STAFF
REPORTS

NO. 1002
FEBRUARY 2022

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FEDERAL RESERVE BANK *of* NEW YORK

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Federal Reserve Bank of New York Staff Reports, no. 1002
February 2022
JEL classification: E44, E52, E58, G2

Abstract

This paper reviews the theoretical literature at the intersection of macroeconomics and finance to draw lessons on the connection between vulnerabilities in the financial system and the macroeconomy, and on how monetary policy affects that connection. This literature finds that financial vulnerabilities are inherent to financial systems and tend to be procyclical. Moreover, financial vulnerabilities amplify the effects of adverse shocks to the economy, so that even a small shock to fundamentals or a small revision of beliefs can create a self-reinforcing feedback loop that impairs credit provision, lowers asset prices, and depresses economic activity and inflation. Finally, monetary policy may affect the buildup of vulnerabilities, but the sign of the impact along some of its transmission channels is theoretically ambiguous and may vary with the state of the economy.

Key words: monetary policy, financial stability, credit, leverage, liquidity, asset prices

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I. Introduction

This paper reviews the theoretical macro-finance literature to draw lessons on the connection between vulnerabilities in the financial system and the macroeconomy, and on how monetary policy affects that connection.[2] This review focuses on the analysis of the connections, taking a "positive" approach in the current monetary and regulatory environment, and deliberately abstracts from the "normative" analysis of the trade-offs in setting monetary policy.

We draw three main lessons from this literature. First, financial vulnerabilities are inherent to financial systems and tend to be procyclical. The financial system enables households and firms to borrow and lend, and to diversify and manage risks, supporting economic activity through credit, maturity, and liquidity transformation. When combined with information asymmetries or other frictions, these transformations may lead to the emergence of financial vulnerabilities. Financial vulnerabilities can accumulate over the course of economic expansions, especially when asymmetric information or other frictions, coupled with potentially irrational beliefs, lead to an underestimation and/or an underpricing of risk, and ultimately to higher risk-taking.

Second, financial vulnerabilities amplify the effects of adverse shocks to the economy. Given high leverage, elevated asset prices, and substantial liquidity or maturity mismatch, even a small shock to fundamentals or a revision of beliefs can create a self-reinforcing feedback loop that impairs credit provision, lowers asset prices, and depresses economic activity and inflation.

Finally, monetary policy can affect the buildup of vulnerabilities. As part of its standard transmission channels, monetary policy affects asset prices, lending and risk-taking by financial institutions, and borrowers' balance sheets, and hence overall vulnerabilities. However, the sign of some of these effects is theoretically ambiguous and may vary with the state of the economy.

Overall, the literature we survey suggests that the academic consensus has evolved since the 2007-2009 financial crisis to recognize that financial vulnerabilities have the potential to adversely affect the real economy, and that monetary policy may contribute to their accumulation over the business cycle and at longer frequencies.

[2] A glossary at the end of this paper defines the concepts of financial instability, financial vulnerabilities, net financial vulnerabilities, and financial conditions.

We also highlight a number of as-yet-unresolved issues that call for more research. First, the nonlinear interactions between monetary policy, financial stability, and macroeconomic outcomes are technically challenging to model and hard to estimate empirically, making definite quantitative conclusions on their relevance difficult. Furthermore, while we focus here on vulnerabilities which remain after accounting for the overall resilience of the financial system—often referred to as net vulnerabilities – the structure of the financial system (including macro-prudential and supervisory policies) may also affect the connections between monetary policy, financial stability, and macroeconomic outcomes.

Second, while many studies consider whether financial vulnerabilities are more likely to emerge in a low interest rate environment, more work is needed to understand how this relationship depends on the source of low interest rates. Conceptually, variation in the level of interest rates can arise from four types of sources: (a) secular variation in the "neutral" interest rate (such as the current "low r*" environment); (b) cyclical variation in the neutral rate (arising for example from productivity or demand fluctuations); (c) the overall conduct of monetary policy as a systematic response to economic outcomes, including potentially financial conditions; (d) monetary policy surprises i.e. deviations from this perceived systematic response. These sources of variation in interest rates potentially act through different channels: for example, the perceived systematic conduct of policy could affect financial vulnerabilities not only directly through current interest rates, but also through their influence on households', firms', and investors' policy expectations and behavior. Separating these sources empirically is challenging; Boyarchenko et al. (2022) discuss the lessons that can be learned from the empirical literature on financial vulnerabilities and monetary policy.

There are several other reviews of these topics.[3] The emphasis in our review is on mechanisms that are relevant for the U.S. financial system, which is less bank-centric than many, and we also emphasize more recent research, including research that incorporates nonlinearities, tail risk, and behavioral frictions.

The rest of the paper is organized as follows. Section II reviews why vulnerabilities arise in the financial system. Section III discusses how vulnerabilities can affect the real economy. Section

[3] Smets (2014), Kashyap and Siegert (2020), Adrian and Liang (2018), Stein (2021), Goldberg et al. (2020).

IV studies how monetary policy affects vulnerabilities. Section V discusses some gaps in the literature.

II. Financial Vulnerabilities Are Inherent to Financial Systems

The financial system facilitates transactions between borrowers and savers. Frictions such as incomplete information, however, can lead to financing decisions that are privately, but not socially, optimal, and that can often generate financial vulnerabilities. This section reviews theories of financial vulnerabilities. These theories highlight how frictions create interdependencies between real activity, its financing, and monetary policy. As the financial system intermediates credit and finances real activity, it performs two key functions that can lead to the build-up of vulnerabilities: (1) credit risk transformation through leverage, and (2) maturity and liquidity transformation.

Credit risk transformation takes place when risky assets are financed with debt. In theory, without frictions, financing decisions do not affect the value of a project.[4] In practice, they do because of private information, agency costs, tax advantages of debt, and other market imperfections. Consequently, debt contracts can be privately, but not socially, optimal because individual borrowers ignore the effect of their decisions on others. For example, future defaults can be associated with bankruptcy costs, forced deleveraging can create fire sales, and spending reductions due to financial constraints can create aggregate demand externalities (as described in section III).[5]

These individually optimal debt choices affect how borrowing evolves with the state of the economy, creating a "borrowing cycle". In expansions, borrowing may increase due to shifts in either credit supply—for example, due to an increase in savings by wealthy households and firms—or credit demand—for example, due to optimism about future productivity growth.[6] These theories all predict a procyclical borrowing cycle, with debt increasing during economic expansions, but disagree on the implications for the cyclicality of leverage – defined as the ratio

[4] Modigliani and Miller (1958).
[5] Jensen and Meckling (1976), Townsend (1979), Gale and Hellwig (1985), Harris and Raviv (1990), Winton (1995), and Park (2000) are some of the early theories of the private optimality of debt contracts.
[6] For models of increasing credit demand in expansions, see Bordalo et al. (2018); Bordalo et al., (2021); Krishnamurthy and Li, (2020); Maxted (2020). For models of increasing credit supply, see Mian, Straub and Sufi (forthcoming), Boz and Mendoza (2014); Bolton, Santos and Scheinkman (2021).

of assets to equity. As discussed in Boyarchenko et al. (2022), the leverage of most U.S. financial institutions is procyclical. From a theoretical perspective, leverage is procyclical when there is a self-reinforcing feedback between asset prices and leverage: higher asset prices increase the value of assets held by financial institutions and the amount that they can borrow against each dollar of those assets, leading to even more leverage and further asset price increases.[7]

Borrowing cycles can be amplified if risk is underpriced in booms either because of a low perceived exposure of borrowers and savers' balance sheets to shocks (the "quantity of risk"), or because constraints are less binding and risk-taking by financial institutions increases, reducing the compensation that market participants require for being exposed to shocks (the "price of risk").[8] Incentives, financial frictions and beliefs interact: when optimism boosts asset prices, borrowing is easier, and incentives can become distorted, leading to increased lending. Expectations of policy support in the event of a financial recession can also encourage agents to take on more risk in anticipation of it, further boosting asset prices and lowering risk premia.[9]

In addition to credit risk transformation through leverage, financial institutions may also engage in maturity and liquidity transformation, creating funding vulnerabilities. Banks transform liquid short term deposits into illiquid loans with long maturities. This transformation makes banks vulnerable to sudden belief reversals, which can trigger runs, even when the value of banks' assets is greater than that of their liabilities.[10] Funding vulnerabilities are also relevant for non-banks, with the same mechanism of funding withdrawals leading to self-fulfilling runs.[11] Changes in the provision of maturity and liquidity transformation over the business cycle have

[7] Geanakoplos (1997, 2010), Fostel and Geanakoplos (2008, 2014), Brunnermeier and Pedersen (2009), Adrian and Shin (2010, 2014), Adrian and Boyarchenko (2012, 2013), and Adrian and Duarte (2020). Asset prices can increase because of changes in investors' beliefs about either the fundamental (Brunnermeier and Pedersen, 2009) or the resale value of assets (Scheinkman and Xiong (2003), Barlevy (2007), Brunnermeier and Oehmke (2013a)). Leverage is countercyclical in Kiyotaki and Moore (1997), Bernanke and Gertler (1989), Bernanke, Gertler and Gilchrist (1999), Carlstrom and Fuerst (1997), He and Krishnamurthy (2012, 2013), and Brunnermeier and Sannikov (2014).

[8] Additionally, falling franchise values may encourage risk-taking by financial institutions due to limited liability and government guarantees (Keeley (1990); Gomes, Grotteria and Wachter (2018)).

[9] See also Minsky (1972), Kindleberger (1991), Allen and Gale (2000b).

[10] In the Diamond and Dybvig (1983) model, deposit insurance prevents runs and is socially optimal. This conclusion, however, rests on the assumption that banks cannot adjust the riskiness of their balance sheets. In contrast, Kareken and Wallace (1978) study the moral hazard problem induced by deposit insurance and show that deposit insurance may lead to more risk taking and, hence, more fragile banks.

[11] Acharya, Gale, and Yorulmazer (2011), Huang and Ratnovski (2011), Parlatore (2016), Foley-Fisher et al. (2020).

not been the subject of many theoretical models, but some work has argued that the ability to issue longer-maturity and, thereby, less runnable debt is impaired during economic downturns, and more so for more levered firms.[12]

The sources of financial vulnerabilities discussed in this section serve as building blocks for models that explore the connection between financial stability and real activity. We discuss these models next.

III. Financial Vulnerabilities and Real Outcomes

This section reviews how financial vulnerabilities affect the real economy in expansions and especially in recessions. We start by discussing traditional (or "first-generation") treatments of the financial accelerator mechanism, in which leverage amplifies business cycles. We then turn to recent extensions, which highlight how leverage can generate asymmetric macroeconomic tail risks. We then consider additional amplification channels created by maturity and liquidity transformation as well as by equity-financed asset price bubbles.

III.1 The Financial Accelerator

Leverage amplifies and propagates the response of the economy to aggregate shocks. Borrowers must pay a premium when they raise funding to compensate their lenders for taking on credit risk. Because this credit risk depends on borrowers' net worth (or equity) and collateral values, borrowers' balance sheets are a crucial determinant of the credit conditions they face.

If negative shocks lead to more precarious balance sheets, credit terms worsen, forcing borrowers to reduce their debt and level of activity. This retrenchment weakens aggregate economic activity, thus propagating the shock. In addition, persistently lower economic activity depresses asset prices, reducing the value of borrowers' assets, which further magnifies their balance sheet distress. This is the so-called financial accelerator.[13]

The first generation of financial accelerator models focused on non-financial business leverage, but the mechanism they illustrate also applies to other borrowers, such as households and financial

[12] See, for example, He and Milbradt (2016).
[13] This mechanism was spelled out in the seminal contributions of Bernanke and Gertler (1989), Bernanke et al. (1999), Carlstrom and Fuerst (1997) and Kiyotaki and Moore (1997).

institutions.[14] The financial accelerator also explains why shocks that originate within the financial sector can persistently lower aggregate output and asset prices.[15] Two characteristics of the traditional financial accelerator diverge from what is typically observed about financial vulnerabilities, however. First, these models do not speak to the systematic relationship between financial vulnerabilities and the phases of the business and financial cycles, therefore missing the link between financial vulnerabilities and the risks to the outlook. Second, they do not generate the abrupt financial crises that are the most recognizable manifestations of financial instability.

III.2. Asymmetric Tail Risk

More recent treatments of the financial accelerator mechanism start from similar economic assumptions but focus on the cumulative effects of macroeconomic shocks on the entire distribution of future economic outcomes, including the possibility of financial crises, and on how those effects depend on the current state of the financial sector.[16] In these models, the economy can be in a "normal" or a "crisis" state depending on financial intermediaries' equity. In the "normal" state, equity is sufficient to absorb moderate shocks. In the "crisis" state, in contrast, even small shocks lead to fire sales, amplifying the adverse feedback loop between lower net worth and lower asset prices. In this environment, therefore, the effect of shocks can depend on financial vulnerabilities. In addition, the theory points to a "volatility paradox:" lower fundamental volatility, as during the Great Moderation, leads to higher leverage, which in turn supports buoyant asset valuations. However, the resulting increase in vulnerabilities can lead to more extreme volatility spikes and macroeconomic disruptions in response to shocks.

III.3 Vulnerabilities Other Than Leverage

[14] For models of financial frictions in household mortgage borrowing, see Iacoviello (2005). For models with financial frictions on financial intermediaries, see Gertler and Kiyotaki (2010) and Gertler and Karadi (2011). Holmstrom and Tirole (1997) and Meh and Moran (2010) present models that combine borrowing frictions for both financial and non-financial agents.

[15] The models of Jermann and Quadrini (2012), Christiano, Motto and Rostagno (2014), Ajello (2016) and Del Negro et al. (2017) feature so-called "financial" or "risk" shocks. These can be thought of as credit supply shocks since they increase intermediation frictions by worsening agency problems.

[16] These "second generation" models focus on nonlinear dynamics rather than on first-order approximations. See for instance, Mendoza (2010), Adrian and Boyarchenko (2012, 2013), He and Krishnamurthy (2013, 2014), Brunnermeier and Sannikov (2014), Akinci and Queralto (Forthcoming), and Akinci et al. (2021).

The non-linear dynamics described above can be further exacerbated by the possibility of runs, whose sudden and discrete nature is one of the key features of financial crises.[17] In models of the financial accelerator that also feature liquidity and maturity transformation, run risk is higher when intermediaries are highly leveraged, since even small liquidity demand shocks can start a run which then becomes self-fulfilling. Runs can thus interact with standard financial accelerator effects, translating maturity or liquidity mismatch together with leverage into macroeconomic instability.[18]

The interconnected nature of financial systems can also lead to nonlinear amplification. A more interconnected financial system can share risks more efficiently, but this risk-sharing property also facilitates propagation of shocks, opening the door to cascading defaults (the "domino effect"). In this case, the mere fear of individual failures can reduce trade between intermediaries, and hence impair the efficient allocation of liquidity and funding.[19]

Finally, it is unclear if asset price increases financed with equity, rather than debt, create vulnerabilities. On the one hand, asset bubbles may be useful, for instance because they alleviate borrowing constraints, spurring investment and innovation.[20] On the other hand, bubbles are inherently fragile, and might be disruptive when they burst, especially if downward wage rigidity prevents wages from adjusting during the bust, or if interest rates are constrained by the effective lower bound (ELB).[21]

[17] Gertler, Kiyotaki and Prestipino (2020) and Gertler and Kiyotaki (2015) are models of the financial accelerator that include potential bank runs.
[18] Gorton and Ordonez (2014, 2020) argue that crises can also arise suddenly when investors shift from presuming that all assets are of high quality to evaluating and sorting them more closely, which uncovers the low credit quality that has built up over time.
[19] See Allen and Gale (2000a), Freixas et al. (2000), Shin (2009), Boissay et al. (2016), Nier et al. (2007), Acemoglu, Ozdaglar and Tahbaz-Salehi (2015). Haldane (2009) calls this feature of networks a "robust-but-fragile" property.
[20] Samuelson (1958) and Diamond (1965) also show that asset bubbles can be beneficial if savings are excessive ("dynamic inefficiency").
[21] For papers discussing the potentially positive effects of bubbles, see Samuelson (1958), Diamond (1965), Martin and Ventura (2012, 2016), Miao, Shen and Wang (2019), Farhi and Tirole (2012b), Morck (2021), Haddad et al. (2020). For papers emphasizing more the negative effects, see e.g. Biswas et al. (2020) and the references cited therein.

IV. The Impact of Monetary Policy on Financial Vulnerabilities

This section reviews theories of how monetary policy can influence the emergence and build-up of financial vulnerabilities described in Section II.[22] A compendium table summarizing the content of Section IV is available in the Appendix.

Many classic theories of monetary policy transmission imply an impact on vulnerabilities as expansionary monetary policy works to lower the price of credit and boost its quantity, thus affecting interest rates and asset prices (the *interest rate and asset price channels*). By lifting asset prices and lowering the price of credit, monetary policy boosts the net worth and financial soundness of borrowers (the *balance sheet channel*), as well as the ability of financial intermediaries to borrow and supply credit (the *bank lending channel*), encouraging risk-taking (through *reach-for-yield*) and the build-up of leverage. Finally, we highlight how policy aimed at affecting market participants' expectations about the macroeconomic outlook (via the *information or signaling channel*) can amplify policy transmission.

IV.1 Interest Rate and Asset Price Channels

Monetary policy works through the *asset-price channel* by affecting the expected path of short-term rates and future cash flows. In addition, monetary policy can impact risk premia by changing aggregate uncertainty and market participants' perception of risks.

There is no dominant theory of the forces that drive risk premia and the role that monetary policy plays in shaping their dynamics. For instance, in many macro-finance models, the systematic component of monetary policy affects risk premia by influencing the distribution of future macroeconomic outcomes.[23] As discussed later in this section, loose monetary policy can also

[22] This paper does not address how monetary policy can partially alleviate the consequences of a financial recession (i.e., "ex-post" policy), and hence reduce the consequences of financial vulnerabilities. The ability of monetary policy to "limit the damage" depends on several factors. On the one hand, easier monetary policy can directly respond to financial stress by boosting asset prices and reducing debt burdens (e.g., Gomes et al. (2016)). On the other hand, the transmission of monetary policy might be impaired if the financial sector does not fully pass-through financing conditions to the rest of the economy, either because of financial institutions' debt overhang (e.g., Wieland and Yang (2020)), or because borrowers can't refinance due to lower asset values (e.g., Alpanda and Zubairy (2019)). In addition, monetary policy might become less effective because private spending becomes less interest rate sensitive, due to uncertainty (Bloom 2014), or to a desire to deleverage. Finally, financial recessions can depress the natural rate of interest, making the ELB a more binding constraint, as in Eggertsson and Krugman (2012).

[23] For example, a reduction in the systematic response of monetary policy to inflation might expose longer-term nominal debt claims to more inflation risk, raising the term premium that marker participants require to hold such assets, as in Rudebusch and Swanson (2012), Campbell, Pflueger, Viceira (2020), and Kung (2015).

indirectly support asset valuations by boosting leverage and the demand for collateral. In some models, a credit expansion fueled by loose monetary policy can also foster an asset price bubble.[24]

Monetary policy can also boost asset prices above their fundamentals by influencing the beliefs of market participants who are not fully rational and may become overly optimistic about the outlook during booms and overly pessimistic during downturns.[25] Monetary policy can also compress risk premia by redistributing wealth between agents with different propensities to take on risk: easier policy can lower risk premia by boosting the value of the portfolios of wealthy, leveraged market participants. Such investors tend to be more optimistic or less risk-averse than the average investor and ultimately bid up risky asset valuations by requiring a lower premium to increase their holdings.[26]

IV.2 Balance Sheet Channel

The literature on the balance sheet channel focuses on the effect of monetary policy on the balance sheet of borrowers and on their demand for credit. In the financial accelerator models described in section III, the net effect of monetary policy on financial vulnerabilities via the balance sheet channel is ambiguous. On the one hand, easier monetary policy may lead to a build-up of financial vulnerabilities by encouraging debt issuance, as market participants borrow against higher asset valuations to finance their purchase of long-maturity, illiquid, or risky assets. On the other, lower interest rates and the associated higher output and inflation can facilitate the deleveraging of indebted firms or financial intermediaries, and/or refinancing of their existing debt at lower rates, reducing vulnerabilities.[27]

[24] In Allen and Gale (2010), lenders have limited information and control over how investors use borrowed funds. Investors therefore can take on profitable leveraged bets on risky assets, bidding up their price above fundamentals, while shifting risk on the lenders' balance sheet. Generally, monetary models of asset price bubbles suggest that tighter monetary policy and higher borrowing costs reduce the size of bubbles and their macroeconomic consequences. In Dong, Miao, and Wang (2020) and Biswas, Hanson, and Phan (2020), for instance, tighter monetary policy can reduce the volatility of the bubble and prevent prolonged economic recessions once the bubble bursts. Gali (2014, 2021) reaches the opposite conclusion in a model in which the short-term policy rate helps pin down the growth rate of asset price bubbles, finding that systematic tightening in response to a rational asset price bubble can increase its volatility. This result, however, appears to rely on an arbitrary equilibrium selection (Miao, Shen and Wang (2019)).

[25] For instance, Krishanmurthy and Li (2020).

[26] For instance, Kekre and Lenel (2020).

[27] In the first-generation models described in section III.1, leverage decreases in response to monetary policy easing, at least in the short run, effectively reducing balance sheet vulnerabilities despite the increase in debt issuance.

The models with tail risk reviewed in section III.2 highlight additional channels through which monetary policy might seed crises. Such models imply that transmission of easier monetary policy via the balance sheet channel increases net vulnerabilities and risks to the real outlook.[28] Lower real interest rates, while improving financial conditions, boosting asset valuations and supporting real activity in the short run, can encourage a gradual increase in risky lending to the private sector, and an endogenous build-up of leverage that makes the system more vulnerable in the longer-run.[29]

Monetary policy might also prove less effective as a macroeconomic stabilization tool if the economy becomes over-leveraged. As policymakers ease the monetary policy stance in response to a deteriorating macroeconomic outlook, borrowers issue debt and set aside increasing resources to service it, thereby transferring wealth to lenders who are more likely to save than to consume. In the medium run, such transfers dampen the effect of monetary policy easing on aggregate spending.[30] Under this premise, accommodative monetary policy is likely to increase financial vulnerabilities, as it raises the debt servicing burden while failing to boost indebted demand, increasing the odds that the economy will further underperform as policy becomes constrained at the ELB.

IV.3 Bank Lending Channel and Reach-for-Yield

The literature on the bank lending channel focuses on the effect of monetary policy on the supply of bank credit.[31] Banks engage in credit and maturity transformation by borrowing funds at shorter maturities and extending risky longer-maturity loans. Accommodative monetary policy reduces the cost of funding for banks, and thus may increase reliance on debt by banks and by the nonfinancial sector, encouraging the build-up of vulnerabilities that stem from credit and maturity transformation.[32]

[28] See for example Akinci, Benigno, Del Negro and Queralto (2021), and recent extensions that assume deviations from rational expectations such as Krishnamurthy and Li (2020). Most of these models assume flexible prices and thus ignore inflation. One recent exception is Adrian and Duarte (2020).
[29] In their model with tail risk, Coimbra and Rey (2020) find that this result depends on overall financing conditions: lower real interest rates stimulate investment and entry by less levered financial institutions when initial interest rates are high—thus reducing vulnerabilities. Lower real interest rates instead can induce risk shifting and stimulate entry by more levered financial institutions when initial interest rates are low—thus increasing vulnerabilities.
[30] Mian, Straub, and Sufi (forthcoming).
[31] Bernanke and Blinder (1988).
[32] Stein (2012).

Banks and, more generally, investors can exhibit "reach-for-yield" behavior when they increase the risk of their portfolio with the objective of partially offsetting the income loss from low rates. Easier monetary policy may reduce bank net interest margins, potentially leading to an easing of bank lending standards and an increase in risk-taking.[33] In the short run, a higher propensity to take risk reduces the cost of funding real activity and can support the macroeconomic outlook. In this respect reach-for-yield is arguably part of the standard transmission of monetary policy.[34]

However, reach-for-yield can increase financial vulnerabilities through the balance sheet of lenders, insofar as risky projects deliver disappointing returns and trigger fire sales and bankruptcies as the macroeconomic outlook deteriorates. At the same time, reach-for-yield may reduce vulnerabilities on the balance sheets of borrowers, as relaxed credit standards provide borrowers with increased flexibility in response to adverse shocks.

An important share of borrowing and lending takes place in nonbank financial institutions, which may exhibit similar behavior to banks but can be more prone to excessive leverage and risk-taking, partly because they are less affected by regulatory requirements than traditional banks. That said, few models are able to rationalize reach-for-yield behavior without institutional or regulatory constraints. For example, endowments or sovereign funds are often required to pay out (no more than) the expected yield on their portfolio.[35] When interest rates fall, the portfolio yield drops and investors face a reduction in payouts. Rebalancing portfolios toward riskier assets with a higher expected return can mitigate the drop in payouts.[36] Other theories emphasize agency issues—e.g., mutual funds may seek to attract naïve retail investors by

[33] Banks' balance sheets are also exposed to funding (or liquidity) risk. Banks hold reserves and other liquid assets as a precautionary buffer, trading off loan profits and insurance against sudden withdrawals of deposits. Lower interest rates reduce both banks' cost of funding and the return on safe assets. On the one hand, accommodative monetary policy can help banks that face liquidity shortages by easing their financing conditions and reducing liquidity risk. On the other hand, lower returns on safe assets may encourage reach-for-yield, as banks rebalance their portfolios toward more profitable risky assets thereby increasing leverage and maturity risk (Dreschler, Schnabl, and Savov (2018), Bianchi and Bigio (forthcoming)).
[34] Dell'Ariccia, Laeven, and Marquez (2010), De Groot (2014), and Silva (2016) also discuss the effect of monetary policy easing on financial institutions' risk-taking and portfolio rebalancing toward riskier assets.
[35] Campbell and Sigalov (2021).
[36] This effect is stronger when interest rates are low because the payout constraint is more likely to bind.

displaying a high yield—often in combination with deviations from rationality, such as nominal illusion.[37]

While low yields may encourage portfolio rebalancing toward riskier assets, lower interest rates are likely to lead to reach-for-yield only if institutional constraints remain static and investors fail to learn or to refine their investment strategies. Moreover, reach-for-yield behavior might be amplified when interest rates are expected to remain persistently low, for instance due to secular declines in r*, rather than to cyclical changes connected with monetary policy stabilization.

IV.4 Expectations and Signaling Channels

An additional channel through which monetary policy may affect vulnerabilities is by shaping market participants' expectations about future macroeconomic outcomes and about the future stance of monetary policy. In both cases, forward guidance might reinforce the channels of transmission described in this section, through lower levels of interest rates and lower uncertainty about future monetary policy decisions. More broadly, the monetary policy regime shapes these expectations powerfully: a monetary policy that responds strongly to the real outlook and financial conditions, in particular if it is perceived to respond asymmetrically to declines in asset values, can lead to risk underpricing, more risk-taking, and in the end increased vulnerabilities.[38] On the contrary, a policy that does not respond as strongly to the real outlook and financial conditions may discourage leverage excessively, and may increase vulnerabilities by making debt less sustainable.[39]

V. Conclusions and gaps in the literature

Most of the theoretical models remain somewhat stylized, abstracting from important features of the economy. First, most models abstract from inflation dynamics and simplify the monetary

[37] Retail investors may be attracted by high advertised yield because they do not fully understand the risk that accompanies those yields, or they may be anchored to higher rates due to historical reference points (Lian et al. (2019)). The spread between the risky rate and the risk-free rate may also be more salient when rates are low (e.g., a 5% return is more attractive relative to a 1% return than 10% is relative to 6%). Mutual funds or hedge funds may also reach-for-yield because lower interest rates affect the likelihood of beating their benchmark and hence influence their fees (Rajan, 2005). Underwater insurance companies and pension funds may take more risk in order to cover their funding shortfall. Banks may also have incentives to take on more risk because of lower franchise value in a world where interest rates (or the slope of the yield curve) are low. Martinez-Miera and Repullo (2017) show that a savings glut that leads to lower interest rates causes an expansion of "low monitoring" lending with higher risk overall.

[38] Bordo and Jeanne (2002), Borio and Lowe (2002), Diamond and Rajan (2012), Farhi and Tirole (2012a).

[39] Bornstein and Lorenzoni (2018), Korinek and Jeanne (2020). See also Koenig (2013) and Sheedy (2014).

environment. Second, most macro-financial frameworks focus on a single representative intermediary, subject to a specific financial constraint, thus ignoring the diversity of financial entities that exist in the U.S., and the unique features of each type of institutions. Third, quantitative models of the interactions between financial vulnerabilities and real outcomes are in their infancy. For example, most models do not capture the predictability of financial crises documented in the empirical literature.

Fourth, monetary policy has theoretically ambiguous effects on financial vulnerabilities. Low interest rates can help firms improve their balance sheets and increase their credit worthiness. However, they may also spur the accumulation of leverage and encourage reach-for-yield behavior. The theoretical models reviewed here tend to showcase the effects of policy on vulnerabilities in isolation rather than discussing their net contributions or assessing tradeoffs across different types of vulnerabilities. Overall, while most theoretical mechanisms discussed above imply that easier monetary policy tends to increase vulnerabilities, the strength of this relationship also depends on the level of financial regulation and the state of macroprudential policy, and on the economic outlook. Moreover, even if monetary policy unambiguously increases vulnerabilities, this may be desirable if the level of vulnerabilities is inefficiently low in the first place, for instance in the early stage of a recovery.

Finally, there is limited theoretical work on how financial vulnerabilities accumulate over durations longer than the business cycle, thus abstracting from the longer horizons of financial cycles that have been identified in the empirical literature. Understanding this asynchronicity between the financial and business cycles could be crucial for a full evaluation of the effect of monetary policy on 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 amplify negative shocks that originate in the real economy or to be a source of shocks itself, both with large negative consequences for the macroeconomy. A stable financial system can withstand most shocks with minimal added disruptions to the real economy.
- **Financial vulnerabilities** are features of the financial system that make it less stable. They represent exposures to shocks and evolve over time at frequencies that potentially differ from those of business cycles.
- **Financial conditions** provide a timely indicator of the current state of the business and financial cycles and are distinct from financial vulnerabilities. Whether financial conditions are accommodative or tight may not have direct bearing on whether a financial system is stable or unstable.
- **Net financial vulnerabilities** are those vulnerabilities that remain after taking into account the regulatory and supervisory environments.

Table. Transmission Mechanisms of Monetary Policy to Financial Vulnerabilities

	Contributions	Affected Vulnerabilities	Effect of Policy Easing
	Models of Systematic Monetary Policy and Risk Premia		
Interest Rate and Asset Price Channels	Rudebusch and Swanson (2012), Campbell, Pflueger, Viceira (2020), Kung (2015), Gourio and Ngo (2020)	Asset Valuations	Ambiguous: A lower Taylor rule coefficient on inflation might expose nominal debt assets to increased inflation risk, increasing nominal term premium. Conversely, a stronger response of policy to real variables could compress real risk premia. ELB acts as a constraint to systematic stabilization of disinflationary demand shocks—for which nominal bonds are a hedge—and can contribute to the compression of nominal term premia.
	Models with Financial Accelerator		
	Literature inspired by Kiyotaki and Moore (1997), Bernanke, Gertler, Gilchrist (1999)	Asset Valuations	Increase: Monetary policy easing can support asset valuations by encouraging lending and the demand for collateral assets. Higher collateral value further boosts lending and economic activity (see Balance Sheet Channel below for the effect on leverage).
	Models of Asset Price Bubbles		
	Allen and Gale (2010)	Asset Valuations	Increase: If lenders have limited information and control over how investors use borrowed funds, low rates encourage investors to take on profitable leveraged bets on risky assets, bidding up their price above fundamentals while shifting risk on lenders' balance sheets.
	Dong, Miao, and Wang (2020), Biswas, Hanson, Phan (2020)	Asset Valuations	Increase: Borrowers subject to credit constraints value bubbles because they are liquid and can be used as store of value to take on future investment opportunities when credit is scarce. Higher inflation can erode borrowers' net worth, tighten credit constraints, and fuel the bubble. Easier policy, by boosting inflation, increases the size of the bubble.
	Galí (2014, 2021)	Asset Valuations	Decrease: Systematic policy easing lowers asset returns and decreases the growth rate and volatility of bubbles.
	Models with Non-Rational Beliefs		
	Krishanmurthy and Li (2020)	Asset Valuations	Increase: Monetary policy may boost asset prices above fundamentals by influencing beliefs of investors, who become overly optimistic about the outlook during booms and too pessimistic during downturns.
	Models of Asset Prices and Inequality		

	Kekre and Lenel (Forthcoming)	Asset Valuations	Increase: Monetary policy can compress risk premia by redistributing wealth to rich, leveraged market participants who are more prone to take risk.
	Contributions	**Affected Vulnerabilities**	**Effect of Policy Easing**
Balance Sheet Channel	*Models with Financial Accelerator*		
	Literature inspired by Kiyotaki and Moore (1997), Bernanke, Gertler, Gilchrist (1999)	Non-Financial Leverage	Ambiguous: Easier monetary policy may lead to a build-up of financial vulnerabilities by encouraging debt issuance, as market participants borrow against higher asset valuations to finance long-maturity, illiquid, or risky assets. Conversely, lower interest rates, together with the associated higher output and inflation, can also facilitate deleveraging and/or refinancing of existing debt at lower rates, reducing vulnerabilities.
	Models with Financial Accelerator and Tail Risk		
	Akinci, Benigno, Del Negro and Queralto (2021) Krishnamurthy and Li (2021) Adrian and Duarte (2020)	Non-Financial and Financial Leverage	Increase (longer-term): Lower real interest rates, while improving financial conditions, boosting asset valuations and supporting real activity in the short run, can encourage a gradual increase in risky lending to the private sector, and an endogenous build-up of leverage that makes the system more vulnerable to shocks in the longer run.
	Coimbra and Rey (2020)	Non-Financial and Financial Leverage	Ambiguous: When interest rates are initially high, lower real interest rates stimulate investment and entry by less levered financial institutions when initial interest rates are high—thus reducing vulnerabilities. When interest rates are initially low, lower interest rates instead can induce risk shifting and stimulates entry by more levered financial institutions when initial interest rates are low—thus increasing vulnerabilities.
	Models with Inequality		
	Mian, Straub, and Sufi (forthcoming)	Non-Financial Leverage	Increase: Easier policy in response to a deteriorating outlook encourages borrowers to issue debt and set aside increasing resources to service it, thereby transferring wealth to lenders who are more likely to save than to consume. As leverage vulnerabilities rise, r* falls and monetary policy proves less effective as a macroeconomic stabilization tool.

	Contributions	Affected Vulnerabilities	Effect of Policy Easing
Bank Lending Channel	Bernanke and Blinder (1988) Stein (2012)	Financial Leverage	Increase: Accommodative monetary policy reduces the cost of funding and thus may increase reliance on debt by banks and by the nonfinancial sector, encouraging the build-up of vulnerabilities that stem from credit and maturity transformation
Reach-for-yield	Dell'Ariccia, Laeven, and Marquez (2010), De Groot (2014), and Silva (2016)	Financial Leverage, Maturity, and Liquidity Transformation	Increase: Easier monetary policy may reduce bank net interest margins, potentially leading to easier bank lending standards and more risk-taking.
	Models with Liquidity Risk		
	Dreschler, Schnabl, and Savov (2018), Bianchi and Bigio (forthcoming)	Financial Leverage and Liquidity Transformation	Ambiguous: Accommodative monetary policy can help banks that face liquidity shortages by easing their financing conditions and reducing liquidity risk. Alternately, lower returns on safe assets may encourage reach-for-yield, as banks rebalance their portfolios toward more profitable risky assets thereby increasing leverage and maturity risk
	Models with Regulatory Constraints, Agency Frictions, or Non-Rational Beliefs		
	Campbell and Sigalov (2021), Lian et al. (2019), Rajan (2005), Martinez-Miera and Repullo (2017)	Financial Leverage, Maturity, and Liquidity Transformation	Increase: Increased risk-taking occurs in low-rate environments as rebalancing portfolios toward riskier assets with a higher expected return can mitigate the drop in portfolio returns. Reach-for-yield might increase with lower rates if: - funds' payout constraints are likely to bind due to nominal hurdle rates, - investors' expectations are anchored to historical higher returns, - mutual funds pursue higher returns to beat their benchmark and earn fees. - franchise value of banks decreases and they bet on risky investments for resurrection. Interest rates that are structurally low might affect reach for yield more than temporary monetary policy accommodation.

Expectations and Signaling Channels	Bordo and Jeanne (2002), Diamond and Rajan (2012), Bornstein and Lorenzoni (2018), Korinek and Jeanne (2020), Benigno et al. (2013)	All	Amplification of other channels: Monetary policy may affect vulnerabilities by shaping expectations about future macro outcomes and about the future stance of policy. Forward guidance might reinforce the channels of transmission described above, through lower levels of interest rates and lower uncertainty not just about current but also future monetary policy decisions.

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