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## Assessing Structure-Related Systemic Risk in Advanced Economies

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## Assessing Structure-Related Systemic Risk in Advanced Economies

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#### Abstract

We examine the role that economic size, the degree of trade and financial openness, dependancy on inward foreign direct investment and various aspects of banking system concentration play in determining systemic risk across advanced economies. Across the three systemic risk measures evaluated, we find that small, financially open and FDI-dependent economies with more concentrated banking systems are more susceptible to severe tail risk outcomes and higher costs of crises than the average advanced economy. Small and financially open economies appear more likely to experience a systemic banking crisis than their counterparts. In most instances, the joint presence of these structural characteristics combine to further increase systemic risk levels and do not offset each other. Our findings suggest that a more activist macroprudential policy stance may be warranted for countries sharing these characteristics, so that the level of resilience is commensurate to the higher level of risk.

JEL classification: E5, G01, G21, G28.

Keywords: Systemic Risk, systemic banking crises, macroprudential policy, macro-

financial structure, macroprudential policy, financial stability.

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## **Non-Technical Summary**

Is a small, trade or financially open economy, with a concentrated banking sector or whose banks are relatively more exposed to a smaller number of economic sectors, more likely to experience a systemic banking crisis? If one emerges are such economies likely to experience greater crisis-related damage than other economies?

In this paper, we seek to answer these questions by examining the role various macro-financial structural characteristics have in determining three different and holistic systemic risk measures (SRMs). Specifically, the structural characteristics we examine include 1) economic size, 2) trade and financial openness, 3) FDI dependency and 4) bank concentration. Two different financial openness variables are considered as well as three types of banking system concentration, including i) market concentration (i.e. the share of total banking system assets held by the three largest retail banks), ii) loan exposure concentration at the sector level (e.g. the proportion of bank's lending that is concentrated in specific economic sectors such as agriculture or manufacturing) and iii) exposure concentration in real-estate specifically. We consider how these structural characteristics affect 1) GDP growth at risk, 2) systemic banking crisis likelihood and 3) systemic banking crisis cost. Where possible, we also examine two characteristics jointly as well as individually. For example, we are able to consider how small, open economies fare in terms of each of the SRMs considered.

Using a large cross-country dataset covering the period since the 1980's, we find that systemic risk levels are typically higher in countries sharing several of the characteristics we examine. For example small, open economies consistently experience worse economic downturns than their larger, less open counterparts. In addition, the extent of downside risks to future growth are also higher for these countries, alongside those that are more dependent on FDI. Should severe banking crises emerge, the costs of those crisis are typically worse for countries with these characteristics, a result which is also found for those with more concentrated banking systems.

From a macroprudential policy perspective, our findings suggest that, at all points in time, a more activist macroprudential policy stance could be appropriate for countries sharing a variety of the characteristics examined in this paper.

## **1** Introduction

Understanding the drivers of systemic risk has been a central feature of the macroprudential policy framework that has emerged since the global financial crisis (GFC).<sup>1</sup> Systemic risk by its nature is multi-faceted and can be complex, having diverse sources and amplifiers. In this paper we examine the role that structural characteristics of the economy and banking system may play in determining systemic risk levels. Specifically we aim to understand the extent that the size of an economy, or its degree of trade or financial openness, influences its systemic risk landscape. In addition, we investigate if banking market concentration, or the extent of banking sector exposure concentration, influences the degree of systemic risk present through time. While previous studies have considered some of these characteristics in isolation, the aim of the current paper is to have a more comprehensive view of their role in informing holistic measures of systemic risk.

To do this we include measures of these macro-financial structural characteristics in the estimation of three distinct systemic risk measures (SRMs). The SRMs include i) GDP growth-at-risk (GaR), ii) systemic banking crisis likelihood and iii) systemic banking crisis-related cost. We quantify the contribution of each structural characteristic towards each SRM both independently as well as jointly. We characterise the extent to which these macro-financial structural characteristics either add to, or minimise, the magnitude of systemic risk for economies that share them.<sup>2</sup>

Overall our results suggest that, relative to the average advanced economy, smaller, more open countries with more concentrated banking systems are particularly vulnerable to the repercussions stemming from financial shocks, especially those severe enough to trigger a financial crisis. A higher degree of inward FDI dependence, in most cases, amplifies the sensitivity of an economy to systemic risk, although not to the same extent as some of the other characteristics. From a policy perspective, our results highlight the need to consider an economy's macro-financial structure and their systemic risk implications when developing and calibrating macroprudential policies.

The rest of the paper is organised as follows. In section 2 we place our paper

<sup>&</sup>lt;sup>1</sup> Systemic risk is the risk of a disruption to the provision of financial services, caused by the impairment of all or parts of the financial system with serious negative consequences for the real economy.

<sup>&</sup>lt;sup>2</sup> In O'Brien & Wosser (2021), we show that, in the case of estimates of Irish GDP-at-risk measures, the country fixed effect persistently weighs against left tail (5th percentile) forecasts, suggesting that structural factors have a role in influencing the extent of downside risks to the economy.

in the context of the prior literature in the area. We describe our data and analytical approach in section 3. As there are 3 different models used, these are presented, along with the associated results, on a model by model basis in section 4. Robustness checks are outlined in section 5 and section 6 concludes.

## 2 Related Literature

Our paper crosses a number of strands of the literature, but is anchored in the empirical work on determinants of systemic risk. Our working hypothesis is that, in general, the structural macro-financial characteristics examined in this paper add to systemic risk, making financial crises relatively more likely and/or more costly for economies which have these characteristics than the average advanced economy. To date, the relationship between macro-financial structure and systemic risk has been only narrowly examined in the existing banking crisis literature, with somewhat mixed findings.

One of the more frequently examined issues is that of concentration in the banking system, both in terms of market concentration (the number of banks that account for a large share of assets in a particular market), and sectoral exposure concentration (the extent to which the banking system exposure is diversified across various sectors of the economy). Beck et al. (2006) and Beck et al. (2018) have found that higher sectoral exposure concentration promotes greater financial stability, because bank executives' subject matter expertise helps them avoid making poor quality investments. However increased sectoral exposure exposure concentration in the banking system may lead to more fragile financial systems, due to banks' failure to diversify their portfolio holdings in a risk-optimal manner (Diamond & Dybvig (1983), Boyd & Prescott (1986)). Regarding market concentration, in economies where there are fewer banks these may benefit from "Too Big to Fail" subsidies and may take more risks as a result. Similarly, where banks enjoy monopoly-like lending rate-setting powers, these generate increased earnings for banks but raise financing costs for firms' investment projects, thereby encouraging the adoption of more risky ventures by firms so as to overcome the higher costs involved, Allen & Gale (2004). Our empirical analysis places both aspects of concentration in the context of holistic measures of systemic risk, contributing to this aspect of the literature.

With the exception of banking market and sectoral exposure concentration, there are relatively few studies examining the more general role of macro-financial structural characteristics in determining systemic risk. A lack of data is one possible

reason for this as banking crises are, thankfully, relatively rare events. Many of the structural characteristics which we examine here can, and often are, associated with observable economic benefits generally. In contrast, identifying various contributions to systemic risk is more straightforward only when such risk has actually materialised. This is the case for our other characteristics of interest - trade and financial openness and dependancy on inward FDI. In all cases, most evidence in the literature point to a higher extent of trade, financial openness and FDI being associated with higher economic growth. However, from a systemic risk perspective, the issue of interest is whether they are also associated with a higher volatility of, and downside risk to, economic growth. This likely depends on a combination of the relative exposure of the economy overall and the domestic banking system to external and domestic shocks and the link between such shocks, which can be influenced by the extent of trade and financial openness and the degree to which inward FDI is used a a source of funding.

Regarding trade openness some papers do find higher downside potential, as vulnerability to external shocks increase (Bejan (2006), Cavallo et al. (2008), and Kose et al. (2003)). However in evaluating this, the fact that increased trade openness can also reduce the degree of exposure to domestic economic shocks also needs to be considered (Caselli et al. (2020)). Popov (2011) finds that increased cross-border financial openness is associated with higher economic growth on average, but also increases the probability of large and abrupt macroeconomic contractions. A dependance on inward FDI, a subset of measures of financial openness, may have similar implications for the volatility of growth. However, in addition there may be related implications for the investment opportunities for the domestic banking system, as FDI may crowd out domestic investment (see Blonigen & Wang (2004), Wang (2010), and Jude (2019) for conflicting views). A relative dominance of FDI as a means of funding more productive sectors of an economy, and hence crowding out investment opportunities intermediated by the local banking sector, may contribute to the likelihood, cost, or sensitivity to downside risks. Our paper contributes to the literature by examining the role of these characteristics in the specific context of systemic risk measures.

In terms of empirical approach, we follow the advances made in recent years which address the data shortage / unobservable issue around systemic risk measurement mentioned above. One such tool is the GDP growth-at-risk framework made prominent by Adrian et al. (2019). Using this framework we extend the work of Aikman et al. (2019) and Beutel et al. (2020). Aikman et al. (2019) highlight how credit and property price dynamics contribute to heightened output growth tail risk. Beutel et al. (2020) find that exposure to US financial shocks, also affects output growth tail risk around the world. In addition we build on O'Brien & Wosser (2018), who produce systemic banking crisis probabilities for up to 27 advanced economies including Ireland by examining whether the dynamics of these crisis probabilities are sensitive to macro-financial structural characteristics.<sup>3</sup>

## 3 Data and Approach

In this section we discuss our data and overall empirical approach. Our dataset comprises an unbalanced panel of 27 OECD countries, measured at a quarterly frequency over the period 1980 through to 2020.<sup>4</sup> A complete list of sample countries is provided in Table 1, with data coverage, definitions and sources in Table 2.

Depending upon the specification required, we examine a variety of structural variables. The latter include trade openness (i.e. the ratio of exports plus imports to GDP), two measures of financial openness, i) an IMF (De Jure) measure of financial openness based on financial supervisory authorities' response to a periodic survey (Fernandez et al. (2016)) and ii) a De Facto openness measure based on external claims (inwards and outwards) relative to GDP. FDI dependency, measured as the stock of FDI to GDP is another structural variable we analyse. Finally, we consider the extent of banking system concentration, which we classify in three ways, i) the share of total banking system assets held by the three largest retail banks, ii) the degree of exposure concentration in lending to various economic sectors and iii) the share of lending to the real estate sector in total. We examine economic size through the share a particular country GDP has in world GDP based on data from the World Bank.<sup>5</sup> Banking crisis data derives from two sources, EU countries from the ECB's dataset (see Lo Duca et al. (2017)) and non-EU countries from Laeven & Valencia (2013).<sup>6</sup>

We introduce binary dummy variables identifying countries in the above or below median of the distribution for a given structural characteristic into our systemic risk measure estimates. A dummy variable representing economic size is added based upon the country's average contribution to world GDP over the time period

<sup>&</sup>lt;sup>3</sup>The logit model used in this instance is similar to the standard in the literature. See Demirgüç-Kunt & Detragiache (1997), Davis & Karim (2008), Eichler & Sobański (2012) and Lo Duca & Peltonen (2013)

<sup>&</sup>lt;sup>4</sup> Some of the data relating to structural variables runs up to 2018H2 only.

<sup>&</sup>lt;sup>5</sup> World Bank data can is available at https://databank.worldbank.org/home.aspx.

<sup>&</sup>lt;sup>6</sup> Grouping of countries by structural characteristic is also presented in Table 1.

examined, with those countries in the lower median of the distribution being given a value of 1. For the other characteristics examined, the binary variable takes a value of 0 for countries in the lower half of the distribution and 1 in the upper half of the distribution, again measured over the entire sample period.<sup>7</sup>

A preliminary graphical analysis points toward an association between the macrofinancial structural characteristics of interest and systemic risk. In Figs. 1 and 2 we observe a positive correlation between systemic banking crisis probability in the period before a crisis materialises and the extent of trade and financial openness in the run-up to the crisis. Trade openness appears to be slightly more positively correlated than financial openness, as shown by the slope of the corresponding fitted line. Similarly, a positive correlation between our measures of banking system exposure concentration and crisis probability is suggested by Figs. 3 and 4. We also see a positive association between some structural characteristics and the costs of crisies, defined as the difference between realised GDP through the crisis and potential GDP evaluated prior to crisis onset (Figs. 5 and 6). This preliminary analysis suggests that more open countries, or those with relatively more concentrated banking systems, experience more severe post-crisis economic losses. The scatter plots, though suggestive, are not by themselves, definitive. In the next section we outline the specific models estimated for each SRM which formally examine the role of economic size, trade and financial openness, dependancy on inward FDI and banking sector concentration on systemic risk.

## 4 Models and Results

For exposition purposes we describe each model, and the corresponding SRM examined, presenting and interpreting the results for each in turn.

## 4.1 Model 1 - GDP Growth At Risk

We examine historical as well as forecast GDP growth-at-risk (GaR) measures. In the case of the historical measure, unconditional ex-post GDP GaR is analagous to Value-at-Risk (VaR) estimates most commonly seen in portfolio investment theory (Hull (2006)). We treat year on year GDP growth, observed quarterly, as the equivalent of a "security" of interest and define the 5% GDP GaR (where "q"=0.05) as follows:

<sup>&</sup>lt;sup>7</sup> We repeat our examination of structure versus crisis probability and crisis-related costs using continuous measures of the structural characteristics and alternative thresholds of the distribution in the robustness checks section.

$$Pr(GDP^i \le GaR^i_q) = q \tag{1}$$

This is akin to saying that, based on historical GDP growth figures, we are 95% certain that GDP growth does not fall below the GaR threshold as measured by Eq. 1 for country "i". In addition, we also examine instances where q=0.01 and 0.1.

For forward-looking conditional GDP growth-at-risk we use the model described in O'Brien & Wosser (2021). Here,  $\Delta GDP_{i,t+h,j}$  represents the annual average growth rate of GDP between time t and t+h, where "h" represents quarters. Using quantile regressions we examine each percentile "j" of the distribution of forecast GDP growth. The conditioning variables includes current growth (measured yearon-year), a financial conditions index, a cyclical systemic risk measure and a country fixed effect.<sup>8</sup> To address the main question of this research we include interactions of the structural characteristic dummy variables (SV) with the financial conditions and cyclical systemic risk variables.

$$\Delta GDP_{i,t+h,j} = \alpha_j + \beta 1_j \Delta GDP_{i,t} + \beta 2_j FinCond_{i,t} + \beta 3_j CycSysRisk_{i,t} + \beta 4_j FinCond_{i,t} * SV_{i,t} + FE_i + \varepsilon_{i,t}$$
(2)

$$\Delta GDP_{i,t+h,j} = \alpha_j + \beta 1_j \Delta GDP_{i,t} + \beta 2_j FinCond_{i,t} + \beta 3_j CycSysRisk_{i,t} + \beta 4_j CycSysRisk_{i,t} * SV_{i,t} + FE_i + \varepsilon_{i,t}$$
(3)

The regression coefficients on the interaction terms can inform us as to the relative sensitivity of countries with the structural characteristic(s) in question to marginal changes in financial conditions or in cyclical risk in the periods between crises.

We examine the 5th, 10th and 50th percentiles of the forecast growth distribution up to 16 quarters into the future, paying attention to the differences between these conditional growth forecasts for varying horizons, with the differences being related to the interaction between financial conditions, cyclical risk and macrofinancial structure.

<sup>&</sup>lt;sup>8</sup>The financial conditions index is the CLIFS - Country Level Index of Financial Stress. The cyclical systemic risk measure is the credit-to-GDP gap. For Ireland we use the preferred national specific measure of the credit gap described in O'Brien et al (2018).

## 4.2 Results - SRM 1

## Historical GDP growth-at-risk and structural characteristics:

The results for the historic GDP GaR estimates are presented in Table 3.

The first, fifth and tenth percentiles associated with the full advanced economy sample of countries are shown in row 1, with the subsequent rows showing the results for the cohort of countries sharing the macro-financial structural characteristics of interest. The structural "Delta" is also shown below the summary statistic in each case. This Delta represents the difference between the typical (full-sample) advanced economy and those grouped by a structural characteristic for corresponding percentiles of their past GDP growth distributions. Negative Deltas imply more harmful growth outcomes associated with a particular structural characteristic. We typically associate first percentile data with financial crisis episodes as they represent the most adverse growth outcomes. Fifth percentile results represent less harmful growth outcomes. They can be roughly equated with recessionary periods. We associate 10th percentile growth outcomes with weak growth (though not necessarily recessions as the period of weak growth may be short-lived, or positive, or both). We perform a two sample Kolmogorov-Smirnov "equality of distribution" test to compare the full sample GDP growth distribution with those of sub-samples of countries sharing a given structural characteristic (see Smirnov (1939)).

Table 3 suggests that small countries experience (on average) worse crisis outcomes, in this case amounting to approximately -0.5 percentage points of negative GDP growth per annum, than the "average" advanced economy. This finding is compatible with our later estimates of crisis-related cost (see below). Similarly, systemic risk appears to be higher for financially open countries (De Jure) and those with concentrated banking systems. For this SRM, being more trade open is not found to have any statistically significant effect, whereas having a higher dependency on inward FDI is associated with a lower degree of systemic risk.

In the lower panel we examine pairs of structural characteristics jointly. All of the combinations considered show statistically significantly weaker historical tail risk, with the exception of the small and FDI dependent combination. Small economies whose banking system is characterised as being heavily concentrated in particular market segments show the largest Delta, at -8.2% for the first percentile gap.

### Forward looking GDP growth-at-risk and structural characteristics:

To examine forward-looking tail risk we perform quantile regressions outlined in

equations 2 and 3 involving interactions of the structural dummy variables with financial conditions and cyclical systemic risk. In these regressions we examine each of the annualised "h" (h = 4, 8, 12 and 16) quarter ahead GDP growth in panel regressions which include country dummy variables for countries that do not share the structural characteristic involved. The quantiles of interest represent the 5th, 10th and median percentiles of each growth series over horizon "h". A set of regression coefficients for each structural variable interaction is then determined, an example of which is shown in Table 4.

In this case the structural variable examined is economic size. The findings demonstrate the sensitivity of forward-looking tail risk to deteriorating financial conditions (the financial conditions index increases), such that a financial conditions shock is observed as typically leading to lower 5th and 10th percentiles of the forecast GDP distribution. Being a small economy appears to amplify financial conditions shocks at the 1 year (10th percentile) and 2 year (5th and 10th percentiles) horizons. Financial conditions shocks have in the past been shown to have only muted effects at longer horizons (see O'Brien & Wosser (2021)) and the results here remain consistent with those findings.

As we are predominantly interested in the interaction of the structural characteristic variables, and for reasons of space, we do not present a separate table for each structural characteristic. Instead, we report only the results from the interaction terms, with financial conditions interactions presented in Table 5 and the cyclical systemic risk and structural variable interactions in Table 6. Particular attention is paid to the sign and statistical significance of the coefficient on the structural interaction terms.

The results in Table 5 suggest that GDP growth tail risk may be negatively influenced by many of our structural characteristics effectively acting as amplifiers for deteriorating financial conditions. We see this to be the case for trade open countries at the 1 year horizon, with bank concentration also having a weakly significant effect at the two year horizon. FDI dependent countries appear somewhat shielded from deteriorating financial conditions, although the effect is delayed until longer forecast horizons and relating to central growth forecasts. The other structural variables, although they reflect frequently negative (more harmful) coefficients, do not appear to signal significant risk amplification, taking their p-stat values into account. When combined with the small country characteristic, the banking system concentration interactions with financial conditions tend to only reflect statistically significant harmful outcomes where concentration is measured as the share of total banking system assets held by the three largest retail banks.

More meaningful structure-related tail risk amplifications are visible in the context of the credit-to-GDP gap interactions (Table 6). Credit imbalances that negatively affect future tail risk appear to be amplified in smaller, more open economies compared with their larger advanced economy counterparts. Similar findings emerge for more FDI dependent countries and those which have banking systems concentrated according to two of our three measures adopted. By contrast, financial openness appears to act as a counterweight to credit shocks where the former is measured on a "De Jure" basis and this effect holds even when the characteristic is coupled with the, typically more dominant, small country variable. However, when "De Facto" financially open as well as small countries are considered, the amplified tail risk to a credit-related shock is again present. Furthermore, the combinations of FDI dependent and bank concentration characteristics also appear to amplify such shocks at longer forecasting horizons.

The economic size of these amplifications are modest, but when they are considered alongside the historical tail risks we have observed, and with the additional cost of crisis results described in Model 3, these results take on added significance.

#### 4.3 Model 2 - Systemic Banking Crisis Likelihood

Systemic banking crisis likelihood for up to 27 countries is estimated using the following regression specification, in line with O'Brien & Wosser (2018):

$$Log(\frac{Pr(Crisis_{it}|Z_{it})}{Pr(NoCrisis_{it}|Z_{it})}) = \alpha + \beta Z_{it} + \epsilon_{it}$$
(4)

In this specification, vector  $Z_{it}$  comprises a set of eight control variables chosen on the basis of their crisis signalling properties. The variables are:- i) changes in the short-term interest rate, ii) the credit-to-GDP ratio, iii) a house price index and iv) house price deviation from its long-run trend, v) losses on equity markets, vi) unemployment rates, vii) a financial conditions index and viii) the extent of household leverage relative to GDP. As we wish to retain countries which do not experience a crisis in our samples, country fixed effects are omitted. Fitted values from this model represent forecast crisis probabilities within the forecasting horizon "h" per country. We then regress the forecast crisis probabilities against the structural variables of interest as defined in section 3, one structural variable at a time.<sup>9</sup>

## 4.4 Results - SRM 2

The results are outlined in Table 7. In terms of the structural variables, in general positive coefficients are associated with increased crisis likelihood, with the z-stat (or p-value) denoting statistical significance. Estimating the effects of a single structural characteristic at a time, there appears to be only a weakly positive or strongly negative correlation between crisis probability and the structural characteristics. Trade open countries tend to display statistically significantly lower crisis probabilities than other developed countries, whereas there is some evidence that the opposite is the case for FDI dependent countries and those with more stringent financial controls (as measured by our De Jure Financial Openness variable). The extent of bank concentration, as defined according to our three alternative measures, is not significantly related to increased crisis likelihood in this dummy structural variable framework.

Measured jointly, small and trade open economies appear less risky as illustrated by the sign and statistical significance of the interaction terms in the lower panels of Table 7. In fact, almost all interactions involving the small country variable are negative, suggesting that the small country effect is associated with reduced crisis likelihood in general.

From these results it would appear that structural variables do not appear to be strongly correlated with increased crisis likelihood, the exceptions being FDI dependent and financially open (De Jure) countries. However, it is worth pointing out that where the structural variables are assessed using their continuous variable forms, we occasionally get different results and may draw different conclusions as a consequence. We discuss these differences and their implications overall in the Robustness Checks section below.

## 4.5 Model 3 - Systemic Banking Crisis Cost

The final SRM we consider addresses systemic banking crisis cost in GDP terms. Costs are estimated as output lost as a proportion of the linearly projected GDP path over the following 5 years at each point in our sample ( $\widehat{GDP}_{i,t}$ ). Projections are from a smoothed GDP growth series ( $SmGDP_{i,t}$ ) according to the following;

<sup>&</sup>lt;sup>9</sup> An alternative approach is to introduce the strucutral characteristic dummy variables directly in the logit estimation, as in McInerney et al. (2022)

$$\widehat{GDP}_{i,t} = SmGDP_{i,t} = \alpha GDP_{i,t} + (1-\alpha)SmGDP_{i,t-1}$$
(5)

The smoothing parameter  $\alpha$  is chosen to minimise the in-sample sum of squared forecast errors between actual and smoothed observations. For each country / crisis observation in our sample we then estimate the average lost GDP flows for crisis "x" in country "i" at time "t":

$$Countryloss_{i,x} = \frac{1}{20} \sum_{t=1}^{20} (\widehat{GDP}_{i,t} - GDP_{i,t})$$
(6)

From these values we estimate the sample average annual GDP loss, due to crises, in our panel. Note, the sample data is limited to quarters when, according to the relevant systemic crisis database, systemic banking crises were taking place. Naturally, this represents only a small proportion of the observations in our dataset. Due to this constraint, we pool our data and make use of OLS regressions, where the dependent variable represents proportionate output loss where  $Loss_{i,t} = \frac{(G\widehat{DP}_{i,t}-GDP_{i,t})}{G\widehat{DP}_{i,t}}$ .<sup>10</sup> We restrict our control variable to the financial conditions index for dimensionality reasons, given the constraint involving relatively few crises and quarterly observations where crisis cost conditions are valid for our purposes. Note, whereas this regression specification is not wholly consistent with the earlier specifications involving crisis probabilities (which already captured the influence of financial conditions), we justify our approach in that it is conceptually aligned with the GDP growth-at-risk approach of Adrian et al. (2019) and we interpret the results accordingly. The specification involved is:

$$Loss_{i,t} = \alpha_i + \beta_1 FinCond_{i,t} + \beta_2 SV_{i,t} + \varepsilon_{i,t}$$
<sup>(7)</sup>

 $SV_{i,t}$  represents the same binary structural characteristic dummy variable as before, with combinations between two structural variables are also included as described above.

#### 4.6 Results - SRM 3

The results are presented in Table 9. The top panel focuses on the stand-alone relationship between the structural dummy variables and crisis cost with the lower panel outlining combinations of structural variables.

When we consider crisis-related cost as our target SRM, there appears to be

<sup>&</sup>lt;sup>10</sup> Both crisis datasets we use include details on crisis commencement date as well as duration.

statistically significant downside risks associated with the structural characteristics of interest. Of particular note is the relatively more severe 8.32% annual output loss associated with small countries whose banking system has concentrated exposures to particular market sectors. In economic terms the bank concentration and trade openness characteristics appear to be associated with the most severe adverse outcomes, when these structural characteristics are evaluated independently of each other. In the trade openness case, this may reflect the potential for crisis-induced recessionary spillovers to propagate from country to country through a trade-related channel, as has been documented in prior financial crises literature (see Yamamoto (2014) and, for volatility spillovers, Diebold & Yilmaz (2012)).

Notwithstanding the obvious economic benefits stemming from FDI flows, we find that in the wake of crises countries that have a higher dependency on FDI can suffer higher economic costs. This is particularly the case for countries whose banking systems are relatively concentrated, with small countries dependent on FDI also tending to experience relatively worse post-crisis recessions than the typical advanced economy.

Whereas the bank concentration variables had little significance in relation to crisis probability, the relatively severe post-crisis costs are more telling. Overall our results tend to support the view that sectoral exposure concentration and market concentration are negatively associated with systemic risk.

Overall we believe the macro-financial characteristics examined here are instructive from a systemic risk perspective and, on balance, pockets of related risk are evident across the spectrum of our SRM measures.

## 5 Robustness Checks

We carry out a number of robustness tests to assess the validity of our results. In relation to our estimates of crisis probability and crisis cost, we replace structural characteristic dummy variables with their continuous, though slow moving, analogues and repeat the analysis. We have given primacy in this paper to the "state of being" associated with a particular structural variable (dummy variable approach), over the the "marginal propensity" for increased (or reduced as the case may be) systemic risk as might be captured by continuous measures of macrofinancial structure. Overall, the dummy variable approach appears to us to be more closely aligned with our research objectives than are the continuous variable

### alternatives.

In the case of the crisis proabilities in particular, we derive some results that appear to conflict with the dummy variable results outlined above. These are presented in Table 8. In particular, we note that as an economy increases in size the likelihood of a banking crisis reduces, suggesting smaller economies are more at risk in this regard. We also observe a statistically significant (though economically minor) coefficient relating to our sectoral exposure bank concentration measure.

The difference between the "state" of being small and the continuous measure of same suggests a break in the linear relationship between our economic size measure and crisis probability at some point. Indeed, during other robustness exercises, where the dummy variable classification scheme is modified to signal top/bottom quartiles or tertiles, for instance, the sign and significance of the corresponding structure-related dummy variables sometimes changes. Where no difference across our two estimation approaches is observed, for example in the cases of financially open economies (De Jure) or small and financially open (De Facto), we believe the increased systemic risk to be relatively more definitive.

There is little to no divergence in our findings with respect to continuous measures of macro-financial structural characteristics and systemic banking crisis-related costs, the results of which are presented in Table 10.

Finally, we experimented with alternatives to the cyclical systemic risk variable, i.e. the credit-to-GDP gap. For this purpose we made use of the the ECB's systemic risk index variable (d-SRI, source ECB statistical data warehouse) and our primary findings of cross-SRM structure related vulnerability remain intact. Our preference was to control for cyclical systemic risk using the credit-to-GDP-gap indicator because the d-SRI variable has less depth (coverage over time), as well as breadth across countries.<sup>11</sup>

In general, we conclude that these robustness checks support our most important findings with respect to the role macro-fiancial structural characteristics play as drivers of systemic risk.

<sup>&</sup>lt;sup>11</sup>The d-SRI and its systemic banking crisis early warning properties are introduced and described in Lang et al. (2019).

## 6 Conclusions

The extent to which various structural characteristics of an economy and financial system influences systemic risk is important for policy-makers to understand. Our examination has focused on the role that economic size, trade and financial openness, FDI-dependency and banking system concentration play in determining the systemic risk landscape. Across the three systemic risk measures examined, we find that that there appear to be pockets of significant structure-related vulnerabilities. In particular, small, financially open economies or those more dependent on FDI seem to have consistently higher systemic risk measures than the average advanced economy. While the results are less definitive for the other characteristics examined, there is some support for the contention that a higher degree of trade openness (in combination with other characteristics) and bank exposure concentration (in isolation and in combination) are also associated with higher systemic risk.

Regarding the systemic risk measures, the role of the structural characteristics of interest is more evident when considering historic and forward looking GDP-atrisk and systemic crisis cost. This suggests that while systemic banking crises are typically rare events, the costs associated with them are more severe for economies that are smaller, more open and FDI-dependent and with a more concentrated banking system than the average advanced economy.

In addition, our results point to the need to consider the implications of multiple structural characteristics jointly to better understand their potential to influence systemic risk levels. The specific approach taken in our analysis has evaluated the role of these characteristics through the financial cycle, indicating that they should be considered when the general risk environment is elevated, subdued or neither. From a policy perspective, this suggests a more activist macroprudential policy stance could be appropriate for certain countries that display some or all of the macro-financial structural characteristics examined in this paper.

## References

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- Adrian, T., Boyarchenko, N. & Giannone, D. (2019), 'Vulnerable growth', American *Economic Review* **109**(4), 1263–89.
- Aikman, D., Bridges, J., Hacioglu Hoke, S., O'Neill, C. & Raja, A. (2019), 'Credit, capital and crises: a gdp-at-risk approach'.
- Allen, F. & Gale, D. (2004), 'Competition and financial stability', *Journal of money*, *credit and banking* pp. 453–480.
- Beck, T., De Jonghe, O. & Mulier, K. (2018), 'Bank sectoral concentration and (systemic) risk: Evidence from a worldwide sample of banks', Available at SSRN 2959273.
- Beck, T., Demirgüç-Kunt, A. & Levine, R. (2006), 'Bank concentration, competition, and crises: First results', *Journal of Banking & Finance* **30**(5), 1581–1603.
- Bejan, M. (2006), 'Trade openness and output volatility', Available at SSRN 965824
- Beutel, J., Emter, L., Metiu, N., Prieto, E. & Schüler, Y. S. (2020), 'Dilemma or trilemma? evidence from the international transmission of us financial shocks to downside risks to growth', *Evidence from the international transmission of US financial shocks to downside risks to growth (June 10, 2020)*.
- Blonigen, B. & Wang, M. (2004), 'Inappropriate pooling of wealthy and poor countries in empirical fdi studies'.
- Boyd, J. H. & Prescott, E. C. (1986), 'Financial intermediary-coalitions', *Journal of Economic theory* **38**(2), 211–232.
- Caselli, F., Koren, M., Lisicky, M. & Tenreyro, S. (2020), 'Diversification through trade', *The Quarterly Journal of Economics* **135**(1), 449–502.
- Cavallo, E. A., De Gregorio, J. & Loayza, N. V. (2008), 'Output volatility and openness to trade: A reassessment [with comments]', *Economia* **9**(1), 105–152.
- Chinn, M. D. & Ito, H. (2008), 'A new measure of financial openness', *Journal of comparative policy analysis* **10**(3), 309–322.
- Davis, E. P. & Karim, D. (2008), 'Comparing early warning systems for banking crises', *Journal of Financial stability* **4**(2), 89–120.
- Demirgüç-Kunt, A. & Detragiache, E. (1997), The determinants of banking crises: Evidence from industrial and developing countries, Technical report, The World Bank.

- Diamond, D. W. & Dybvig, P. H. (1983), 'Bank runs, deposit insurance, and liquidity', *The journal of political economy* pp. 401–419.
- Diebold, F. X. & Yilmaz, K. (2012), 'Better to give than to receive: Predictive directional measurement of volatility spillovers', *International Journal of Forecasting* **28**(1), 57–66.
- Eichler, S. & Sobański, K. (2012), 'What drives banking sector fragility in the eurozone? evidence from stock market data', *JCMS: Journal of Common Market Studies* **50**(4), 539–560.
- Fernandez, A., Klein, M. W., Rebucci, A., Schindler, M. & Uribe, M. (2016), 'Capital control measures: A new dataset', *IMF Economic Review* **64**(3), 548–574.
- Hull, J. C. (2006), Options, futures, and other derivatives, Pearson Education India.
- Jude, C. (2019), 'Does fdi crowd out domestic investment in transition countries?', *Economics of Transition and Institutional Change* **27**(1), 163–200.
- Kose, M. A., Prasad, E. S. & Terrones, M. E. (2003), 'Financial integration and macroeconomic volatility', *IMF Staff papers* **50**(1), 119–142.
- Laeven, L. & Valencia, F. (2013), 'Systemic banking crises database', *IMF Economic Review* **61**(2), 225–270.
- Lang, J. H., Izzo, C., Fahr, S. & Ruzicka, J. (2019), 'Anticipating the bust: a new cyclical systemic risk indicator to assess the likelihood and severity of financial crises', *ECB Occasional Paper* (219).
- Lo Duca, M., Koban, A., Basten, M., Bengtsson, E., Klaus, B., Kusmierczyk, P., Lang,J. H., Detken, C. & Peltonen, T. A. (2017), A new database for financial crises in European countries, Occasional Paper Series 194, European Central Bank.
- Lo Duca, M. & Peltonen, T. A. (2013), 'Assessing systemic risks and predicting systemic events', *Journal of Banking & Finance* **37**(7), 2183–2195.
- McInerney, N. A., O'Brien, M., Wosser, M. & Zavalloni, L. (2022), 'Rightsizing bank capital for small, open economies', *Central Bank of Ireland Research Technical Paper Series (forthcoming)* **2022**(4).
- O'Brien, M. & Wosser, M. (2018), 'An early warning system for systemic banking crises a robust model approach', *Central Bank of Ireland Research Technical Paper Series*.
- O'Brien, M. & Wosser, M. (2021), 'Growth at risk and financial stability', *Financial Stability Note*, No. 2021:2.
- Popov, A. A. (2011), 'Output growth and fluctuations: The role of financial openness'.

- Smirnov, N. V. (1939), 'Estimate of deviation between empirical distribution functions in two independent samples', *Bulletin Moscow University* **2**(2), 3–16.
- Wang, M. (2010), 'Foreign direct investment and domestic investment in the host country: evidence from panel study', *Applied Economics* **42**(29), 3711–3721.
- Yamamoto, S. (2014), 'Transmission of us financial and trade shocks to asian economies: Implications for spillover of the 2007–2009 us financial crisis', *The North American Journal of Economics and Finance* **27**, 88–103.



Figure 1. Crisis Probability and Trade Openness



Figure 3. Crisis Probability and Bank Concentration (R.E.)



Figure 2. Crisis Probability and Financial Openness



Figure 4. Crisis Probability and Bank Concentration (Mkt. Sect.)



Figure 5. Crisis Cost and Fin. Openness (De Facto)





Figure 7. GDP Growth and Credit-to-GDP Gap

Figure 6. Crisis Cost and Trade Openness

#### Table 1. Countries, Crises and Macro-financial Structure

	Crisis Start	Years End	Source	Small Country	Fin. Open Country (De Facto)	Fin. Open Country (De Jure)	Trade Open Country	Bank Conc. (R.E.)	Bank Conc. (WB)	Bank Conc. (Mkt. Sect.)	FDI Dep. Country
Argentina	1980O1	198004	Laeven and Valencia (2012)								
	1989Q1	1989Q4	Laeven and Valencia (2012)								
Australia	-	-	Laeven and Valencia (2012)		х						
Austria	2007Q4	2014Q1	ECB MPG/AWG Systemic Crisis Database (2016)				х	х	х		
Belgium	2007Q4	Ongoing	ECB MPG/AWG Systemic Crisis Database (2016)		х	х	х		х	х	Х
Brazil	199001	199004	Laeven and Valencia (2012)								
	1994Q1	1994Q4									
Canada	-	-	Laeven and Valencia (2012)			Х		х			
China	1998Q1	1998Q4	Laeven and Valencia (2012)								
Denmark	1987Q1 2008Q1	1995Q1 2013Q4	ECB MPG/AWG Systemic Crisis Database (2016)	х		х	х		х		
Finland	1991Q3	1996Q4	ECB MPG/AWG Systemic Crisis Database (2016)	х	х				х	х	
France	1991Q2 2008Q2	1995Q1 2009Q4	ECB MPG/AWG Systemic Crisis Database (2016)		х	х				х	
Germany	2001Q1 2007Q3	2003Q4 2013Q2	ECB MPG/AWG Systemic Crisis Database (2016)		х	х					
Greece	2010Q2	Ongoing	ECB MPG/AWG Systemic Crisis Database (2016)	х		х					
Hungary	1991Q1 2008Q3	1995Q4 2010Q3	ECB MPG/AWG Systemic Crisis Database (2016)	х			х				х
Ireland	2008Q3	2013Q4	ECB MPG/AWG Systemic Crisis Database (2016)	х	х		х	х	х	х	х
Italy	1991Q3 2011Q3	1997Q4 2013O4	ECB MPG/AWG Systemic Crisis Database (2016)			х					
Japan	1997Q3	1997Q4	Laeven and Valencia (2012)			х					
Luxembourg	2008Q1	2010Q4	ECB MPG/AWG Systemic Crisis Database (2016)	х	х	х	х		х		х
Netherlands	2008Q1	2013Q2	ECB MPG/AWG Systemic Crisis Database (2016)		х	х	х	х	х	х	
New Zealand	-	-	Laeven and Valencia (2012)	х					х		
Norway	1991Q1	1991Q4	Laeven and Valencia (2012)	х		Х			х		
Poland	1981Q1	1994Q4	ECB MPG/AWG Systemic Crisis Database (2016)				х	х			
Portugal	1983Q1 2008Q4	1985Q1 Ongoing	ECB MPG/AWG Systemic Crisis Database (2016)	х	х					х	х
Spain	1980Q1 2009Q1	1985Q3 2013Q4	ECB MPG/AWG Systemic Crisis Database (2016)		х			х			х
Sweden	199101	199702	ECB MPG/AWG Systemic Crisis		x		×	×	x		
Jweuen	200803	201004	Database (2016)		^		^	^	^		
Switzerland	2008Q1	2008Q4	Laeven and Valencia (2012)		х	х	х				х
United Kingdom	1991Q3	1994Q1	Database (2016)		х	х					х
United States	2007Q3 1988Q1 2007Q4	2010Q1 1988Q4 2011Q4	Laeven and Valencia (2012)					х			

This table presents information identifying the name and number of countries in the panel. Crisis start and end dates are also presented based upon the ECB crisis dataset of Lo Duca et al. (2017) and also that of Laeven & Valencia (2013) for non-EU countries. Countries are designated as small if they fall into the smallest 1/3 of countries in the underlying EWS database based on the IMF (2016) rankings of contribution to world GDP. Trade openness measures exports plus imports to GDP ratio. Financial openness has two measures. De Facto measures the top 1/2 of countries based upon the ratio of external claims of the banking system (inwards and outwards) relative to GDP. De Jure financially open countres as designated based upon their relatively high La, new score as per the IMF survey of the capital account of countries (see China & Ito GDP). De Jure financially open countres is designated based upon their relatively high La, new score as per the IMF survey of the capital account of countries (see China & Ito GDP). De Jure financially open countres is designated based upon their relatively high La, new score as per the IMF survey of the capital account of countries (see China & Ito GDP). De Jure financially open countres side starts of foreign-direct investment to GDP according to a CIA World Factobook survey (2018). World Bank (WB) concentration measures the proportion of total banking system assets held by the largest 3 retail banks in a country. Bank Concentration by market segment measures market segment concentration by NACE code (see ECB statistical data warehouse). Concentration by real estate (R.E.) measures the proportion of bank assets that are real-estate related with underlying bank balance sheet source data provided by Bloomberg and aggregated at the country level.

Variable Name	Mean	Summary S.D.	Statistics Min	Max	Description	Obs.	Countries	Coverage	Source
GDP growth rate	0.026	0.032	1127	0.297	GDP growth rate	4196	27	1980Q1-	OECD
Losses only S&P 500 Index	-0.014	0.04	-0.26	0.00	S&P gains are set to 0, losses only are retained as recorded	4184	27	2020Q4 1980Q1- 2020Q4	Yahoo Finance
Credit to GDP ratio	135.48	64.63	9.4	455.3	during the quarter Ratio of total credit extended, all	3877	27	1980Q1- 2019Q4	BIS - Total Credit Statistics
Financial Stability Index	0.14	0.11	0.00	1.00	borrowers, to כשר Country level index of financial stress	2385	17	2000Q1- 2019Q4	ECB - Statistical Data Warehouse
House Price Index	145.63	91.93	15.56	504.98	(aka CLIFS) Index House Price Index in Levels, with 1995 as	3326	17	1980Q1- 2019Q4	BIS - Long Property Series
Trade Openness	99.	0.5	.05	4.23	Ratio of exports plus imports as a	1394	27	1980H1- 2018H2	IMF - IFS database
Financial Openness (De Facto)	.11	0.47	0.00	4.66	percentage סד טרא External claims inwards and outwards as a	587	27	1980H1- 2018H2	IMF - IFS database
Financial Openness (De Jure)	0.79	0.24	0.00	1.00	percentage of GDP Index calculated based upon regulatory survey responses (IMF	486	27	1996H1- 2013H2	IMF
Tier 1 Capital Ratio	0.11	.04	.01	.25	survey) Tier 1 Capital as a proportion of Risk	436	15	2000H1- 2018H2	Bloomberg
GDP World Share	2.41	4.08	0.042	22.269	Weighted Assets Contribution to World GDP PPP	4185	27	1980Q1- 2018Q3	World Economic Outlook Database -
Foreign Direct Investment (FDI Dependency)	49.57	62.27	0.58	391.11	Foreign Direct Investment Stock as a share of national	1,225	27	2005Q1- 2018Q4	World Bank OECD
Bank Concentration I	66.47	20.02	20.19	100	Share of total banking assets in a country held by three	2,252	26	1996Q1- 2018Q4	World Economic Outlook Database - World Bank
Bank Concentration II	2318	520.43	1365.43	3588.03	largest retail panks Herfindahl Hirschmann Index	682	11	2003Q1- 2018Q4	ECB Statistical Data Warehouse
Bank Concentration III	53,39	11.28	21.87	74.27	based on NACE code Share of total bank lending that is real-estate based	744	11	2003Q1- 2018Q4	Bloomberg Bank Annual Reports
This table presents information or collapsed according to the frequer Valencia (2013) for non-EU count rates.	the variable ncy available rries.EWS var	s in the pane for analysis. iables includ	el. The EWS p The bank cris le S&P losses,	aanel is held sis data is dri , Financial St	at quarterly frequency wherea ven by the ECB's crisis databas ability Index, House Price Inde	s bank balar se (see Lo Du sx, Credit to	nce sheet data is o uca et al. (2017) f. GDP gap, unemp	only available. E' or EU countries loyment and sho	WS data is and by Laeven & ort-term interest

Table 2. Variable Description and Summary Statistics

#### Table 3. Historical GDP Growth At Risk

	No. Obs (f	ull sample) :	2918
Summary of Hist. GDP Growth	1st	5th	10th
Density	percentile	percentile	percentile
Full Sample	-0.0626	-0.0228	-0.0064
Small Economy	-0.0696	-0.0273	-0.0101
Delta	-0.007 **	-0.005 **	-0.003 **
Trade Openness	-0.0632	-0.0229	-0.0065
Delta	-0.001	-0.001	-0.001
Financial Openness - I (De Facto)	0605	-0.0250	-0.0071
Delta	0.002 ***	-0.002 ***	-0.001 ***
Financial Openness - II (De Jure)	-0.0660	-0.0189	-0.0061
Delta	-0.003 ***	0.004 ***	0.000 ***
FDI Dependent	-0.0592	-0.0185	-0.0040
Delta	0.003 ***	0.004 ***	0.002 ***
Bank Concentration I - (3 bank share of total assets) Delta	-0.0694 -0.007 ***	-0.0261 -0.003 ***	-0.0093 -0.003 ***
Bank Concentration II - (Loan exposures by market sector) Delta	-0.0667 -0.004 ***	-0.0261 -0.003 ***	-0.0065 0.000 ***
Bank Concentration III - (Real Estate)	-0.0638	-0.0298	-0.0089
Delta	-0.001 ***	-0.007 ***	-0.003 ***
Small and Trade Open	-0.0618	-0.0252	-0.0071
Delta	0.001 ***	-0.002 ***	-0.001 ***
Small and Financially Open I (De Facto) Delta	-0.0626 0.000 **	-0.0261 -0.003 ***	-0.0086 -0.002 ***
Small and Financially Open II (De Jure)	-0.0795	-0.0229	-0.0077
Delta	-0.017 ***	-0.000 ***	-0.001 ***
Small and FDI Dependent	-0.0618	-0.0217	-0.0064
Delta	0.001	0.001	-0.000
Small and Banking Concentration I (3 bank share of total assets) Delta	-0.0749 -0.012 ***	-0.0266 -0.004 ***	-0.0104 -0.000 ***
Small and Concentrated Banking System II (Loan exposures by market sector) Delta	-0.0820 -0.019 **	-0.0355 -0.013 **	-0.0119 -0.006 **
Small and Concentrated Banking System III (Real Estate) Delta	-0.0696 -0.007 *	-0.0363 -0.013 *	-0.0168 -0.001 *
FDI Dependent and Concentrated Banking System I (3 bank share of total assets) Delta	-0.0618 0.001 ***	-0.0217 0.001 ***	-0.0070 -0.001 ***
FDI Dependent and Concentrated Banking System II (Loan exposures by market sector)	-0.0605 -0.004 ***	-0.0210 -0.003 ***	-0.0063 -0.000 ***
FDI Dependent and Concentrated	-0.0667	-0.0268	-0.0007
Banking System III (Real Estate)	-0.004 ***	-0.003 ***	-0.000 ****

This table presents the historical GDP growth density for all the countries in our sample (EWS) and then summarised according to whether or not a country exhibits the characteristics as described in Table 1. In the upper panel the independent variables are dummy variables which are set to 1 if a country exhibits the structural characteristic in question or 0 otherwise. In the lower panel are interaction terms for a selection of joint combinations of the dummy variables outriable avoid the full sample density is shown in the first row and then the structural Delta is identified for countries with the (combinations of) structural characteristics. All structural Delta's are expressed relative to the full sample. Delta significance is denoted according to the Kolmogorov-Smirnov test of distribution equivalence between the full sample and the sample angle comprising the cohort of countries exhibiting the structural characteristic. Statistically significant percentile differences are inferred from the full distribution KS test results.

¥
Growth
GDP
Looking
Forward
Table 4.

Risk

Model : Quantile Regession with country level fixed effects Dep. Variable: ForwardDP GaR (h quarter ahead annualised growth rate)

	50th Coeff. (S.E.)	0.1686***********************************
T+16Q	10th Coeff. (S.E.)	0.0028 (0.007) (0.007) (0.007) (0.007) (0.007) (0.002)
	5th Coeff. (S.E.)	-0.0219 -0.0219 -0.0066 -0.0000 -0.00015 -0.0015 -0.0015 -0.0013 -0.0013 -0.0013 -0.0014 -0.0013 -0.0014 -0.0013 -0.0014 -0.0013 -0.0014 -0.0013 -0.0012 -0.0012 -0.0023 -0.0020 -0.0023 -0.0022 -0.00
	50th Coeff. (S.E.)	0.1642*** 0.0024) 0.0024) 0.0005 0.00018 0.00018 0.00107*** 0.0107*** 0.0107*** 0.0107*** 0.01038 0.0063*** 0.0063** 0.0063** 0.0063** 0.0063** 0.0063** 0.0063** 0.0063** 0.00652 0.0063** 0.00652** 0.00652** 0.00652** 0.00653** 0.00653** 0.00655** 0.00655** 0.00655** 0.00655** 0.00655** 0.00655** 0.00655** 0.00655** 0.00655** 0.00655** 0.00655**
T+12Q	10th Coeff. (S.E.)	0.0080 (0.037) 0.0131 0.0131 (0.014) 0.00285 (0.003) 0.0112 (0.003) 0.0137 0.0033 (0.007) 0.0137 0.0033 0.0137 0.0033 0.0137 0.0033 0.0137 0.0033 0.0137 0.0055 0.0033 0.0141 0.0005 0.0
	5th Coeff. (S.E.)	-0.0129 (0.042) 0.0021 (0.012) -0.0002 (0.000) (0.004) (0.004) 0.0018) -0.00654 (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.004) (0.005
	50th Coeff. (S.E.)	0.2085 0.2085 0.0009 0.0009 0.0009 0.0000 0.000113 0.00113 0.00113 0.00113 0.00113 0.00113 0.00113 0.0013 0.00125 0.0027 0.0027 0.0027 0.0027 0.0023 0.0027 0.0023 0.0027 0.0023 0.0027 0.0023 0.0027 0.0023 0.0022 0.0023 0.0023 0.0022 0.0023 0.0022 0.0023 0.0022 0.0023 0.0022 0.0023 0.0023 0.0023 0.0023 0.0022 0.0023 0.0023 0.0022 0.0023 0.0023 0.0022 0.0023 0.002
Т+8Q	10th Coeff. (S.E.)	0.0021 0.0021 0.0056 0.0011 0.0002 0.0002 0.00131 0.0168* 0.00131 0.0168* 0.00131 0.0168* 0.00131 0.0168* 0.00131 0.0118 0.00131 0.0112 0.00131 0.0112 0.00131 0.0112 0.00131 0.0112 0.0026 0.0027 0.0026 0.0027 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007 0.007
	5th Coeff. (S.E.)	0.0135 0.0135 0.072) 0.072) 0.021) 0.0235 0.0235 0.0004 0.0001 0.0047 0.0015 0.0125 0.0010 0.0126 0.0011 0.0013 0.0126 0.0011 0.0013 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0023 0.0012 0.0023 0.0012 0.0012 0.0012 0.0012 0.0012 0.0023 0.0012 0.00012 0.0002 0.0012 0.00012 0.00012 0.00012 0.0002 0.0002 0.00012 0.0002 0
	50th Coeff. (S.E.)	0.2691** 0.2691** 0.0229 0.0352* 0.0352* 0.0352* 0.0001** 0.0001** 0.0003 0.0047 0.0003 0.0047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.00047 0.0005 0.0
T+4Q	10th Coeff. (S.E.)	0.2218*** 0.2218*** 0.0.046) 0.0.046) 0.0.000 0.0.000 0.0000 0.0007 0.01152** 0.0012 0.0012 0.0012 0.0012 0.0012 0.0012 0.0013 0.0014 0.0013 0.0014 0.0015 0.0005
	5th Coeff. (S.E.)	0.1558* 0.1558* 0.0001 0.0001 0.0001 0.0001 0.0001 0.00134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.01134 0.00131 0.00131 0.00131 0.0022 0.00162 0.00017 0.00233 0.00067 0.0017 0.0017 0.0017 0.00162 0.00064 0.00162 0.0007 0.00064 0.0007 0.00064 0.0007 0.00064 0.0007 0.00064 0.0007 0.0
precast growth over horizon :-		with anditions DP Gap anditions X Small Country D.V. t - Country B t - Country B t - Country B t - Country E t - Country E t - Country E t - Country H t - Country N t - Country C t - C
Anualised fc	Percentile	Current Grc Financial Cc Credit to Gl Financial Cc Fixed Effect Fixed Effect

Table 5. Forward Looking GDP Growth At Risk

Model : Quantile Regession with country level dummy variables. This table reports results of Structural Variables interacted with Financial Conditions

Anualised forecast growth over horizon :- Fit Percentile Coe (S.F Small Economy -0.02	-	λ++			۲ <u>0</u> +1			ן + ד∠U				DoT+
Percentile 5tt Coe (S.f. Small Economy -0.07			+									
Coe (S.F Small Economy -0.02	5th	10th	50th	5th	10th	50th	5th	10th	50th	5t	ے	h 10th
Small Economy0.07	Coeff. C (S.E.) (	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff (S.E.)		. Coeff. (S.E.)
	0.0727 -0.0	0906**	-0.0156	-0.0977**	-0.0612**	-0.0199	-0.0227	-0.0285	0.0018	-0.001	10 -	5 -0.0094 0.015)
Trade Openness	0.1096** -0 0.1096** -0	0.0766	0.0287	-0.0648*	-0.0228	0.0084	-0.0226	-0.0025	0.0294**	0.0087		0.0067
Financial Openness - I (De Facto) -0.00	0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-	0.0128	0.0212	0.0327	0.0167	0.0013	0.0190	0.0247	0.0143	0.0148		0.0138
Financial Openness - II (De Jure)	0.0303 0.0	0203**	-0.0146	0.0373	0.0218	-0.0124	0.0173	0.0132	-0.0119	-0.0169		-0.0123
FDI Dependent	0.0616 0.0616 0.0700	.0046 C	(0.0463***	0.0157	0.0231	0.0460***	0.0196	0.0285**	0.0773***	0.0420*	*	* 0.0283**
Bank Concentration I - (3 bank share of total assets) -0.0 -0.01	0.0156 -0	(0671 10671	0.170.0	-0.0645*	-0.0386	-0.0181	-0.0153	-0.0105	0.0002	0600.0- 1410.0/		(5100) -0.0076
Bank Concentration II - (Loan exposures by market sector) - 0.05	0.0913 -0.	.0830*	0.0217	-0.0194	-0.0263	0.0181	-0.0024	-0.0016	0.0387*	0.0237**		0.0092
Bank Concentration III - (Real Estate) (0.06 (0.06	(0.085) (0.085) (0.0000) (0.00	.0962* .050)	(210.0) 0.0017 (0.017)	-0.0461 -0.0461 (0.056)	(0.026) -0.0453* (0.026)	-0.0057 -0.0057 (0.016)	-0.0090 -0.0090 (0.028)	-0.0192 -0.022) -0.022)	0.0012 0.0012 (0.015)	0.0071 0.0071 (0.015)		(0.010) (0.0110)
Small and Trade Open	0.0622 -0	0710	0.0170	-0.0344	-0.0247	0.0048	0.0025	0.0053	0.0234	0.0148		0.0092
Small and Financially Open I (De Facto)	0.0096 -0	0.0593	0.0211	-0.0183	-0.0215	0.0054	0.0060	0.0124	0.0235	0.0250		0.0096
Small and Financially Open II (De Jure)	0-00099	0177	-0.0331	-0.0218	-0.0544	-0.0263*	-0.0730**	-0.0611**	-0.0420**	-0.0615**		-0.0508**
Small and FDI Dependent	0.0096 -0	0.0163 (	0.0311**	0.0112	0.0037	0.0261	0.0136	0.0217	0.0580***	0.0469		0.0172
Small and Banking Concentration I (3 bank share of total assets)	0.0727 -0.	0912**	-0.0225	-0.1034**	-0.0685*	-0.0280*	-0.0305**	-0.0314**	-0.0138	0.0042		-0.0076
Small and Concentrated Banking System II (Loan exposures by market sector) -0.10 0.01	0.1069 -0.	1112**	0.0072	-0.0443	-0.0592*	0.0115	-0.0484	-0.0230	0.0286	0.0102		-0.0012
Small and Concentrated Banking System III (Real Estate) -0.14 0.07	0.1497** -0.	1219**	-0.0020	-0.0827	-0.0635*	-0.0218	-0.0601**	-0.0493**	-0.0040	-0.0015		-0.0103
FDI Dependent and Concentrated Banking System I (3 bank share of total assets) -0.0.	0.0768 -0	0.0567	0.0197	-0.0020	-0.0107	0.0186	0.0102	0.0199	0.0536***	0.0315		0.0157
FDI Dependent and Concentrated Banking System II (Loan exposures by market sector) -0.05	0.0913 0	0.040)	0.0217	-0.0194	-0.0263	0.0181	-0.0024	-0.0016	0.0387**	0.0237**		0.0092
FDI Dependent and Concentrated Banking System III (Real Estate) -0.03 -0.03 (0.03)	(0.0072) (C 0.072) (0	0/3) 0830 059)	(0.0217* 0.0217* (0.012)	(0.035) -0.0194 (0.035)	(0.028) -0.0263 (0.028)	(c10.0) 0.0181 (0.016)	-0.0024 -0.0024 (0.013)	-0.0016 -0.0016 (0.020)	0.0387* 0.022)	0.0237 0.0237 (0.016)		(400.0) (2000) (0.0092

This table shows the relationship between average GDP growth, annualised over the forward h quarters (i.e. between "t" and "t+h" for h=4.8.12 and 16) and structural variables interacted with coincident financial conditions. In the upper panel the protect coefficients related to a single structural dummy variable. The latter are set to 1 if a country exhibits the structural variables in the lower panel are interacted variables. We examine the effect of variables and their interactions at the 5th, 10th and median percentiles of tuture GDP growth. Standard errors are listed below coefficients task structured variables. We examine the effect of variables and their interactions at the 5th, 10th and median percentiles of tutue GDP growth. Standard errors are listed below coefficients with statistical significance denoted by "", "", and " at the 15, 5% and 10% level.

At Risk
Growth
GDP
Looking
Forward
Table 6.

Model : Quantile Regession with country level fixed effects. This table reports results of S Dep. Variable: ForwardDP GaR (h quarter ahead annualised growth rate)	structural Varial	oles interacted v	vith Systemic Ris	ik Observ	ations	643 - 720						
Anualised forecast growth over horizon :-		T+4Q			T+8Q			T+12Q			T+16Q	
Percentile	5th	10th	50th	5th	10th	50th	5th	10th	50th	5th	10th	50th
	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)	Coeff. (S.E.)
Small Economy	-0.0001	-0.0001	-0.0003***	-0.0006***	-0.0004	-0.0003***	-0.0005***	-0.0004**	-0.0001	-0.0003**	-0.0003**	0.0000
Trade Openness	-0.0013***	-0.0005*	-0.0004***	-0.0005 **	-0.0005**	-0.0004***	0.0003*	-0.0003*	-0.0004**	-0.0003***	0.0002	-0.0004 ***
Financial Openness - I (De Facto)	0.0005	0.0003	-0.0002*	0.0002	0.0003	00000	0.0002	0.0001	0.0002	0.0001	0.0003**	0.0005***
Financial Openness - II (De Jure)	(10.001) 0.0012***	0.0005*	0.0003***	0.0007***	0.0006 ***	0.0003***	0.0006***	0.0005***	0.0002	0.0000	0.0005***	0.0003*
FDI Dependent	(0000) •00000-	(0.000) -0.0004	(0.000) -0.0001	(0.000) -0.0005**	(0.000) -0.0005**	(0.000) -0.0002	(0.000) -0.0003**	(0.000) -0.0003*	(0.000) -0.0002	(0.000) -0.0002*	(0.000) -0.0001	(0.000) -0.0002
Bank Concentration I - (3 bank share of total assets)	-0.0010*	(0.000) -0.0005	(0.000) -0.0005***	(0.000) -0.0004***	(0.000) -0.0004	-0.0005***	(0.000) -0.0003**	(0.000) -0.0004 ***	(0.000) -0.0004**	-0.0003***	(0.000) -0.0003**	-0.0005 ***
Bank Concentration II - (Loan exposures by market sector)	(100.0) -0.0012***	0.0006	-0.0005***	(00000- ***60000-	(00000) ***	-0.0007***	-0.0008***	-0.0006***	-0.0007***	(00000- ***\$9000.0-	-0.0005***	-0.0007***
Bank Concentration III - (Real Estate)	(0.004) -0.0004 (0.001)	-0.0004 -0.0004 (0.000)	-0.0004*** -0.0004*** (0.000)	-0.0005 -0.0005 (0.000)	-0.0005** -0.0005**	-0.0004*** -0.0004*** (0.000)	(000.0) -0.0006***	-0.0005 **** -0.0005 ****	(0.000) -0.0003**	-0.0004*** -0.0004	-0.0004*** -0.0004***	(0.0003* -0.0003*
Small and Trade Open	-0.0004	-0.0001	-0.0003***	-0.0005	-0.0003	-0.0003**	-0.0003**	-0.0002	-0.0001	-0.0003**	-0.0002	0.0001
Small and Financially Open I (De Facto)	-0.0004	000000	-0.0003***	0.0004	-0.0003	-0.0003**	00003*	-0.0002	-0.0001	-0.0003**	0.0002	0.0001
Small and Financially Open II (De Jure)	0.0018***	0.0013***	0.0003**	0.0011***	0.0008***	0.0005***	0.0005***	0.0004	0.0005**	0.0005**	0.0005	0.0006
Small and FDI Dependent	(TOO'O')	0.0004	00003	(00000) ***60000-	(00000) **90000-	-0.0004***	(00000) ***	-0.0004***	-0.0003*	-0.0003***	-0.0003**	-0.0003*
Small and Banking Concentration I (3 bank share of total assets)	-0.0002	0.0002	-0.0004***	(00000) ***	-0.0004*	-0.0003**	(00000) ***	-0.0004***	-0.0002	-0.0003***	-0.0004***	-0.0002
Small and Concentrated Banking System II (Loan exposures by market sector)	(100.0) -0.0010	-0.0005	-0.0005***	(00000- ***	-0.0008***	-0.0006**	(00007***	(00000) ***	(00000- ***	(000.0) ***9000.0-	-0.0004 ***	-0.0006***
Small and Concentrated Banking System III (Real Estate)	0.004	0.0004	-0.0004***	-0.0005*	-0.0005	-0.0003***	*** 90000-	-0.0004***	-0.0002	-0.0004***	-0.0004***	0.0001
FDI Dependent and Concentrated Banking System I (3 bank share of total assets)	-0.0013***	-0.0006	-0.0004***	0.000.0	(00000) ***	-0.0004***	-0.0005***	-0.0004**	(00000- ***	-0.0003**	0.0003*	-0.0006
FDI Dependent and Concentrated Banking System II (Loan exposures by market sector)	-0.0012*	(00000; •00000;	-0.0005***	(000.0) ****	(000.0) **** 60000-	-0.0007***	-0.0008***	-0.0006 ***	(00000	(000.0) ****9000.0-	-0.0005***	(00000) ***
FDI Dependent and Concentrated Banking System III (Real Estate)	(0.001) -0.0012* (0.001)	(0.000) -0.0006 (0.000)	-0.0005*** -0.0005***	(000.0) ****(000.0-	(000.0) -0.0009**** (000.0)	-0.0007*** -0.0007***	(0,000) -0.0008*** (0,000)	(000.0) **** 00000- (000.0)	-0.0007*** -0.0007***	(00000) ****00000- (00000)	-0.0005*** -0.0005***	-0.0007*** -0.0007***

This table shows the relationship between average GDP growth, annualised over the forward h quarters (i.e. between "t" and "t+h" for h=4,8,12 and 16) and structural variables interacted with cyclical systemic risk. In the upper panel the reported coefficients with set between a dummy variable. The latter are set to 11 is contry exhibits the structural characteristic in question or 0 otherwise. In the lower panel are interaction terms for 10 min variables suffined above. The structural variables rule area in the reported above. The structural variables rule area interaction set to 11 is contry exhibits the structural characteristic in question or 0 otherwise. In the lower panel are interaction terms for joint combinations of the dummy variables outlined above. The structural variables rule area interactions at the 13, 5% and 10% level.

Table 7. Crisis Probability	y and Dummy ۱	Variable-based Macro	o-financial Structural	Variables

Crisis Probability and	I Dummy Variable	-Based Struct	tural Variable	5	
	Coefficient	S.E.	t-Stat	P >z	Obs.
Small Economy	-0.0088	0.008	-1.11	0.268	1,185
Trade Openness	-0.0160 **	0.008	-2.00	0.046	1,185
Financial Openness - I (De Facto)	-0.0149 *	0.009	-1.77	0.077	1,185
Financial Openness - II (De Jure)	0.0224 ***	0.008	2.82	0.005	1,185
FDI Dependent	0.0197 **	0.007	2.45	0.014	1,185
Bank Concentration I - (3 bank share of total assets)	-0.0021	0.008	-0.26	0.797	1,185
Bank Concentration II - (Loan exposures by market sector)	0.0099	0.010	1.15	0.251	1,185
Bank Concentration III - (Real Estate)	-0.0048	0.009	-0.57	0.568	1,185
Small and Trade Open	-0.0309 ***	0.009	-3.89	0.000	1,185
Small and Financially Open I (De Facto)	-0.0295 ***	0.008	-3.69	0.000	1,185
Small and Financially Open II (De Jure)	0.0165 *	0.010	1.73	0.084	1,185
Small and FDI Dependent	-0.0170 **	0.008	-2.10	0.036	1,185
Small and Banking Concentration I (3 bank share of total assets)	0.0038	0.008	0.47	0.637	1,185
Small and Concentrated Banking System II (Loan exposures by market sector)	0.0129	0.009	1.41	0.160	1,185
Small and Concentrated Banking System III (Real Estate)	-0.0037	0.009	-0.41	0.679	1,185
FDI Dependent and Concentrated Banking System I (3 bank share of total assets)	0.0049	0.008	0.61	0.544	1,185
FDI Dependent and Concentrated Banking System II (Loan exposures by market sector)	0.0010	0.009	1.15	0.251	1,185
FDI Dependent and Concentrated Banking System III (Real Estate)	0.0010	0.009	1.15	0.251	1,185

#### Crisis Probability and Dummy Variable-Based Structural Variables

This table shows the relationship between systemic banking crisis probabilities of OECD countries and those which share certain macro-financial structural characteristics. Crisis probabilities relate to the likelihood of a crisis emerging within the coming 8 quarters, estimated via a multivariate pooled logit model. The fitted probabilities are then regressed against dummy variables characterising the structure of interest as defined in the paper. Recorded crisis data comes from the ECB's MPPG / AWG crisis dataset, augmented by Laeven and Valencia (2012) for non-EU countries. Statistical significance at the 10%, 5% and 1% levels are denoted by \*, \*\* and \*\*\* respectively.

Crisis Probabili	ty and Continuou	s Structural V	ariables		
	Coefficient	S.E.	t-Stat	P >z	Obs.
Small Economy	-0.0023 ***	0.007	-3.05	0.002	1,185
Trade Openness	-0.0015 ***	0.000	-5.19	0.000	1,145
Financial Openness - I (De Facto)	-0.0002 ***	0.000	-10.59	0.000	1,106
Financial Openness - II (De Jure)	0.1030 **	0.048	2.13	0.033	854
FDI Dependent	-0.0002 ***	0.000	-6.04	0.000	757
Bank Concentration I - (3 bank share of total assets)	0.0002	0.000	1.14	0.256	1,130
Bank Concentration II - (Loan exposures by market sector)	0.0000 *	0.000	1.69	0.091	654
Bank Concentration III - (Real Estate)	-0.0001	0.001	-0.21	0.832	696
Small and Trade Open	-0.0523 *	0.032	-1.65	0.099	1,185
Small and Financially Open I (De Facto)	-0.0002	0.001	-0.29	0.773	1,106
Small and Financially Open II (De Jure)	-0.0043 ***	0.001	-3.68	0.000	854
Small and FDI Dependent	0.0000	0.000	0.24	0.807	757
Small and Banking Concentration I (3 bank share of total assets)	-0.0001 **	0.000	-2.05	0.040	1,130
Small and Concentrated Banking System II (Loan exposures by market sector)	-0.0003 *	0.0002	-1.69	0.092	654
Small and Concentrated Banking System III (Real Estate)	-0.0001	0.000	-1.50	0.134	696
FDI Dependent and Concentrated Banking System I (3 bank share of total assets)	0.0049	0.008	0.63	0.531	1185
FDI Dependent and Concentrated Banking System II (Loan exposures by market sector)	-0.0000	0.000	-0.86	0.39	492
FDI Dependent and Concentrated Banking System III (Real Estate)	-0.0000 ***	0.000	-3.71	0.000	516

This table shows the relationship between systemic banking crisis probabilities of OECD countries and those which share certain macro-financial structural characteristics. Crisis probabilities relate to the likelihood of a crisis emerging within the coming 8 quarters, estimated via a multivariate pooled logit model. The fitted probabilities are then regressed against dummy variables characterising the structure of interest as defined in the paper. Recorded crisis data comes from the ECB's MPPG / AWG crisis dataset, augmented by Laeven and Valencia (2012) for non-EU countries. Statistical significance at the 10%, 5% and 1% levels are denoted by \*, \*\* and \*\*\* respectively.

	Coefficient	S.E.	t-Stat	P >z	Obs.
Small Economy	0.0492 ***	0.009	5.6	0.000	340
Trade Openness	0.0555 ***	0.009	6.4	0.000	340
Financial Openness - I (De Facto)	-0.0138	0.010	-1.37	0.170	340
Financial Openness - II (De Jure)	0.0124	0.001	1.25	0.211	325
FDI Dependent	0.0409 ***	0.009	4.61	0.000	340
Bank Concentration I - (3 bank share of total assets)	0.0201 **	0.009	2.17	0.031	345
Bank Concentration II - (Loan exposures by market sector)	0.0562 ***	0.010	5.43	0.000	340
Bank Concentration III - (Real Estate)	0.0365 ***	0.010	3.71	0.000	340
Small and Trade Open	0.0402 ***	0.009	4.45	0.000	340
Small and Financially Open I (De Facto)	0.051 **	0.180	2.44	0.015	340
Small and Financially Open II (De Jure)	0.0489 ***	0.011	4.45	0.000	325
Small and FDI Dependent	0.0538 ***	0.009	5.89	0.000	340
Small and Banking Concentration I (3 bank share of total assets)	0.0298 ***	0.009	3.25	0.001	340
Small and Concentrated Banking System II (Loan exposures by market sector)	0.0832 ***	0.011	7.46	0.000	340
Small and Concentrated Banking System III (Real Estate)	0.0529 ***	0.010	5.08	0.000	340
FDI Dependent and Concentrated Banking System I (3 bank share of total assets)	0.0530 ***	0.011	4.92	0.000	257
FDI Dependent and Concentrated Banking System II (Loan exposures by market sector)	0.0562 ***	0.010	5.43	0.000	340
FDI Dependent and Concentrated Banking System III (Real Estate)	0.0654 ***	0.012	5.62	0.000	257

#### Proportionate GDP Loss % and Dummy Variable-Based Structural Variables

This table shows the contribution towards systemic banking crisis cost associated with macro-financial structures of interest. All models are pooled regressions with robust standard errors, due to the limited number of quarters in the panel where crises are recorded as being "underway". In all regressions we include a constant term and control for financial conditions as per the financial stability index, in keeping with the GDP growth-at-risk analysis control variable as used by Adrian et al. (2019). Recorded crisis data comes from the ECB's crisis dataset (see Lo Duca et al. (2017)), augmented by Laeven and Valencia (2013) for non-EU countries. The dependent variable is the proportionate reduction of GDP in percentage points per annum lost as a result of a systemic banking crisis, measured relative to the pre-crisis GDP trajectory. Dummy variables are defined as per the Data and Approach section. For example a country is designated as small if its average contribution to world GDP places it in the lower half of our sample based on a ranking of countries according to this sample average. Statistical significance at the 10%, 5% and 1% levels are denoted by \*, \*\* and \*\*\* respectively.

Table 10. Cr	risis Cost and	Continuous	Structural	Variables
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Proportionate GDP Loss % and Continuous Structural Variables							
	Coefficient	S.E.	t-Stat	P >z	Obs.		
Small Economy - (GDP world share)	-0.0050 ***	0.001	-6.25	0.000	340		
Trade Openness	0.0010 ***	0.000	8.98	0.000	340		
Financial Openness - I (De Facto)	0.0010 ***	0.000	10.56	0.000	340		
Financial Openness - II (De Jure)	0.136 **	0.064	2.12	0.035	325		
FDI Dependent	0.0012 ***	0.000	11.84	0.000	253		
Bank Concentration I - (3 bank share of total assets)	-0.001 *	0.000	-1.91	0.057	340		
Bank Concentration II - (Loan exposures by market sector)	.0001 ***	0.000	4.32	0.000	212		
Bank Concentration III - (Real Estate)	0.0025 ***	0.001	3.50	0.001	232		
Small and Trade Open	-0.0001 ***	0.000	-6.53	0.000	340		
Small and Financially Open I (De Facto)	-0.0004	0.001	-0.83	0.406	340		
Small and Financially Open II (De Jure)	-0.0062 ***	0.001	-6.10	0.000	325		
Small and FDI Dependent	-0.000 ***	0.000	-6.13	0.000	253		
Small and Banking Concentration I (3 bank share of total assets)	-0.0002 ***	0.000	-6.99	0.000	340		
Small and Concentrated Banking System II (Loan exposures by market sector)	-0.0000 ***	0.000	-4.65	0.000	212		
Small and Concentrated Banking System III (Real Estate)	-0.0004 ***	0.000	-6.09	0.000	232		
FDI Dependent and Concentrated Banking System I (3 bank share of total assets)	0.0000 ***	0.0000	9.39	0.000	253		
FDI Dependent and Concentrated Banking System II (Loan exposures by market sector)	0.0000 ***	0.000	10.50	0.000	167		
FDI Dependent and Concentrated Banking System III (Real Estate)	0.0000 ***	0.000	14.45	0.000	171		

This table shows the contribution towards systemic banking crisis cost associated with macro-financial structures of interest. All models are pooled regressions with robust standard errors, due to the limited number of quarters in the panel where crises are recorded as being "underway". In all regressions we include a constant term and control for financial conditions as per the financial stability index, in keeping with the GDP growth-at-risk analysis control variable as used by Adrian et al. (2019). Recorded crisis data comes from the ECB's crisis dataset (see Lo Duca et al. (2017)), augmented by Laeven and Valencia (2013) for non-EU countries. The dependent variable is the proportionate reduction of GDP in percentage points per annum lost as a result of a systemic banking crisis, measured relative to the pre-crisis GDP trajectory. For example, row 1 shows that as a country's contribution to world GDP share increases (i.e. marginally increases) its crisis likelihood reduces. Statistical significance at the 10%, 5% and 1% levels are denoted by \*, \*\* and \*\*\* respectively.

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