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"Low for Long" and Risk-Taking

Tobias Adrian

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Executive Summary

The coronavirus disease (COVID-19) pandemic is causing an unprecedented worldwide economic contraction, leading central banks to reduce interest rates to historically low levels and making unconventional monetary policies—including "low for long" interest rates and asset purchases—increasingly common. Arguably, however, the policies implemented are efficient *because* they encourage increased risk-taking, and they may have, if unintentionally, increased medium- and long-term macro-financial vulnerabilities. This paper argues that the resulting trade-offs need to be carefully accounted for in monetary policy models and outlines how that can be achieved in practice.

Policymakers now face the challenge of charting a steady path toward economic renewal—envisioning ways to promote inclusive, sustainable growth in a post-pandemic society that needs to make up for lost time, lost jobs, and lost wealth. Monetary-policy decision makers must be equipped with plans that can help strengthen the post-pandemic economic recovery for the long term, avoiding the potential threats that might endanger a renewal of growth. The latter is particularly important as the underlying risks may keep building up, especially if accommodative policies remain in place for an extended period of time, that is, if "Low for Long" becomes the new normal.

Many central banks' policy frameworks now specify goals for inflation and real economic activity, as well as objectives for financial stability. A world where macroprudential policies could address all financial stability risks is imaginable, in theory: In such a world, monetary policy could—in principle—focus solely on inflation and real economic activity. In fact, the IMF has long argued that macroprudential tools are the first line of defense to ensure financial stability (see IMF 2015), and some countries have strived to develop macroprudential toolkits, often deploying them successfully to further financial stability. Despite these efforts, however, macroprudential policy often comes short, particularly with respect to market-based credit intermediation.

Political considerations, arising on account of the distributional implications of such policies, also have the propensity to overrule economic arguments. For these reasons, traditional macroprudential tools cannot address all risks to financial stability and a growing recognition of this fact has led policymakers to increasingly seek frameworks that speak to the buildup of macro-financial vulnerabilities.

This paper develops and applies such a framework. It allows policymakers to internalize not only the traditional trade-off between inflation and real economic activity, but also the risk-return trade-off between a short-term boost to inflation and output via easy monetary policy and the medium-term buildup of financial stability risks through increased macro-financial vulnerabilities. The paper argues that central banks should consider not only the path of output, unemployment, and inflation, but also expected macro-financial stability, with the proposed approach capable of jointly quantifying risks to all these variables. Importantly, the key linkages between macroeconomic and financial aggregates occur via financial conditions (Adrian, Boyarchenko, and Giannone 2019), which measure the cost of funding risky projects in the economy, that is, the price of risk. The price of risk in turn is driven by the volatility of output.

The framework laid out in this paper incorporates risk-taking but is otherwise standard. When monetary policy is easy, aggregate demand is stimulated not only via the traditional intertemporal consumption decision channel, but also via the “risk-taking channel.” This extra link generates rich macro-financial feedback effects. High growth is associated with easy financial conditions and relatively small risks to output, but easy financial conditions can increase medium-term risks. Hence a “low for long” monetary policy faces a tradeoff between short-term output growth and medium-term financial stability risks. And the key novel feature of the proposed framework is that it places this balance between short-term gain and medium-term risk at the heart of practical monetary policy making.

An important outcome of optimal policy analysis is that adverse shocks should be met with aggressive monetary easing (Adrian, Erceg, Linde, and Zabczyk 2020). This can be achieved by a combination of lower interest rates, forward guidance and asset purchases. In practice, the combined scale of such unconventional operations in response to the pandemic was truly staggering, as, by IMF estimates, they amounted to more than $7 trillion globally. The importance of central banks, also in emerging market economies, exercising their implicit “put option” cannot be overstated and has been a game changer helping stabilize key markets. The proposed framework also suggests, however, that the policies’ efficacy was, in part, due to the “risk-taking channel.” Since output gaps are likely to persist in many economies, making accommodative monetary policy appealing, the underlying tradeoffs need to be quantified, with risks monitored using approaches such as the one advocated here.

This paper first describes the empirical facts underlying the conceptual framework. It then explains the intuition of the modeling strategy and presents concrete examples of alternative policy paths. Finally, it discusses how the basic model can be embedded in richer settings featuring banks or open-economy considerations. The framework is empirically validated across countries, is theoretically coherent, and is straightforward to implement in practice. As such, the approach outlined here can be the basis for central banks to incorporate risk-return tradeoff considerations explicitly into their monetary-policy decisions, which is illustrated using several pertinent examples.

Chapter

1 Introduction

Challenges associated with COVID-19 have called for exceptional policy responses. Central banks overwhelmingly stepped up to the plate: In advanced economies policy space was severely constrained and policymakers relied on "low for long" policies, but also purchased a wide variety of assets, established foreign exchange swap lines, and provided credit guarantees. In emerging market economies, central banks actively used more ample initial policy space and engaged in asset purchases to ease domestic financial conditions.

The combined scale of unconventional interventions was truly staggering, since, by IMF estimates, they amounted to $7.5 trillion globally. The importance of central banks exercising their implicit "put option" cannot be overstated and has been a game changer helping stabilize key markets. But such policies work in part *because* they encourage risk taking. As such, these central bank interventions may also have, if unintentionally, increased medium-term macro-financial vulnerabilities.

While the IMF has long advocated that macroprudential tools should be the primary policy to mitigate related financial stability risks (IMF, 2015), they are not a universal panacea. Specifically, there is a growing recognition, that macroprudential tools do not address all the risks to financial stability. Vulnerabilities related to market-based credit intermediation are one important example, in addition to sizeable lags in transmission, and political considerations that can occasionally overrule economic arguments.

Monetary policymakers are thus increasingly focusing on macro-financial risks. In Europe, the Governing Council of the European Central Bank routinely discusses the balance of risks to growth and inflation, as do the Federal Open Market Committee in the United States and many other central banks around the world. Many emerging markets have similar approaches. This paper is strongly supportive of the evolving focus and argues that all central banks should closely monitor the endogenous path of risk in addition to the more traditional policy paths for output and inflation.

However, the monetary policy literature has, so far, not come up with structural models that capture the path of risk alongside the central path of relevant state variables in a parsimonious yet policy-relevant fashion. Models are needed that speak to not only the traditional tradeoff between inflation and real economic activity, but also the risk-return tradeoff between a short-term boost to inflation and output due to accommodative monetary policy, and to the medium-term buildup of financial stability risks due to intensified vulnerabilities.

This paper argues that it is time to position the endogenous buildup of macro-financial vulnerabilities at the heart of monetary policymaking and proposes a parsimonious model to that effect. The approach advocated here allows policymakers to quantify the potential costs and benefits from "low for long" type policies and it closely matches the dynamics of forecast densities documented in Adrian and others (2020b). In what follows we describe the key building blocks of the underlying conceptual framework before focusing on a number of applications.

Chapter

2 Vulnerable Growth

Easy financial conditions tend to precede high output growth and low output risk (Adrian, Boyarchenko, and Giannone 2019). The ease of financial conditions is gauged through indicators, which aggregate information from credit spreads, stock-market valuations, interest rates, and financial market volatility. Accordingly, financial conditions indexes measure the average pricing of funding across risky projects.

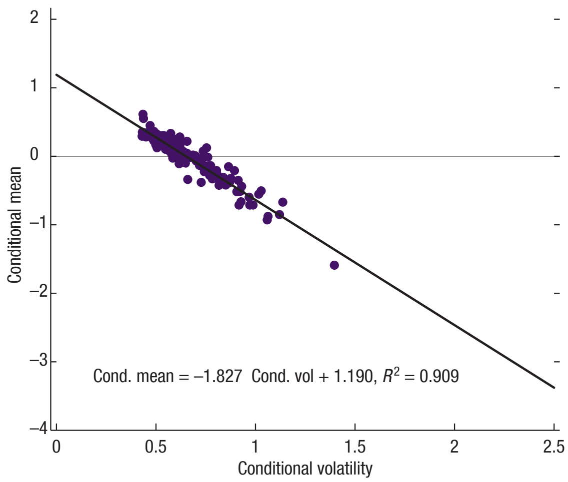
Forecasts of output growth and of risks to output are negatively correlated. When financial conditions tighten, expected output growth declines, and the risk to output growth increases. The conditional mean of output and the conditional riskiness of output are thus negatively related: They have opposite relationships with financial conditions. The empirical relationship between the conditional mean and volatility of output is shown in Figure 1.[1]

The negative correlation between output growth and the riskiness to output gives rise to an unconditional output distribution that is strongly negatively skewed (Adrian, Boyarchenko, and Giannone 2019). The upper quantiles of output are relatively stable, because a tightening of financial conditions leads to a downward shift in the whole distribution due to the impact of financial conditions on the conditional mean, and an upward shift in conditional volatility. Those two effects offset each other, more or less. For the lower quantiles, however, the lower mean combined with the higher variance implies that downside risks increase sharply when financial conditions tighten.

Figure 2 illustrates the strongly negative skew of the output distribution, which we refer to as "vulnerable growth." The conditional output distribution is labeled as being "vulnerable" because periods of relatively high

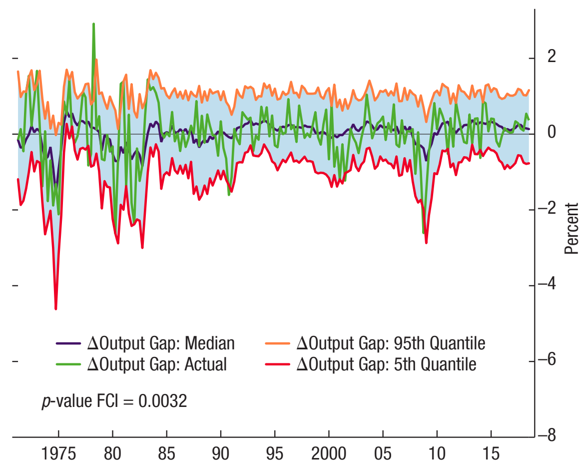
[1]All figures reproduced in this Departmental Paper are taken from Adrian and others (2020b), except for Figures 5 and 6, which are discussed in more detail in Adrian, Erceg, Linde, and Zabczyk (2020).

Figure 1. Empirical Relationship between the Conditional Mean and Volatility of Changes in the Output Gap



Source: Author’s calculations from quantile regressions on US data (1971:Q1–2019:Q3) featuring the one quarter ahead Δ(output gap) on the left-hand side, and current Δ(output gap), inflation, and financial conditions on the right-hand side.

Figure 2. Dynamics of the Conditional Distribution of Changes in the Output Gap



Source: Author’s calculations from quantile regressions on US data (1971:Q1–2019:Q3) featuring the one-quarter-ahead Δ(output gap) on the left-hand side, and current Δ(output gap), inflation, and financial conditions on the right-hand side.
Note: FCI = US Financial Conditions Index.

growth and low risk tend to be followed, at some point, by periods of sharp downside risks, due to the cumulative effects of high conditional volatility and low growth.

These “vulnerable growth” properties hold true in out-of-sample performance tests, implying that vulnerable growth can be detected in real time. Adrian, Boyarchenko, and Giannone (2019) conduct extensive out-of-sample tests relative to “random walk” estimators, other Bayesian approaches, and fully parametric maximum likelihood approaches. Significantly, they evaluate the forecast performance across the whole density. All these tests confirm the vulnerable growth properties of the conditional distribution and good out-of-sample fit.

Further research has expanded on these results by studying the term structure of risks to GDP growth (Adrian, Grinberg, Liang, and Malik 2020). The shape of the estimated term structure of risks to growth is consistent with endogenous risk-taking and the volatility paradox: when the economy is booming and financial conditions are particularly loose, downside risks in the near term are small, but they are projected to increase in the medium term.

Chapter

3 A Conceptual Framework

Since the seminal contributions of Bernanke, Gertler, and Gilchrist (1999) and Kiyotaki and Moore (1997), economists have been working on incorporating financial frictions in monetary models. A huge effort has been made to apply such specifications in policy settings.[1] However, their nonlinear features have not proven relevant for policy purposes, because the exact nature of the nonlinearity is highly model-specific and is difficult to fit to the data. Instead, macro-financial setups that are widely used in central banks today rely predominantly on modeling financial frictions in a linear fashion.[2]

This paper argues that the way forward might be a compromise between highly nonlinear models and simplified linear ones. Instead of considering fully nonlinear models, it proposes that specifications with endogenous risk (that is, volatilities of output as a function of state variables) are sufficiently rich. In the type of model that is presented here, the reduced form is very closely related to standard first-order approximations. The error terms, however, feature volatilities that depend on state variables in a theory-consistent fashion.

In fact, while the proposed setup shares many features with the textbook New Keynesian (NK) model (Woodford 2003; Galí 2008), it is nonlinear, and thus does not suffer from "certainty equivalence." In other words, in the model, risk matters and conditional second moments are not restricted to be constant. Certainty equivalence is strongly rejected in the data where, as shown in Figure 1, conditional first and second moments are tightly linked.

[1]See in particular recent work by Fernández-Villaverde, Guerrón-Quintana, and Rubio-Ramírez (2015) on estimating dynamic equilibrium models with stochastic volatility and Andreasen, Fernández-Villaverde, and Rubio-Ramírez (2016) on perturbation methods. Dou and others (2018) provide a critical review of macroeconomic models for monetary policy from a finance perspective.

[2]To the author's knowledge, no major policy institution is currently actively using medium- or large-scale DSGE models that are solved to second or higher order in policy settings.

Moreover, it is significant that the conditional mean and conditional volatility are negatively related.

Adrian and Duarte (2017) solve a micro-founded NK model with financial vulnerability in a fully nonlinear fashion.[3] They then study the reduced form of the model, in which endogenous second moments are linear functions of the state variables. The setup is exactly like the standard NK three-equation model. There are two exceptions, however. First, it features financial vulnerability as an additional state variable, and hence the model has four equations. Second, there are two new parameters. The first parameter determines the slope of the conditional output volatility (which is proxied by financial conditions) as a function of the expected output gap. This slope corresponds to the risk-return tradeoff that was discussed earlier. The magnitude of the slope determines the "vulnerability channel," as it pins down how vulnerability depends on expected growth. The second parameter governs the degree to which expected growth depends on the pricing of risk, and thus it appears in aggregate demand. This second channel is the "financial accelerator" of Bernanke, Gertler, and Gilchrist (1999). Thus, in a very parsimonious model, Adrian and Duarte (2017) capture not only the "vulnerability channel" but also the "financial accelerator channel."[4,5] The two together are referred to as the "risk-taking channel of monetary policy."

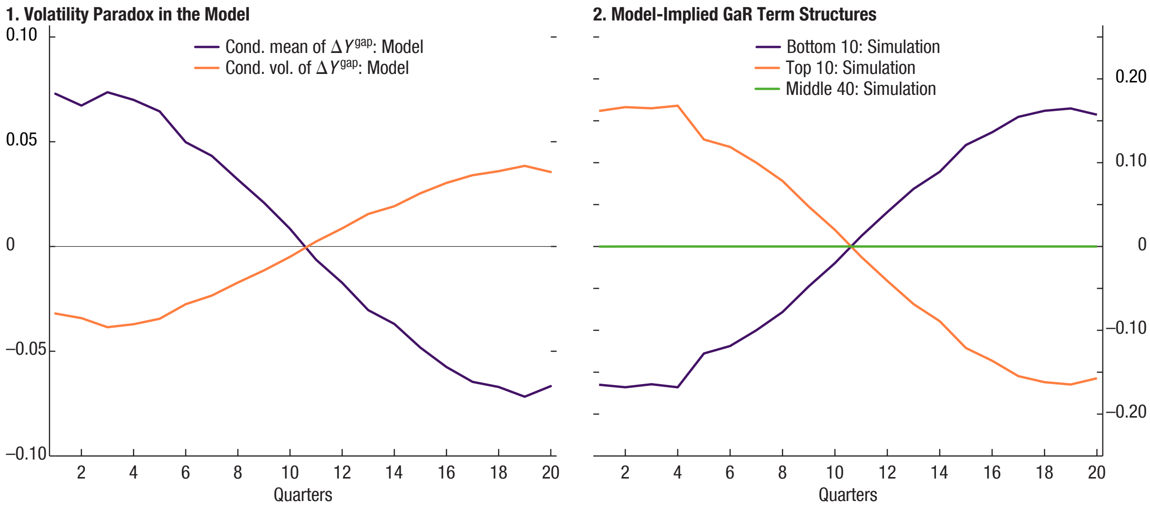
Simulations from a discrete-time version of the model, which we refer to as NKV ("New Keynesian Vulnerability"), show that it captures all the stylized facts described in the previous section (Adrian and others, 2020b). Four factors are significant. First, the NKV model replicates the negative correlation between expected output gap growth and risks to output gap growth, as shown in Figure 1. Second, the NKV model features "vulnerable growth"—that is, an output gap growth distribution with relatively constant upper quantiles, along with highly volatile lower quantiles, giving rise to a strongly skewed output gap growth distribution. Third, the NKV model features the volatility paradox, in which easy financial conditions are associated with low short-term volatility to output gap growth but large medium-term volatility. Fourth, the NKV model replicates the intersection of growth-at-risk (GaR) term structures (see Figure 3).

[3]Other examples of non-linear macro-financial models include Goodhart and others (2013), Brunnermeier and Sannikov (2014) or Ajello and others (2019). Relatedly, Collard and others (2017), Bodenstein and Zhao (2019) and Carillo and others (2020), amongst others, focus on monetary-macroprudential interactions in the context of models accounting for endogenous financial sector risk.

[4]Cai and others (2018) examine the performance of the Federal Reserve Bank of New York DSGE model throughout the financial crisis and find that the built-in financial accelerator did improve downside risk forecasts markedly relative to benchmark forecasts.

[5]Arguably, leverage is an important additional consideration, though outside the scope of the parsimonious setup outlined here (see Greenwood and others, 2020 or Krishnamurthy and Muir, 2020 for a further discussion).

Figure 3. The Volatility Paradox and GaR Term Structures



Source: Model simulation. Model is calibrated based on US data 1971:Q1–2019:Q3.
Note: The figure plots the model-based responses of the conditional mean and volatility of Δ(output gap) to loose financial conditions (panel 1), as well as the generalized impulse responses of its 5th and 95th quantiles (computed as averages of the bottom 10% and top 10% IRFs, respectively; panel 2). GaR = growth-at-risk.

The NKV model thus captures movements in the output distribution over time. The setup replicates the empirical relationships between first and second moments, with the key feature being that high growth is associated with easy financial conditions and low output volatility. At the same time, easy financial conditions lead to a buildup of risk in the medium term, which is often referred to as the volatility paradox.

The NKV model also features a risk-taking channel of monetary policy. Lower interest rates not only shift consumption from the future into the present, but also fuel risk-taking by easing financial conditions. Monetary policy thus acts on both first and second moments of the output distribution.

Chapter

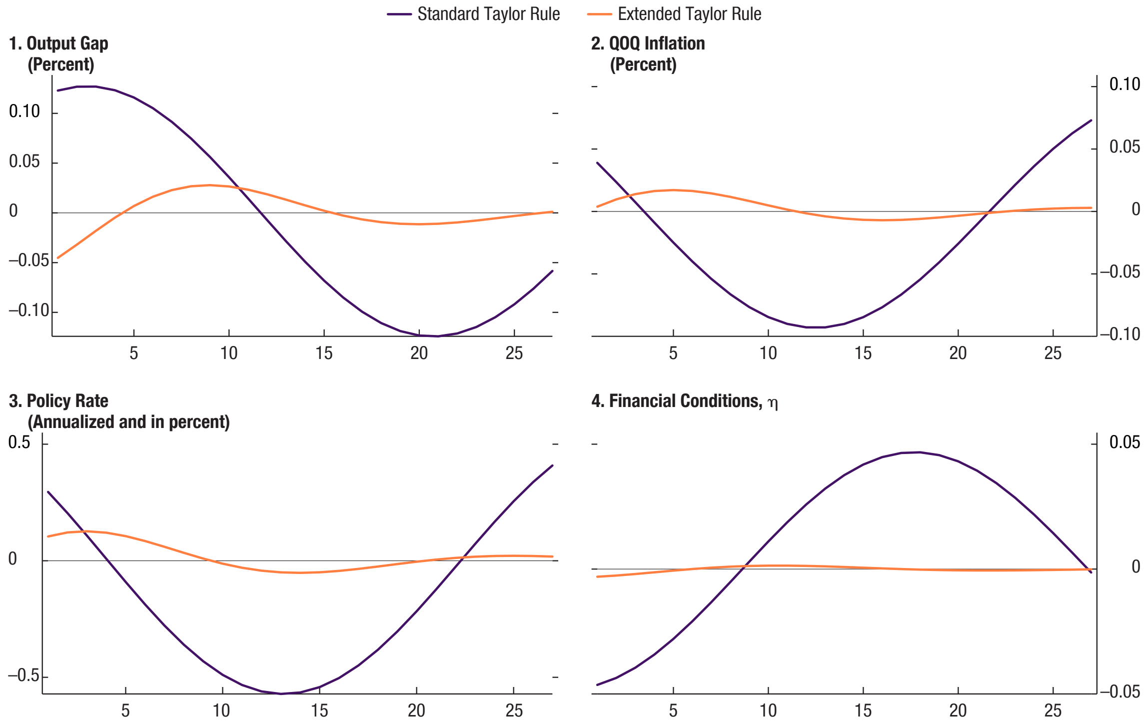
4 Optimal Policy with Macro-Financial Risk

Monetary policymakers should take the expected path of risk into account when formulating policy. In traditional monetary-policy decisions of central banks that pursue flexible inflation targeting, monetary policymakers consider the expected impact of alternative policy decisions on the future path of inflation and real activity (Adrian, Laxton, and Obstfeld 2018). This paper argues that policymakers should also consider the future path of *risk* to output.

Merits of alternative policy paths in monetary policy decision-making should be analyzed in setups such as the NKV, which account for macro-financial risk and thus more fully capture the challenging trade-offs facing policymakers. For example, in the short run the greater impact of risk, evident through markedly tighter financial conditions, may warrant considerably more accommodative policy, as was arguably the case with interventions aimed at mitigating the adverse impact of the COVID-19 pandemic. By a similar token, however, the additional risk-taking unlocked by more accommodative policy may lead to a buildup of medium-term vulnerabilities. While the relative strength of these effects may be highly context specific, both aspects of the underlying intertemporal trade-off need to be fully accounted for to ensure unbiased policy decisions and efficient economic outcomes.

Figure 4 contains one of the main takeaways from this paper. It compares the policy paths and economic outcomes in the NKV model—with the solid lines corresponding to a standard Taylor rule and the dashed lines representing an alternative that is additionally conditioned on expected financial vulnerability, as advocated in Adrian and others (2020a,b) and broadly in line with Curdia and Woodford (2010, 2016). While in both cases financial conditions are calibrated as very loose to start, panel 4 underscores the fact that the meaning of "very loose" can crucially depend on the underlying monetary policy rule.

Figure 4. Impulse Responses to Looser Financial Conditions, η



Source: Model simulation. Model is calibrated with US data 1971:Q1–2019:Q3.
Note: Figures plot responses of key model variables, under two alternative policy regimes, to initial conditions in which financial conditions are one standard deviation looser than average.

More specifically, the rule accounting for expected vulnerability efficiently reduces the volatility of financial conditions. This means that policymakers implementing it would be less likely to face levels of vulnerability experienced by their counterparts who are pursuing a standard Taylor rule.[1] Accordingly, even though the extended rule would prescribe (all other things being equal) tightening interest rates and increasing output volatility more sharply in the near term, the actually observed interest-rate hike under the extended rule—along with output gap and inflation volatility—are all smaller. All these facts imply lower welfare losses under the extended rule. The exact magnitude of the resulting benefit could, of course, depend on the closeness to the effective lower bound as well as secular changes in neutral rates, both of which are assumed away in the analysis underlying Figure 4.

The crossing of financial conditions shows an additional benefit of the NKV rule relative to the Taylor rule. Under the Taylor rule, in the medium term, financial conditions are tighter, and thus conditional output volatility is

[1]Formally, under both rules, the NKV is initialized with financial conditions one standard deviation below (that is, looser) than their unconditional mean.

greater, than under the extended rule. This illustrates the intertemporal risk trade-off, where higher conditional volatility in the near term may yield benefits in the form of lower volatility over the medium term.

Importantly, this paper does not advocate "leaning against the wind" and is fully consistent with the Fund's position outlined in IMF (2015). As Figure 4 highlights, naïve comparisons of interest rate paths implied by standard and extended rules for identical initial conditions would be misleading, as they would implicitly ignore the Lucas (1976) critique. In the NKV changes in the policy rule affect the entire transmission mechanism and attenuate the volatility of financial conditions. As a result, policymakers implementing such a rule are much less likely to face elevated levels of vulnerability and, on average, change rates by less. Expressed alternatively, the volatility of nominal interest rates ends up lower under the extended Taylor rule because, in equilibrium, the credible commitment to respond more obviates the need for larger responses.

Adrian and Duarte (2017) derive the optimal monetary policy rule, confirming that it depends on expected financial conditions. This is consistent with Curdia and Woodford (2010, 2016) and reflects the fact that the augmented monetary-policy rule in the NKV framework tends to reduce downside risks to growth without undermining growth on average (see also Figure 6). At the same time, and in line with the Fund's endorsement of accommodative policy packages aimed at curbing the short-term impact of COVID-19, the prospect of a severe contraction can optimally result in very accommodative policy, which *ceteris paribus* induces more contemporaneous risk taking.[2]

Estimations for 20 economies (both advanced and emerging market) show that welfare gains from using the optimal policy rule can be sizable (Adrian, Duarte, Grinberg and Mancini-Griffoli, 2017). It is significant that the central bank is assumed to minimize a standard welfare-loss function. Expressed alternatively, the fact that the optimal monetary-policy rule looks much like flexible inflation targeting that additionally conditions on financial vulnerability is an important result, rather than a modeling assumption.[3]

[2]The optimal policy stance can also depend on microprudential regulations in place, as well as the availability of macroprudential policy space. Adrian and Liang (2018) provide a literature review of the risk-taking channel of monetary policy and associated "leaning against the wind" monetary-policy rules.

[3]Svensson (1997) introduced flexible inflation targeting.

Chapter

5 "Low for Long" and Risk-Taking

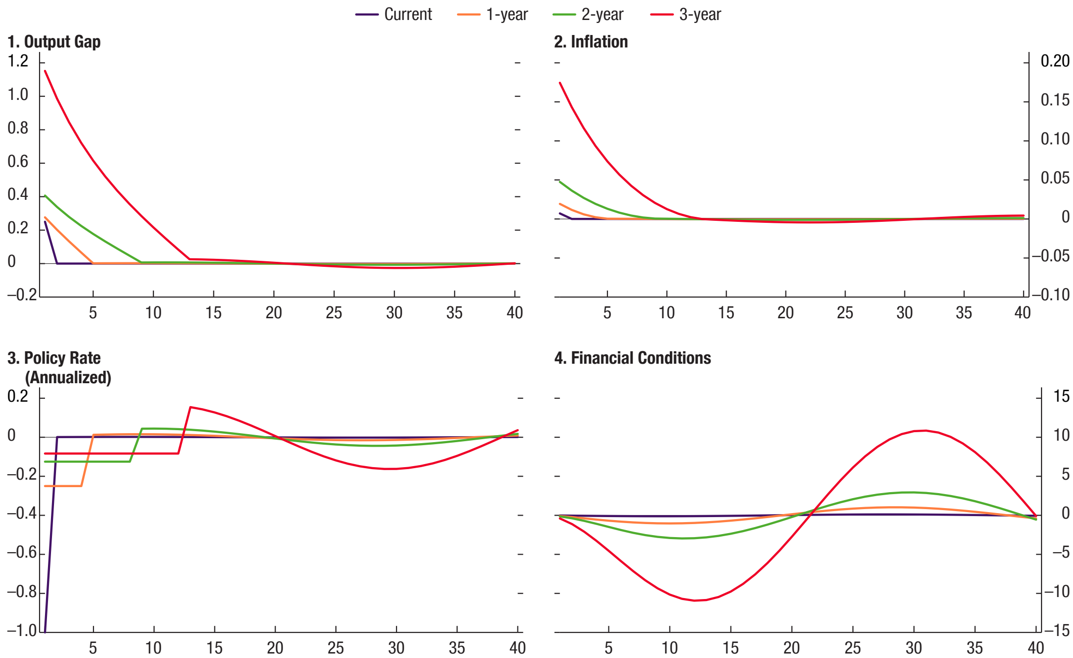
A notable implication of the COVID-19 crisis is that many central banks worldwide now expect to keep interest rates lower for longer periods. As alluded to at the outset, actions of many monetary policymakers are constrained by the effective lower bound, forcing them to provide stimulus using a wide array of unconventional policies, helping explain why "low for long" has spread around the world. The need to effectively boost demand to reduce the real impact of the shock is widely recognized, but a major concern is that these actions may increase financial vulnerability in the medium- to long term.[1] The NKV is well-suited to quantify such risks, whereas standard policy models arguably fail to address them. In this section, we thus use the NKV model to analyze the evolution of endogenous risk, assuming that efficient macroprudential tools may not be immediately available to counteract the buildup of financial vulnerability.

The NKV model largely inherits the standard monetary-policy transmission mechanism. Figure 5 shows that, in the NKV model, "forward guidance"—that is, a policy of committing to keep interest rates low for prolonged periods of time—provides an efficient way of stimulating output and inflation (as shown in the panels 1 and 2), in a way that is similar to its NK counterpart.[2] Panel 4 illustrates the added benefit of conducting the analysis in the NKV model. The panel shows that the boost to output and inflation is initially associated with very loose financial conditions, but that these factors overshoot after around five years. Such explicit quantification of the

[1]Inflationary risks are an additional concern, particularly in some emerging markets, whose policymakers have limited experience implementing unconventional monetary policy, and where credibility issues may play an important role (see also Adrian, Erceg, Linde, Zabczyk and Zhou, 2020, for an extended discussion).

[2]Indeed, the fact that forward guidance seems to be counterfactually effective in theoretical models has been dubbed the "forward guidance puzzle."

Figure 5. The Impact of Keeping Interest Rates "Lower for Longer" in the NKV Model



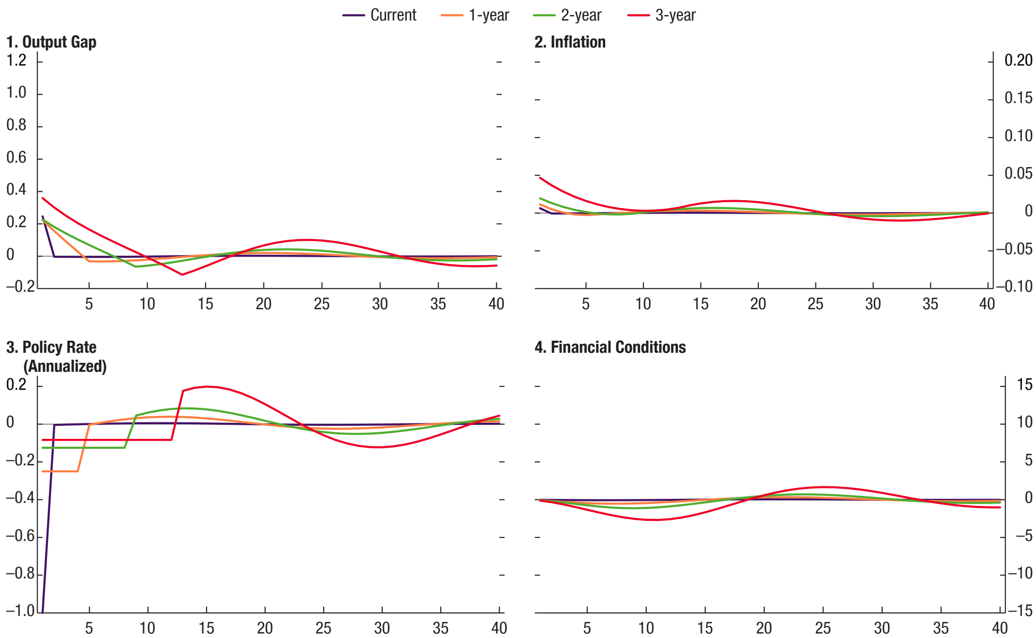
Source: Model simulation. Model is calibrated using US data 1971:Q1–2019:Q3.
Note: The lines plot impulse responses to "lower for longer" type policies, normalized to have similar magnitudes; specifically: a 100 basis point interest rate cut for 1 quarter (purple line), a cut of 25 basis points spread over 4 quarters (orange line), a cut of 12.5 basis points spread over 8 quarters (green line), and a cut of 8.3 basis points spread over 12 quarters (red line).

intertemporal trade-off can help eliminate short-term biases and can facilitate greater efficiency.

While an extended Taylor rule, designed to proxy optimal monetary policy, attenuates swings in financial conditions, it also limits the effectiveness of forward guidance. Comparing Figures 5 and 6 highlights that when policymakers who follow the same extended Taylor rule analyzed previously commit to holding rates lower for longer, the economy ends up less vulnerable in the medium to long term. However, the immediate stimulus associated with forward guidance is also smaller in scale. While this reflects the impact of credible changes in the conduct of policy on the transmission mechanism, it provides an additional rationale for *ceteris paribus* more accommodative policy in response to the pandemic. Specifically, to achieve the same amount of stimulus, policy makers would need to resort to larger policy surprises. Arguably, such intriguing relationships provide a clear rationale for continued development of NKV-like models.

While many aspects of how monetary policy is transmitted are common to the risk-centric NKV model, not all conclusions carry over. An important difference, documented in Adrian and others (2020a), pertains to the benefits

Figure 6. The Impact of Forward Guidance Under an Extended Taylor Rule



Source: Model simulation. Model is calibrated using US data 1971:Q1–2019:Q3.
Note: The lines plot impulse responses to "lower for longer" type policies, normalized to have similar magnitudes; specifically: a 100 basis point interest rate cut for 1 quarter (purple line), a cut of 25 basis points spread over 4 quarters (orange line), a cut of 12.5 basis points spread over 8 quarters (green line), and a cut of 8.3 basis points spread over 12 quarters (red line).

of running very aggressive monetary policy. In a standard NK setup, such a policy typically stabilizes inflation and the output gap very efficiently. When the evolution of endogenous risk is also factored into the analysis, however, aggressive policies can be a recipe for real and financial instability. This highlights an additional reason for closely monitoring the evolution of financial conditions and further points to potential benefits of augmenting monetary policy with suitable macroprudential rules—an issue we turn to now.

CHAPTER

6 Macroprudential Policy

This NKV framework features macro-financial risk and can be used to model, jointly, monetary and macroprudential policies. In line with the intuition discussed previously, Adrian and others (2020a) show that if macroprudential policy could entirely take care of downside risks stemming from financial vulnerability, then monetary policy could go back to the prescriptions from the standard NK model. In particular, it would no longer risk destabilizing the economy. Accordingly, in a perfect world, there would be perfect separation of monetary and macroprudential policies along with full economic and financial stabilization.[1]

The IMF has long argued that macroprudential policy is the first line of defense against financial stability risks (IMF 2015; Svensson 2017). Ideally, macroprudential policy instruments should be sufficiently developed and rich enough to mitigate all risks to financial stability. This would cover not only banks, but also nonbanks, and possibly households, corporations, and risk taking by the sovereign.

In practice, however, optimal monetary policy does need to track downside risks, even when macroprudential tools are available. This is because the world, arguably, isn't perfect and macroprudential tools and governance have limitations. For example, macroprudential tools usually take several quarters, sometimes up to a year, to be phased in, and their impact on economic activity might be even less timely and subject to regulatory arbitrage. In addition, communicating these policies can be much more challenging than is true for "standard" and "unconventional" monetary-policy decisions, and their reach,

[1]Interestingly, these results chime with the empirical findings of Brandao-Marques and others (2020), who suggest that macroprudential policies are effective in dampening downside risks to growth stemming from the buildup of financial vulnerabilities, and that the trade-off for monetary policy acting alone is considerably worse.

typically limited to the banking sector, poses an extra limitation. Furthermore, most countries have not fully developed their macroprudential toolkits.

The NKV framework allows us to think about the joint determination of optimal macroprudential and monetary policy in a rigorous, model-consistent way while staying tractable and empirically relevant. As shown by Adrian and Vitek (2020), the endogenous risk mechanism of the NKV model can be embedded in a medium-sized dynamic stochastic general equilibrium (DSGE) model—similar to Christiano, Eichenbaum, and Evans (2005), or Smets and Wouters (2007)—but featuring housing and financial intermediation as well. Doing so makes it optimal for monetary policy to respond more aggressively to the business cycle, and for macroprudential policy to manage the resilience of the banking sector more actively over the full length of the financial cycle. Embedding the NKV framework in a medium-sized DSGE model with endogenous risk yields further quantitative insights by disaggregating its transmission mechanisms. The effects of monetary and macroprudential policy are asymmetric: Tightening measures raise growth at risk to a larger degree than easing measures reduce it in the short term (and vice versa over the medium term).

Chapter

7 Open Economy Extensions

Naturally, the underlying endogenous risk considerations discussed so far are, if anything, even more relevant in an open economy context. Swings in global financial conditions, such as those associated with spikes in sovereign and corporate risk premiums or rapid exchange-rate depreciations, can bring about "sudden stops" or even reversals of capital flows, wreaking havoc in the vulnerable economies affected by such developments. Importantly, these changes can be amplified by local factors but triggered by global ones, significantly complicating risk-management considerations and the analysis of various policy tradeoffs.

Efforts to quantify such tradeoffs, and to understand the synergies associated with various policy mixes, are at the heart of the IMF's efforts to develop an Integrated Policy Framework (Georgieva 2020). To that effect, Adrian, Erceg, Linde, Zabczyk, and Zhou (2020) study the interactions between monetary policy, foreign-exchange interventions and capital-flow measures in a quantitative DSGE model. The analysis also accounts for effective lower bound considerations, as well as the potential for international policy spillovers.

Foreign-exchange interventions and capital-flow measures may improve policy tradeoffs for vulnerable economies. The aforementioned analysis shows that the evolution of endogenous risk can be affected by sovereign net foreign asset positions and substantial foreign-exchange mismatches, with policy tradeoffs also made more complicated by less-well-anchored inflation expectations. The underlying model thus embeds nonlinear balance-sheet channels and includes a range of empirically relevant frictions, which jointly affect the dynamics of financial conditions and endogenous vulnerability.

CHAPTER

8 Conclusion

This paper argues that models of optimal monetary policy should take the endogeneity of risk into account. The arguments have been in three steps:

- Data strongly suggest that the conditional volatility of output depends on financial conditions and gives rise to an intertemporal risk-return trade-off for policymakers: Easy financial conditions boost short-term growth and reduce short-term risk, but they might lead to a buildup of medium-term financial vulnerabilities. This finding holds true across countries and across time.
- Endogenous macro-financial risk can be parsimoniously modeled in a standard NK model with risk as an additional endogenous state variable, and with only a small number of additional parameters governing the evolution of "financial vulnerability" along with the "financial accelerator." Such a model, which we call NKV, is parsimonious, tractable, and captures the stylized facts from "vulnerable growth."
- This framework provides policymakers with an *endogenous* forecast *distribution*. The NKV model generates highly skewed and "fat-tailed" unconditional output gap growth distributions, even when shocks are Gaussian. A rule that, relative to a standard Taylor rule, also accounts for expected financial conditions is shown to mitigate downside risks to output.

Of course, what the "right decision" is for the policymaker depends on their preferences, including the discount factor, risk aversion, and the intertemporal elasticity of substitution. In an actual monetary-policy setting, any decision would require policymakers' judgment given the lack of precision in measuring the output gap in real time, and one might want to use a more realistic medium-sized DSGE model, that fits the data along various additional dimensions (see, for example, Adrian and Vitek 2020, or Adrian, Erceg, Linde, Zabczyk, and Zhou 2020). Moreover, any outcome will also reflect the ability of the policymaker to clearly communicate objectives, including the relevant endogenous risk metrics and measurement horizons.

The NKV model proposed in this paper can be used to determine macroprudential and monetary policy jointly. When macroprudential tools are fully developed, the classic separation between monetary policy tools and financial stability tools can be achieved. But in the more realistic case where macroprudential policy is imperfectly developed, the framework can be used to assess the optimal interaction between both types of instruments. This modeling is thus fully consistent with the IMF's traditional approach to monetary policy and financial stability (IMF 2015).

The policymaker who is aware of and tries to actively reduce vulnerability, in addition to the usual focus on the inflation gap and the output gap, will "trim the tails" of the output gap distributions over time. In other words, prudent monetary policy in the presence of endogenous risk reduces risks to GDP. All interested parties can surely agree: this is a desirable outcome.

Appendix I. The NKV Model

Model Equations

1. Dynamic IS curve

$$y_t^{gap} = E_t y_{t+1}^{gap} - \tfrac{1}{\sigma}\left(i_t - E_t \pi_{t+1} - r_t^{nat}\right) - (\gamma_\eta)\,\eta_t - V(\eta_{t-1}, \eta_{t-2}, y_{t-1}^{gap})\,\varepsilon_t^{gap}$$

2. Endogenous financial conditions

$$\eta_t = (\lambda_\eta)\,\eta_{t-1} + (\lambda_{\eta\eta})\,\eta_{t-2} - (\theta_y)\,y_t^{gap} - (\theta_\eta)\,E_t y_{t+1}^{gap}$$

3. New Keynesian Phillips Curve

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t^{gap}$$

4. NKV rule

$$i_t = (\phi_\pi)\,\pi_t + (\phi_y)\,y_t^{gap} - (\phi_\eta)\,E_t \eta_{t+1}$$

Calibration

1. NK parameter values

κ	ϕ_π	ϕ_y	σ
0.1275	1.5	0.125	1

2. Vulnerability and financial accelerator parameter values

γ_η	λ_η	$\lambda_{\eta\eta}$	θ_η	θ_y	ϕ_η
0.01	1.97	–1.01	0.31	0.08	0.01

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