabl, 2021).[23] For NBFIs the evidence is limited, but suggests (Xiong, 2020) that monetary tightening may promote the migration of deposits from banks to money market funds (MMFs). To the extent that bank deposits are insured but large deposits at MMFs are not, this migration may have financial stability implications.

IV.4 Household and Business Leverage

Event-study analyses provide compelling evidence that conventional and unconventional monetary policies affect the cost of borrowing for businesses and households by changing corporate bond yields and primary mortgage rates (Krishnamurthy & Vissing-Jorgensen, 2011; Gilchrist, López-Salido & Zakrajšek, 2015; Di Maggio, Kermani and Palmer, 2020). However, evidence that monetary policy influences household and business debt is mixed.[24]

For households, monetary policy may increase borrowing through home-equity extraction. Available estimates suggest that monetary policy easing that leads to lower mortgage rates is associated with a rise in the likelihood of households borrowing against home equity (Bhutta and Keys, 2016). The literature also documents that half of the increase of U.S. household debt since the 1980s has been driven by equity extraction, underlining the quantitative importance of the channel (Bartscher et al., 2020). Monetary policy can also affect household debt through mortgage rate refinancing, which can help households to reduce debt servicing costs and strengthen their balance sheets (Di Maggio, Kermani and Palmer, 2020; Beraja, Fuster, Hurst, Vavra, 2019). Partly because of data limitations, there is not much evidence relating monetary policy to other forms of household debt, such as auto and credit card loans.

Regarding the role of monetary policy for nonfinancial business leverage, the available U.S. evidence suggests that while policy easing raises the share of loans versus bonds in total corporate borrowing, it does not necessarily boost aggregate corporate leverage (Becker and Ivashina, 2014; Crouzet, 2021). For unconventional monetary policy, there is some evidence that

[23] See, however, Begeneau and Stafford (2021) for recent evidence that banks are not fully insulated from interest rate risk. A canonical example of interest rate risk in the financial sector is the Savings and Loan (S&L) crisis of the 1980s, when the interest rate sensitivity of deposits for S&Ls jumped as Regulation Q was repealed, causing S&Ls insolvency when interest rates begun to rise in the 1980s.

[24] Mason and Jayadev (2014) show that the historical evolution of U.S. household leverage ratios has largely been driven by variation in income growth, inflation and interest rates, rather than changes in borrowing.

firms relying mostly on longer-term debt benefit from the reductions in long-term interest rates by issuing more long-term debt (Foley-Fischer, Ramcharan, and Yu, 2016).

IV.5 Caveats

There are a number of caveats to the conclusions that can be drawn from the empirical research on the effects of monetary policy on financial vulnerabilities. First, event studies that rely on micro data and high-frequency identification of monetary policy surprises—while useful to identify a causal channel running from monetary policy—cannot evaluate the role that monetary policy plays in the build-up of financial vulnerabilities over time.

Second, estimates of the elasticities relating vulnerabilities to monetary policy do not usually account (either because of data limitations or empirical design) for asymmetries and nonlinearities related to the state of the economy, the monetary policy stance, and the regulatory environment. For example, expansionary monetary policy in the middle of a recession may have different effects on financial vulnerabilities than during a long expansion.

Third, and related to the second caveat, while the literature documents that financial vulnerabilities may build following a monetary policy easing, monetary policy tightening may also increase financial stability risks. Tighter monetary policy may, for example, lead to the migration of credit from banks to less regulated financial intermediaries, possibly reducing financial stability if these institutions have more structural vulnerabilities than regulated banks.

V. Conclusions and Gaps in the Literature

Overall, the literature surveyed in this paper suggests that the academic consensus has evolved since the 2007-2009 financial crisis to recognize that financial vulnerabilities are quantifiable, that such vulnerabilities have the potential to adversely affect the real economy, and that monetary policy may contribute to their accumulation over time.

Several gaps, however, remain in evaluating empirically the relationship between monetary policy, financial vulnerabilities, and real outcomes. First, quantifying the direct link between monetary policy and financial vulnerabilities with data alone (as opposed to in a structural model) is challenging due to the slow-moving nature of financial vulnerabilities, predictable

variation in the stance of monetary policy over the business cycle, and other confounding factors. The rare nature of financial crises further makes it hard to measure how structural changes in the economy, such as those due to technological innovations, regulatory changes, the evolving nature of financial intermediation and low frequency macro trends, affect the interaction between monetary policy and financial vulnerabilities and their impact on the real economy.

Second, the literature often confounds the financial stability implications of changes in monetary policy from those due to changes in the long-run natural rate of interest, especially with reference to the evidence on reach-for-yield discussed in section IV.1.

An equally unexplored area of research is quantifying the extent to which keeping monetary policy accommodative for a prolonged period to run a high-pressure economy contributes to the buildup of financial vulnerabilities. In addition, little is known about the extent to which monetary policy that stabilizes the economy and reduces economic volatility invites more risk-taking and increases financial vulnerabilities.

Glossary

- **Financial instability** is the propensity of the financial system – defined broadly to include financial intermediaries, financial markets, payment systems and the central bank – to materially amplify negative shocks that originate in the real economy and/or to be a source of sizable shocks itself, both with negative consequences for the real economy. A stable financial system can withstand most shocks with minimal disruptions to the real economy.
- **Financial vulnerabilities** are features of the financial system that make it less stable. The financial vulnerabilities that are the object of this paper evolve over time, where the frequencies with which they vary potentially differ from those of business cycles.
- **Financial conditions** provide a timely indicator of the near-term state of the business and financial cycles. They are distinct from financial vulnerabilities, which summarize potential exposures to future shocks. A system may be unstable even when financial conditions are accommodative.
- **Net financial vulnerabilities** are those vulnerabilities that remain after taking into account the regulatory and supervisory environments.

Table. Selected Elasticities of Key Asset Prices and Financial Vulnerabilities to Monetary Policy

Panel A. Asset Valuations				
	Author	**MP Regime/ Time Period**	**Method**	**Estimated Effects**
Stock Prices	Bernanke and Kuttner (2005)	Conventional 1989-2002	Event Study	100bps decline in fed funds futures is followed by a 4% rise in the S&P500 index.
	Rigobon and Sack (2004)	Conventional 1994-2001	Event Study	100bps decline in the federal funds rate is followed by 7% rise in the S&P500 index
	Nakamura and Steinsson (2018)	Conventional/ Unconventional 2000-2014	Event Study	100bps decline in the two-year nominal Treasury yield is followed by 6.5% rise in the S&P500 index.
	Lunsford (2020)	Unconventional 2000-2006	Event Study	A forward guidance surprise about the economic outlook (roughly equivalent to 100bps decline in the expected path of the federal funds rate over the next 6-months) is followed by a 9% drop in the S&P500 index. The same surprise about policy inclinations is followed by a 23% increase.
Treasury Yields	Krishnamurthy and Vissing-Jorgensen (2011)	QE1 and QE2	Event Study	QE1 announcement of $300 billion in Treasury securities purchases is followed by 25-40bps decline in longer-term Treasury bond yields. Weaker effects for QE2.
	Swanson (2021)	Unconventional 1991-2019	Event Study	LSAPs shock, equivalent to $125 billion in asset purchases, is followed by a 10-year Treasury yield decline of 6.5bps.
	Hanson and Stein (2015)	Conventional/ Unconventional 1999-2012	Event study	100bps decline in the two-year nominal yield is followed by a 45bps decline in the ten-year nominal forward rate.

Panel A. Asset Valuations (*continued*)				
	Author	**MP Regime/ Time Period**	**Method**	**Estimated Effects**
Corporate Bond Yields and Spreads	Krishnamurthy and Vissing-Jorgensen (2011)	Unconventional	Event Study	QE1 announcements were followed by a decline in 10-year CDS rates on Baa corporate bonds of up to 40bps.
	Gertler and Karadi (2015)	Conventional/ Unconventional 1979-2012	VAR	100bps decline in the one-year rate is followed by a 40bps decrease in credit risk premium on corporate bonds
	Gilchrist, Lopez-Salido and Zakrajsek (2015)	Conventional 1999-2008 Unconventional 2008-2013	Event study	100bps decline in the two-year nominal Treasury yield is followed by 70bps and 150bps decline in investment-grade corporate bond yields of nonfinancial firms during a conventional and an unconventional monetary policy regime, respectively.
House Prices	Del Negro and Otrok (2007)	Conventional 1986-2005	VAR	100bps monetary policy easing is followed by a 2 to 4% increase in house prices.
	Jaroncinsky and Smets (2008)	Conventional 1987-2007	VAR	100bps monetary policy easing is associated with a 3% increase in house prices after 2 years.
	Kuttner (2012)	Conventional 1984-2011	VAR	100bps decline in the fed funds rate is followed by a house prices increase of 1% to 3%.
	Paul (2021)	Conventional/ Unconventional 1991-2017	VAR	House price response to a 100bps unexpected change in the fed funds rate is twice as large when house prices are low as when prices are high.

Panel B. Reach-for-yield				
	Author	**MP Regime/ Time Period**	**Method**	**Estimated Effects**
Banks	Maddaloni and Peydro (2011)	Conventional 2002-2008	Panel regression	100bps decline in the fed funds rate is associated with a softening of standards for business loans roughly five times higher than the softening due to a comparable increase of real GDP growth.
	Dell'Ariccia, Leaven and Suarez (2017)	Conventional/ Unconventional 1997-2011	Panel regression	100bps decline in the fed funds rate is associated with a decline of loan risk ratings of roughly 1% for a bank with a relatively high Tier 1 capital ratio relative to low Tier 1 capital ratio banks.
	Delis, Hasan, and Mylonidis (2017)	Conventional/ Unconventional 1987-2012	Panel regression	100bps monetary policy unanticipated decline in the fed funds rate results in a decline in loan spreads of 25bps.
Non-Bank Financial Institutions	Di Maggio and Kacperczyk (2017)	Unconventional 2005-2013	Event study	A fed funds rate decline from 1% to 0% increases money market funds' returns by almost 60bps, the weight of risky assets by 6%, the weighted maturity by 2 days, and the concentration of risky assets by 3%.
	Choi and Kronlund (2019)	Conventional/ Unconventional 2002-2012	Panel regression	100bps decline in the 1-year Treasury yield increases reach-for-yield (deviation from benchmarks) of corporate bond mutual funds by 4bps.
	Lu, Pritsker, Zlate, Anadu, and Bohn (2019)	Conventional/ Unconventional 2001-2016	Panel regression	100bps decline in the 1-year Treasury yield increases portfolio risk (measured by the conditional VaR) by 1.8bps.
	Chodorow-Reich (2014)	Unconventional 2008-2009	Event study	QE announcements associated with a 100bps fall in the 5-year Treasury yield were followed by a fall in life insurers' CDS spread and bond yields of 80bps and 120bps, respectively, and a 20% rise in their stock prices.

Panel C. Financial Leverage, Liquidity and Maturity Transformation				
	Author	**MP Regime/ Time Period**	**Method**	**Estimated Effects**
Banks and other Financial Intermediaries	Cecchetti, Mancini-Griffoli and Narita (2020)	Conventional/ Unconventional 1998-2014	International panel regression	After a 2-year prolonged monetary policy easing, banks' leverage ratios rise from roughly 17 to 20. An extra quarter of easing increases banking system leverage about 20bp.
	Miranda-Agrippino and Rey (2020)	Conventional/ Unconventional 1980-2010	VAR	100bps unanticipated decline in the fed funds rate is associated, over a one-year horizon, with an increase in aggregate leverage of U.S. banks of 1 percentage point.
Panel D. Household and Business Leverage				
	Author	**MP Regime/ Time Period**	**Method**	**Estimated Effects**
Household and Business Leverage	Bhutta and Keys (2016)	Conventional/ Unconventional 1999-2011	Panel regression	100bps decline in the fed funds rate increases equity extraction by roughly 2pp.
	Di Maggio, Kermani and Palmer (2020)	Unconventional 2008-2014	Event study	QE1 reduced mortgage interest rates by 100bps and increased mortgage refinancing by over 56% over the first six months.
	Crouzet (2021)	Conventional/ Unconventional 1990-2007	Panel regression	100bps easing in monetary policy is followed by an increase in nonfinancial business borrowing by approximately 2pp in the short-run, and 4.5pp one year out.
	Foley-Fischer, Ramcharan, and Yu (2016)	Unconventional	Event study	During QE1, firms with high dependence on long-term debt increased long-term debt growth by about 8pp.

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