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A risk management perspective on macroprudential policy

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Abstract

Macroprudential policymakers assess medium-term downside risks to the real economy arising from financial imbalances and implement policies aimed at managing those risks. In doing so, they face an inherent intertemporal trade-off between the expected growth and downside risks. This paper reviews the literature on Growth-at-Risk, embeds it in the wider literature on macroprudential policy, and proposes an empirical risk management framework that combines insights from the two literatures, by forecasting the entire real GDP growth distribution with a structural quantile vector autoregressive model. It accounts for direct and indirect interactions between financial vulnerabilities, financial stress and real GDP growth and allows for potential non-linear amplification effects. The framework provides policymakers with a macro-financial stress test to monitor downside risks to the economy and a macroprudential stance metric to quantify when interventions may be beneficial.

Keywords: Growth-at-risk; stress testing; quantile vector autoregression; financial conditions; macroprudential policy.

JEL Codes: G21, C33

Non-technical summary

Macroprudential policy has developed as a self-standing discipline to prevent and mitigate systemic risks to financial stability. Macroprudential authorities monitor cyclical fluctuations in key financial variables and implement counteracting policies if the identified risks pose a threat to financial stability. While the macroprudential objective may be intuitively clear, the trade-offs policymakers face for managing risks to maintain financial stability have only been limitedly formalised.

In this paper we propose a risk management framework for macroprudential policy that explicitly considers a trade-off by relating the mean outlook for economic growth with its downside risks. We quantify the policy trade-off by estimating a quantile vector autoregressive model (QVAR) on euro area data that captures the dynamic interactions between a financial vulnerability indicator (financial cycle), a measure of systemic stress and economic growth. The empirical model forecasts the entire distribution of real GDP growth by combining the strength of linear VARs to capture direct and indirect interactions between the variables and the ability of the quantile regression to estimate potential non-linear amplification effects in the tails. By employing real GDP as the main variable of interest, the assessment focuses on the transmission of financial imbalances that may be severe enough to adversely impact real economic activity.

The risk management framework proposed in this paper combines the early warning approach and the stress-testing approach into a time series modelling framework that accounts for intertemporal trade-offs. We consider an average growth shortfall, defined as the expected real GDP contraction over a given forecast horizon. The growth shortfall captures the expected GDP decline conditional on a contraction, multiplied by the probability of a contraction occurring. Stress tests focus primarily on the conditional losses in the first term, while early warning applications tend to focus on the probability of (severe) contractions, captured in the second term.

Equipped with the QVAR estimates and forecasts we conduct three policy exercises. First, we develop a forward-looking monitor for downside risks which relates underlying vulnerabilities in the financial system to adverse tail outcomes, akin to a macro-financial stress test. The second exercise assesses the implications for economic growth of taming the financial cycle. It reduces asymmetries in economic growth and raises mean growth. Third, we propose a stance metric to guide macroprudential policy defined as net benefits from leaning against the financial cycle in times of exuberance and sustaining it in times of crisis. The stance metric trades off mean real GDP growth and downside risks in a policy counterfactual.

The proposed general framework supports the communication of macroprudential policy as it explicitly formulates the trade-offs faced by policymakers. It offers operational tools to inform macroprudential policy decisions and highlights the relevance of endogenous interactions and non-linear feedback loops between financial and real economy variables. The framework can be used to assess the relative effectiveness of macroprudential policy in its impact on GDP growth relative to other policies.

1 Introduction

Macroprudential policy has developed as a self-standing discipline to prevent and mitigate systemic risks to financial stability. It builds on the notion of financial cycles, prominent in the writings of Kindleberger (1978) and Minsky (1977). The exuberant phase of a financial cycle is generally associated with excessive risk-taking, buoyant asset prices and abundant credit provision. Eventually, the cycle turns and triggers the so-called ‘Minsky moment’, a sudden and major collapse of risk-taking, asset prices and credit provision causing a financial crisis. The Global Financial Crisis (GFC) has shown that crises can be triggered not only by large external shocks, but also by smaller shocks experiencing amplification within the financial system, thereby reflecting the limited resilience of an already vulnerable economy (Mishkin, 2011). The cyclical movements of exuberance and financial crisis are often related to externalities from individual behaviour and associated with high costs for the aggregate real economy (De Bandt et al., 2012, Laeven and Valencia, 2012 and 2020, Lo Duca et al., 2017). The mitigation and prevention of such high real economic costs caused by the transmission of financial imbalances are the main objective of macroprudential policies (Borio, 2003).

To accomplish their objective, macroprudential authorities monitor cyclical fluctuations in key financial variables and implement counteracting policies if the identified risks pose a threat to financial stability. In practice, countercyclical macroprudential measures are activated or tightened when downside risks to the economy are deemed too severe to be absorbed by the financial system, and they are released when risks subside or materialise. By preventing and mitigating systemic risk, authorities improve the resilience of the financial system and the economy (Constâncio, 2016).

While the macroprudential objective may be intuitively clear, the trade-offs faced by policymakers for managing risks to maintain financial stability have only been limitedly formalised. Trade-offs emerge when balancing the medium-term benefits from containing systemic risk with the short-term costs of forgone financial intermediation and economic activity due to tighter macroprudential policy. Quantifying this cost-benefit analysis is no trivial task as it involves specifying an analytical financial stability objective as well as quantifying losses when missing the target. In the case of macroprudential policy, the task is further complicated by the facts that systemic risk is highly complex and hard to measure, and that there are multiple – potentially interacting - instruments available to address it.

The risk management framework for macroprudential policy proposed in this paper explicitly considers a trade-off by relating the mean outlook for economic growth with its downside risks. The framework is forward-looking and is based on a theoretically founded objective function described as the discounted expected (mean) real GDP growth net of the risk of GDP contractions, labelled ‘growth shortfall’. By relating mean GDP growth and the growth shortfall, the framework embeds the risk management task of macroprudential policy. Effectively, it transposes and applies the monetary policy risk management idea described in Greenspan (2003), Cecchetti (2006), Kilian and Manganelli (2008) and Evans et al. (2015) to the macroprudential policy context. More recently, Carney (2020) and Suarez (2020) have advocated similar approaches. Extensions to existing general equilibrium setups are provided by Mendicino et al. (2020) and Caballero and Simsek (2020). The approach also relates to the trade-off between the duration of a credit-sustained expansion and the subsequent severity of the recession, as studied in Laeven et al. (2020b).

How can the specific trade-offs for managing risks be formalised and quantified in an empirical model? We quantify the policy trade-off by estimating a quantile vector autoregressive model (QVAR) on euro area data that captures the dynamic interactions between a financial vulnerability indicator, a measure of systemic stress and economic growth. By employing real GDP as the main variable of interest, the assessment focuses on the transmission of financial imbalances that may be severe enough to adversely impact real economic activity. The empirical model combines the three variables into a QVAR to forecast the entire distribution of real GDP growth. While the VAR captures possible direct and indirect interactions between the model variables, the quantile component in the regression estimates potential non-linear amplification effects present in abrupt and severe economic downturns. The estimation method relies on the seminal quantile regression paper of Koenker and Bassett (1978), and builds on Cecchetti and Li (2008), White et al. (2015) and Chavleishvili and Manganelli (2019).

The estimation results for the euro area confirm previously identified non-linearities and find intertemporal trade-offs from financial vulnerabilities. Financial stress triggers tail events in euro area real GDP, similar to the findings in Adrian et al. (2019) for the US and for the euro area in Figueres and Jarociński (2020), Chavleishvili and Manganelli (2019), Chavleishvili and Kremer (2021) and Ruzicka (2021). In addition, financial exuberance – captured by high values for the financial cycle – creates the conditions for amplifying future downturns into tail outcomes. This economic vulnerability does not result from the financial cycle's long-run predictive power for financial crises as suggested in early warning studies (Alessi and Detken, 2018; Lo Duca and Peltonen, 2013; Schularick and Taylor, 2012; and a critical assessment by Reichlin et al., 2020), but rather emerges from a pronounced boom-bust pattern in financial activity, amplified by an adverse feedback loop with systemic stress in a downturn ("vicious circle"). This finding implies that the short-term negative growth effects of smoothing the financial cycle should be weighed against the medium-term positive effects of a reduced amplification mechanism during crisis times.

The estimated model can be used for forward-looking policy applications to monitor downside risks related to underlying vulnerabilities in the financial system. To unveil the vulnerabilities, we apply a sequence of adverse shocks to obtain a time series of 'stressed GDP growth', akin to a series of macro-financial stress tests. When applied to euro area data, the model anticipates the risks related to the GFC as early as 2007Q3 and identifies severe downside risks during the euro area sovereign crisis in 2011-2012. Beyond downside risks, the empirical results also suggest that the upside potential during the GFC declined and only recovered to its pre-crisis average level at the beginning of 2015. A comparison with the coronavirus crisis from 2020 reveals that the shock size during the coronavirus crisis is a multiple larger than the shock from the GFC.

Equipped with the macroprudential objective function and the QVAR estimates we propose a metric of stance to guide macroprudential policy. The stance metric subtracts the preference-weighted growth shortfall from the expected mean real GDP growth over an arbitrary forecast horizon. The metric incorporates multiple facets related to the assessment of financial stability risks. It captures downward shifts of GDP growth, fatter tails of the growth distribution or, more generally, a larger mass of the distribution with negative future GDP growth. We conduct a counterfactual to quantify a policymaker's intertemporal trade-off between mean real GDP growth and downside risks when tightening macroprudential policy to curtail the financial cycle in times of exuberance.[1]

The proposed framework can support the communication of macroprudential policy deliberations. It overcomes the challenges faced by macroprudential policymakers to spell out implicit trade-offs in the conduct of macroprudential policy. By explicitly formulating the trade-offs, the risk management framework offers an operational tool to compare macroprudential strategies and to weigh the arguments underlying policy decisions.

The paper proceeds as follows. Section 2 reviews recent advancements in the assessment of financial stability and macroprudential policy. Section 3 defines the risk management framework focussing on downside risk measures and presents the econometric model, the data and estimation results for the euro area. The companion paper Chavleishvili et al. (2021) provides the technical details and additional estimates for U.S. data. Section 4 applies the estimated model to typical macroprudential policy questions. It provides a macro-financial stress test, implications of a policy fully stabilising the financial cycle, and a stance metric capturing the intertemporal trade-off inherent in countercyclical macroprudential policy. Section 5 indicates additional application possibilities and concludes.

[1] Given the lack of historical data between macroprudential instruments and the financial cycle, we implicitly assume that the macroprudential authority can directly control the financial cycle. Incorporating these instruments in our empirical framework remains an important area of research and policy modelling, see e.g. Ampudia et al. (2021).

2 Advancements in financial stability assessments

Macroprudential authorities have the responsibility of managing the risks to the financial system. Government intervention is justified by market failures that induce individual agents to take risks which are inefficient from an aggregate perspective (see De Bandt et al., 2012, and Martin et al., 2021 for a review of the literature). The main externalities underlying the inefficiencies are contagion due to interconnectedness (Allen and Gale, 2000), pecuniary externalities or fire sales (Lorenzoni, 2008), and aggregate demand externalities (Farhi and Werning, 2016). Financial regulation may be justified even in the absence of market failures based on a trade-off between economic growth and financial stability (Popov and Smets, 2011).

The question how to translate these theoretical arguments into a measurable objective, which serves as a compass for macroprudential authorities and for accountability purposes still lacks a satisfactory answer. As a first step towards operationalising macroprudential policy, financial authorities have developed definitions of financial stability that refer to the ability of the financial system to absorb external shocks without impairing the functioning of the real economy.[2] Such definitions has been instrumental for distinguishing financial crises from standard economic downturns. Much of the empirical research has focused on identifying factors predicting financial crises, implicitly suggesting that the macroprudential policy objective is to manage crisis probabilities, which is problematic as probabilities are not observable.

The initial research on the timing of financial crises has nevertheless being useful to identify the key macroeconomic and financial variables to monitor for financial stability purposes. While first early warning applications focussed on the Asian financial crisis in the late 1990s, the GFC in 2008-2009 renewed the interest in early warning indicators with comprehensive analyses conducted by Alessi and Detken (2018), Bernanke (2018) and Schularick and Taylor (2012). Databases on financial crises compiled information on crisis characteristics such as start and end dates, fiscal costs and overall output losses (see, for instance, Laeven and Valencia, 2012, 2020, and Lo Duca et al., 2017). Related research has uncovered leading indicators of financial crises in cross-country early warning models (Kaminsky and Reinhart, 1999; Estrella and Mishkin, 1998; Gilchrist and Zakrajsek, 2012). The leading indicators for financial crises are – by definition – also highly correlated with loss metrics, given that crises are typically associated with sizable economic or fiscal losses. To anticipate the potential severity of crises, practitioners have relied on stress tests conditional on specifically designed scenarios, see e.g. Dées, Henry and Martin (2017), Anderson et al. (2018), Budnik et al. (2019) or Gornicka and

[2] The ECB (2005) considers a financial system as stable when it performs its key functions of efficiently intermediating financial funds, arranging payments and managing and pricing risks in a smooth manner, see also Fell and Schinasi (2005).

Valderrama (2020). The vast research on early warning systems and stress tests has been important to provide a conceptual justification for countercyclical macroprudential policy, aiming both at limiting the probability of crises and at attenuating losses during crises. This work has, however, provided only a limited discussion of trade-offs associated with the implementation of macroprudential measures. Spelling out these trade-offs is central to the discussion to avoid promoting “financial stability of the graveyard”, in the words of George Osborne.

Inherent to the conduct of countercyclical macroprudential policy is an intertemporal trade-off between loose financial conditions today relative to financial (in)stability in the future. While the current performance of economic activity can be directly observed, its underlying vulnerability is only assessed indirectly, conditional on specific shocks. Current vulnerabilities are related to amplification mechanisms that morph adverse shocks into downside tail outcomes. The objective of macroprudential policy thus consists in actively managing downside risks by acting on existing vulnerabilities. In practice, this not only implies implementing measures to contain the probability and the severity of financial crises whenever appropriate, but to weigh the risks of downside amplification against economic costs of mitigating policy measures.

Following an early contribution by Cecchetti (2006), recent research on financial stability has focussed on better understanding what drives the left tail of the real GDP growth distribution. Adrian et al. (2019) use quantile regression to show that financial variables have an over-proportional negative impact on the lower quantiles of the GDP distribution, referred to as Growth-at-Risk (GaR) in analogy to the Value-at-Risk measure widely used in risk management. They base their analysis on the National Financial Conditions Index (NFCI) which combines data from money markets, debt and equity markets, as well as the traditional and shadow banking systems.[3] The index explains especially the short-term downward changes in real GDP growth while the upper tails of the growth distribution remain unaffected, as also confirmed by Adams et al. (2020). Our companion paper (Chavleishvili et al., 2021) documents similar results for the Composite Indicator of Systemic Stress (CISS) as a strong predictor of short-term downside risks to the euro area economy. These indicators provide advance information on downside risks to GDP growth, but mainly over the shorter horizon (Reichlin, Ricco and Hasenzagel, 2020; Plagborg-Møller et al., 2020).

The GaR literature focuses on the short-term predictive content of financial conditions. The early warning literature points to several indicators of financial vulnerability associated with crises over medium- and long-term horizons. The early warning literature identified vulnerability indicators such as credit or leverage dynamics that tend to anticipate financial or banking crises by several years and sow the seeds for these crises (see Schularick and Taylor, 2012; Lang et al., 2019, for a comprehensive assessment of leading indicators for the euro area). These stylised facts are in line with recent theoretical models featuring endogenous credit booms and the associated build-up of systemic risk which can trigger severe recessions

[3] The index is a weighted average of 105 measures of financial activity, each expressed relative to their sample averages and scaled by their sample standard deviations.

without relying on large exogenous adverse shocks; see Boissay, Collard and Smets (2016) and Bianchi and Mendoza (2020). In such models, market imperfections including asymmetric information (moral hazard and/or adverse selection) may first feed a financial boom and then cause its sudden reversal owing to market freezes, banking runs and credit crunches, and ultimately end up in severe “financial” recessions.

To capture the interaction of financial vulnerabilities and stress requires splitting financial conditions into a metric of vulnerabilities and one of systemic stress. The vulnerability metric serves as a barometer to the conditions of the financial system (Duprey and Roberts, 2017). It characterises the general state of the financial environment in which small perturbations may be amplified. Even if the vulnerability indicator contains forward-looking properties, it provides only limited information for a specific point in time in the future, given the uncertainty surrounding the specific moments of crisis triggers. In turn, the indicator of systemic stress operates as a ‘thermometer’. It measures the current level of financial frictions, or the current state of financial instability (Chavleishvili and Kremer, 2021). When interacting the stress index with a vulnerable state of the financial system, it can capture how an adverse shock is propagated and amplified into a full-blown financial crisis. The distinction of financial vulnerability and stress is especially important to estimate the intertemporal relation between vulnerabilities and downside tail risks.

We operationalise these intuitions with a quantile vector autoregressive (QVAR) model that relates economic activity to measures of financial vulnerabilities and systemic stress, allowing for unrestricted interactions between all variables. The setup may be considered as a minimum representation of a meaningful dynamic macro-financial model featuring financial instability. Quantile regressions capture potential asymmetries in the mutual relationships which may give rise to the intertemporal trade-off between loose financial conditions today and future downside risks. Adrian et al. (2018) surveyed the literature on evidence whereby policies that improve current financial conditions and economic activity raise downside risks in the future, reflecting a ‘term structure’ of Growth-at-Risk. This tension between the short-term gains from financial expansion and the medium-term costs when conditions reverse is the key inherent trade-off faced by macroprudential policymakers. Macroprudential policymakers cannot prevent exogenous shocks from occurring, but by influencing the vulnerability of the financial system they can mitigate the prospect of financial disruptions that would be severe enough to adversely impact real economic activity.

Equipped with a metric for the financial cycle and for systemic stress, macroprudential policy can act on the financial cycle to influence the degree by which exogenous shocks would be amplified. Effective macroprudential policy requires a quantification of the link between observable indicators of financial vulnerability and their future repercussions under a range of shocks. In essence, macroprudential policy can act on the cycle to manage financial stability and limit the likelihood and severity of tail downside risks (see Ampudia et al., 2021, for a review of the impact of macroprudential measures on financial variables). The tail risks become apparent only in some states of the world, when adverse shocks materialise. The QVAR model allows to quantitatively assess policy actions in counterfactual scenarios. Specifically, by tightening financial conditions and reducing vulnerabilities in exuberant times would reduce expected growth in the short term but bears the advantage to limit downside risk in the medium term. When applied to capital buffers, for instance, a pre-emptive tightening provides for the macroprudential policy space to release them in adverse times and to support the financial system.

3 An empirical risk management framework

3.1 Downside risks and the macroprudential policy objective

The proposed risk management approach focuses on downside risks to the macroeconomy while considering the entire forecasted real GDP growth distribution. A metric to quantify downside risk to real GDP growth commonly used by international institutions is Growth-at-Risk (GaR), see IMF (2017). It is the rate of future real GDP growth falling below a certain threshold with a given probability. As it is conditional on the information set available at time t it varies over time:

$$P_t[y_t \leq GaR_t^{\gamma}] = \gamma, \tag{1}$$

where y_t denotes the real GDP growth rate and GaR_t^{γ} is implicitly defined as the threshold below which real GDP growth occurs with probability γ. GaR metrics capture movements at a specific level in the lower tail of the distribution, the probability is therefore set to a small low positive value of 5% or 10%.

While GaR accounts for downside risks at a specific point in the growth distribution, we extend it in two relevant steps for the policymaker. First, we expand it to the entire tail of the distribution to capture a 'growth shortfall' and, second, we compute the 'average growth shortfall' over an arbitrary future time horizon. These two extensions are important to devise robust financial stability policy implications aimed at the full range of downside risks over relevant policy horizons.

The 'growth shortfall' (GS) captures the expected growth below a given threshold and considers the entire tail of the distribution. It is defined as

$$GS_t^{\tau} = \int_{-\infty}^{\tau} y_t \, dF_t(y_t) = E_t[y_t | y_t < \tau] \times P_t[y_t < \tau\,], \tag{2}$$

where $E_t[y_t | y_t < \tau\,]$ denotes the expected value for GDP growth, conditional on being below the growth threshold τ and on the information set available at time *t*. The threshold can be a quantile of the GDP growth distribution or a numerical value of GDP growth. If $\tau = 0\%$, it quantifies expected contractions as the product of average GDP contractions conditional on GDP declining $E_t[y_t | y_t < 0\%\,]$, multiplied by the probability of such a contraction occurring $P_t[y_t < 0\%\,]$. Both components are of interest in their own right and the GS summarises them tractably into one metric. Stress tests focus primarily on the conditional losses in the first term, while early warning applications tend to focus on the probability of (severe) contractions, captured in the second term.

The average future growth shortfall (AGS) captures the growth shortfall over a pre-defined horizon. It is defined as

$$AGS_{t,t+H}^{\tau} = \frac{1}{H}\sum_{h=1}^{H} GS_{t,t+h}^{\tau}. \tag{3}$$

where H indicates the number of quarters over which the horizon is computed. When τ = 0%, the AGS reflects the average future expected contraction of the economy over H quarters into the future.

Financial stability policies may focus on containing downside risks but should also consider impacts on the expected (mean) growth rate of the economy or the upper tail of future GDP growth. We therefore define the growth longrise (GL) as the complement to GS: $GL_t^{\tau} = E_t[y_t|y_t > \tau] \times P_t[y_t > \tau]$. By definition, expected GDP growth is the sum of GS and GL: $E_t[y_t] = GL_t^{\tau} + GS_t^{\tau}$. Consistently, with τ = 0% the AGL measures the average future expected expansion of the economy over H quarters into the future.

The objective of the macroprudential policymaker is to especially manage downside risks by implementing macroprudential policies. While macroprudential policy instruments may influence the entire predicted growth distribution, the policymaker focuses especially on downside risks given the potentially disruptive effects for the real economy. The proposed objective function for the policymaker is the discounted sum of future expected growth whereby downside risks are penalised:[4]

$$\max_{\{c_{t+h}\}_{h=1}^{H}} \sum_{h=1}^{H} \beta^h \left(E_t[y_{t+h}] + \lambda GS_{t,t+h}^{\tau}\right), \tag{4}$$

where $\lambda > 0$ is the relative extra weight attached to the growth shortfall to reflect the larger aversion to negative realisations of output growth; $0 < \beta < 1$ is the intertemporal discount factor; and $\{c_{t+h}\}_{h=1}^{H}$ describes the optimal future path of certain macroprudential policy instrument c_t over the relevant policy horizon H.

It is instructive to think about limiting cases. Setting $\lambda = 0$ assumes that the policymaker is not concerned about downside risk, and therefore eliminates the need for macroprudential policy. On the other hand, by setting $\lambda = \infty$, the policymaker cares only about avoiding downside risk and will calibrate its instruments without considering potential implications for the mean growth of the economy (risking the so called ‘stability of the graveyard’). When λ is strictly positive and finite, the objective function (4) captures the essence of the macroprudential trade-off.[5]

The objective function combines the mean forecast, commonly developed in standard forecasting exercises, with future downside risks to the economy. It

4 The specification is reminiscent of the mean with downside risk model in asset allocation, see Fishburn (1977). Note, the maximisation is equivalent to a specification in which downside risks, measured as weighted distance of growth shortfall from the expected mean, are subtracted from the expected mean: $E_t[y_{t+h}] + \lambda GS_{t,t+h}^{\tau} = (1+\lambda)\left(E_t[y_{t+h}] - \frac{\lambda}{1+\lambda}\left(E_t[y_{t+h}] - GS_{t,t+h}^{\tau}\right)\right)$.

5 Other specifications can be formulated, for instance by considering higher lower partial moments or casting the optimisation problem in the more traditional mean-variance trade-off. As long as predictive distributions of the underlying random variables are available, they can be used to compute any desired expected utility function of the macroprudential authority.

is similar to the expression suggested by Carney (2020) and can be micro-founded, as done for instance by Suarez (2020) for a similar objective function based on a representative agent with a CARA utility function on GDP. With this objective function the policymaker's risk management approach is explicit about maximizing expected future growth while mitigating the average expected growth shortfall by penalizing downside risks in line with its degree of risk aversion. It encapsulates the trade-off between downside risks and the upside potential for the economy, similar to those suggested by Aikman et al. (2019) and Duprey and Ueberfeldt (2020).

Apart from the risk aversion parameter, we can estimate all required elements of the intertemporal objective function with our proposed QVAR model (see Box A). While the VAR setup takes account of possible direct and indirect interactions between the model variables, the quantile estimation can account for potential non-linear amplification effects present only in certain states of the financial system and the real economy. By influencing the financial cycle, macroprudential policy instruments manage the cycle's direct effects on the GDP growth distribution as well as its indirect effects transmitting via financial stress conditions.

Box A – The Quantile Vector Autoregression (QVAR) model

In order to estimate the relevant metrics for the risk management framework we rely on the structural quantile vector autoregressive (QVAR) model by Chavleishvili and Manganelli (2019). Our choice for the VAR is guided by the aim to allow interactions of all endogenous variables over time and to transparently identify structural shocks to conduct policy counterfactuals. In turn, the choice for the quantile regression method allows the dynamic properties of the system to differ across quantiles, i.e. to depend on the state of the economy and the financial system. The empirical model thus combines the advantages of a standard (linear) VAR with those from quantile regressions which can capture potential non-linearities in the propagation of structural shocks.[6] Effectively, the QVAR model relates to the single-equation QR of Adrian et al. (2019) as the VAR model of Sims (1980) relates to the single-equation autoregressive approaches of e.g. Koyck (1954) and Almon (1965).

The model combines real GDP growth with variables of financial vulnerabilities and systemic stress into a three-variable QVAR to forecast the entire distribution of real GDP growth. Vulnerabilities to the economy are captured by the broad financial cycle indicator developed by Schüler et al. (2020), and systemic stress is measured by the ECB's composite indicator of systemic stress (CISS) as originally introduced in Holló et al. (2012). Both variables are shown in Figure 1 together with annualised quarterly GDP growth for the euro area between 1988Q3 and 2018Q4.

The CISS is a summary measure of the level of financial stress.[7] It includes 15 market-based financial indicators split into five sub-indices: financial intermediaries, money markets, equity markets, bond markets, and foreign exchange markets. The aggregation for the overall index takes account of the time-varying cross-correlations between sub-indices. It implies that the CISS takes

6 In addition, the QR parameter estimates are less sensitive to outliers relative to their least squares counterparts. This robustness feature is generally welcome as financial variables face abrupt or large changes, and is particularly important given the extreme outliers observed in during the coronavirus crisis in 2020.

7 The CISS is regularly updated and publicly available on the ECB website: https://sdw.ecb.europa.eu/.

higher values when stress prevails in several market segments at the same time. High values of the CISS are observed during the recession in 1992, the GFC in 2008-2009, and during the euro area sovereign debt crisis between 2010 and 2012. In each case, elevated systemic stress is associated with negative GDP growth.

The financial cycle indicator measures medium-term variations in financial imbalances especially captured by elevated credit growth in times of exuberant asset price inflation. The construction mirrors that of the CISS by taking high values when growth in total non-financial credit volumes coincides with real estate, equity, and/or bond prices. The choice for the financial cycle variable as a macroprudential metric for risk build-up is based on a variable selection exercise based on its forecasting performance using the average check function value as selection metric (See companion paper Chavleishvili et al. (2021) for details.

The three variables are stacked in the vector $\tilde{x}_t$ and for each of the variables i the QVAR for a fixed quantile γ is given by

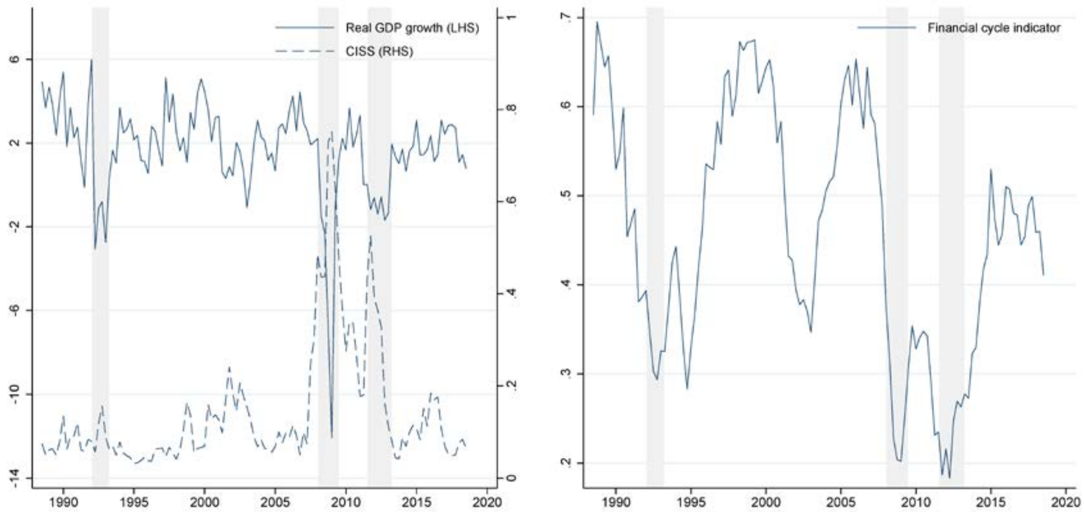
$$\tilde{x}_{t+1} = \omega^{\gamma} + A_0^{\gamma}\tilde{x}_{t+1} + A_1^{\gamma}\tilde{x}_t + \epsilon_{t+1}^{\gamma}$$
$$P\left(\epsilon_{t+1}^{\gamma} < 0 | \mathrm{F}_{it}\right) = \gamma \text{ for } i = 1, 2, 3,$$

where ϵ_{t+1}^{γ} represents the vector of structural quantile residuals.[8]

Figure 1: Euro area real GDP growth rate, CISS, and financial cycle indicator

Systemic stress is contemporaneous to downside realisations of GDP and the financial cycle captures medium-term vulnerabilities.

Left panel: Real GDP growth rate is annualiseannualised (left scale), the CISS by Holló et al. (2012) (right scale). Right panel: The real-time broad financial cycle indicator by Schüler et al. (2020).



Source: Eurostat, ECB calculations, Schüler et al. (2020) and Holló et al. (2012).
Note: The financial cycle indicator takes high values when total non-financial credit volumes grow at a fast pace, and real estate, equity, and bond prices grow at a fast pace as well. Shaded areas indicate CEPR euro area recession periods.

The recursive identification of the structural residuals is achieved by restricting the 3×3 matrix A_0^{γ} to be lower triangular with zeros along the main diagonal. Hereby real GDP growth is placed first, the financial cycle second and systemic stress third. The identification strategy thus

8 The estimation for a single quantile can be expanded to consider multiple quantiles. Technically this is done by stacking the equations for the individual quantiles, see companion paper Chavleishvili et al. (2021).

implies that the systemic stress variable (placed third) can react contemporaneously to macroeconomic and financial cycle shocks, while the financial cycle (placed second) can only react contemporaneously to shocks to output growth, and real output growth (placed first) only reacts with a lag to shocks of the financial cycle and the stress indicator.[9] This follows standard assumptions in the empirical literature such as Christiano et al. (1999), Kilian (2009), and Gilchrist and Zakrajsek (2012). The estimated model with its identification strategy allows us to quantify amplifications of risks for future economic activity caused by elevated levels of financial imbalances as well as systemic stress. This is relevant for forecasting the variables over time and for the counterfactual policy scenarios.

3.2 The propagation of financial shocks – estimation results

To assess the dynamic implications from exogenous movements in the financial cycle, systemic stress and GDP growth we use quantile impulse response functions (QIRF). The estimation is based on euro area data from 1988Q3 to 2018Q4 with quarterly annualised real GDP growth, the ECB's composite indicator of systemic stress (CISS) and the real-time financial cycle indicator by Schüler et al. (2020) (see Box A for the description of the model setup and the data). The QIRF is the change in the quantile forecast conditional on a one standard deviation shock applied to the structural residual of a variable while maintaining the evolution of the other variables at their median values. In a standard (linear) VAR an impulse response function would be the mean forecast and independent of the state of the economy. The QVAR approach, instead, differentiates the impact of the innovation by the position of the variable within its distribution. It can thereby illustrate varying transmission dynamics and amplification effects depending on the position within the distribution, see also Ruzicka (2020, 2021).

The results from the impulse responses confirm the important role of financial variables to explain asymmetric responses across the GDP growth distribution. Figure 2 represents the impact of the innovations (from left to right) onto the three variables in the QVAR (top to bottom). An innovation of one standard deviation to systemic stress (CISS) shifts the left tail (10^{th} percentile) of future GDP growth downward by 17 bps but leaves the median and the right tail (90^{th} percentile) broadly unaffected (see row 1, col. 3 in Figure 2). This finding illustrates and confirms the asymmetric transmission of adverse financial conditions captured in Adrian et al. (2019) and Reichlin et al. (2020).

Beyond the impact of systemic stress, the three-variable setup also allows to analyse the propagation of an innovation to the financial cycle on real GDP growth. The impulse responses of the financial cycle on real GDP (row 1, col. 2) capture the direct and the indirect effect via the CISS. They indicate the short- to medium-term expansionary effects of a higher financial cycle for real GDP growth. At

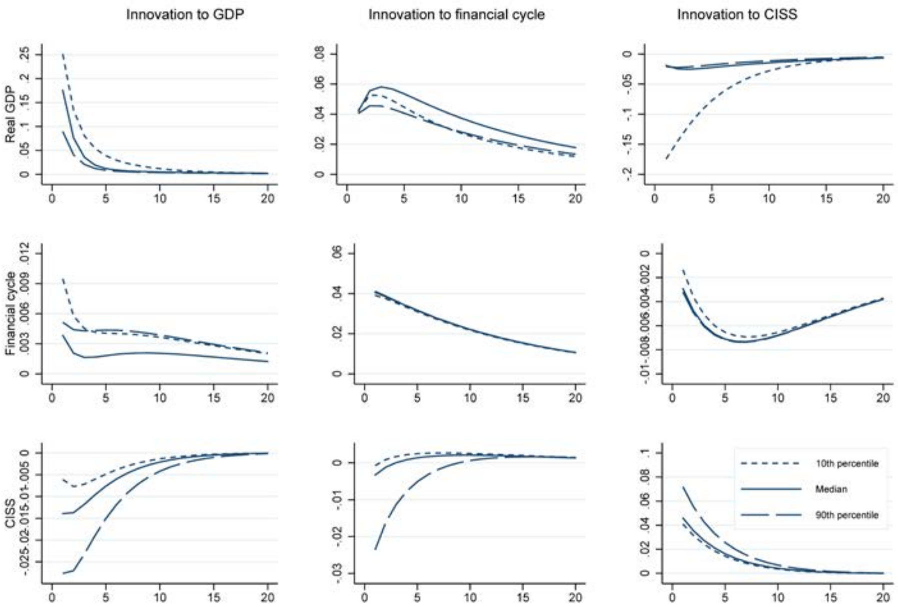
9 The available information for each variable at each point in time is determined as follows: For the first variable the information set is $\mathrm{F}_{1t} = \{\tilde{x}_{t,}\tilde{x}_{t-1}, \ldots\}$ and for subsequent variables it is $\mathrm{F}_{it} = \{\tilde{x}_{i-1,t+1,}\mathrm{F}_{i-1,t}\}$ for $i \in \{2,3\}$.

the same time, the response of the CISS to an innovation of the financial cycle (row 3, col. 2) is negative and especially so when the CISS is already elevated (at its 90th percentile). The strong asymmetry implies that when the financial cycle deteriorates in times of crisis, i.e. when the CISS is elevated, it would strongly increase systemic stress which would deteriorate real GDP.

Figure 2: Quantile impulse response functions

Innovations to financial variables create sizable asymmetric transmission dynamics.

Impulse response functions to a one-standard deviation positive innovation for each variable.



Note: Identification strategy is based on Cholesky decomposition with the following ordering of variables: GDP growth (respective first row), financial cycle (second row), and CISS (third row). Estimation sample is 1988Q3 to 2018Q4. Impulse response functions implied by the parameter estimates are provided in Chavleishvili et al. (2021).

The mutual reaction patterns between the financial cycle and the CISS hint towards a vicious financial circle in bad states of the world. While the CISS responds to shocks in the financial cycle in an asymmetric way (row 3, col. 2), adverse shocks in the CISS depress financial activity uniformly across the financial cycle's distribution (row 2, col. 3). As a result, in periods of elevated stress, adverse shocks in systemic stress and the financial cycle would tend to reinforce each other, and, if left unchecked, possibly erupting into a full-blown systemic crisis. This vicious circle offers insights for the crisis management function of macroprudential and other policies. In order to avoid that financial tensions generate systemic crises, macroprudential measures should aim at mitigating stress in core segments of the financial system, thereby limiting the risk of stress spillovers to the remaining system.[10] Conversely, by directly supporting financial intermediation, macro-prudential policy – along with monetary, supervisory and fiscal policies – would exert

[10] In this regard, large-scale asset purchases by central banks in systemically important financial market segments can also be seen as having a macroprudential crisis management dimension. They help contain the spreading of stress to the financial system as a whole. The same holds true for the role of the central bank as liquidity provider of last resort; see e.g. Caballero et al. (2020).

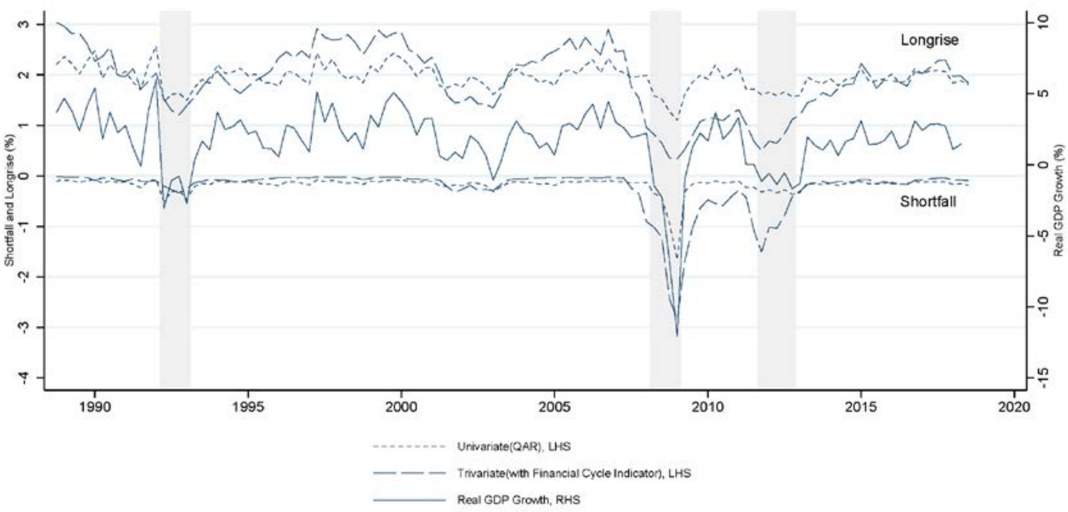
positive externalities on the level of financial stress. This can be achieved by loosening capital requirements, providing deposit guarantees, or offering emergency liquidity facilities during crisis times.

The interaction between financial cycle and systemic stress captured by the quantile impulse responses is not only relevant for computing downside risks, but also to track the upside potential to the economy. Figure 3 compares the annualised growth shortfall and longrise for a 2-year-ahead horizon together with realised annual real GDP growth over time. The univariate QAR – when compared to the three-variable QVAR – only limitedly captures the downside risks (growth shortfall) for the economy, especially during the GFC and the euro area sovereign debt crisis. The three-variable QVAR specification reveals that the GFC did not only generate an extremely low value for the growth shortfall, but also reduced the upside potential captured by the growth longrise. With a value of only 0.4% at the trough in 2009, the average expected expansion of the economy over the following two years would have been approximately 0.8%. This compares to an average of around 4% (2 years times 2%) observed over the entire sample. The GFC thus reduced living standards especially because of the contraction, but also persistently muted the upside potential of the economy until early 2015.

Figure 3: Growth shortfall and longrise for the euro area

The QVAR model captures amplifications from financial variables on real GDP growth.

(in percent)



Note: The average future growth shortfall (AGS) and average future growth longrise (AGL) is computed over 8 quarters (dashed lines, left hand scale). Quarterly annualised real GDP growth (solid line, right hand scale). The trivariate estimate is based on the QVAR model and allows for macro-financial interactions between annualised real GDP growth, the financial cycle indicator and the composite indicator of systemic stress (dashed line, left hand scale). The univariate estimate is based on a one-equation restricted model with a constant and lagged GDP growth (dotted line, left hand scale). Shaded areas indicate euro area recessions as determined by the CEPR business cycle dating committee. The estimation sample is 1988Q3 to 2018Q4.

4 Applications for macroprudential policy

This section considers three policy applications of the estimated Quantile VAR. The first application is a macro-financial stress test designed as a sequence of standardised shocks applied at each point in time to monitor underlying vulnerabilities of the financial system and the economy. The second policy exercise assesses the implications of a macroprudential authority to fully stabilising the financial cycle around its conditional median. The third exercise is a counterfactual to capture the intertemporal trade-off between taming the financial cycle in times of exuberance and supporting financial conditions in times of stress through looser policies.[11]

4.1 Macro-financial stress test

Underlying vulnerabilities of the economy can be uncovered by exposing it to macro-financial stress scenarios. The macro-financial stress test responds to the question what would happen to forecasted tail GDP growth if subjected to adverse financial shocks. It conditions the estimated model on a sequence of adverse shocks and focuses on the 10th percentile of forecasted GDP growth.[12] The 'stressed GDP growth' captures one aspect of macroprudential policy stance as it reveals underlying vulnerabilities of the economy and signals if adjustments in the calibration of macroprudential instruments are warranted.

The macro-financial stress test is designed as a fixed sequence of adverse shocks, similar to those observed during the Global Financial Crisis or in times of the coronavirus crisis, hitting the economy at any given point in time. By exposing the economy to the same sequence of shocks over time, the conditional forecasts track the implied response to the entire future real GDP growth distribution in a standardised manner. The shock series is applied to all three variables of the model, real GDP growth, the financial cycle and the systemic stress indicator. In the case of the GFC stress the calibration corresponds to the shocks observed in the midst of the GFC between 2008Q2 and 2009Q2. Technically speaking, the scenario places GDP growth, the financial cycle and CISS at their observed quantile realization for four consecutive quarters starting in 2008 Q2.[13] As a result, the outcome of the stress scenario performed in 2008 Q2 coincides - by construction - with the actual GDP contraction observed in 2009 Q2 (see Figure 4). We then apply the same scenario associated with these quantile realisations at each point in time.

11 The quantitative results of the macro-financial stress test and the counterfactual exercise for the macroprudential stance metric are identical to those in Chavleishvili et al. (2021).

12 The scenario is similar to those by Adrian et al. (2019) but expands to also consider adverse realisations for the financial cycle in the stress scenario.

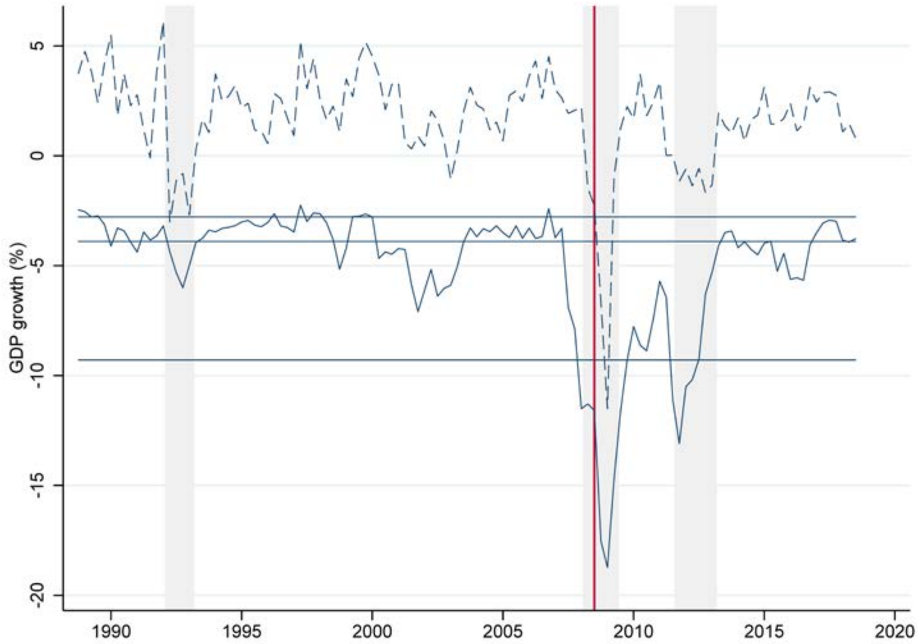
13 The exercise is conducted using the full sample parameter estimates to focus on the interaction of stress scenario and the initial conditions at each point in time, rather than emphasizing the changing information set available to forecasters.

As the model accounts for a non-linear transmission, the resulting forecasts will vary because of changing states of the economy as well as the varying transmission of the shocks given the different states of the economy at the onset of the stress. Differently to a linear VAR, the QVAR model accounts for the non-linear interaction between the state of the economy at the onset of the stress and the scenario itself. Figure 4 depicts the estimated real GDP growth four quarters ahead, conditional on the standardised stress scenario materialising over four quarters at each point in time. The median of the annual stressed GDP growth series amounts to around -4% (depicted by the middle horizontal line), reflecting the large adverse shock captured by the scenario. Box B offers a comparison with a stress scenario based on the coronavirus shock from early 2020.

Figure 4: Euro area resilience to a standardised macro-financial stress test

The stress test provides real-time indications of vulnerabilities to the real economy.

Annual GDP growth at 10th percentile in percent, as realised in historical data (dashed line) and under stress (solid line).



Notes: Dashed line: euro area annualised quarterly real GDP growth (historical data). Solid line: predicted average annualised quarterly real GDP growth one year ahead conditional on stress scenario of four consecutive quarters with quantile realizations for GDP growth, the financial cycle and CISS that occurred as of 2008 Q2. Horizontal lines refer to 0.1, 0.5, and 0.9 empirical quantiles. Predictions are based on full sample parameter estimates based on estimation sample 1988Q3 – 2018Q4.

Two episodes stand out as particularly vulnerable periods: the global financial crisis in 2008-2009 and the euro area sovereign debt crisis in 2011-2012. Thanks to the four-quarter ahead shock scenario, stressed GDP growth starts to deteriorate already as early as 2007Q3. The macro-financial stress test indicates that the underlying vulnerability of the economy amplifies the stress given the realisations of the variables during the GFC episode. A comparison with the euro area sovereign debt crisis illustrates sizable vulnerabilities in 2011, but the realised declines in real GDP were more benign. Seen through the lens of the model, it appears that the realised shocks during the sovereign debt crisis were either smaller or effectively attenuated through policy interventions. When considering the individual time series, it becomes evident that the tail of forecasted real GDP growth is particularly vulnerable when financial imbalances and systemic stress are high (see Figure 1). Additional comparisons with the recession following the ERM crisis in 1992-93 and the downturn following the dot-com bubble, reveal a more resilient euro area financial system at the time.

Box B – The coronavirus crisis through the lens of the Quantile VAR

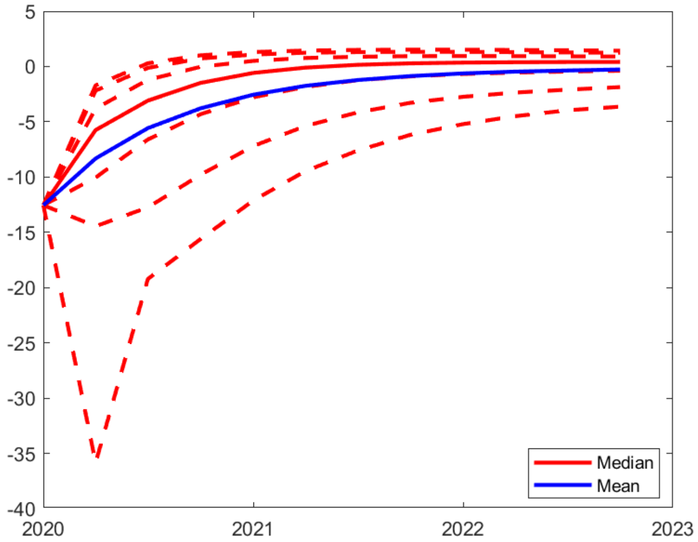
The coronavirus crisis hitting the euro area economy from March 2020 provides an example of an extreme stress scenario for the macro-financial conditions given the unprecedented size of the real shocks. Through the lens of the trivariate QVAR model, the coronavirus shock implied a surge in financial stress, captured by the CISS, accompanied by a slight decline in the financial cycle and a severe decline in real GDP growth. The crisis can be characterised as being a negative shock on real economic activity of unprecedented dimension given the lockdown measures, while the GFC originated in the financial sector. Based on the time series observed until 2020Q2, this box provides the conditional forecast of annualised real GDP growth three years ahead and uses the coronavirus crisis as basis for a stress test, complementary to the GFC scenario in the main text.

The forecasted annual real GDP growth distribution conditional on the coronavirus shock features large downward asymmetries around the median forecast. The QVAR can capture the non-linear transmission of shocks over the forecasted distributions of the individual variables. Given the historical regularities in which variables mutually amplify each other in downside tail events, quarterly real GDP growth at the 5th or 10th percentile of the distribution is forecasted to further decline in 2020Q2 before recovering (Figure B.1). At the same time, the upside potential of the economy is strongly muted. As a result of the strong left skew of the distribution, mean real GDP growth remains consistently below the median growth for the entire forecast horizon.

Figure B.1: Quarterly real GDP growth forecast distribution conditional on the coronavirus crisis

The forecasted real GDP growth distribution exhibits larger asymmetries captured by the QVAR approach.

Quarterly GDP growth (in %) over 3-year forecast horizon, conditional on information up until 2020Q2.



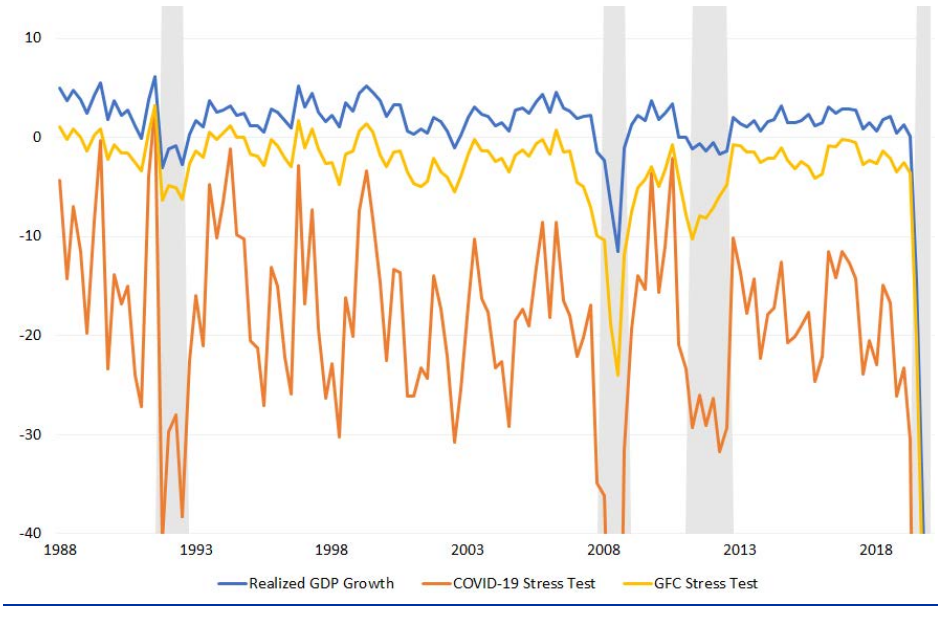
Notes: Solid blue line corresponds to mean forecasted quarterly real GDP growth, solid red line is median (50th percentile) quarterly real GDP growth; dotted red lines correspond to forecasts for the 5th, 10th, 25th, 75th, 90th, 95th percentile (from bottom to top).

The coronavirus shock can also be used as basis for a stress scenario to complement the GFC scenario. The choice of the specific stress scenario for the macro-financial stress test affects the assessment of the underlying economic and financial vulnerability. It is possible to compare the implications when considering the underlying shocks from the coronavirus crisis for stressed GDP relative to those from the GFC. A direct comparison of the two episodes in Figure B.2 reveals the exceptional size of the realised shocks during the coronavirus crisis, relative to standard GDP growth rates as well as relative to the GFC. The coronavirus scenario indicates that stressed real GDP growth ahead of the GFC would have been lower than ahead of the coronavirus crisis (see last observation ahead of the recessions of the two periods). The lower stressed GDP growth indicates the larger vulnerability ahead of the GFC as the same shock scenario would have triggered a larger decline in real GDP. Beyond the direct comparison, the application of the coronavirus shocks indicates the potential limitations of empirical models (also beyond the QVAR) to realistically predict model dynamics when the size of the shocks goes far beyond historical standards.

Figure B.2: Comparison of stress test based on GFC and Covid-19 scenarios

The direct comparison of shocks from the GFC and from the coronavirus crisis illustrates the sizable real economic impact of the coronavirus crisis.

Annual GDP growth (in %) as realised in historical data (blue line) and at 10th percentile under GFC stress (yellow line) and coronavirus crisis stress (orange).



Notes: Blue line: euro area annualised quarterly real GDP growth (historical data). Yellow line: predicted annualised quarterly real GDP growth at 10th percentile two quarters ahead conditional on quantile realizations for GDP growth, the financial cycle and CISS that occurred of 2008 Q4 and 2009Q1. Orange line: predicted annualised quarterly real GDP growth at 10th percentile two quarters ahead conditional on quantile realizations of 2020Q1 and Q2. Grey shaded areas indicate euro area recessions. Predictions use sample parameter estimates based on estimation sample 1988Q3 – 2020Q2. Vertical axis capped at -40%.

The macro-financial stress test can inform macroprudential policy. The stress test is effectively a quantitative yardstick to assess macroprudential stance in real time and to calibrate financial buffers for the financial system. Moderate levels of vulnerability indicate times when macroprudential capital buffers should be built up to support the financial system's resilience when stress hits. By increasing buffers in these periods would lean against excessive credit growth and would make them available for release when necessary. In turn, stress episodes are times when severely adverse shocks materialise and when macroprudential policy buffers should not only be released but also used by financial institutions to support financial conditions and the economy. A fully effective macroprudential policy would be able to stabilise the financial cycle and strongly curtail downside risks to the economy, as discussed in the next section.

4.2 Macroprudential policy to stabilise the financial cycle

What are the economic benefits of fully stabilising the financial cycle? We consider in this section an all-powerful macroprudential policymaker who is able to fully counteract large gyrations of the financial cycle. We want to analyse how the euro area real GDP growth distribution would differ in an environment where the financial cycle is stabilised by setting it to its conditional median without changing the remaining structural shocks to the economy.

To implement the counterfactual financial cycle requires identifying the structural shocks to real GDP growth and the stress indicator. We first assume that all model parameters remain fixed at their full-sample estimates. For each time period, we select the one-period ahead filtered structural shocks for real GDP and the CISS. In turn, for the financial cycle we select the one-period ahead conditional median realisation, in line with the assumption that the macroprudential policy can fully control the deviations of the financial cycle from its median. With these values at hand, we are able to iteratively rebuild a counterfactual series spanning the entire time horizon. The counterfactual time series accounts for the original structural shocks of real GDP growth and systemic stress but excludes the exogenous swings in the financial cycle as active drivers of the dynamics.[14]

The counterfactual paths for real GDP growth and systemic stress conditional on a stabilised financial cycle exhibit less asymmetry than their historical correspondents. The panels in Figure 5 compares the three historical time series for the euro area with their counterfactual series and the bottom right panel illustrates the kernel estimates of the real GDP growth distribution. As imposed, the counterfactual financial cycle does not exhibit the large swings observed in historical data.[15] As a result of the stabilised financial cycle, systemic stress and real GDP growth also exhibit smaller deviations, especially during crisis times. This is due to the inherent non-linear amplification mechanisms between the financial cycle, systemic stress and real GDP growth, captured by the parameter estimates and

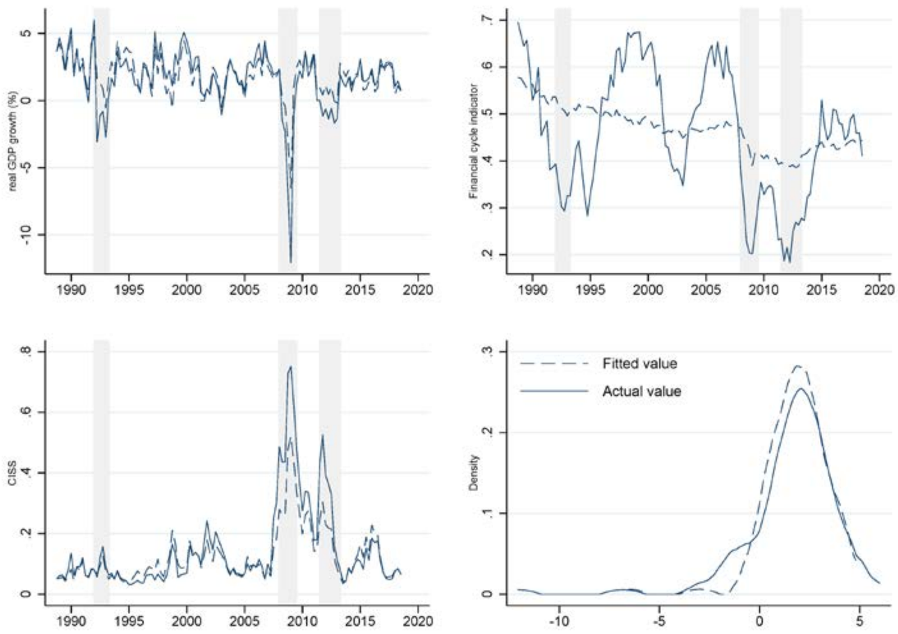
[14] To interpret the outcome we need to assume that all quantile-specific parameters remain fixed at their full-sample estimates as the system is subjected to counterfactual shocks. This assumption can be phrased and tested in terms of the "super-exogeneity" of certain variables; see Engle et al. (1983) and Favero and Hendry (1992). Accordingly, the policy interventions should be small enough to not cause pronounced variation in deterministic parameters; see e.g. Lucas (1976).

[15] The counterfactual sets the values for the financial cycle at each point in time to its one-quarter ahead conditional median which varies given that the realisations of real GDP and CISS from the previous period endogenously propagate based on the estimated parameters of the QVAR.

illustrated in the quantile impulse response functions of Figure 2. The resulting real GDP growth distribution (bottom right panel) illustrates how the stabilised financial cycle especially reduces the downside skew while leaving the upper tail of the distribution broadly unaffected (see Table 1 for descriptive statistics). By stabilising the financial cycle, the macroprudential authority effectively mitigates downside risks by limiting the downside amplification mechanisms between the cycle and systemic stress.

Figure 5: Implications from a stabilised financial cycle

A stabilised financial cycle implies reduces downside amplifications for real GDP growth.



Note: Historical data as solid lines, counterfactual realizations as dashed lines. The counterfactual exercise assumes that the policy maker sets the financial cycle to its one-quarter ahead conditional median for each quarter.
Top left panel: quarterly annualiseised real GDP growth for the euro area in percent, top right panel: financial cycle (range from -0.5 to 0.5), bottom left panel: systemic stress indicator CISS (range from 0 to +1), bottom right panel: Kernel estimate of real GDP growth.

The potential trade-offs facing the macroprudential authority are illustrated by Table 1. By smoothening the financial cycle, both the lower and upper tails of the distribution are shifted towards the centre. This implies lower downside risk, but also lower upside potential. In this specific example, it turns out that the mean under the counterfactual distribution (1.83) is higher than the mean under the historical distribution (1.66), because the shift in the left tail is more pronounced than the shift in the right tail. According to the objective function (4), the macroprudential authority would prefer the counterfactual distribution for any value of the downside risk aversion coefficient λ. There may be nevertheless circumstances in which the comparison with the counterfactual distribution requires to take a stand on the coefficient λ.

Growing evidence indicates that macroprudential policies are effective in dampening downside risks to economic growth related to financial vulnerabilities, see e.g. Cerutti et al. (2017) and Brandao-Marques et al. (2020).

The results obtained via the counterfactual show that counteracting the swings in financial vulnerabilities implies little-to-no cost for average GDP growth. However, macroprudential policymakers will not always be able to fully steer the financial cycle to its median but, instead, be able to partially offset the swings of the financial cycle. A key question for policymakers is thus when to intervene and if so by how much.

Table 1: Annual real GDP growth distribution: historical vs counterfactual statistics

The counterfactual time series result from a stabilised financial cycle.

(in percent)

	Historical annual real GDP growth	Counterfactual annual real GDP growth (with financial cycle at median)
Mean	1.66	1.83
Standard deviation	2.28	1.56
Skewness	-2.33	-1.31
Kurtosis	13.93	8.51
5th percentile	-1.59	-0.30
10th percentile	-1.04	0.13
Median (50th percentile)	1.98	1.89
90th percentile	3.79	3.71
95th percentile	4.46	4.24

Note: The counterfactual exercise assumes that the policymaker sets the financial cycle to its one-quarter ahead conditional median for each quarter.

4.3 Towards a metric for macroprudential policy stance

An intense debate revolves around the management of the financial cycle and the specific timing and calibration of macroprudential policies. While the previous section provided evidence on the benefits to fully stabilise the financial cycle, this section illustrates the use of the risk management framework to inform policy decisions. Specifically, we ask the question when would a macroprudential policymaker draw net benefits from cyclically tightening policy measures before loosening them again at a later stage? The counterfactual exercise speaks directly to the intertemporal trade-off typically faced by macroprudential authorities when financial conditions are frothy and they need to decide if to raise the countercyclical buffer to lean against imbalances and, if so, by how much (see Detken et al., 2014).

The thought experiment requires an active macroprudential policy strategy which tightens policy in the short-run and loosens it at a later stage in crisis times. In our model experiment, we define first a passive macroprudential policy as one where the financial cycle evolved at its 60th percentile over the first six quarters and at its 10th percentile for the subsequent six quarters in crisis times. The active macroprudential policy reduces the financial cycle by 10 percentiles over the first six quarters (short-term), with the assumption that this gives space to lift it by 10 percentiles during the financial crisis seven to twelve quarters ahead. We refer to Chavleisvili et al. (2021) for details. The crisis is captured in the model by a combination of high values for the CISS and low values for the financial cycle. The thought experiment thus contains a tighter macroprudential policy over six quarters, assumes a crisis over the subsequent quarters and sets a looser macroprudential policy during the crisis. This is in line with the strategy adopted for the countercyclical buffer which is intended to increase well ahead of mounting imbalances in the banking sector to offer an opportunity to support it against unforeseen impairments and to support the sustainable provision of credit to the real economy in the subsequent downturn, see Darracq Pariès et al. (2019) and Babić and Fahr (2019). Differently to reality, the thought experiment assumes a fixed time period for the onset of the crisis to illustrate the intertemporal trade-off by policymakers and assumes and that policymakers can effectively lift the financial cycle by releasing macroprudential measures. In reality the macroprudential policymaker may face difficulties in alleviating tight market conditions, especially in a severe financial crisis. We abstract from these additional aspects to focus on the intertemporal trade-off instead.

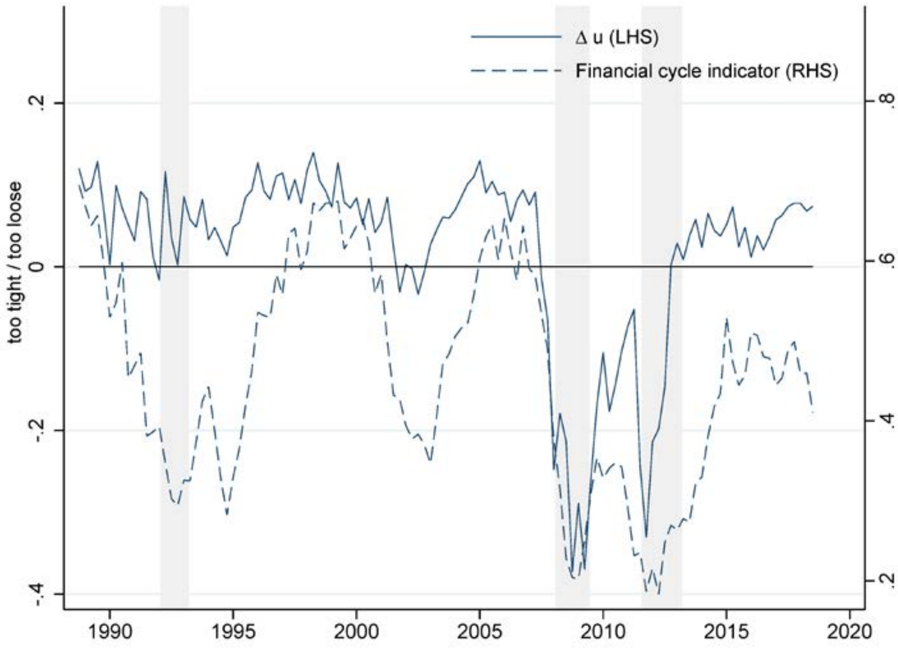
We equip the policymaker with a quantitative objective function to assess the net benefits of the active countercyclical macroprudential policy. The forward-looking objective function in equation *(4)* maximises discounted expected GDP growth and additionally penalises downside risks by the factor $\lambda > 0$ over the entire future. To illustrate its policy application we limit in this exercise the forward-looking horizon to 12 quarters, disregard the discount factor $(\beta = 1)$ and set the penalisation factor to $\lambda = 0.5$, indicating a 50% higher weight on negative relative to positive GDP growth rates. The resulting value of the policy objective varies with expected growth and especially so when downside risks are large. Based on the objective function we ask if a more countercyclical macroprudential policy could raise the value for the objective. Figure 6 reports the difference between the values of the objective function under the active (countercyclical) and passive policies described above. This difference in the objective value represents the macroprudential stance metric for the policymaker.

The macroprudential stance metric provides indications for additional tightening or loosening. If the difference of the objective function in the counterfactual and the historical series is positive, there are gains in initially taming the financial cycle to support it later when the crisis hits. Figure 6 plots the stance metric and reveals that the net benefits from actively leaning against the financial cycle are positive most of the time. They are maximal during the late 1990s before the bust of the dot-com boom in 2000, and during the mid-2000s before the onset of the GFC in 2007. This is intuitive, as the financial system was buoyant during these times, arguably sowing the seeds for the busts later on. However, a tighter policy during the GFC of 2008-2009 or during the euro area sovereign debt crisis in 2011-2012 would have amplified downside risks, even if policy had released the measures later on. During these times the financial system was already deleveraging and an additional tightening would have made matters worse.

In exuberant times, a tightening of macroprudential policy would raise welfare by taming the financial cycle and bringing it closer to the median. In turn, it appears less effective in raising welfare during crisis times. This underlines the need for tightening macroprudential policy in good times, in line with the arguments for macroprudential space (Darracq Pariès et al. 2019 and 2020).

Figure 6: Net gains from countercyclical macroprudential policy

A countercyclical macroprudential policy tends to reap benefits most of the time.



Note: The solid indicates net benefits of adopting an actively countercyclical macroprudential policy based on the objective function (5). Parameters are chosen as $\beta = 1$, $\lambda = 0.5$, $\tau = 0\%$ and $H = 12$ applied to the full sample estimates from 1988Q3 to 2018Q4. Shaded areas indicate euro area recessions based on CEPR.

The stance metric is mildly correlated with the euro area financial cycle, suggesting that it is a valuable variable to inform macroprudential policy discussions. The countercyclical exercise provides indications for specific time periods in which it is worthwhile to actively manage the financial cycle by initially taming it with a view to supporting it in crisis times. The correlation between the assessment and the financial cycle indicator itself provides policymakers with a real-time indicator to guide policy action. While Figure 6 points a mild correlation between the cycle and the stance, three episodes of discrepancy are worth discussing. During and following the recessions/downturns of the early 1990s and the early 2000s, the financial cycle was markedly subdued, but the stance metric would have provided only limited indications for the need to loosen macroprudential measures. Similarly, the subdued credit dynamics following the GFC are not sufficient an indication that the financial cycle would need additional support to support GDP growth. Instead, the stance metrics indicates that a gradual tightening starting at the end of 2013 could be warranted in case a downturn hits.

5 Conclusion

In this paper we discussed the use of a Quantile Vector Autoregression (QVAR) estimated on euro area data as a risk management tool for macroprudential policy. The QVAR takes account of asymmetries and interactions among variables of financial vulnerability, systemic stress and real GDP. It allows estimating and forecasting the entire distribution for the growth outlook. The risk management approach explicitly takes account of tail risks in addition to expected growth and offers an operational implementation for macroprudential policy. The proposed risk management framework lends itself to assess changes in vulnerabilities of the macro-financial system and to assess policy impacts by steering financial cycles and counteracting systemic stress.

Three applications of the QVAR model illustrate its usefulness in the macroprudential policy context. The QVAR model lends itself for a forward-looking macro-financial stress test to identify underlying vulnerabilities in the economy in a timely manner. It reveals that the stabilisation of the financial cycle reduces amplification thereby reducing downside risks and raising expected mean GDP growth. This provides empirical evidence that macroprudential policy can effectively raise GDP growth in the long run. Based on the model estimates we propose a macroprudential stance metric in which we consider the net benefits of a short-term marginal tightening to be loosened at a later stage should a crisis hit.

The GaR framework can also be used to assess the relative effectiveness of macroprudential policy relative to other policies. Adrian et al. (2020b) extend the New Keynesian (NK) model to include endogenous risk giving rise to a vulnerability channel of monetary policy through risk-taking by economic agents. By expanding the GaR framework to also account for interest rates and inflation – in addition to the financial cycles and systemic stress (Chavleishvili et al., 2021) – provides an important empirical contribution to the relative assignment of objectives to monetary and macroprudential policy respectively (Fahr and Fell, 2017).

The use of a multivariate quantile regression approach and its application to macroprudential policy indicates potential avenues for future development. The strong role played by endogenous interactions and non-linear feedback loops between financial and real economy variables point to remaining research on multi-equation modelling to carve out the specific transmission mechanisms underlying the aggregate interactions identified in this setting. The application in this paper focussed on the euro area. The companion paper Chavleishvili et al. (2021) provides additional estimates for the US. More generally, the expansion of quantile regression approaches to panel setups and multi-country estimation models can help strengthen research on cross-border transmission mechanisms of financial risk and real activity. Finally, recent developments in DSGE modelling have emphasised non-linearities from occasionally binding constraints or financial amplifiers. The empirical QVAR model of this paper provides an estimation framework to empirically validate the implications of these models on their aggregate dimensions.

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