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Stress-ridden Finance and Growth Losses: Does Financial Development Break the Link?*

Abstract

Does financial development shield countries from the pass-through of financial shocks to real outcomes? We evaluate this question by characterising the probability density of expected GDP growth conditional on financial stability indicators in a panel of 28 countries. Our robust results unveil a non-linear nexus between financial stability and expected GDP growth, depending on countries' degree of financial development. While both domestic and global financial factors affect expected growth, the effect of global factors is moderated by financial development. This result highlights a previously unexplored channel trough which financial development can break the link between financial (in)stability and GDP growth.

Keywords: economic growth, financial development, financial stability, growth at risk

JEL classification: G01, G15, O16, O43

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1 Introduction

Financial development is considered by academics, practitioners and policymakers a basic condition to spur economic growth. From a macrofinancial perspective, the arguably positive effect of financial development on economic growth reflects that developed financial markets ameliorate market frictions between savers and borrowers, leading to efficiency gains in capital allocation. To the extent that this dynamic positively affects countries' saving rates, developed financial markets can reduce external financing constraints that limit real-sector expansion. The stocktake of research in this area shows that the expansion of financial markets creates better cross-sectional and intertemporal risk sharing, inducing portfolio realignments with better risk-return profiles that are important for long-term economic growth (see, e.g., Levine, 2005, Levine and Warusawitharana, 2021).

These positive views on the relationship between financial development and growth contrast with sharp disagreements about the role of the financial sector in economic growth in both public and academic debates, raising the question of whether more finance is necessarily better (Beck et al., 2014). Many concerns have to do with incentives: as financial intermediation expands, further layers between managers and ultimate investors arise, creating incentives for excessive risk taking. Moreover, intermediaries' herding behavior and financial interconnectedness can magnify tail risks (see, e.g., Feroli et al., 2014, Ramos-Francia and Garcia-Verdu, 2018). These features of developed financial markets can create a financial sector-induced procyclicality, highlighting a 'dark side' of the finance-economic growth nexus. Despite these sharp debates, little is known about whether the bright or dark sides of the interaction between financial development and growth dominate in periods of financial stress.

This paper fills this gap by asking whether higher degrees of financial development affect the relationship between financial stability and economic growth. To this end, we characterize the whole density of expected GDP growth conditional on measures of financial market stress looking to a panel of 28 European countries. We then assess

whether the sensibility of the expected GDP growth densities to financial stress varies depending on countries' ex-ante financial development. Importantly, we contrast the effect of domestic and foreign measures of financial stress. This approach allows us to explore possible interactions between financial development and different sources of financial stress that can have an heterogeneous impact across the distribution of countries' GDP growth prospects.

Our approach can be related to previous studies that have investigated the relationship between financial development and economic growth (see, e.g., Aghion et al., 1999, Levine and Warusawitharana, 2021,). While empirical studies provide mixed evidence on the sign and size of this effect (Beck et al., 2014), financial stability conditions have not been considered, to the best of our knowledge, as a factor through which financial development can operate to moderate the volatility of GDP growth. Moreover, by focusing on average effects of financial development on country or sectoral-level outcomes, previous studies have ignored possible differential effects on upside and downside risks of GDP growth. Our contribution is to provide first evidence on whether financial development can moderate the link between financial stability and growth. Addressing our research question comes with strong empirical challenges. Economic growth and financial development are likely to have a reverse causality relationship which can bias the estimation of a potential effect of financial development on growth. Financial development itself can be confounded by other country characteristics, such as financial openness, opening the scope for further measurement errors. Most important for our question is the need to zoom in on how financial development can influence the effect of financial stability on different percentiles of the GDP growth density. This latter challenge is important to quantify the heterogeneous relationship between financial stress and right- vs. left-tails of GDP growth, exploring whether this relationship is similar in periods of economic expansion or recession.

We address these challenges with a research design based on three building blocks. First, we construct a database on macrofinancial variables for 28 European countries cov-

ering the period between 1990 and 2018. These data include the construction of financial stability indices capturing both domestic and foreign factors that can affect GDP growth forecasts. Second, we estimate the effect of financial stress on GDP growth via panel quantile regressions that identify heterogeneous effects across the GDP growth distribution. Armed with these estimates, we characterize the complete density of expected GDP growth conditional on macrofinancial conditions following the Growth-at-Risk (GaR) approach (Adrian et al., 2019). Finally, we extend this baseline model to explore whether the effect of financial stress on GDP growth varies according to countries' ex-ante degree of financial development. To address identification concerns, we also replicate the analysis replacing financial development by multiple variables capturing countries' degree of institutional and economic development that could operate as confounding factors.

Our results show that higher degrees of financial development can help to 'break the link' between financial stress and negative GDP growth. As a first step, we confirm previous findings indicating that financial stress has a negative effect on expected GDP growth. This effect is most acute on the left tail of the expected GDP growth density, suggesting that the financial stability - growth nexus materializes the most in downside risk scenarios. These findings are not only statistically significant but also sizable in terms of economic magnitudes: for example, a one standard deviation increase in our measure of domestic financial stress increases the probability of negative GDP growth by roughly 57% one quarter ahead, from 7% to 11%.

Next, explore whether our benchmark findings vary according to countries degree of financial development, using information contained in the IMF Financial Development Index. We find that higher degrees of financial development moderate the pass-through of financial instability to economic growth. However, the compensating force exerted by financial development crucially depends on the geographical source of financial distress. When contrasting domestics vs. foreign financial stability shocks, we find that only the effect of the latter factor on GDP growth is moderated by financial development.

To quantify the economic magnitude of this result, consider the case of a country

with an average degree of financial development experiencing a foreign financial shock in the form of a one standard deviation increase in our measure of foreign financial stress (i.e., the VIX Index). This country would face an increase of 146% in the probability of negative GDP growth one quarter ahead. As a comparison, a country with a one standard deviation higher financial development facing the same shock would report an increase of 'only' 96% in the probability of negative GDP growth. Therefore, increasing financial development by one standard deviation compensates approximately 50 percentage points of the average increase in the probability of negative growth following an adverse financial stability scenario.

These results survive an extensive list of robustness checks. For example, we find similar results when using alternative measures of financial market stress. The results are also confirmed when fixing the measure of financial development at the begin of the panel, or by excluding countries experiencing large changes in financial development. We further find that when replacing financial development by measures such as financial openness, GDP per capita, or the mere size of the financial sector the results vanish. This latter tests are in line with our interpretation that financial development alleviates market frictions and prevents sharper adjustments under adverse financial stability scenarios. Finally, the results remain in place when excluding periods — such as the 2008 global financial crisis — of major financial shocks, suggesting that financial development also helps to curbe the finance-growth nexus across more regular financial cycles.

Our main finding can be explained by the effect that financial development has on both the stability and the efficient allocation of capital flows. Previous studies have shown that when capital flows are driven by global factors and allocated domestically by imperfect financial markets plagued with market frictions, the risk of capital misallocation increases CGFS (2021). While capital flows can be a relevant instrument to generate gains in productivity, the presence of financial frictions can make these flows more volatile and poorly allocated. This argument coincides with the fact that fewer market frictions have been associated with larger shares of stable FDI flows in contrast to portfolio or banking

flows (see, e.g., Blonigen and Piger, 2014, Nguyen and Lee, 2021).

The remainder of the paper proceeds as follows. Section 2 discusses the position of our study in the literature. Section 3 describes our methodological approach and describes our data. We present our main results in Sections 4 and 5. Section 6 concludes.

2 Related literature

This study builds on a large strand of research analyzing the link between financial development and economic growth. Early studies documented how financial development can promote economic growth. King and Levine (1993), for example, found cross-country evidence that financial development is associated with higher rates of economic growth and improvements in the efficiency with which countries employ physical capital. The evidence also points out that productivity improvements associated with financial development can be driven both by well-functioning stock markets and banking sectors (Levine and Zervos, 1998). The positive impact of financial development on economic growth was later confirmed using more advanced panel settings (Beck et al., 2000, Beck and Levine, 2004, Rajan and Zingales, 1998).[1]

Recent studies set a spotlight on identifying non-linear effects of financial development on growth. Beck et al. (2014) shows, for example, that the positive effect of financial development vanishes when, in more advanced stages of financial development, financial markets expand more in non-intermediation financial activities. This vanishing positive impact has been often characterized as an inverted u-shape in the relationship between financial development and growth (see, e.g., Samargandi et al., 2015, Benczúr et al., 2019). Studies have also explored heterogeneous effects depending on economic and institutional development (Demirgüç-Kunt et al., 2013) and on which market segment leads financial development (Rioja and Valev, 2014).[2] Our paper shifts the focus to the effect of financial

[1] See Levine (2005) and Panizza (2013) for summaries of this literature.

[2] Micro-level evidence shows that the positive effect of financial development on growth can be explained by productivity gains (Bai et al., 2018), an improved firm survival (Tsoukas, 2011), and increases

development in mitigating the pass-through of financial stress to economic growth.

Closer to our approach are studies exploring the link between financial development and GDP growth volatility, given our focus on the expected density of GDP growth. While several studies associate financial development with a decrease in output volatility (see, e.g., Aghion et al., 1999, Easterly and Stiglitz, 2003), we are unaware of other studies exploring the potential dampening role of financial development in the transmission of financial stress to GDP growth volatility.

From a general perspective, institutional development has being historically associated with lower degrees of output volatility (Acemoglu et al., 2003). Financial development, in particular, exerts an effect on GDP growth volatility by fostering productivity (Levine and Warusawitharana, 2021) and shifting capital allocation towards industries less prone to short-term fluctuations (Manganelli and Popov, 2015). Well-functioning financial markets can also alleviate information asymmetries between borrowers and lenders, mitigating the propagation of shocks (Caballero and Krishnamurthy, 2001). These effects converge on the notion that financial development can both increase firms' growth possibilities and mitigate the negative effects of left-tail events.[3]

Despite these findings, different views persist in the debate on the link between finance and growth. Authors' have argue, for instance, that financial development can incentivize risk taking by fueling competition, negatively affecting GDP growth (Murdock et al., 2000). In the same vein, Beck et al. (2006) suggest that financial development can magnify the transmission of monetary shocks to the real economy.

Our contribution to this literature is twofold. First, by exploring the effect of financial development across the density of expected GDP growth, we can verify whether the arguably positive effect on GDP growth is similar across tails. That is, whether it operates

in rate of firms' creation (Levchenko et al., 2009).

[3]Other studies have reached similar conclusions by using sectoral data. For example Braun and Larraín (2005) and Raddatz (2006) find a negative relationship between financial development and output volatility in financially-dependent industries. Such industries are found to react stronger to periods of financial stress in the presence of large financial frictions.

both by mitigating negative growth scenarios and spurring economic expansions. Second, our focus on financial stability allows us to quantify the potential moderation in the pass-through of financial stress to GDP growth when financial frictions are alleviated.

Finally, our paper connects to a growing body of literature exploring how macrofinancial conditions affect economic growth by modelling the entire density of GDP growth using the GaR approach. These models originate in seminal contributions by Giglio et al. (2016) and Adrian et al. (2019).[4] Our approach is closer to studies that have used the GaR approach to explore non-linear effects of macrofinancial conditions depending on the stance of macroprudential regulation (see, e.g., Sánchez and Röhn, 2016, Aikman et al., 2019, Franta and Gambacorta, 2020, Eguren-Martin et al., 2020, Galán, 2020). Our approach is different given our focus on financial development as a potential factor affecting the relationship between macrofinancial conditions and GDP growth.

3 Methodology and data

3.1 Identifying domestic and foreign financial stress

We measure domestic financial stress resorting to the Country-Level Index of Financial Stress (CLIFS) methodology developed in Duprey et al. (2017). The CLIFS method was designed to ensure both (i) cross-country comparability, and (ii) the comparison of financial stress events over time, taking spillover effects across financial market segments into account. In general, one can define financial stress as financial turbulence for several markets and asset classes.[5]

The CLIFS index aims to identify periods of financial stress which are reflected by higher uncertainty in market prices, sharp correction in market prices, and a high degree of similarity across sectors. The approach constructs a composite index of stress in three

[4]See Prasad et al. (2019) for a detailed description of GaR applications implemented by the IMF.

[5]The elaboration of CLIFS is based on early work by Holló et al. (2012), also known as the Composite Indicator of Systemic Stress (CISS).

market segments: (i) equity markets, represented by the stock market index (rSTX); (ii) bond markets, represented by the 10 years government yields (rR10) and (iii) foreign exchange market, represented by the effective exchange rate (rEER). These variables are computed in real terms to reflect long-term changes in inflation patterns. Section A.3 in the Appendix provides a brief description of how the index is constructed.

We rely on the CLIFS index to capture stress events driven both by individual market segments (e.g, only in stock markets) or by increases in the correlation between sectors. The index should be therefore interpreted as measuring not only the materialization of financial stress, but also the potential of cross-sectoral spillovers in an adverse scenario. Henceforth, we refer to our measure of the CLIFS index as a domestic financial conditions index, or FCI.

We measure foreign financial stress using the Chicago Board Options Exchange Market Volatility Index (VIX Index). Movements in the VIX index are often related to markets' risk-aversion sentiment. Moreover, it has been used as an indicator of the global financial cycle (see, e.g., Rey, 2015), and as proxy of foreign financial conditions in other related works, including Adrian et al. (2019) and Alessandri et al. (2019). We ortogonalize the VIX index with respect to FCI. This adjustment is done by taking the residuals of a regression of foreign against local conditions.

3.2 Measuring financial development

Previous studies often rely on two well-known metrics of financial development: the credit and the stock market capitalization to GDP ratios. Nevertheless, financial markets and the financial system have evolved into a much more complex apparatus that include the so called shadow banking system as well as other types of non-bank financial intermediaries. To reflect this multi-dimensional feature of financial markets, we rely on the IMF financial development index described in Svirydzenka (2016). Nevertheless, we also perform exercises using separate sub-indices of this metric focusing on financial institutions

and financial markets development separately.

The individual indices for institutions and markets are composed by metrics of markets' depth, access and efficiency, leading to six sub-indices in total. Figure A.1 illustrates how the aggregated index is composed. In terms of the steps followed to compute the index, the process involves (i) the normalization of variables, ii) the aggregation of the normalized variables into functional sub-indices, and iii) the aggregation of sub-indices into the final index.

Svirydzenka (2016) provide a detailed description of the treatment of missing data and outliers, as well as of the functional form of the aggregation. The aggregation process of the corresponding variables into the sub-indices is done via a weighted linear average in which the weights are obtained from a Principal Component Analysis (PCA) that reflects the contribution of individual variables to the sub-indices. Once computed, all six sub-indices are normalized again and the final index is obtained in the same way, i.e., via a weighted linear average normalized into a $[0, 1]$ interval. In Section 3.4 we provide summary statistics for the IMF Financial Development Index.

3.3 Quantile regression and the GaR approach

Our empirical approach is based on a quantile regression model (Koenker and Bassett, 1978), which allows us identifying heterogeneous effects across the distribution of a dependent variable instead of looking only at effects on its conditional mean. More recently, quantile regressions has become the main econometric tool supporting the GaR methodology.

In general, GaR applications begin by identifying relevant macrofinancial variables that could arguably explain dynamics in GDP growth in a given country (see, e.g., Adrian et al., 2019 or Prasad et al., 2019). Researchers typically rely on a combination of local macroeconomic conditions, local macrofinancial conditions, and international macrofinancial conditions. The selection of specific variables will depend on a country's risk

profile, its economic and financial openness, or the characteristics of the financial system.

Having identified relevant macrofinancial risk factors, the next step is to estimate the relationship between these risk factors and GDP growth using a panel quantile regression approach. This method allows characterising the entire probability distribution of GDP growth conditional on the stance of macrofinancial conditions. Therefore, we are not interested in point estimates of expected GDP growth but rather in understanding how macrofinancial conditions affect different moments of the distribution of expected GDP growth.

Equation 1 shows the baseline specification of our empirical model. The estimation is performed over a panel at the country-quarter level, which allows us to control for unobserved time-invariant country characteristics, as in Adrian et al. (2019) or Galán (2020). We recall that according to Koenker (2005), quantile regressions with fixed effects are estimated on a quantile by quantile fashion, allowing different fixed effects for each quantile.

$$\begin{aligned} Q(\Delta GDP_{i,t+h};\tau) =& \alpha_h(\tau) + \beta_{1,h}(\tau)\Delta GDP_{i,t} + \beta_{2,h}(\tau)FCI_{i,t} + \beta_{3,h}(\tau)VIX_t \\ &+ \mu_{i,h}(\tau) + \varepsilon_{i,t}(\tau) \end{aligned} \tag{1}$$

In Equation 1, τ represents the quantile level, h is the forecasting time horizon in quarters, $\Delta GDP_{i,t+h}$ is the change on GDP for country i, h quarters ahead and $\alpha_h(\tau) + \mu_{i,h}(\tau)$ represents the unobserved country effects. The coefficients $\beta_{2,h}$ and $\beta_{3,h}$ capture the relationship with the FCI and the VIX h quarters ahead and $\varepsilon_{i,t}$ is the error term. The results for this specification are shown in Figure 3.

While Eq. 1 illustrates our benchmark specification, we are interested in exploring non-linear effects of the macrofinancial variables of interest conditional on the stance of countries' financial development. We therefore adjust Eq. 1 to allow for heterogeneous effects of macrofinancial conditions conditional on countries' ex-ante degree of financial

development. This adjusted model takes the following form:

$$\begin{aligned} Q(\Delta GDP_{i,t+h};\tau) =& \alpha_h(\tau) + \beta_{1,h}(\tau)\Delta GDP_{i,t} + \beta_{2,h}(\tau)FCI_{i,t} + \beta_{3,h}(\tau)VIX_t \\ &+ \beta_{4,h}(\tau)FD_{i,t} + \beta_{5,h}(\tau)(\Delta GDP_{i,t} * FD_{i,t}) \\ &+ \beta_{6,h}(\tau)(FCI_{i,t} * FD_{i,t}) + \beta_{7,h}(\tau)(VIX_t * FD_{i,t}) \\ &+ \mu_{i,h}(\tau) + \varepsilon_{i,t}(\tau) \end{aligned} \tag{2}$$

where the additional terms $\beta_{4,h}$, $\beta_{5,h}$, $\beta_{6,h}$ and $\beta_{7,h}$ capture the relationship of expected growth change with FD, the interaction between FD and growth, the interaction between FD and the FCI and the interaction between FD and the VIX respectively. Throughout the paper we focus our analysis on horizons of one quarter ($h = 1$), that is, we look at the effect of financial conditions on GDP growth one quarter ahead. However, we also explore alternative horizons, exploring the term structure of the estimations.

If financial stress matters to explain future GDP growth, we would expect the coefficients $\beta_{2,h}$ and $\beta_{3,h}$ to report a negative sign, given that our financial indices VIX and FCI increase when financial conditions tighten. If these effects materialize especially during tail events, the coefficients would be statistically significant for the smallest and largest quantiles τ of the GDP growth distribution. The path-dependence of GDP growth documented in previous studies (see, e.g., Galán, 2020) should lead to a positive coefficient on $\beta_{1,h}$. Finally, we would verify an offsetting effect of financial development on the transmission of financial stress if the coefficients $\beta_{6,h}$ or $\beta_{7,h}$ report a positive and statistically significant coefficient.

3.4 Data and descriptive statistics

Our sample consists of 28 European countries, of which 27 belong to the European Union plus the UK. For these countries, we collected quarterly data on a set of macrofinancial variables for a time span between 1990Q1 and 2018Q4. Out of these countries, 16 correspond to advanced economies and 12 to emerging economies according to the definition

of the IMF.[6].

Our analysis relies on four main variables of interest. First, we collected data on countries' quarterly GDP at current prices in US$, from which we compute the GDP growth series used as dependent variables in Eqs. 1 and 2. We compute quarterly GDP growth as the percentage change in GDP on a year-on-year basis. These series were downloaded from Eurostat. Second, we collected data for the VIX Index from Yahoo Finance. We computed quarterly averages from the daily closing series of the index.

Third, we used data from the European Central Bank Statistical Data Warehouse which reports CLIFS indices for the countries in our sample. We ortogonalize these series with respect to the VIX index to keep only the informational content related to domestic financial conditions (FCI). Following Duprey et al. (2017), the CLIFS series capture the three dimensions of financial stability mentioned above.

Fourth, we use the IMF Financial Development Index to measure countries' stance of financial development. This source allows us to explore the main index together with two sub-indices measuring financial markets and financial institutions dimensions of financial development. The information contained in the index is obtained from multiple sources, including the IMF Financial Access Survey, the BIS debt securities database, and the Dealogic corporate debt database. The index matches our full time span from 1990 to 2018, although only with an annual frequency.[7]

Figure 1 provides a visual inspection of the VIX (left panel) and FCI (right panel)

[6]The countries included in the sample are the following: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom.

[7]We extended our dataset with country-level variables to implement robustness tests discussed in detail in Section 5.3. First, we merged to our main dataset annual data on GDP per capita at constant 2010 US$ from the World Bank. Second, collected annual data of the Regulatory Quality Index reported by the Worldwide Governance Indicators of the World Bank (see Kaufmann et al., 2010). Third, we collected data on capital inflows from the IMF Balance of Payment database. Fourth, we included a measure countries' degree of capital account openness as accounted by the Chinn-Ito index (see Chinn and Ito, 2006). Fifth, we collected annual data on countries' credit-to-GDP ratio from the World Bank database. Finally, we complemented our sample with data on the VSTOXX index obtained from Yahoo Finance and Bloomberg.

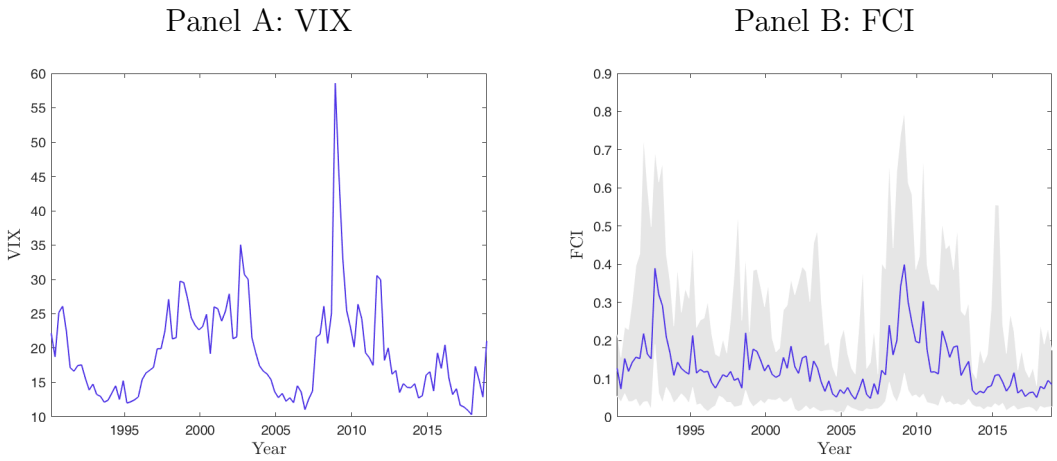

Figure 1 Foreign and Domestic Financial Indicators. This figure illustrates the evolution of the quarterly foreign and domestic financial indicators from 1990 to 2020. Panel A reports quarterly averages of the VIX index used to capture global financial conditions. Panel B reports the average measure of CLIFS (domestic financial conditions, FCI) across the sample. The shadow area marks the minimum and maximum observations for this variable in each period. On both indices tighter financial conditions are represented by an increase in the indices' values.

series as they enter the econometric model. While the VIX index is the same for all countries in the sample, the reported FCI index corresponds to the sample average per quarter. The shadow area marks the minimum and maximum observations in each period. In both series the 2008 global financial crisis represents the main peak, with financial conditions remaining tight for approximately three years following the crisis' outbreak.

Table 1 provides descriptive statistics for our sample, including the main variables of interest in Eqs. 1 and 2. Our final sample consists of an unbalanced panel containing 2,610 observations. The summary statistics depict clear heterogeneities across the GDP growth percentiles. Moreover, the minimum and maximum values are indicative of major tail events during the sample period. Below, we discuss preliminary tests exploring the linear relationship between the macrofinancial variables and GDP growth.

An unbiased estimation of Eq. 2 is challenged by the possibility that financial development may have a double-causality relationship with GDP growth. For example, we could expect financial development to increase as countries enter into a positive trend of economic expansion. While the lagged structure in Eq. 2 reduces endogeneity concerns, we provide an alternative estimation in Section 5.3 in which financial development is kept fixed in its first value for each country to address this challenge.

	Mean	S.d.	Min.	Max.	p5	p25	p50	p75	p95
	I	II	III	IV	V	VI	VII	VIII	IX
Variable:									
ΔGDP	2.34	4.06	-21.72	29.09	-4.71	0.90	2.63	4.35	8.03
Financial Cond. Index (FCI)	0.12	0.10	0.01	0.80	0.03	0.05	0.09	0.16	0.33
VIX Index	19.47	7.20	10.30	58.59	12.04	13.94	17.39	23.23	30.72
Financial Dev. Index	0.53	0.20	0.01	0.95	0.20	0.36	0.54	0.71	0.83

Table 1 Descriptive statistics. This table reports the summary statistics for the working sample. Cols. I to IV report the mean, the standard deviation (S.d.), the minimum, and the maximum value for each variable for the entire sample period. Cols. V to IX report the percentiles for each variable.

Given our interest in cross-sectional differences in financial development, we are mainly concerned about changes in countries relative position (i.e., rank) in financial development, as such changes could be a result of changing patterns in GDP growth. A preliminary check reported in the Appendix (see Figure A.2) suggests that financial development is, however, a rather structural characteristic for the countries in our sample. The relative stability of countries' rank supports our choice of using time-variant measures of financial development.

To describe our baseline scenario, we inspect in Figure 2 the linear relationship between global macrofinancial conditions and GDP growth. For this purpose we estimate OLS regression of ΔGDP against the VIX Index (with a one quarter horizon) in country-specific estimations for each of the 28 countries included in the sample. Figure 2 illustrates a negative correlation over time between the VIX Index and future GDP growth, in coincidence with the notion that tighter global financial conditions negatively affect GDP growth prospects in the short run.[8] These results show that our macrofinancial conditions of interests matter for explaining future GDP growth, opening the scope to explore non-linearities across GDP growth quantiles using the full structure of Eq. 1.

[8]The exercise is replicated using lagged ΔGDP and our index of domestic financial conditions (FCI) in Figure A.3 in the Appendix. This extended exercise shows a similar effect of the FCI Index (Panel A), whereas Panel B shows that lagged GDP growth is positively correlated with current GDP growth in all countries in the sample, suggesting a path-dependence trend in line with previous studies (see, e.g., Adrian et al., 2019).

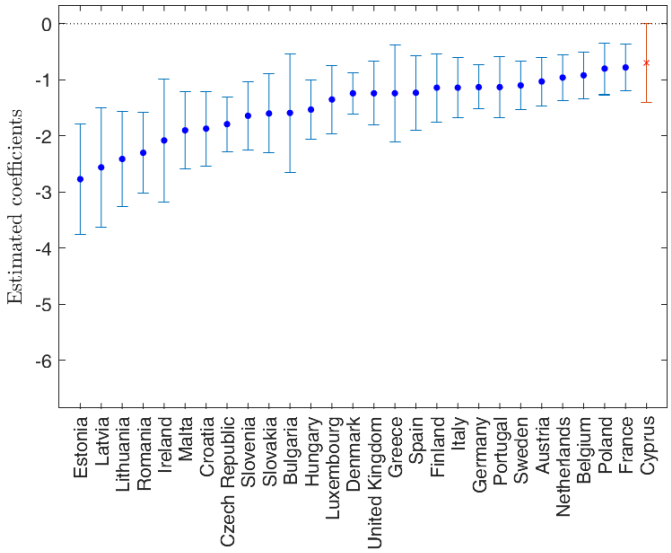

Figure 2 Linear effect of the VIX Index on GDP growth. This figure illustrates the linear average effect of global financial conditions on GDP growth over a one quarter horizon. The estimations are based on a simplified version of Eq. 1 obtained from OLS estimates at the individual country level. The estimation is run separately for each of the 28 countries in the sample considering the full time-span in the sample from 1990 to 2018. Global financial conditions are measured with the VIX index. The blue dots represent the respective point estimates, whereas the whiskers represent the corresponding 95 percent confidence intervals for each estimation. This exercise is extended to the FCI Index and GDP growth as explanatory variables in Figure A.3 in the Appendix.

4 Benchmark results

Our benchmark results based on the quantile regression model in Eq. 1 are reported in Figure 3. Each panel represents the estimated coefficients for our variables of interests, including the lagged value of ΔGDP, the domestic financial conditions index (FCI) and the VIX index as our measure of foreign financial conditions. We recall that given the quantile regression estimation, the coefficients represent the effect of a unit change in macrofinancial conditions on the expected percentile τ of the GDP growth density. The coefficients represented by dots in Figure 3 are reported along their confidence intervals (brackets) at a 95% confidence level.

Tighter financial conditions, either domestic or foreign, are negatively associated with future GDP growth one quarter ahead, in line with the preliminary findings from Figure 2. However, this effect varies considerably depending on the percentiles τ. The effect is the largest on the left tails of the density, suggesting that tighter financial market conditions

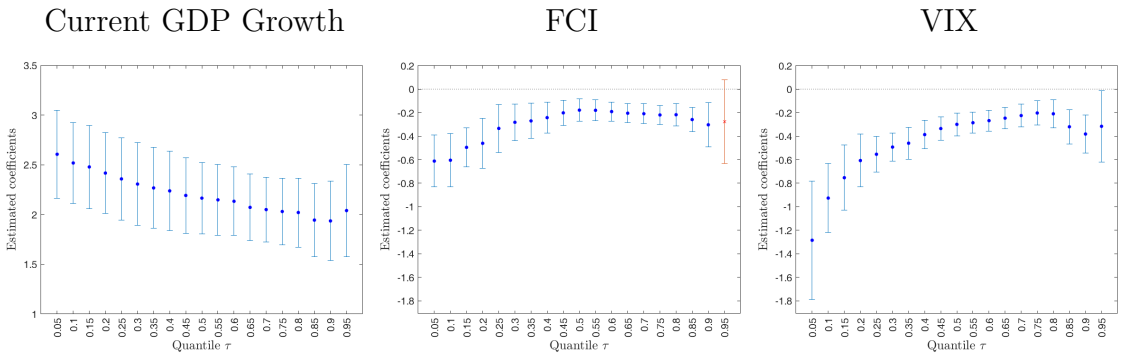

Figure 3 Benchmark results. This panel reports the results from estimating Eq. 1 using a panel quantile regression approach. The blue dots represent the respective point estimates, whereas the whiskers represent the corresponding 95 percent confidence intervals for each estimation. These whiskers are plotted in blue when representing a statistically significant estimation (and in red otherwise). The left-side chart shows the effect of current GDP growth on the individual percentiles of the expected GDP growth density one quarter ahead ($h = 1$). The center chart reports the results for our measure of domestic financial conditions (FCI), whereas the right-side chart reports the estimated coefficients for our measure of global financial conditions (VIX). The confidence intervals are based on bootstrap methods. The panel includes 28 European countries and spans from 1990 to 2018 with a quarterly frequency. See Table A.1 in the Appendix for a detailed definition of the variables of interest used in the analysis.

are associated with a higher probability of realizing large drops in GDP. On the contrary, the negative effect of financial stress on upper percentiles of the GDP growth density is smaller, implying that the relationships are nuanced in periods of economic expansion.

The left-tail effects are more pronounced for foreign than domestic financial conditions. For example, a one-standard deviation increase in the VIX index (7.2 points) is associated with a left-shift of approximately 1.2 percentage points in the 5th percentile of the GDP growth density. In contrast, a similar increase in the (residuals of the) FCI index by one standard deviation (0.08 points in CLIFS units) leads to a left-shift in the same percentile of only 0.6 percentage points. Therefore, the left tail of the GDP growth density becomes much fatter following a shock on VIX compared to FCI.

Scenario analyses reported in Figure A.4 the Appendix provide a sense check of the economic magnitudes implied by our findings. For FCI, a negative one-standard deviation shock is associated with a 57% increase in the probability of experiencing a negative GDP growth rate one quarter ahead, whereas a similar shock to VIX can be connected with an increase of 108% in this probability.[9]

[9]It should be noted that the documented effect could be alternatively attributed to a few countries in which trading-intensive financial markets create a pro-cyclical relationship between our financial stability

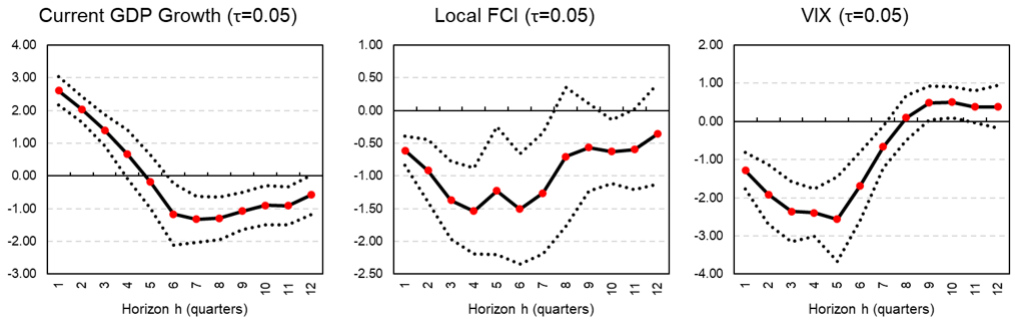

Figure 4 Term structure of the results. This panel depicts the results from replicating our benchmark exercise reported in Figure 3 for alternative horizons, following the same structure as in Eq. 1. Each point estimate (red circles) represents the effect of one of our macrofinancial variables of interest on the 5th percentile of the expected GDP growth density. The dotted area represents the estimated 95 percent confidence intervals for each estimation obtained with bootstrap. Each estimation is repeated separately for horizons ranging from 1 to 12 quarters ahead of the explanatory variables. The left-side chart shows the results for current GDP growth; the center chart reports the results for our measure of domestic financial conditions (FCI); the right-side chart reports the results for our measure of global financial conditions (VIX). The panel includes 28 European countries and spans from 1990 to 2018 with a quarterly frequency. See Table A.1 in the Appendix for a detailed definition of the variables of interest used in the analysis.

To provide a more detailed account of the term structure of the estimated effects, Figure 4 depicts the effect of macrofinancial conditions on the 5th percentile ($\tau = 5$) of future GDP growth replicating our baseline estimation for multiple horizons ranging from 1 to 12 quarters ahead. This extension is important to shed light on the informational content of current financial stability in terms of long-term trends in GDP growth. We focus on $\tau = 5$ given the evidence documented above on a larger effect of financial stress on the left-tails of the estimated GDP growth densities. Figure 4 shows that the negative effect of financial stress on the 5th percentile of GDP growth materializes on impact (1-quarter ahead) but also remains in place for up to 6 to 7 quarters ahead. This finding further highlights the economic significance of our results. The identified effect fades entirely after 2 years, becoming then statistically insignificant.

A few interesting conclusions can be drawn when comparing the effect of FCI (center chart) vs. the effect of VIX (right-side chart). First, this comparison reinforces our finding that foreign events captured in the VIX index have a seemingly larger effect on GDP growth.The results for FCI suggests that locally sourced financial stress scenarios do

indices and GDP growth, as discussed by Beck et al. (2014). However, the fixed-effect structure in Eq. 1 mitigates concerns that such unobserved factors could bias our findings. Despite this advantage, we are cautious about interpreting the findings in a causal way, considering the lack of a measure of true (exogenous) shocks to financial stability.

matter to explain short- and mid-term developments in GDP growth, albeit to a smaller extent when compared to the VIX index. We also find some evidence of a sign reversal of the effect at longer horizons for the VIX index, also observed in the case of lagged GDP growth.

5 Zooming-in: the role of financial development

5.1 Effects conditional on financial development

Having established our benchmark findings, we turn next to our main research question and exploit the model to investigate the possibility that our effects vary in either direction depending on countries' ex-ante degree of financial development. Given previous findings in the literature, we could expect the effects depicted in Figure 3 to be offset if financial development is associated with a more efficient allocation of capital that shields more productive firms from the negative consequences of shocks.[10]

We estimate the model in Eq. 2 adding interaction terms between the macrofinancial variables of interest and the lagged measure of the IMF Financial Development Index. The coverage and time span of this source make it an ideal input to our empirical approach.[11] Given that the IMF Financial Development Index only provides information on an annual basis, we use the same value for the index over the four quarters of a given year. To keep consistency and mitigate reverse-causality concerns, the variable enters the model lagged in one year.

Our main results are reported in Figure 5. Each panel corresponds to the quantile effect of financial development as a single variable and the interaction effects with macro-

[10]We note that this hypothesis is supported by recent findings showing that financial development may come along with a reallocation of capital towards industries less prone to suffer from short-term volatilities, stabilizing output volatility in periods of financial distress (Levine and Warusawitharana, 2021).

[11]The index has also received increasing attention in the literature. Recent applications include, for example, studies by Araujo et al. (2017), Ogrokhina and Rodriguez (2019), Altunbaş and Thornton (2019), and Sobiech (2019).

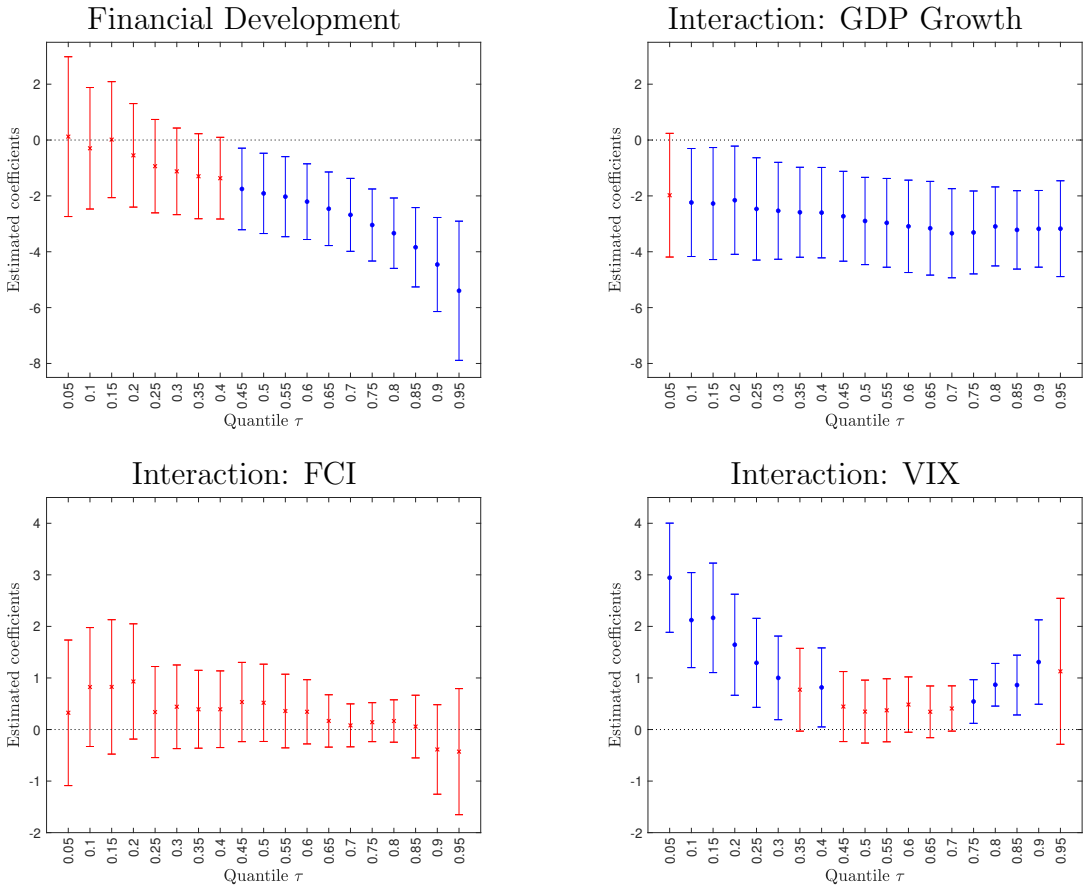

Figure 5 Effects conditional on financial development. This panel reports the results of estimating Eq. 2 (with a one quarter horizon, $h = 1$), focusing on the interaction terms between our macrofinancial variables of interest and a measure of financial development, using the IMF Financial Development Index. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). The upper-left chart reports the result for the stand-alone coefficient for financial development in Eq. 2. The upper-right chart reports the interaction coefficient between current GDP growth and financial development. The bottom-left chart reports the interaction coefficients between domestic financial conditions (FCI) and financial development. The bottom-right chart shows the estimated coefficients for the interaction term between global financial conditions (VIX) and financial development. The panel includes 28 European countries and spans from 1990 to 2018 with a quarterly frequency. See Table A.1 in the Appendix for a detailed definition of the variables of interest used in the analysis.

financial conditions. The dots in this figure represent point estimates for a given quantile that are statistically significant (blue) or insignificant (red) at a 5 percent confidence level (the whiskers represent the confidence intervals at this confidence level).

The interaction terms of interest show mixed results, from which three main conclusion can be drawn. First, the negative interaction term with lagged GDP growth implies that higher degrees of financial development moderate the path-dependence of GDP growth. This result is similar across the GDP growth density but it is estimated

with less precision for lower quantiles, becoming statistically insignificant for the percentile $\tau = 0.05$. On the contrary, financial development is seemingly more effective at curbing GDP growth trends in periods of economic expansion, probably moderating episodes of economic overheating.[12]

A second conclusion relates to the lack of explanatory power of the interaction term between financial development and FCI. Across the density of GDP growth, we observe that the relevant interaction term remains statistically insignificant. This result suggests that the negative effect of FCI on the left tail of the GDP growth density captured in Figure 3 does not vary at different levels of financial development.

Finally, an interesting result emerges when looking at the interaction term with the VIX index. The pass-through of global financial conditions to GDP growth observed in Figure 3 is moderated by financial development in both tails, as represented by the positive and statistically significant coefficients in the bottom-right panel of Figure 5. This result illustrates a shielding effect of financial development, leading to a loss of sensitivity of GDP growth with respect to foreign financial conditions. Recall that this offsetting effect is expected to be economically more important in the left-tail, considering our benchmark findings.[13]

To illustrate the economic magnitude of this finding, consider that a country with an average degree of financial development facing a shock represented by a one standard deviation increase in the VIX index, would experience an increase in 146% in the probability of negative GDP growth. This probability would increase by 50 percentage points less in a country with a one standard deviation higher degree of financial development. In this example, the higher degree of financial development reduces by roughly 52% the

[12]It should be noted that the stand-alone coefficient for financial development represents the intercept when the interaction macrofinancial variables are at their minimum. This intercept tends to be negative and statistically significant for larger percentiles of GDP growth, implying that these upper percentiles become smaller for higher degrees of financial development.

[13]In unreported results we confirmed that our findings can be replicated when estimating Eq. 2 separately for each macrofinancial variable of interest, an approach that does not alter the conclusions drawn from Figure 5. Moreover, we find that the term-structure described in Figure 4 can also be verified with similar patterns for the interaction terms wit financial development. These results are available upon request.

increase in the probability of negative growth.

A natural question is whether the heterogeneous effects by financial development are similar across different components of the IMF Financial Development Index. We address this question by replicating the main exercise for the sub-indices of financial institutions and financial markets separately. Recall that the financial institutions sub-index aggregates measures of financial institutions' size and liquidity, including, e.g., measures of credit to GDP and measures of the size of investment funds. On the contrary, the financial markets sub-index focuses mostly on the relative size of stock and securities' (bonds) markets, capturing the availability of multiple marketplaces.[14]

We explore this question in Figures 6 and 7, which replicate our main findings by replacing the aggregate financial development index by its respective sub-indices. While our main conclusions can be verified in both exercises, the higher precision of the estimates on Figure 7 suggests that the financial markets development sub-index is most likely explaining our findings.

While both sub-indices seem to matter, the results highlights that the possibility of accessing different types of well-functioning marketplaces matters more than the mere size and geographical spread of banking markets in explaining our findings. Overall, these exercises confirm that our main results remain in place regardless the definition of financial development being considered.

Relating these results to the literature is not straightforward considering the mixed evidence on the effect of financial development on GDP growth volatility. While a body of literature suggests that financial development can attenuate output volatility (e.g., Bacchetta and Caminal, 2000, Beck et al., 2006, Levine and Warusawitharana, 2021), previous studies do not ask whether this effect operates via a more nuanced transmission

[14]Ex ante, we remain agnostic regarding which of these sub-indices could explains our results. On the one side, a 'risk-aversion story' could imply that as market liquidity expands, agents become less sensible to shocks in a single funding channel. In this case, the financial markets sub-index which focuses on market liquidity could explain our results. On the other hand, a 'diversification story' would imply that with the availability of multiple financial marketplaces as captured by the financial institutions sub-index, agents have better chances to offset liquidity drains in a particular market segment.

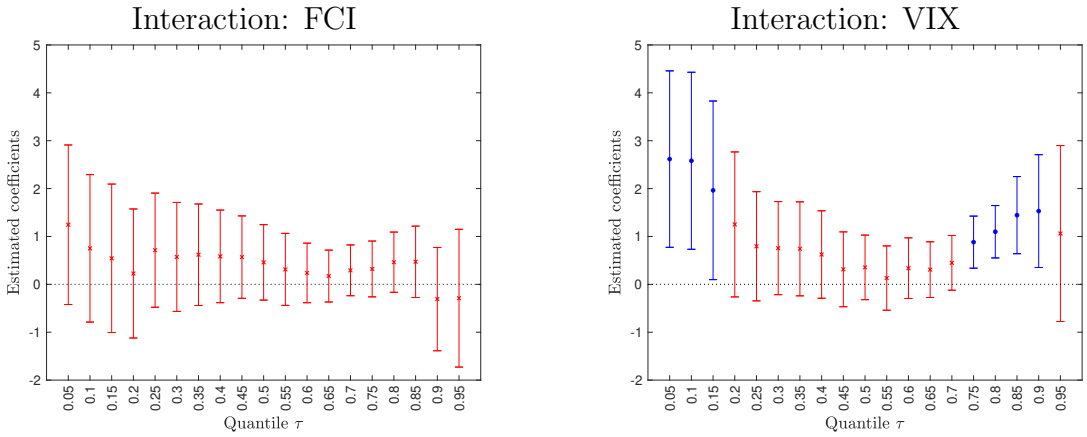

Figure 6 Effects conditional on financial development - Financial institutions. This panel reports the results of estimating Eq. 2 (with a one quarter horizon, $h = 1$), focusing on the interaction terms between our macrofinancial variables of interest and a measure of financial development, using the IMF Financial Development Index defined by its sub-index of financial institutions development.Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). The left-side chart reports the interaction coefficients between domestic financial conditions (FCI) and financial development. The bottom-side chart shows the estimated coefficients for the interaction term between global financial conditions (VIX) and financial development. All other interaction and single terms from Eq. 2 are also included in the regressions. The panel includes 28 European countries and spans from 1990 to 2018 with a quarterly frequency. See Table A.1 in the Appendix for a detailed definition of the variables of interest used in the analysis.

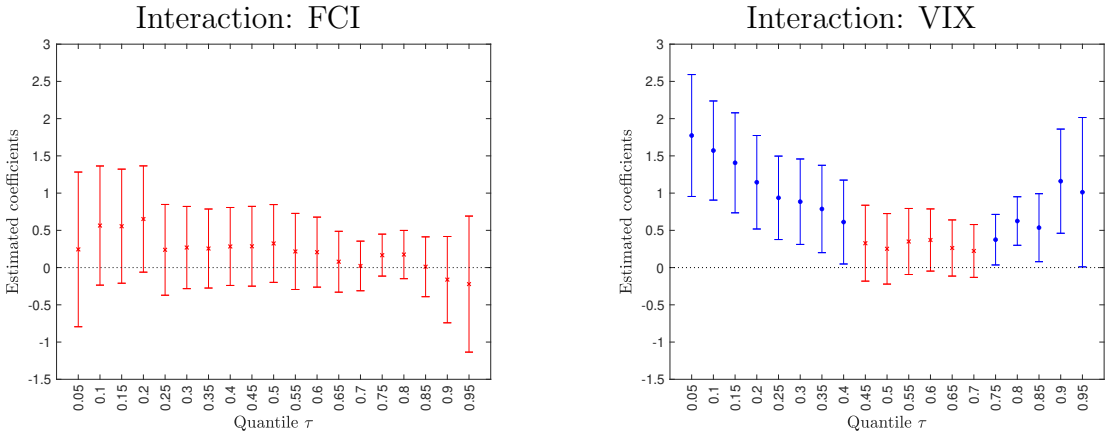

Figure 7 Effects conditional on financial development - Financial markets. This panel reports the results of estimating Eq. 2, focusing on the interaction terms between our macrofinancial variables of interest and a measure of financial development, using the IMF Financial Development Index defined by its sub-index of financial markets development. The dots represent the respective point estimates (with a one quarter horizon, $h = 1$), whereas the whiskers represent the corresponding 95 percent confidence intervals for each estimation. These whiskers (and their corresponding point estimates) are plotted in blue when representing a statistically significant estimation (and in red otherwise). The left-side chart reports the interaction coefficients between domestic financial conditions (FCI) and financial development. The right-side chart shows the estimated coefficients for the interaction term between global financial conditions (VIX) and financial development. All other interaction and single terms from Eq. 2 are also included in the regressions. The panel includes 28 European countries and spans from 1990 to 2018 with a quarterly frequency. See Table A.1 in the Appendix for a detailed definition of the variables of interest used in the analysis.

of financial stability shocks – either domestic or foreign –. Moreover, previous studies focus on average estimates of GDP growth or sectoral output, providing little guidance on the expected differential effect of financial development on the tails of the GDP growth density.

The interaction results for lagged GDP growth on Figure 5 can more easily related to previous findings by Beck et al. (2006) or Singh et al. (2019), who find that larger credit markets relative to GDP help to curbe the transmission of terms of trade shocks to economic growth. This finding can be connected to the idea that imperfect capital markets are detrimental for countries' economic performance (Bernanke and Gertler, 1990). Beck et al. (2006) also find that financial development can exacerbate the effect of monetary (i.e., inflation) shocks. Discussions about different samples and estimation approaches aside, these studies do not provide evidence on whether financial development can moderate the pass-through of financial stability shocks to economic growth.

5.2 Discussion: possible underlying drivers

Our main results suggest that developed financial markets contribute to a higher resilience against foreign financial shocks. This finding provides a rationale to frames previous evidence suggesting a negative relationship between financial development and output volatility. However, the question remains about why financial development may interact with foreign financial factors — in contrast to domestic ones — in buffering against the real effects of financial shocks. In what follows we discuss a few possible explanations.

A first explanation relates to the role of capital flows in financial stability. The effect of the VIX index on GDP growth is likely capturing the effect of capital flows' booms and busts that react to global financial factors. It is well known that changes in global financial factors such as the price of the US Dollar create large shifts in capital flows (see, e.g., Bruno and Shin, 2015, Ivashina et al., 2015), a dynamic that is affected by both push and pull factors (Eguren-Martin et al., 2020).

Our findings could therefore reflect that, as financial markets expand and the enforcement of contracts improve, foreign investors will find it easier to identify investments for which appropriate collateral can be obtained (Martin and Taddei, 2008). Three main consequences derive from this dynamic. First, foreign investors will have a more diversified portfolio in the destination countries, cushioning against large individual exposures. Second, the availability of a diversified portfolio of investments will likely incentivize more foreign actors to enter into a market, diversifying countries' international liabilities (Eichengreen and Leblang, 2003). Third, financial markets' expansion provides foreign investors larger liquidity pools in the destination countries, a factor that could attract and retain foreign investors (Desai et al., 2021). These forces could interact to make countries less sensible to foreign financial shocks.

A second but — closely related — explanation concerns the impact of financial development on the share of foreign direct investment (FDI) in total capital flows. Even though multinational companies can rely on more liquid home-country markets, they also closely interact with host countries' financial markets in search for financing (Kinoshita and Campos, 2008). Again, easing capital market imperfections creates favorable conditions that can tip the balance in favor of FDI against other forms of arms' length foreign investment (Desai et al., 2021). This argument has been confirmed by empirical evidence linking financial development with increasing FDI flows (see, e.g., Blonigen and Piger, 2014, Nguyen and Lee, 2021). FDI could explain our results given the evidence on the stability of FDI flows compared to other forms of capital flows (see, e.g., Montiel and Reinhart, 1999, Broner et al., 2014).[15]

Finally, a third argument is that financial development could mechanically moderate the relative importance of portfolio and banking flows for economic growth. As domestic financial sector expands, capital flows may end up representing a smaller fraction of GDP, making the economy less sensible to global factors. We do not believe, however, that this

[15]This interpretation is in line with the findings by Eguren-Martin et al. (2020), who show that global financial conditions do not affect the prospects of future FDI flows, in contrast to a significant effect on portfolio and banking flows.

argument is a valid interpretation of our findings. First, the evidence suggests that the share of capital flows in countries' GDP tends to expand with financial and economic development, as countries become more integrated globally (Vermeulen and de Haan, 2014). Second, this argument would mostly apply to larger economies. Given that we control for country characteristics, factors such as countries' size should not be a relevant factor when interpreting our results.

5.3 Robustness tests

Our results survive an extensive set of robustness tests, reducing concerns of our findings being driven by measurement errors or omitted variable bias. We report these robustness tests in the Appendix A.2.

We first replace our measure of financial development by variables that capture country characteristics arguably correlated with financial development. We report these results in Figure A.5. We test in Panel A whether our results can be explained by economic development (as measured by GDP per capita), considering that developed economies could be better equipped to mitigate financial shocks. Second, we evaluate in Panel B whether countries' regulatory quality could explain our findings. Finally, we check whether the share of portfolio and FDI flows to GDP explains our results. If the increase in capital flows in an economy is correlated with a larger diversification of foreign liabilities, the sensibility to global financial shocks could be moderated even if domestic financial frictions remain in place.

These tests show that the interaction terms of interest between the VIX index and these competing variables are largely statistically insignificant. We do find, however, some evidence that the effect of domestic financial stress (FCI) varies according to countries' economic development and also depending on countries' regulatory quality. Even though the interaction of FCI and these latter variables is statistically insignificant in the tails, the result suggests that — as long as domestic financial conditions are not 'too' tight —

developed economies with well-designed regulatory frameworks benefit from a moderated finance-driven procyclicality.[16]

Our results could also be affected by a reverse causality error given the possibility that financial development could be increasing as countries enter into positive trends in GDP growth. To address this concern we replicate our main estimation by fixing each countries' measure in the IMF Financial Development Index in the first year in which all countries report a non-missing observation in the database (i.e., 1993). The intuition of this test is that if reverse causality matters, the results should vanish once a pre-existent fixed value of financial development is used. The results of this test are reported in Figure A.7, confirming that our results remain unaltered when using ex-ante fixed measures of financial development.[17]

We also test the robustness of our results to more mechanical modifications of our empirical setup. For example, the results can be replicated when replacing the VIX index by a geographically closer European measure of market volatility as represented by the VSTOXX index (see Figure A.9). The fact that this alternative measure does not alter our results confirms that foreign financial stress is driving the non-linear effect of financial development on GDP growth.

Our results could also be explained by the mere increase in the size of domestic credit markets, irrespective of the alleviation of financial frictions. This line of argument could suggest that larger credit markets relative to the economy can 'mechanically' reduce the sensibility to foreign financial shocks as foreign capital becomes a smaller liquidity source. We explore this hypothesis by estimating a model in which financial development

[16] Alternatively, we also run a similar test replacing financial development by the Chinn-Ito Index of financial openness (Chinn and Ito, 2006). One could argue that as countries' capital account becomes more globally integrated, diversification effects may lead to a milder effect of foreign financial shocks. However, the results reported in Figure A.6 show that the coefficients for the interaction term between the Chinn-Ito and the VIX indices are largely statistically insignificant.

[17] We also consider a test in which we exclude countries that, during the sample period, changed their sample rank in terms of the IMF Financial Development Index the most. These results are reported in Figure A.8. We exclude countries with a standard deviation in the year-specific rank above the 75th percentile. This test confirms our findings for the downside risk of GDP growth. However, we are cautions about interpreting this result as the sample exclusion penalizes countries with longer time series in the IMF Financial Development Index.

is replaced by a measure of countries' credit-to-GDP ratio. The results for the interaction terms of interest are reported in Figure A.10. Even though the credit-to-GDP ratio is included as an input in the IMF Financial Development Index, we find that this variable cannot explain by itself the documented interaction between the VIX index and financial development.

Our results could be driven exclusively by the 2008 global financial crisis or other periods in which global financial conditions experienced a peak. To explore this possibility, we run tests in which we drop the observations corresponding to the year 2008 or to the years 2003, 2008, and 2012. The results, reported in Figures A.11 and A.12, show that even when excluding the largest peaks in the VIX Index during the sample period our results remain unaltered. These findings corroborate that the moderating effect of financial development also applies to regular financial cycles, underscoring the policy relevance of our findings.

A further concern relates to our sample, as the focus on European countries limits the representation of emerging market economies for which financial development represents a major policy challenge. Our analysis is limited to European countries given our interest in using a more comprehensive measure of domestic financial stress like the CLIFFS, whose data requirements make it difficult to be computed for emerging and developing economies. Acknowledging this limitation, we have tested in unreported results the robustness of our findings when replacing the CLIFFS index by a widely available IMF index of financial conditions (IMF, 2018). The fact that the results remain unaltered with this modification, opens the scope for future extensions including a larger sample.

6 Conclusion

This paper provides first evidence on the moderating effect of financial development on the pass-through of financial stability shocks to GDP growth. Using a panel quantile regression approach, we characterize the density of expected GDP growth one quarter

ahead of periods of domestic and global financial stress for a sample of 28 European countries for the period between 1990 to 2018.

Our main result is that financial stress, either foreign or domestic, is negatively associated with expected GDP growth. However, this baseline effect diminishes with financial development, albeit only for scenarios of foreign financial stress. While previous literature has found mixed evidence on the relationship between financial development and GDP growth, our results show that via moderating the sensibility of GDP growth to foreign financial stress, financial development can help countries to build resilience against shocks. This conclusion unveils a previously unexplored mechanism through which financial development can reduce the volatility of GDP growth.

Our findings suggest a changing pattern in countries' sensibility to global financial factors as financial development increases. This idea is likely reflecting that alleviating capital market imperfections creates incentives to diversify countries' international liabilities. Well-functioning financial markets have been also associated with an increase in more stable FDI flows in contrast to portfolio and banking flows. These two forces offer an explanation to the lower sensitivity to foreign financial stress as domestic financial markets develop. Future research could shed light on these explanations, exploring how the contribution of global capital flows to domestic financial stability varies in the presence of frictions in domestic financial markets.

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A Appendix

A.1 Variables Definitions

Variable	Definition	Unit and Sources
ΔGDP	Change in quarterly GDP (year-on-year) computed from the quarterly series of GDP and its main components based on chain linked volumes (2010=100) at market prices.	Growth rate (ECB).
FCI	Financial condition index based on the CLIFS methodology (end of period) obtained from the ECB Statistical Data Warehouse. The index measures domestic financial conditions and is based on the index proposed by Duprey et al. (2017).	Index unit. End of period (ECB Statistical Data Warehouse).
VIX	Chicago Board Options Exchange's CBOE Volatility Index. It measures the stock market's volatility expectation based on S&P 500 index options.	Index unit (Yahoo Finance).
FDI	Financial Development Index. It measures the development of financial markets and financial institutions with respect to the depth, access and efficiency (see Svirydzenka, 2016).	Index unit (IMF database).
GDP per capita	GDP per capita (constant 2010 US$)	US$ (World Bank).
Regulatory quality	Index computed by the Worldwide Governance Indicators of the World Bank (see Kaufmann et al., 2010).	Index unit (World Bank).
Capital flows	Sum of net inflows of portfolio, equity and foreign direct flows.	Millions of US$ (Balance of Payments database, IMF).
Chinn-Ito Index	Index measuring countries' degree of capital account openness (see Chinn and Ito, 2006).	Index unit (IMF's Annual Report on Exchange Arrangements and Exchange Restrictions).
Credit-to-GDP ratio	Ratio of domestic credit (to private sector) to GDP	% of GDP (World Bank database).
VSTOXX	EURO STOXX 50 Index. It reflects market expectations of future volatility in the main European markets.	Index unit (Bloomberg and Yahoo Finance).

Table A.1 Variables definitions. This table provides a description of the main variables used for the empirical analysis reported in the paper. Sources are reported in parentheses.

A.2 Further tables and figures

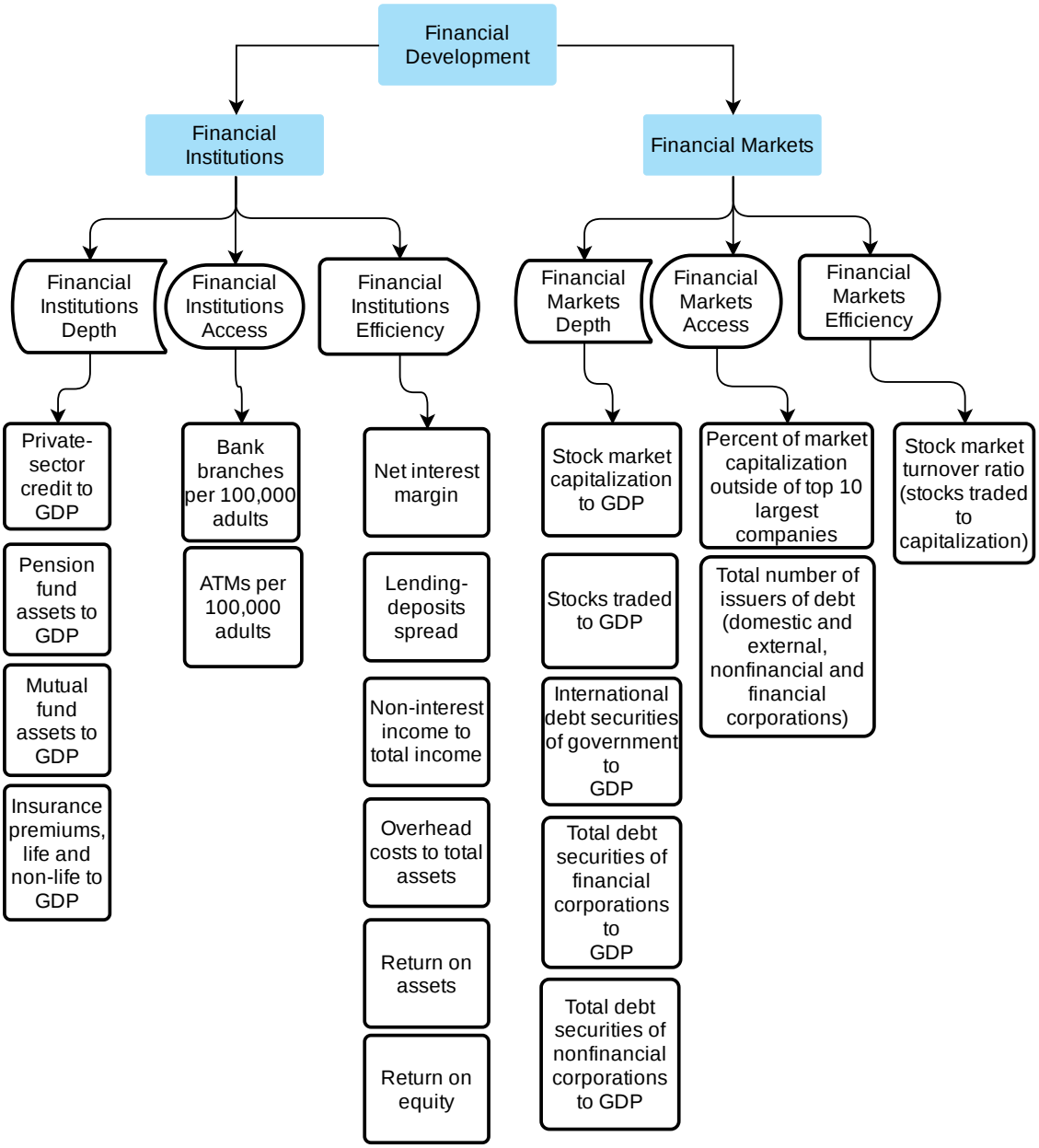


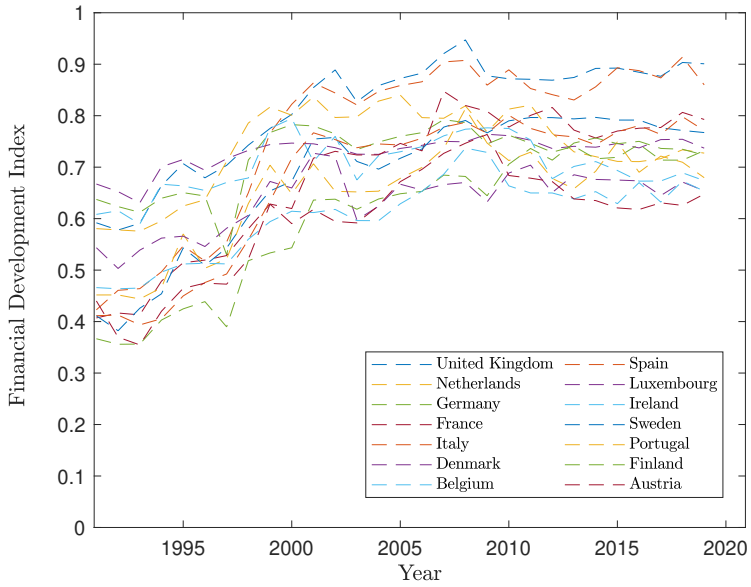
Figure A.1 Financial Development Index conceptual approach This diagram provides a description of the main indicators used to defining the Financial Development Index. It mainly uses data from FinStats 2015, IMF Financial Access Survey, BIS debt securities database and Dealogic corporate debt database. Own elaboration with information from Svirydzenka (2016).

Table A.2 List of countries in the sample

Advanced economies	
Austria	Italy
Belgium	Luxembourg
Germany	Netherlands
Denmark	Poland
Finland	Portugal
France	Spain
Greece	Sweden
Ireland	United Kingdom
Emerging economies	
Bulgaria	Latvia
Cyprus	Lithuania
Czech Republic	Malta
Croatia	Romania
Estonia	Slovenia
Hungary	Slovakia

Notes: This table lists the jurisdictions included in our main empirical analysis. 28 European countries including 16 advanced economies and 12 emerging economies. The selection of these countries is based on the European Union country list and the UK.

Panel A: 14 highest FDI



Panel B: 14 lowest FDI

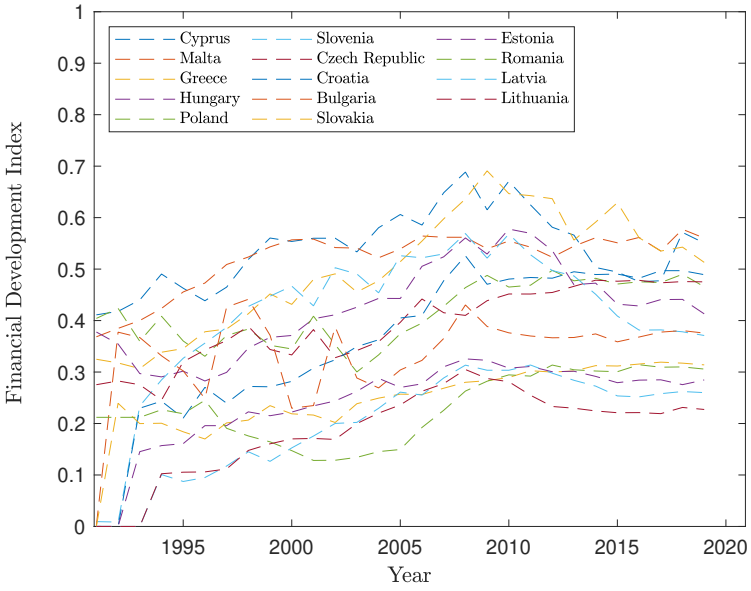
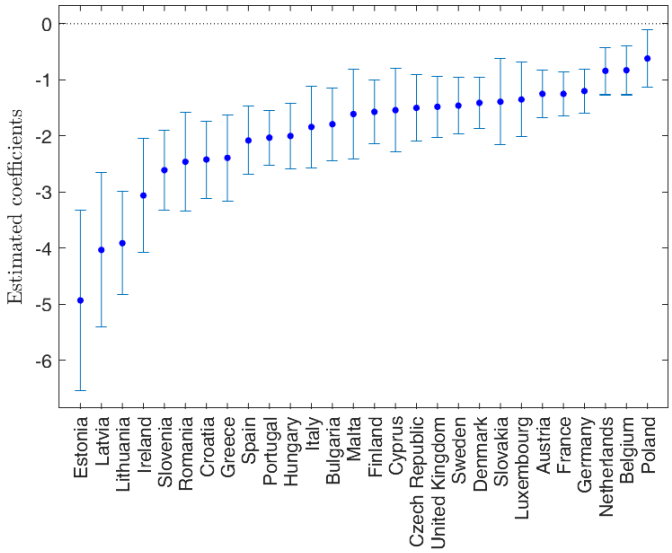


Figure A.2 Financial Development Index Ranking. This figure illustrates the evolution of the annual financial development index used in the empirical analysis from 1990 to 2018. Panel A includes the top 14 countries with the highest index value on average. Panel B reports estimates for the 14 countries with a the lowest index value, on average. Both panels show a steady behavior of the index which is important for the robustness of the analysis.

Panel A: FCI



Panel B: GDP Growth

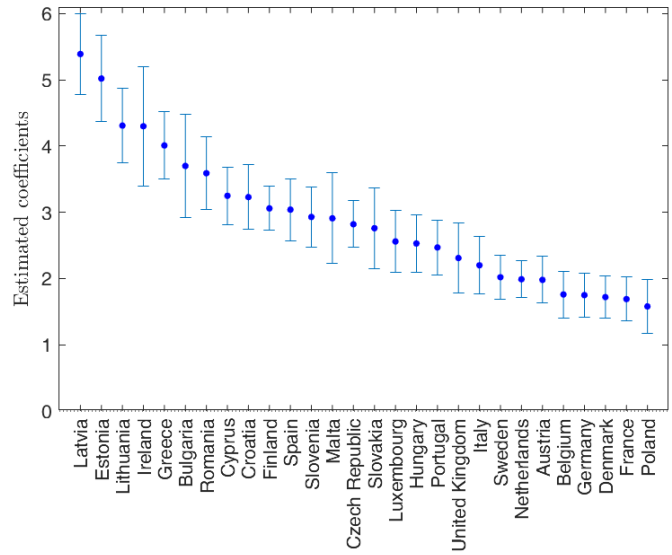


Figure A.3 Linear effects on GDP growth. This figure illustrates the linear average effect of macrofinancial conditions on GDP growth over a one quarter horizon. The estimations are based on a simplified version of Eq. 1 obtained from OLS estimates at the individual country level. The estimation is run separately for each of the 28 countries in the sample considering the full time-span in the sample from 1990 to 2018. Panel A reports the coefficient estimates for the regression of current GDP growth on future GDP growth. Panel B reports reports the coefficient estimates for the regression of current domestic financial conditions (FCI) on future GDP growth. The results for the VIX Index are reported in Figure 2 in the article. The dots represent the respective point estimates, whereas the whiskers represent the corresponding 95 percent confidence intervals for each estimation.

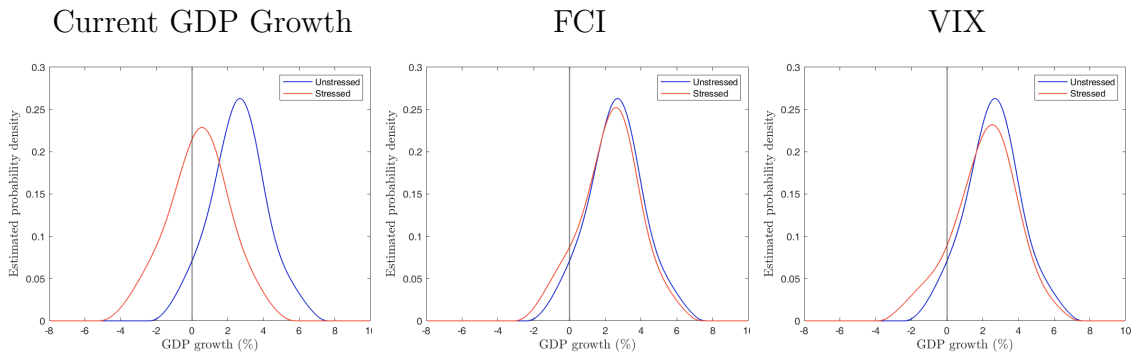


Figure A.4 Scenario analyzes. This panel reports a scenario analysis based on the estimates reported in Figure 3. Each exercise shows the result of a one-standard deviation left-shift in one of our macrofinancial variables of interest on future GDP growth, one quarter ahead. The blue lines represent the baseline expected GDP growth density using the estimates from Figure 3. The orange line shows the alternative expected GDP growth density after the left-shift in the respective variable. The left-side chart shows the results for current GDP growth. The center chart reports the exercise for domestic financial conditions (FCI). The right-side chart depicts the results for our measure of global financial conditions (VIX). The panel includes 28 European countries and spans from 1990 to 2018 with a quarterly frequency. See Table A.1 in the Appendix for a detailed definition of the variables of interest used in the analysis.

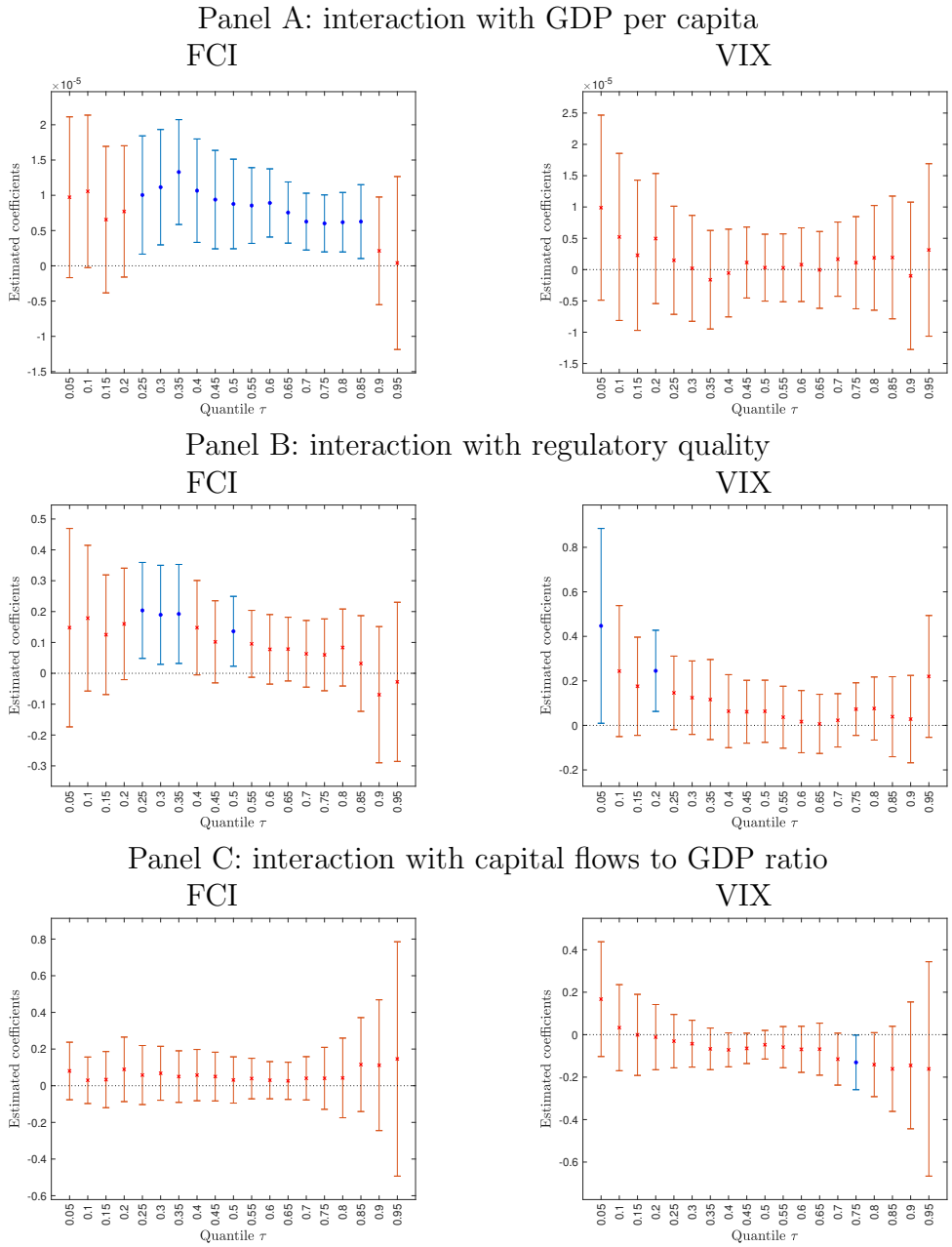


Figure A.5 Interaction models with competing variables. This figure reports the results of estimating alternative versions of Eq. 1 in which financial development is replaced by alternative country characteristics. Each panel reports only the estimated coefficients for the interaction term between the FCI and VIX indices and the respective competing variable. Panel A interacts these variables with countries' GDP per capita; Panel B includes interaction terms with an index of regulatory quality from the World Bank Governance Indicators; Panel C includes and interaction term with countries' capital flows to GDP ratio. Capital flows are computed as the sum of portfolio and FDI flows reported in the IMF Balance of Payments Statistics. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

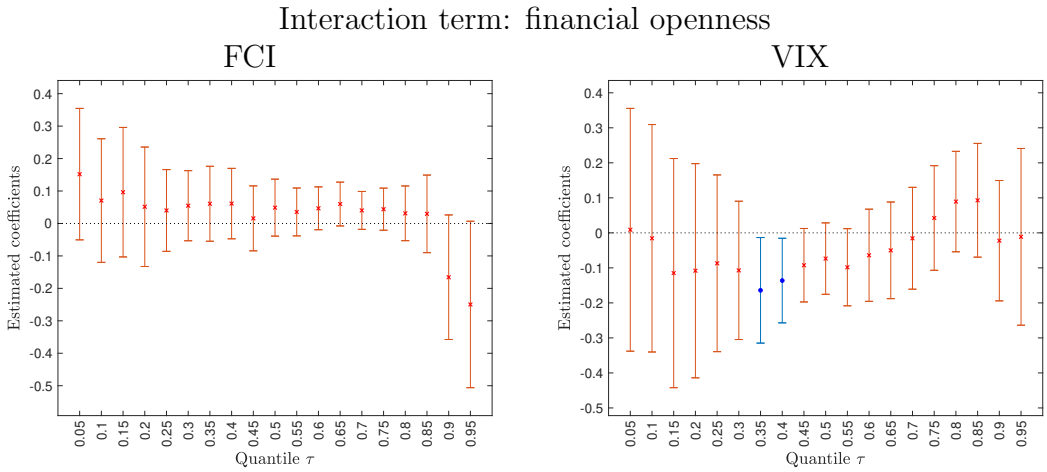


Figure A.6 Interaction model with financial openness. This figure reports the results of estimating an alternative version of Eq. 1 in which we replace financial development by the Chinn-Ito Index of financial openness (Chinn and Ito, 2006). This index measures countries' degree of capital account openness an is updated until 2018, allowing us to cover the full time span of our sample from 1990 to 2018. The index measures restrictions in cross-border financial transactions as reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. The panel reports the coefficients for the interaction term between the FCI (left) and VIX (right) indices and the Chinn-Ito Index. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

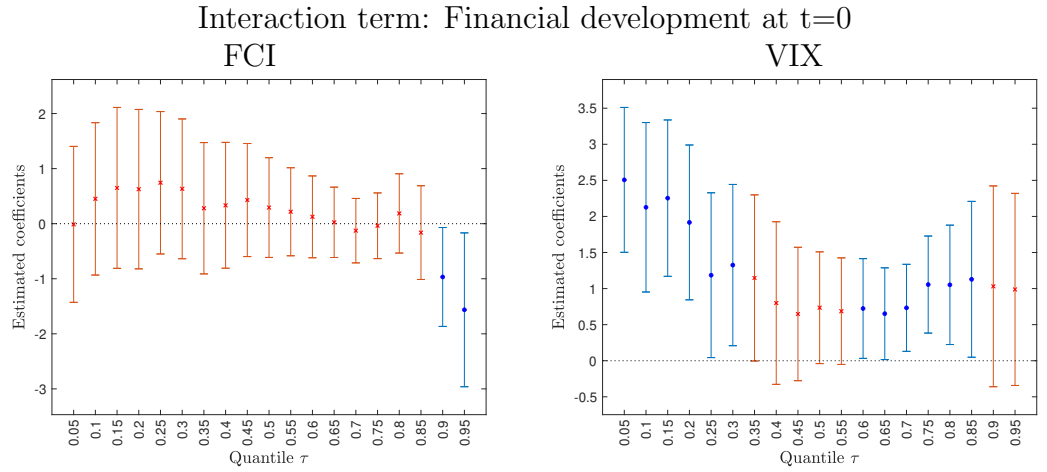


Figure A.7 Fixing financial development over time. This figure reports the results of estimating Eq. 1 with financial development entering the model fixed with its value representing the first observation available for all countries in the sample. This observation is kept fixed throughout the sample period. The panel reports the coefficients for the interaction term between the FCI (left) and VIX (right) indices and our measure of financial development. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

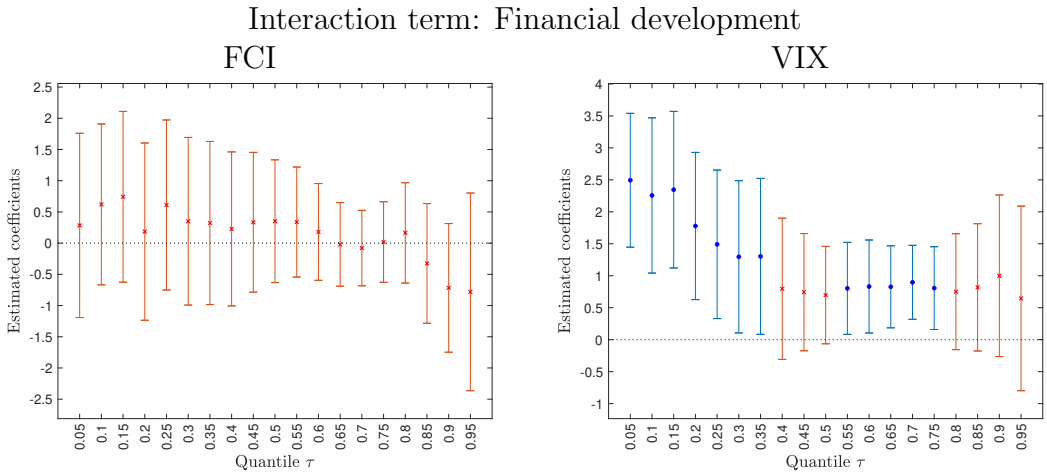


Figure A.8 Excluding countries with large changes in financial development rank. This figure reports the results of estimating an alternative version of Eq. 1 in which we exclude countries that changed by most their financial development rank during the sample period. In this exercise we first compute each country's rank in the IMF Financial Development Index within our sample per year. Next, we compute the country-specific standard deviation in this rank variable between 1990 and 2018. Finally, we identify countries with a standard deviation above the 75th percentile of the sample's distribution, excluding them from the sample. These countries correspond to Austria, Spain, France, Greece, Italy, Sweden, and Slovenia. The panel reports the coefficients for the interaction term between the FCI (left) and VIX (right) indices and financial development. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

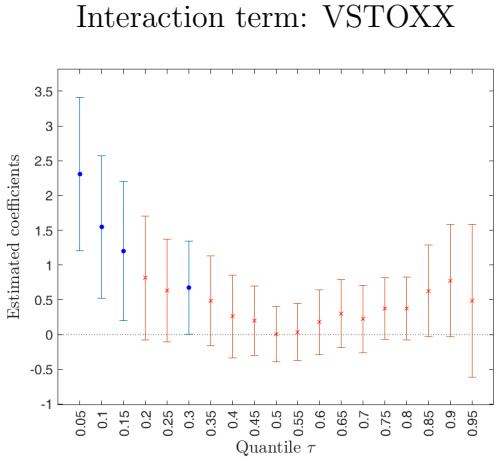


Figure A.9 Replacing the VIX by the VSTOXX index. This figure reports the estimated coefficients for the interaction term between financial development and the VIX index in Eq. 1 when the VIX index is replaced by the VSTOXX index. The VSTOXX reflects market expectations of future volatility as captured by the variance across all options at a given time in the main European markets. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

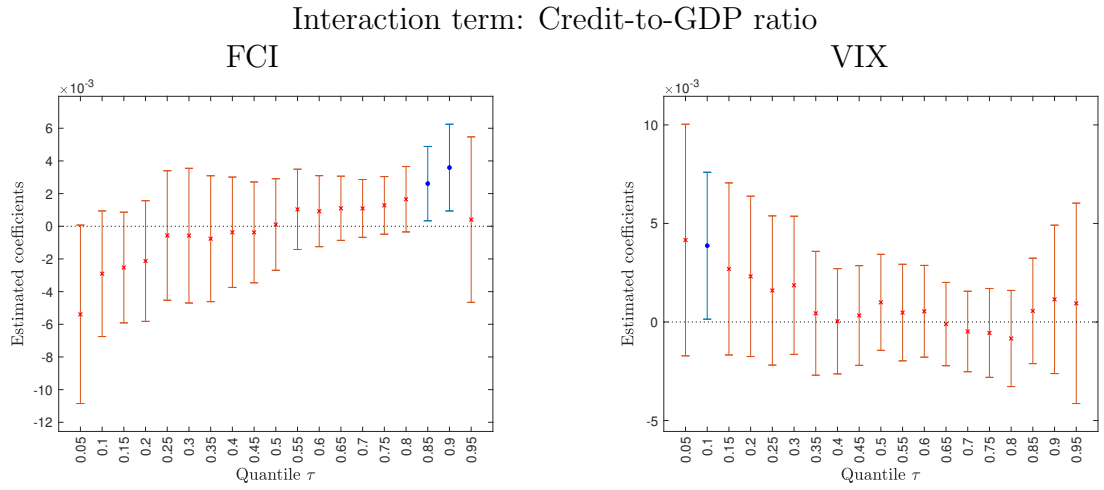


Figure A.10 Interaction effect with the credit-to-gdp ratio. This figure reports the results of estimating Eq. 1 by replacing financial development by countries' credit-to-gdp ratio. The panel reports the coefficients for the interaction term between the FCI (left) and VIX (right) indices and our measure of financial development.Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

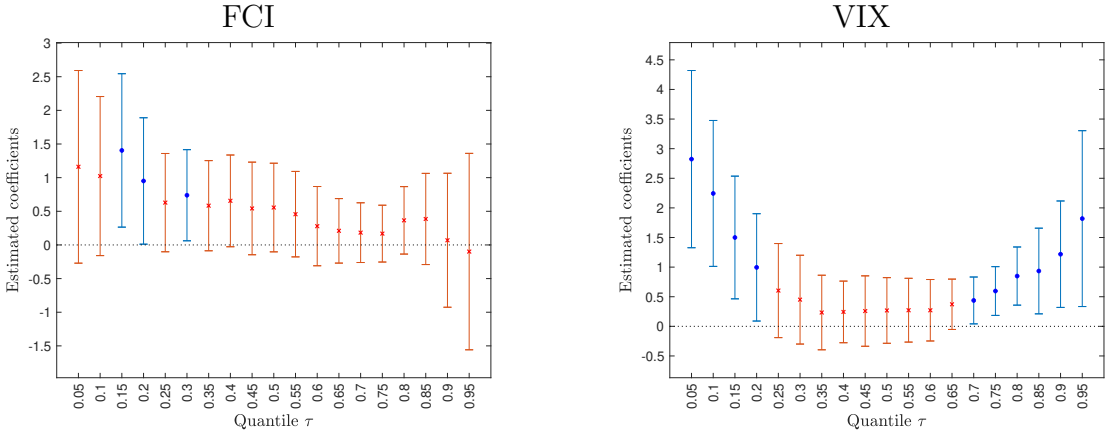


Figure A.11 Dropping 2008 from the sample. This figure reports the results of estimating an alternative version of Eq. 1 in which we drop the observations corresponding to the year 2008 from the sample. The panel reports the coefficients for the interaction term between the FCI (left) and VIX (right) indices and our measure of financial development. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

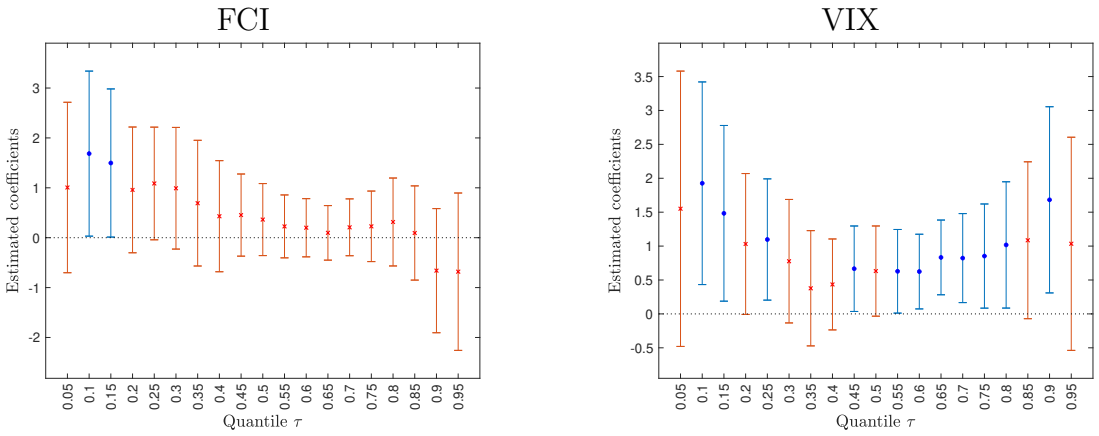


Figure A.12 Dropping peaks in financial conditions. This figure reports the results of estimating Eq. 1 when dropping the observations corresponding to the years 2003, 2008, and 2012 from the sample. The panel reports the coefficients for the interaction term between the FCI (left) and VIX (right) indices and our measure of financial development. Statistically significant estimates with their corresponding confidence intervals a 5 percent confidence level are reported in blue (and in red otherwise). All relevant interaction and single terms are included in the regressions but not reported. The sample period spans from 1990 to 2018. The variables are described in detail in Table A.1.

A.3 Domestic Financial Conditions Index (FCI)

This section provides a brief explanation of the construction of the Country-Level Index of Financial Stress (CLIFS), as proposed by Duprey et al. (2017), used as a source for the domestic financial conditions index in our analysis (FCI).

In their work, the authors focus on three key elements of financial markets. These three elements are (i) equity markets, represented by the stock market index (STX); (ii) bond markets, represented by the 10 years government yields (R10) and (iii) foreign exchange market, represented by the real effective exchange rate (rEER). Additionally, given that the period of time is long and inflation rates have declined considerably, the authors use real stock prices (rSTX) and real bond yields (rR10).

Recognizing the probability that structural breaks in output volatility could exist, volatility measures are computed after dividing the variables by a 10 years trailing standard deviation. The tilde denotes variables under such standardization. The detailed formulas are discussed in detail by Duprey et al. (2017). For each market segment, the method computes two variables: one measuring market volatility, and a second variables capturing the cumulative performance of each market over a certain time window. The variables can be summarized as follows:

1. Equity market stress:
    - $VSTX$: the monthly realized volatility ($VSTX$) computed as the monthly average of absolute daily log-returns of the real stock price index.
    - $CMAX$: the cumulative maximum loss that corresponds to the maximum loss compared to the highest level of the stock market over two years.
2. Bond market stress:
    - $VR10$: the monthly realized volatility computed as the monthly average of absolute daily changes in the real yield on 10-year government bonds.

- $CDIFF$: the cumulative difference corresponding to the maximum increase in basis points of the real government bond spread with respect to Germany over a two-year rolling window.

3. Foreign exchange market stress:

   - $VEER$: the realized volatility computed as the absolute value of the monthly growth rate of the real effective exchange rate.
   - $CUMUL$: the cumulative change over six months.

Having computed these variables, the next step is translate the six individual indicators into common units. Here, the the method follows the approach proposed in Holló et al. (2012), which uses the empirical cumulative density function (CDF) calculated over an initial window of 10 years that expands with new data entries. The CDF transforms each variable into percentiles by computing at each time the rank of each new observation in the sample of all past data. To obtain single indicators for each market segment we take the average value of the two indicators within each bucket.

Finally, in the last step each market sub-index is weighted by the cross correlation with the other sub-indices. As a result, the aggregated index reflects the higher risk associated with important co-movements in the different market segments. The authors compute CLIFS as follows: $CLIFS_t = \boldsymbol{I}_t \cdot C_t \cdot \boldsymbol{I}_t'$, where $\boldsymbol{I}_t$ is the 1×3 vector of standardized indices and C_t is the 3×3 time variant cross correlation matrix of the indices. The time variant entries of the matrix are estimated by an exponentially weighted moving average with smoothing parameter $\lambda = 0.85$. An important advantage of this index is that it increases if conditions tighten in specific sectors (e.g., in stock markets) but also if the correlation between sectors (e.g., between stock markets and interest rate spreads) increases. This feature allows us to obtain a measure of realized and potential financial stability stress, as higher correlation values are arguably associated with a higher probability of aggregate financial stability stress even if a single market segment is hit by a shocks.

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