A GPS NAVIGATOR TO MONITOR RISKS IN EMERGING ECONOMIES: THE VULNERABILITY DASHBOARD

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A GPS NAVIGATOR TO MONITOR RISKS IN EMERGING ECONOMIES: THE VULNERABILITY DASHBOARD (*)

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Abstract

This paper presents a simple, transparent and model-free framework for monitoring the build-up of vulnerabilities in emerging economies that may affect financial stability in Spain through financial, foreign direct investment or trade linkages, or via global turbulences. The vulnerability dashboards proposed are based on risk percentiles for a set of 34 key indicators according to their historical and cross-section frequency distributions. The framework covers financial market variables, macroeconomic fundamentals –which are grouped into real, fiscal, banking and external variables– and institutional quality and political indicators. This methodology is a valuable complement to other existing tools such as the Basel credit-to-GDP gap and vulnerability indices.

Keywords: emerging economies, crisis, vulnerabilities, heat maps, risks.

JEL classification: F01, F34, G01, G32.

Resumen

Este documento ocasional presenta un marco sencillo, transparente e independiente de modelos para supervisar la acumulación de vulnerabilidades en las economías emergentes que puedan llegar a afectar a la estabilidad financiera de España, a través de vínculos —bien financieros, bien de inversión extranjera directa o comerciales— o por ser capaces de generar turbulencias globales. Los paneles de vulnerabilidad propuestos se elaboran a partir del percentil de riesgo de las distribuciones de frecuencias histórica y de sección cruzada en el que se sitúan un conjunto de 34 indicadores, que incluyen variables de mercados financieros, fundamentos macroeconómicos —que se agrupan en variables reales, fiscales, bancarias y externas— e indicadores de calidad institucional y tensiones políticas. Estos paneles de vulnerabilidad, presentados en forma de mapas de calor, pueden ser una herramienta complementaria a otras utilizadas habitualmente, como la brecha crédito-PIB de Basilea y los índices sintéticos de vulnerabilidad.

Palabras clave: economías emergentes, crisis, vulnerabilidades, mapas de calor, riesgos.

Códigos JEL: F01, F34, G01,G32.

Contents

1 Introduction

To what extent is a country, and in particular its banking sector, exposed to turbulence in emerging market economies (EMEs)? This is a key question for policymakers that attempt to mitigate the effects of contagion risks through prudential and other macro financial measures such as banks' capital buffers, the increase in the level of reserves or any other measure to deal with a relevant EME crisis.[1]

To answer this question for Spain, we set out to first identify the relevant countries and, second, the main risks stemming from them. To this end, this Occasional Paper considers a broad concept of financial risk which accounts not only for the usual EME banking sector stance but also for currency and sovereign crises impacting financial stability through transmission channels involving Spanish financial institutions and Spanish firms located in EMEs. In addition, we examine a large number of EMEs. The EMEs considered "material" countries in this study are identified as such based on criteria put forward by the European Systemic Risk Board (ESRB) [2], as well as on the relevance of economic trade and financial ties with Spain, along with systemic EMEs, whose turbulences can have global effects owing to their size or weight in certain markets.

The paper presents a simple, transparent and model-free framework for monitoring vulnerabilities arising in the external environment, which can be employed for policy and policy evaluation purposes. The vulnerability dashboards proposed are based on risk percentiles for each indicator of each country, using variables that have a higher frequency and longer time series. The framework covers financial market variables, macroeconomic fundamentals (grouped into real, fiscal, banking and external variables) and institutional quality and political indicators. The analysis in this paper should be complemented by more sophisticated models, such as the vulnerability indices developed for the same economies using a signalling approach and a logistic estimation (labelled SHERLOCs[3]), explained in detail in Alonso and Molina (2019). In other words, the vulnerability dashboards are flag-raising exercises that need to be pondered together with expert judgement and other analytical tools. The objective is not to predict crises, but to identify those countries that are more prone to undergoing a crisis. The existence of substantial vulnerabilities does not imply per se an imminent outbreak of a crisis.

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1 The current EU legislation on capital requirements for credit institutions foresees that national macroprudential authorities may impose a countercyclical capital buffer (CCyB) rate applicable to domestic banks for their credit exposures to a given material third country (i.e. a non-EU/EEA jurisdiction). The aim of such measure (not yet exercised as of early 2021) is to mitigate any cyclical systemic risk related to excessive credit growth that is deemed unaddressed by the local CCyB rate (set by the macroprudential authority of the third country).The operationalization of this use of the CCyB is set out in the Recommendation ESRB/2015/1 and the Decision ESRB/2015/3.

2 Specifically, as per the ESRB criteria, a country outside the EU shall be identified as material if the exposures of the banking system of a member country exceed 1% of the total exposures in at least one of the following three categories: i) original exposures; ii) risk-weighted exposures; and iii) exposures in default. In particular, it is required that this threshold be exceeded in each of the last two quarters of the previous year and in the average of the last eight quarters up to the reference date defined as December of the year immediately prior to the identification exercise. In 2020, Banco de España identified seven third countries as material for the Spanish banking system, namely, the United States, Mexico, Brazil, Turkey, Chile, Peru and Colombia. (https://www.bde.es/bde/en/areas/estabilidad/politica-macropr/Fijacion_del_po_abd79f06544b261.html).

3 SHERLOC stands for Signalling Heightened Emerging Risks that Lead to the Occurrence of Crises.

The methodology provided has some interesting features, especially for policy purposes. First, we propose a complementary approach by combining a cross-section and a time series analysis. While the former assesses the countries with impaired fundamentals – in comparison with their peers – that could be more affected in periods of heightened global financial stress, the latter points to the possibility of a crisis stemming mainly from idiosyncratic factors, giving rise to more nuanced conclusions. Second, the analysis is flexible since it combines indicators that signal risk (as they are situated in the high-risk tail) with those that mitigate risk (well below the median risk), presenting a "net risk framework" and leaving room for the analyst's judgement. Third, we use a model-free approach for the sake of transparency and simplicity, and we opt to show all the indicators considered without aggregating them in order to avoid hiding some "key" indicators. Finally, we use a broad framework, since it aims to include all the indicators that might detect in advance any type of crisis and not only those closely related to banking sector performance. For this purpose, we use the quarterly dataset of sovereign, currency and banking crises, previously constructed in Alonso and Molina (2019).

The rest of the paper is structured as follows. The next section provides a brief review of the literature on heatmaps developed by major institutions. Section 3 presents the main features of the dataset used in the proposed heatmaps, while section 4 explains how we process the data to build vulnerability dashboards. Finally, section 5 focuses on specific EME turbulence episodes to assess how the dashboards would have worked in the face of some well-known periods of turbulence, and section 6 concludes.

2 Heatmaps used in other institutions

Heatmaps are a graphical representation of data where values are depicted by colour. They facilitate the understanding of complex data. In the context of identifying risks, heatmaps provide a clear image of the situation and developments over a wide range of indicators that tend to be associated with the outbreak of crises. Usually, darker colours are associated with higher risks and lighter colours with lower or no risks.

Dashboards have been broadly used to monitor risks. For instance, and without being exhaustive, the ESRB uses a large set of quantitative and qualitative indicators to monitor the accumulation of imbalances in the EU banking system.[4] The OECD has also developed a set of more than seventy indicators to detect country risks in its members, considering imbalances stemming from the financial, non-financial, public and external sectors and from asset market disequilibria and international spillovers (see Rohn et al (2015)). The IMF follows a broad set of indicators of macrofinancial imbalances and estimates an aggregate measure of financial stability risks to support its systematic approach to multilateral surveillance (see Adrian et al (2019)). The World Bank discusses how linkages between the real and financial sectors can lead to a build-up of overborrowing or some types of balance sheet disequilibria for key entities—corporates, financial institutions, households, and the public sector- and how, once such imbalances have accumulated, they can make the economy more vulnerable to macroeconomic shocks (see Ghosh (2016)). Finally, the BIS has also developed a framework for Global Risk Surveillance for both advanced and emerging economies. It takes into consideration financial vulnerabilities at both the global and country level, including global liquidity indicators. In the case of Spain, the Banco de España has developed an analytical framework for macroprudential policy, including a broad set of indicators that enables systemic risks monitoring in order to inform the Banco de España's macroprudential stance (see Mencía and Saurina (2016)).

Heatmaps mainly differ depending on the indicators selected, the identification of the risk thresholds and the aggregation method. With regard to the indicators, their selection depends on the ultimate goal of the dashboard, which is usually related to the monitoring of financial stability risks and vulnerabilities. This is the case, for example, of the ESRB dashboard, which takes into consideration macro, credit, liquidity, market and structural risks, along with the profitability and solvency of banking and insurance groups to address financial risks. The BIS follows a similar stance in respect of the financial sector but focuses on fewer indicators and distinguishes between domestic and international conditions. The IMF focuses on macrofinancial imbalances across different types of lenders and borrowers, which involves assessing asset valuations, leverage and liquidity mismatches of financial intermediaries and the credit of borrowers. The IMF's vulnerability matrix is complemented by an aggregate measure of financial stability risks, using a growth-at-risk approach. The World Bank has also developed a global surveillance framework of macro-financial risks,

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4   See *ESRB risk dashboard*, various issues.

complementary to the country-specific surveillance framework. The analysis covers a large number of indicators, grouped into nine areas: spillover, macro, bank, public sector, corporate sector, households, funding and liquidity risks, monetary and financial conditions and risk appetite. Other institutions take a broader approach and consider the risks arising from sovereign, banking and currency crises. This is the case of the OECD. An interesting feature of this early warning system is that contagion risks arising from other countries are also taken into consideration since risks could pass through from one country to another via trade, financial and confidence channels.

In this paper, we follow a similar approach to that of the OECD and monitor 34 indicators that the literature on early warning signals (EWS) has shown to be leading indicators of crises. We consider three types of crisis: sovereign defaults, currency crashes and banking sector stress. The selection of indicators is based on the extensive literature on EWS, which determine the variables that can anticipate a crisis in advance. Since the seminal work of Kaminsky, Lizondo and Reinhart (1998), the literature has focused firstly on the estimation of EWS for emerging markets[5]. In the wake of the Global Financial Crisis, the EWS literature regained vigour and focused on developed countries[6] and on the financial sector[7], mainly with a financial stability objective.[8] We build on these papers and select the leading indicators to be included in the dashboard.

Another key issue is how to determine the thresholds above which an indicator issues a signal. Different methodologies have been developed, but most heatmaps use thresholds either based on some evaluation techniques, such as reducing the noise-to-signal ratio, or ad hoc thresholds, based on the literature. The use of ad hoc thresholds can be problematic since it involves imposing the same threshold on all the countries without taking into consideration the idiosyncratic features of each economy. This is even worse in the case of emerging economies, where the reference values or threholds could evolve over time due to the convergence process. Another widespread alternative is to identify the risks depending on the percentile position of each indicator in the selected distribution. This is the practice of the IMF and the BIS which uses deciles instead of percentiles. The higher the percentile, the higher the risk.

This is the alternative that we follow. The main difference relies on the distribution used. While most dashboards use pooled data (including all the countries together) distinguishing between advanced or emerging economies (for instance the BIS and the IMF), we opt to elaborate heatmaps using both cross-section and time series distributions separately in order to have a broad flag-raising exercise. This has several advantages. First, the use of these two complementary approaches, which is a novelty in this kind of analysis, enables us both to assess which countries could be more vulnerable to a global financial

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5 See, among others, Bussiere and Fratzscher (2006) and Kamin et al (2007).

6 See, for example, Rose and Spiegel (2012),Catão and Milesi-Ferretti (2014) and Frankel and Saravelos (2012).

7 Oet et al (2013) and Dieter et al. (2010).

8 Castro et al. (2016).

turbulence and also to monitor the developments of domestic risks over time, which could lead to a sovereign default or to another type of crisis.[9] Second, it avoids the use of literature-based thresholds that are difficult to establish for the indicators monitored in emerging economies or the use of thresholds based on evaluation techniques which would provide different thresholds for each country, making it difficult to interpret the results. Finally, we avoid the use of pooled data due to the heterogeneity between countries in our sample.

Finally, the aggregation method also differs in terms of the dashboards proposed. A large portion of heatmaps aggregate indicators in different risk dimensions for the sake of conciseness. For instance, the World Bank ranks the variables used in the global surveillance framework of macro financial risks and then averages them in nine different areas of risks. The IMF also aggregates indicators by sector (non financial corporations, households and the external sector) using equal weighted averages. While this type of aggregation deals with the "curse of dimensionality", it also can mask the evolution of key indicators. What we do, in line with the BIS, is to show the developments of the 34 indicators chosen separately.

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9 With the cross-section approach we can infer whether investors withdraw their positions from the most vulnerable EMEs in comparison with their peers, as it was the case during the taper tantrum episode of May 2013. The time series dimension enables us to detect those countries which have larger deviations from their historical developments.

3 Data and methodology

3.1 Data

Our dataset includes 34 indicators for 27 emerging economies, which account for 78% of the GDP of non-advanced economies, and around 45% of world GDP. It comprises economies from Latin America, Eastern Europe, Asia, and Africa and the Middle East.[10] The selection of countries is determined by their relevance to the Spanish financial system. Either they are considered a "material" country by the Banco de España based on the ESRB's identification criteria, or they have strong trade and financial ties with Spain, or are systemic, like China. We use both national and international sources (IMF or EMEs' central banks) in order to be able to extend the dataset back to the first quarter of 1993 and focus on readily updatable data. This allows a frequent monitoring of the risks faced by the countries in the sample.
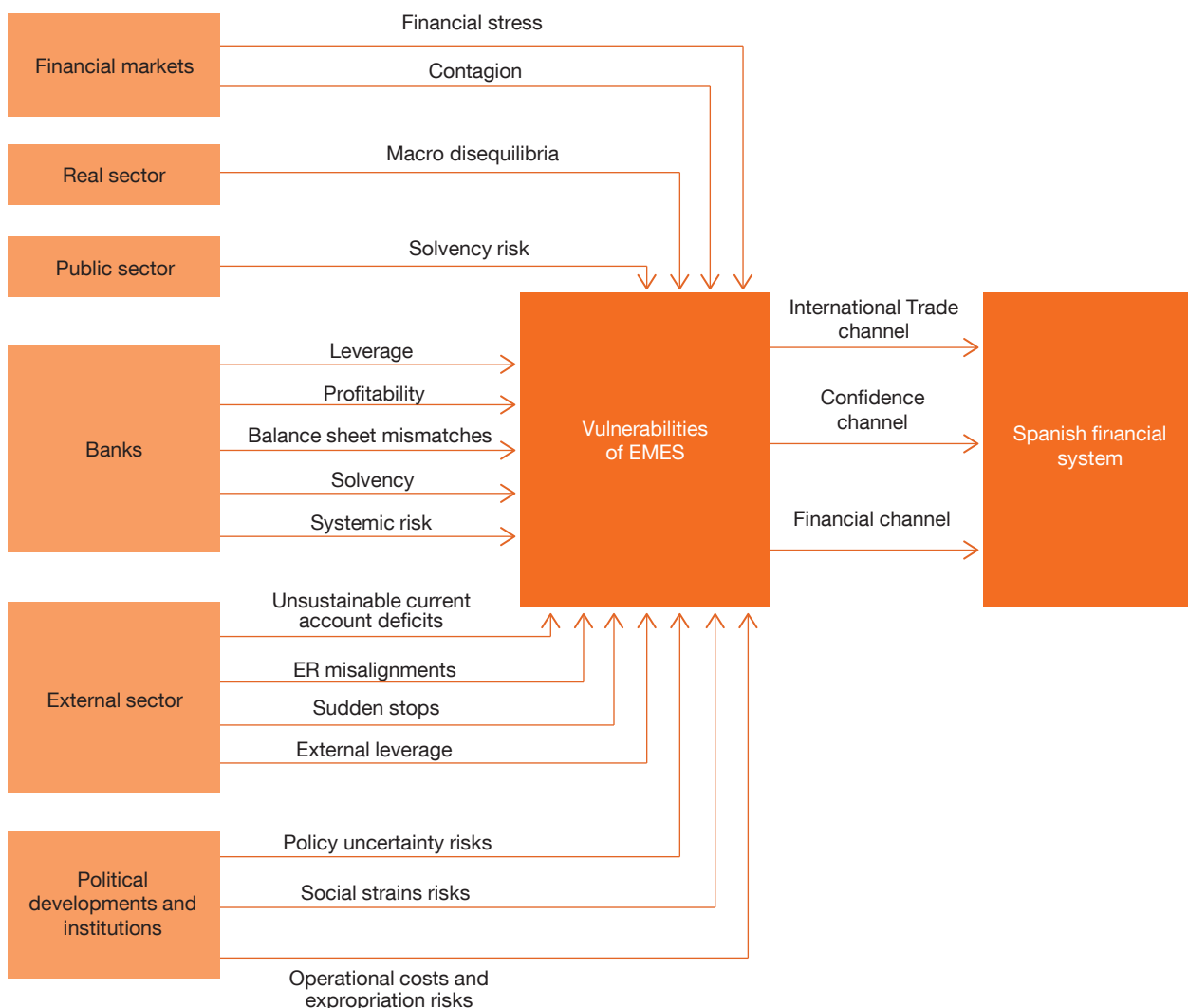
The indicators used can be classified into three groups, which mainly reflect the frequency of update and the different pace of reaction to an increase in risks: financial market variables (with a daily frequency and a quicker reaction to an increase in risks); macroeconomic fundamentals indicators (updated quarterly or monthly and with a more parsimonious reaction); and institutional quality and wealth variables, updated with a significant delay, and a longer ripening process and different transmission channels.

Figure 1 provides a stylised description of the potential imbalances covered. Financial markets can signal markets' perceptions of how the fundamentals of that economy are evolving. But they can also overreact and trigger a crisis, and could lead to contagion to other sectors within the country (for example, a deterioration of sovereign risks could lead to a withdraw of capital from foreign investors and a currency crash) or to other countries. Macroeconomic fundamentals represent the developments in an economy's fundamentals, which are grouped into real, fiscal, banking and external variables. The real sector provides us with information about imbalances stemming from a recession or overheating of the economy. The fiscal sector focuses more on fiscal policy uncertainty or sovereign solvency risk. The banking sector, which is monitored with a large number of variables to reflect the fact that banking crises have become more relevant in the 21st century, might reflect a high leverage of the sector, lack of profitability, balance sheet mismatches, solvency or systemic risks. The external sector offers information on unsustainable current account balances, sudden stops, capital flight or excessive leverage on foreign currency of domestic agents. Finally, the institutional and political area covers risks such as the lack of willingness to pay back debt, policy uncertainty, the expropriation risk, geopolitical risk, violence and social strain risk, as well as high operational costs. Vulnerabilities in each area are closely interconnected and interact and reinforce one another. For instance, a recession can lead to social distress, and an increase in non-performing loans. A worsening of the institutional

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10 Argentina, Brazil, Mexico, Chile, Colombia, Venezuela, Peru, Ecuador, Uruguay, China, South Korea, India, Indonesia, Thailand, the Czech Republic, Hungary, Poland, Romania, Russia, Turkey, Algeria, Morocco, Egypt, South Africa, Saudi Arabia, Tunisia and Nigeria. Korea and the Czech Republic are included in the sample for the sake of completeness, although according to the IMF classification both are advanced economies.

Figure 1

MAIN RISKS COVERED BY VULNERABILITY DASHBOARDS

Financial markets — Financial stress
Financial markets — Contagion
Real sector — Macro disequilibria
Public sector — Solvency risk

Banks — Leverage
Banks — Profitability
Banks — Balance sheet mismatches
Banks — Solvency
Banks — Systemic risk

External sector — Unsustainable current account deficits
External sector — ER misalignments
External sector — Sudden stops
External sector — External leverage

Political developments and institutions — Policy uncertainty risks
Political developments and institutions — Social strains risks
Political developments and institutions — Operational costs and expropriation risks

Vulnerabilities of EMES — International Trade channel — Spanish financial system
Vulnerabilities of EMES — Confidence channel — Spanish financial system
Vulnerabilities of EMES — Financial channel — Spanish financial system

SOURCE: Banco de España.

framework can deter foreign investment and lead to sudden stops or capital flights. Public sector solvency risks could affect banking sector profitability, and solvency if public sector owns a high proportion of domestic public debt.

3.2 Methodology

To construct the vulnerability heatmaps, we first calculate the frequency distributions for each variable both at the cross-country and time series level. In other words, we estimate a frequency distribution for the 27 different countries and 34 indicators at each moment of time, and a historical frequency distribution for each variable since the first quarter of 1993 for each country in the dataset. Those frequency distributions are then filtered from crisis

periods to proxy developments during calm times. If crisis periods were to be included, the frequency distributions would have fatter tails and result in upward bias of the thresholds that determine higher risks[11].

A key issue in early warning models is how to determine the relevant episodes of crises in the 27 emerging economies analysed in order to avoid misclassification issues and uncertainty. Stress episodes are also relevant in the construction of heatmaps since the historical frequency distribution used is cleared from crisis times[12]. The main idea is that indicators tend to have an erratic dynamic over crisis periods and need to be removed to avoid overestimating crisis thresholds. To do so, we use the quarterly dataset of Alonso and Molina (2019) of sovereign, banking and currency crises. In that paper, we mainly identify sovereign and banking crises following Laeven and Valencia (2008, 2012), but defining the beginning and the end on a quarterly basis instead of an annual frequency, and updating the dataset until the end of 2018. The beginning of a sovereign crisis is defined as the quarter in which the sovereign defaults, while the end is associated with the quarter in which an agreement with debtholders is reached or the date of debt exchange. Banking periods of stress are determined when there are significant signs of financial stress in the banking system and banking policy interventions. With regards to currency crises, we use a similar, though more restrictive, definition, namely that of Reinhart and Rogoff (2009), which is an annual depreciation against the US dollar or the relevant currency of 30% or more.

We then identify the degree of vulnerability of each indicator in each country depending on its position on the percentile scale of both frequency distributions (cross-section and time series). We assign a different colour to each percentile from dark red (for the riskiest tails, which represent more vulnerability) to dark green (for those involving very low risk), changing the colour hue every 5% (see Chart 1). This methodology combines indicators that measure risk (in red, orange and yellow) with those that present buffers that mitigate risks (in green), presenting a "net risk framework" that provides a better image of a country's mitigating capacity against potential shocks.

We are aware that some indicators could pose a two-tail risk problem, which means that both the left tail and the right tail of the frequency distribution may represent a risk of outbreak of a crisis. For example, a decrease in credit could generate a risk of a recession potentially leading to a sovereign default. But an excessive increase in credit could feed asset bubbles, potentially deriving in a banking crisis. In our sample, the two-tail risk problem may arise in the equity index, real credit growth and foreign portfolio inflows, but also in inflation and GDP growth (recession risks versus overheating of the economy). In this dashboard we consider just one of the tails. We assume that a strong decrease in real credit and the equity index, and high portfolio outflows represent more risk, as EMEs tend to incur more crises from a sudden stop of capital inflows than from a credit bubble fed by strong inflows.

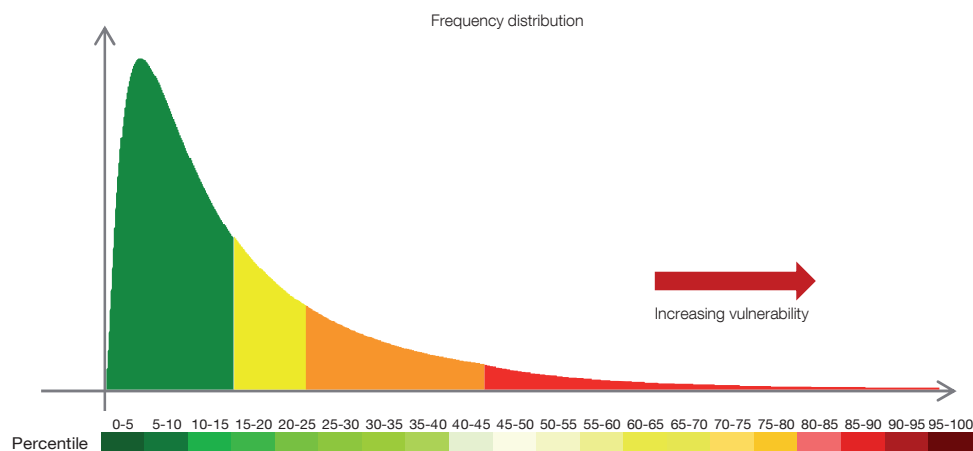**11**   We are not taking into account expansions in our risks assesment as we consider vulnerability developments that could trigger a sovereign default, a banking system crisis or a currency crash. Then tranquil times also include expansions, and the unsustainability of those expansions are tackled with indicators like inflation, the current account balance and so on.

12   See Table A.1 in the Annex.

Chart 1
DESIGN OF HEAT MAPS

Percentile scale and colour distribution for risks.

Frequency distribution

Increasing vulnerability

| Percentile | 0-5 | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30-35 | 35-40 | 40-45 | 45-50 | 50-55 | 55-60 | 60-65 | 65-70 | 70-75 | 75-80 | 80-85 | 85-90 | 90-95 | 95-100 |

SOURCE: Own calculations.

In addition, a drop in GDP growth and an increase in inflation are considered riskier than the other way round[13]. Table 1 summarises the indicators used in the dashboards, their sources and the direction of vulnerability.

The use of cross-country and time series frequencies provides us with a complementary approach to vulnerability. Chart 2 offers an example of the usefulness of both approaches. Let us randomly take the public sector balance of Chile in the last quarter of 2019 (-2.83% of GDP). According to the frequency distribution of the historical public sector balance in Chile since 1993, this figure corresponds to a very high degree of vulnerability (percentile 95.4%), so a red dark should be assigned to this cell in the time series heatmap for Chile. But according to the cross-country distribution, the percentile in the last quarter of 2019 for the Chilean public deficit was 42.4%, so the colour assigned will be light yellow (medium-low risks). On the contrary, the public sector balance of Brazil in the same quarter was -5.91% of GDP. This entailed a percentile of just 65.1% in the time series distribution (yellow in the heatmap) but soared to 92.4% in the cross-section distribution (red in the heatmap). The guess would then be that, in the case of global turbulence that could undermine the ability or willingness of the sovereign to pay back its debt, investors would tend to undo their portfolio positions in the markets with worse fundamentals at that moment in time (in this case Brazil). However, the persistence of a public sector imbalance higher than its historical median in a country - which could generate an unsustainable path for the public debt and ultimately lead to a sovereign crisis - could also affect foreign investors who might withdraw capital from Chile. On the contrary, the high level of the public deficit

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13 Another possibility to deal with the two tail risks problem would be to include the data in absolute values, and leave room for experts judgement to determine the specific risk.

Table 1

INDICATORS INCLUDED IN HEAT MAPS

Variables included in the vulnerability dashboards, mainly taken from EWS literature, and the direction of mounting risks.

|	Source	Higher risks
Financial markets		
Sovereign spread (bps level)	JP Morgan EMBI or equivalent	↑
Sovereign spread (change over 3 months)	JP Morgan EMBI or equivalent	↑
Equity index (change over 3 months) (a)	Refinitiv	↓
Exchange rate vs USD (apr(+) or dep (-) over 3 months)	Refinitiv	↓
Macroeconomic fundamentals		
Real sector		
GDP (change y-o-y) (a)	National Statistics, Oxford	↓
Inflation rate (CPI change y-o-y) (a)	National Statistics	↑
Industrial production (12 month MA, y-o-y)	National Statistics	↓
NEER overapreciation (deviation from trend)	JP Morgan and own calculations	↑
Fiscal sector		
Public sector surplus (+) or deficit (-) (% GDP)	National Statistics, Oxford, IMF IFS	↓
Public sector gross debt (% GDP)	National Statistics, Oxford, IMF IFS	↑
Banking sector		
Real credit to private sector (y-o-y) (a)	IMF IFS	↓
Real deposits on domestic banks (y-o-y)	IMF IFS	↓
Loan to Deposit ratio	IMF IFS	↑
Non performing loans (% total loans)	National Central Banks, World Bank	↑
Net foreign assets of domestic banks (% GDP)	IMF IFS	↓
Bank's equity index (change over 3 months) (a)	Refinitiv	↓
Spread of bank's international bond (change over 3 months)	JP Morgan	↑
Short term interbank rate (%)	National Central Banks	↑
Intermediation margin (loan rate - deposit rate)	National Central Banks	↑
Standard and Poor's BICRA group (1-10)	Standard and Poor's	↑
IHS Markit Banking Sector Risk Score (0-100)	IHS Markit	↑
External sector		
Current account surplus (+) or deficit (-) (% GDP)	National Statistics, Oxford, IMF IFS	↓
Gross external debt (% GDP)	National Statistics, Oxford, IMF IFS	↑
FDI (% GDP)	National Statistics, Oxford, IMF IFS	↓
Short term external debt (% Reserves)	National Statistics, Oxford, IMF IFS	↑
Reserves (% GDP)	National Statistics, Oxford, IMF IFS	↓
External debt service (% exports)	National Statistics, Oxford, IMF IFS	↑
Portfolio gross inflows (% GDP) (a)	National Statistics, Oxford, IMF IFS	↓
Politics, wealth and institutional quality		
Per capita GDP (USD PPP)	World Bank	↓
Per capita GDP (annual change %)	World Bank	↓
Doing Business (percentile)	World Bank	↓
Political Instability and Absence of Violence (percentile)	World Bank	↓
Geopolitical Risk index (GPR)	Dario Caldara and Matteo Iacoviello	↑
Sovereign rating (average of the three main agencies)	Standard & Poor's, Fitch, Moody's	↓
IHS Markit Political Risk Score (0-10)	IHS Markit	↑

SOURCE: Own calculations.
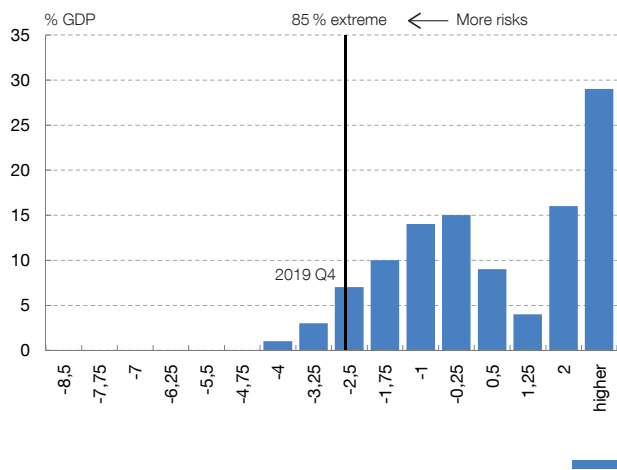
a Two tail risk variables.

Chart 2

AN EXAMPLE OF THE METHODOLOGY USED IN CROSS-SECTION AND TIME SERIES HEAT MAPS

1 PUBLIC SECTOR BALANCE: CROSS-SECTION 2019 Q4
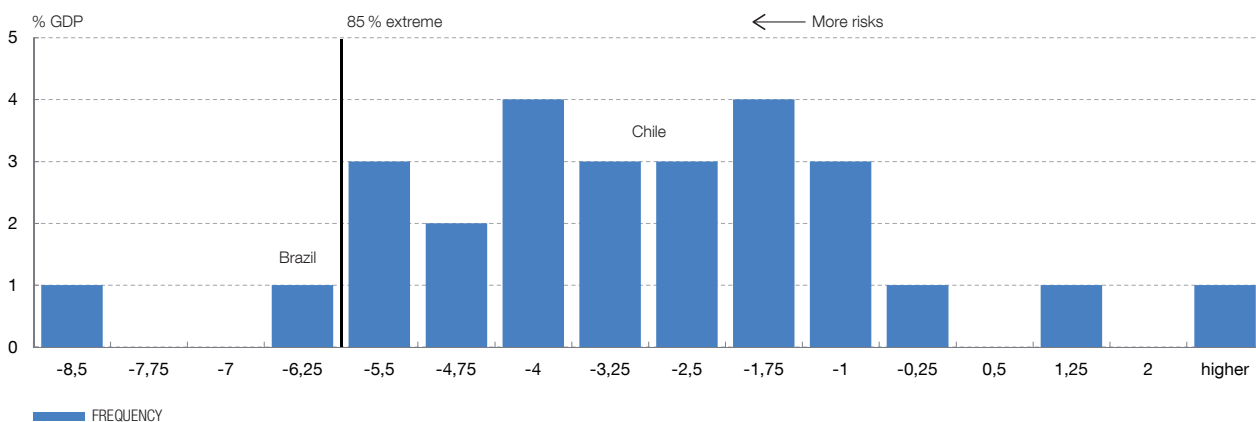
2 PUBLIC SECTOR BALANCE: TIME SERIES CHILE

3 PUBLIC SECTOR BALANCE:TIME SERIES BRAZIL
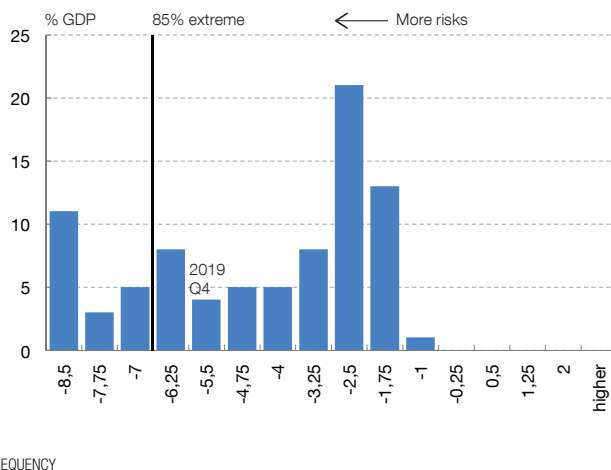
SOURCES: National Statistics Offices and own calculations.

in Brazil is not strongly misaligned with the historical median and could then be considered sustainable, bearing in mind that Brazilian public debt is issued mainly in domestic markets and owed by domestic banks. Moreover, a persistent disequilibrium in public accounts could also lead to an increase in the percentile of risks in the cross-section distribution. Therefore, a balanced combination of both approaches would enrich the analysis of vulnerability of the main emerging economies. On the contrary, the high heterogeneity of the countries included in the sample – even within regions, as countries had undergone different types of crises and their degree of openness to trade and capital flows are very different - prevents us from using a panel frequency distribution. Finally, it is worth noting that the heatmap analysis is just a flag-raising exercise, which needs to be evaluated by expert judgement in order to properly assess the imbalances of these countries, and it should be complemented by other analytical tools.

4 Some historical examples of vulnerability dashboards

Are vulnerability dashboards useful for anticipating crises or financial strains in a country? As already stated, the dashboards are complementary tools to detect the accumulation of vulnerabilities, but they cannot replace expert judgement or other more sophisticated analitycal tools. Nevertheless, in this section, with the benefit of hindsight we examine how well the vulnerability dashboards proposed would have performed months before three well-known historical episodes of EME turbulence, namely Argentina in 2001, Brazil in the summer of 2002 and Turkey in the second quarter of 2018.[14]

Table 2 shows the real-time[15] historical vulnerability dashboard for Argentina in September 2000, around 15 months before the currency board broke down. The sequence of Argentina's 2001 crisis started with balance of payments difficulties between 1998 and 1999, derived from the overvaluation of the peso (linked to the dollar through a Currency Board at a 1:1 parity), a huge devaluation of the main trading partners' currencies (Brazil 1999) and falling commodities prices. These led to an agreement with the IMF in December 2000 (the so called "shielding", or *blindaje* in Spanish), which amounted to USD 40 billion. The conditionality of the agreement included a pension system reform, the rationalisation of the public sector and a reduction in public expenditure (up to 1.5% of GDP in the second half of 2001). The agreement was finally reinforced by an external debt swap during the first quarter of 2001 *(Megacanje* in Spanish). Nevertheless, the failure in the fiscal adjustment led to several changes in the Ministry of Finance that undermined the credibility of the agreement, even after the architect of the successful 1991 Convertibility Law, Domingo Cavallo, took office. The October 2001 legislative elections resulted in Congress and Senate being controlled by the opposition, undermining the legitimacy of the government. There was massive capital flight from November and the IMF interrupted the disbursements of funds in December. A bank run led to a decree freezing and immobilising all bank deposits (the so-called *corralito)*, the resignation of the President, the sovereign default, the abandonement of the exchange rate regime and a massive depreciation of the currency.

The real-time heatmap of Argentina in September 2000[16] suggested a high level of vulnerability that could lead to a crisis that finally erupted 15 months later. Currency overvaluation was still high even after an internal devaluation, reflected in a moderate

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14 When evaluating an EWS, four states of nature can be distinguished: (1) signal issued / crisis occurs; (2) signal issued / crisis does not occur; (3) no signal issued / crisis occurs; and (4) no signal issued / no crisis occurs. The most suitable EWS will be the one that maximises the states of nature 1 and 4, and minimises 2 and 3, i.e. the one that minimises type I errors (3 / (1 + 3)) and type II errors (2 / (2 + 4)). Alternatively, the best EWS will be the one that minimises the noise-signal ratio (2 / (2 + 4) / 1 / (1 + 3)). Therefore, the heatmap of Argentina in 2000 would be a possible example of a type (1) hit as well as Argentina in 2018; Brazil in the summer of 2002, an example of a type (4) hit; and, on the contrary, Turkey in April 2018 would be an example of a type (3) fail. Finally an example of a type (2) fail would be Venezuela until 2014, that is, before oil price slump. As long as oil prices were high Venezuela could sustain a very vulnerable situation on the fiscal front and with a huge exchange rate deviation. This is a key example of the relevance of the experts' judgement as a complement of heatmaps.
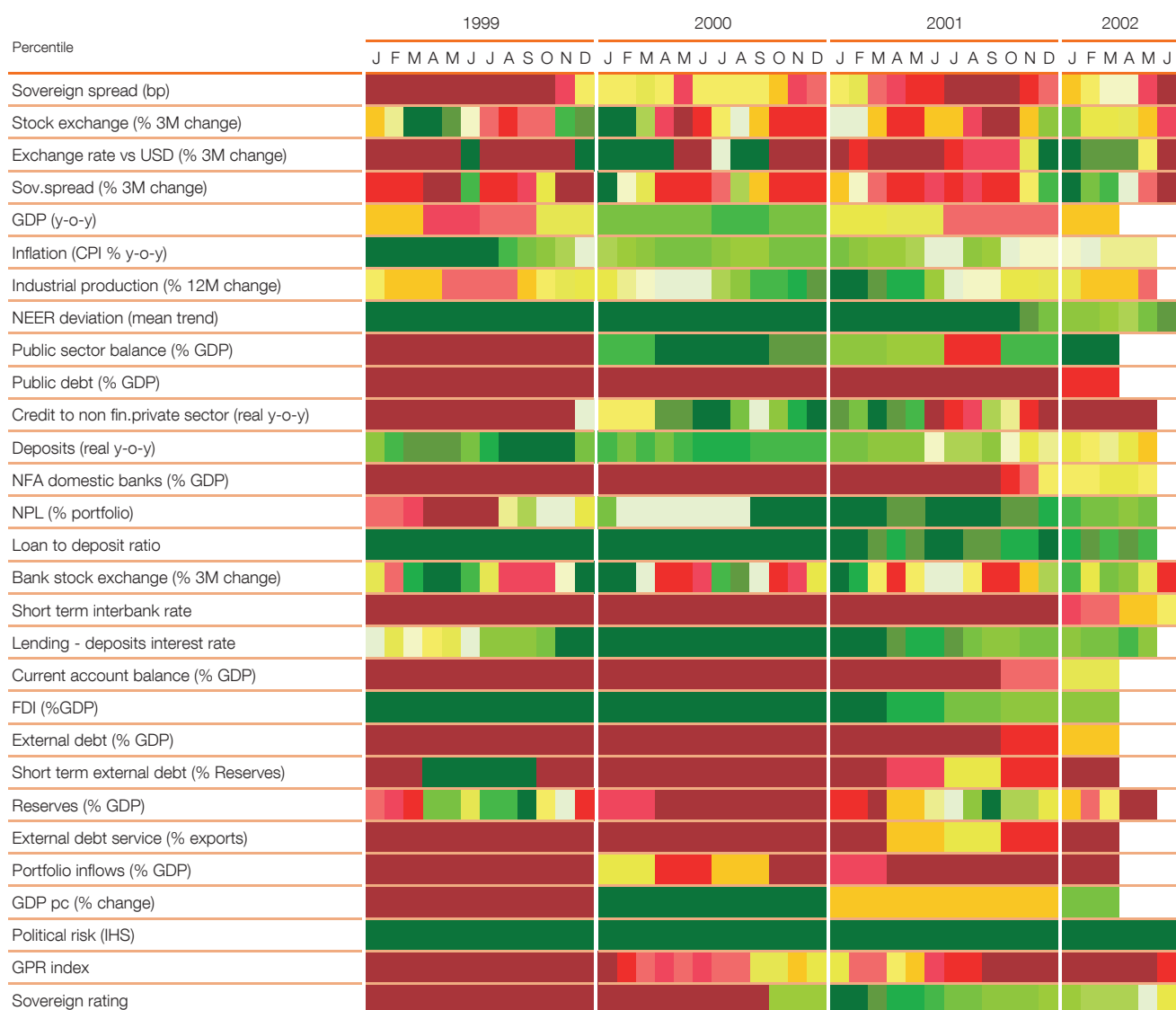
15 Throughout the Occasional Paper we use real-time heatmaps, i.e.the heatmap that analysts saw in each moment of time, taking into account the usual delays in data releases.

16 We only show the time-series dashboard for Argentina 2000 since this is a clear example of a crisis with a domestic origin and development.

Table 2
ARGENTINA: TIME SERIES VULNERABILITY DASHBOARD IN SEPTEMBER 2000

In September 2000 vulnerability in Argentina was very high.

Percentile

	1997	1998	1999	2000
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S
Sovereign spread (bp)				
Stock exchange (% 3M change)				
Exchange rate vs USD (% 3M change)				
Sov.spread (% 3M change)				
GDP (y-o-y)				
Inflation (CPI % y-o-y)				
Industrial production (% 12M change)				
NEER deviation (mean trend)				
Public sector balance (% GDP)				
Public debt (% GDP)				
Credit to non fin.private sector (real y-o-y)				
Deposits (real y-o-y)				
NFA domestic banks (% GDP)				
NPL (% portfolio)				
Loan to deposit ratio				
Bank stock exchange (% 3M change)				
Short term interbank rate				
Lending - deposits interest rate				
Current account balance (% GDP)				
FDI (% GDP)				
External debt (% GDP)				
Short term external debt (% Reserves)				
Reserves (% GDP)				
External debt service (% exports)				
Portfolio inflows (% GDP)				
GDP pc (% change)				
GPR index				
Sovereign rating				

SOURCE: Own calculations.

increase in CPI and weak activity in 1999, which led also to a decrease in GDP per capita. The heatmap also showed strong imbalances in public sector accounts, combined with plummeting real credit and real deposits - which reflected the lack of confidence in banks - and non-performing loans at historical highs. On the external front, external debt as a proportion of GDP escalated to historical highs; short-term external debt was above total reserves. Reserves amounted to scarcely 8% of GDP, in the lower range of all EMEs, and the country was in the midst of a sudden stop in portfolio inflows (around -2.6% of GDP in the third quarter of 1999). Rating agencies started to cut the sovereign rating, undermining the access to private external funds. In sum, in September 2000 the average percentile of

Table 3

BRAZIL: TIME SERIES VULNERABILITY DASHBOARD IN JUNE 2002

Brazil was not in such a vulnerable position to trigger a crisis in June 2002.

Percentile	1999	2000	2001	2002
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J
Sovereign spread (bp)				
Stock exchange (% 3M change)				
Exchange rate vs USD (% 3M change)				
Sov.spread (% 3M change)				
GDP (y-o-y)				
Inflation (CPI % y-o-y)				
Industrial production (% 12M change)				
NEER deviation (mean trend)				
Public sector balance (% GDP)				
Public debt (% GDP)				
Credit to non fin.private sector (real y-o-y)				
Deposits (real y-o-y)				
NFA domestic banks (% GDP)				
NPL (% portfolio)				
Loan to deposit ratio				
Bank stock exchange (% 3M change)				
Short term interbank rate				
Lending - deposits interest rate				
Current account balance (% GDP)				
FDI (%GDP)				
External debt (% GDP)				
Short term external debt (% Reserves)				
Reserves (% GDP)				
External debt service (% exports)				
Portfolio inflows (% GDP)				
GDP pc (% change)				
Political risk (IHS)				
GPR index				
Sovereign rating				

SOURCE: Own calculations.

risk of fundamental variables was 68% (99.6% for the public sector, 75% for the banking sector). But the situation deteriorated very quickly, and in December 2000 – the month in which Argentina reached an agreement with the IMF - the risk mean percentile was 71%. It held at 69% in March 2001 (the month of the *Megacanje)*, and climbed to 75% in June and to 79% in September 2001. In that month all but five fundamental indicators were above the 85% percentile of risk.

Table 3 shows the time series real-time vulnerability dashboard for Brazil in June 2002. From May 2002, Brazilian sovereign spreads and the exchange rate against the

USD were battered by international investors as the campaign for the October presidential elections began with a big lead for the opposition Workers' Party (PT in Portuguese) in the polls, with former union leader Lula da Silva as candidate. Some global[17] and regional factors[18] also contributed to the depreciation of the real. The country lost around USD 4.5 billion in reserves in April-May 2002 (around 1.2% of GDP), and the high percentage of the public debt linked to the exchange rate threatened to turn the exchange rate crisis into a fiscal crisis. Finally, on 22 June the PT candidate signed a commitment to maintain Brazil's macroeconomic policies (especially the control of inflation and the maintenance of the primary fiscal surplus) and to observe national and international contracts signed by Brazil (thereby commiting himself to avoiding default on external debt or the expropriation of foreign investments) if he attained the Presidency. In September 2002, the IMF announced a 15-month Stand-by Credit of about $30.4 billion to support Brazil's economic and financial programme up to December 2003, which ultimately bought time to help markets to learn to trust the new administration. Brazil's economic and financial situation improved significantly following the PT election victory since, to allay concerns over debt sustainability, the government increased the primary surplus target by 1 pp of GDP. In conjunction, the central bank undertook a proactive interest rate policy to guide inflation back to target, and the authorities took measures to reduce the vulnerability of fiscal variables to the exchange rate.

The real-time heatmap of Brazil as at June 2002[19] shows an economy that improved steadily since the 1999 crisis, as reflected in a reduction in the external disequilibria of both the whole economy and of domestic banks; a public sector deficit very low in comparison with the past; and a financial system in relatively good shape. The levels of the closely correlated public and external debt were the main concern, although both adjusted slightly during 2001 and 2002, along with the increase in political noise –and its repercussion in financial markets- due to the upcoming elections. The average percentile for fundamental variables was 60%, exactly the same as at the end of 2001, and only 23% of the macro indicators stood above the 85% percentile of risk.[20]

Finally, we examine the cases of Turkey and Argentina in the first quarter of 2018. Around that quarter the sustained removal of the US Federal Reserve monetary accommodation as a result of the acceleration in the economic expansion, in part boosted by Trump's fiscal stimulus, led to an increase in long-term US rates and a tightening of global financial conditions. This tightening derived also from the uncertainty created by the

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17 Such as the increase in US spreads triggered by the Enron-Arthur Andersen case as from October 2001.

18 Like Argentina's sovereign default in December 2001.
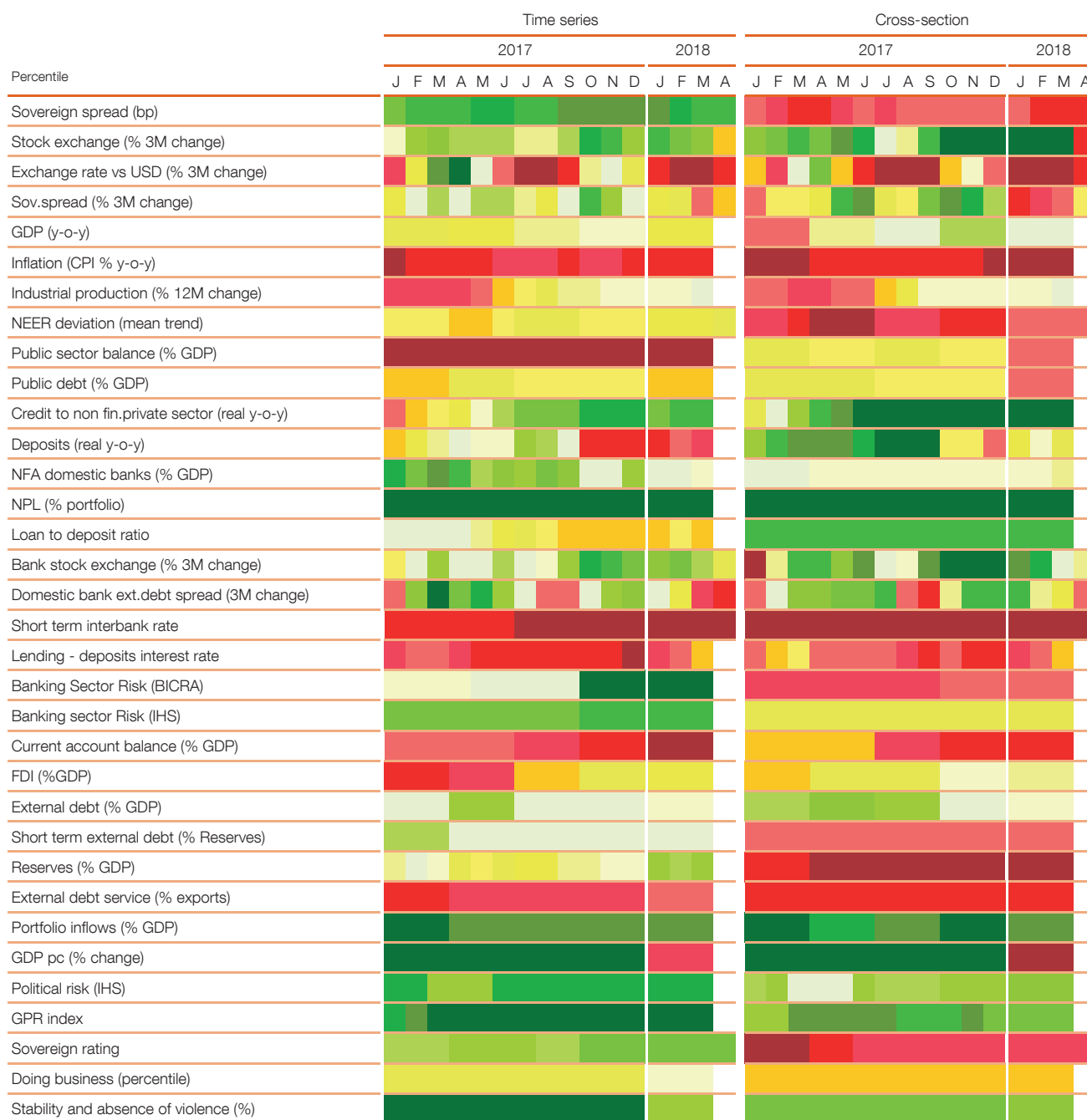
19 Again, this is another example of a (non) crisis with a domestic origin and therefore we focus on the time-series dashboard.

20 According to the BBVA Chief for Brazil in 2002, "Brazil is living a 100% electoral crisis. The stress is hiding a clear improvement in fundamentals. Brazil registered a trade surplus for 14 consecutive months, and a primary surplus for 14 consecutive quarters. The banking system is in a very good shape, public debt is sustainable, and the floating regime worked well until now. But the PT is not giving clear signals to the market, they say that they will respect contracts and support fiscal responsibility, but this is obvious and irrelevant". Chang (2006) remarked on the interaction and interdependence between capital flows and elections: when the (assumed) commitment problem of the pro-labour candidate is solved, this increased both the inflows and the chances of the leftist candidate winning the election. Miller et al. (2004) point to direct political contagion from Argentina and to the role of IMF lending as an emergency bridge until markets learn to trust Lula.

Table 4

ARGENTINA: VULNERABILITY DASHBOARDS IN APRIL 2018

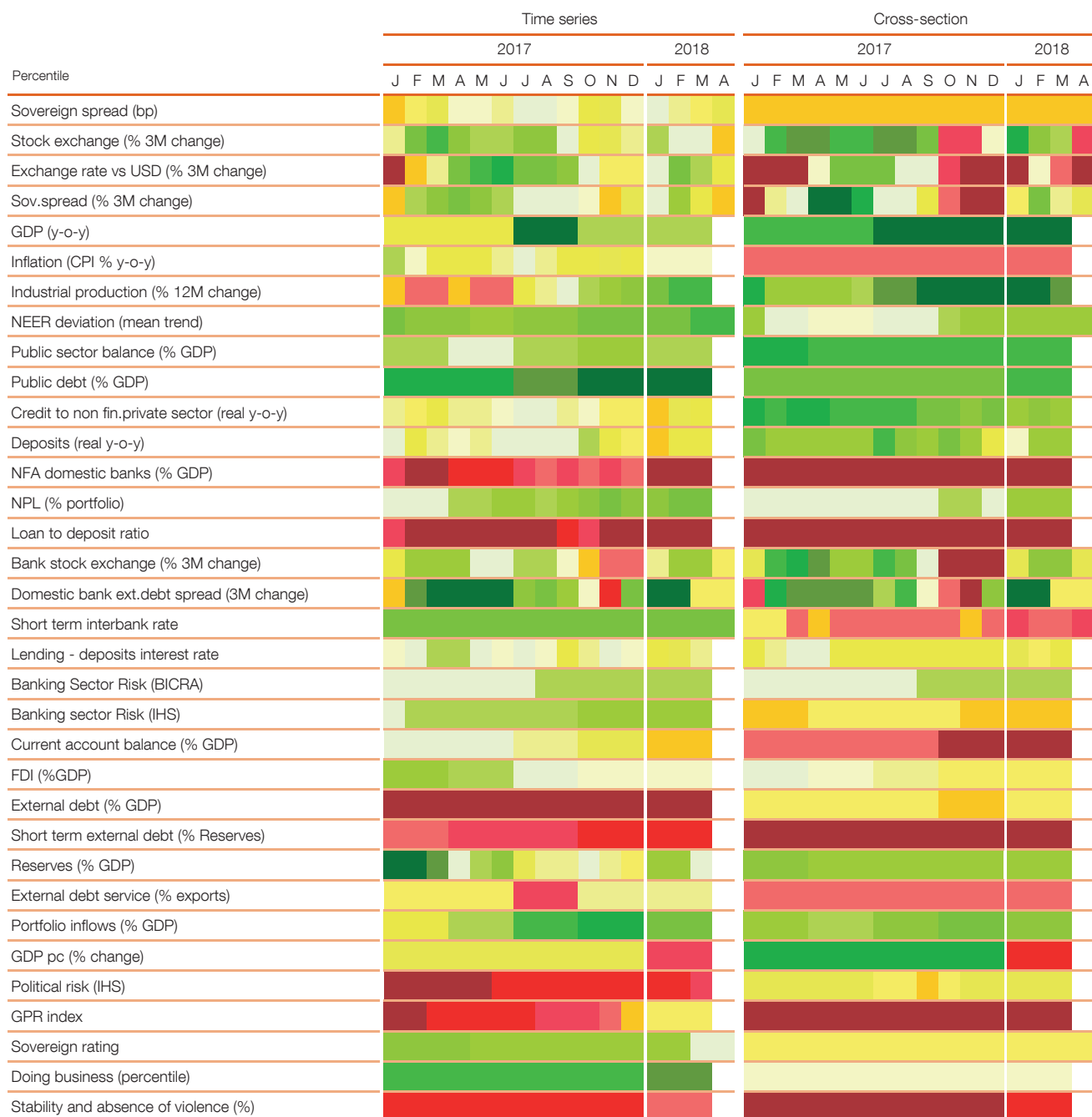Argentina's vulnerability in April 2018 was high both in the time series and cross-section distributions.

Percentile	Time series		Cross-section	
	2017	2018	2017	2018
	J F M A M J J A S O N D	J F M A	J F M A M J J A S O N D	J F M A
Sovereign spread (bp)				
Stock exchange (% 3M change)				
Exchange rate vs USD (% 3M change)				
Sov.spread (% 3M change)				
GDP (y-o-y)				
Inflation (CPI % y-o-y)				
Industrial production (% 12M change)				
NEER deviation (mean trend)				
Public sector balance (% GDP)				
Public debt (% GDP)				
Credit to non fin.private sector (real y-o-y)				
Deposits (real y-o-y)				
NFA domestic banks (% GDP)				
NPL (% portfolio)				
Loan to deposit ratio				
Bank stock exchange (% 3M change)				
Domestic bank ext.debt spread (3M change)				
Short term interbank rate				
Lending - deposits interest rate				
Banking Sector Risk (BICRA)				
Banking sector Risk (IHS)				
Current account balance (% GDP)				
FDI (%GDP)				
External debt (% GDP)				
Short term external debt (% Reserves)				
Reserves (% GDP)				
External debt service (% exports)				
Portfolio inflows (% GDP)				
GDP pc (% change)				
Political risk (IHS)				
GPR index				
Sovereign rating				
Doing business (percentile)				
Stability and absence of violence (%)				

SOURCE: Own calculations.

US-China trade conflict and the economic slowdown in China. Contrary to other previous episodes of global turbulence, such as that in May 2013, the USD appreciated strongly, and this added pressure to those countries with external imbalances or highly dependent on external investors or external funds, such as Turkey and Argentina.

Table 5

TURKEY: VULNERABILITY DASHBOARDS IN APRIL 2018

Turkish vulnerabilitiy dashboards in April 2018 shown low risks in aggregate terms, although some external indicators were under stress.

	Time series		Cross-section	
	2017	2018	2017	2018
Percentile	J F M A M J J A S O N D	J F M A	J F M A M J J A S O N D	J F M A
Sovereign spread (bp)				
Stock exchange (% 3M change)				
Exchange rate vs USD (% 3M change)				
Sov.spread (% 3M change)				
GDP (y-o-y)				
Inflation (CPI % y-o-y)				
Industrial production (% 12M change)				
NEER deviation (mean trend)				
Public sector balance (% GDP)				
Public debt (% GDP)				
Credit to non fin.private sector (real y-o-y)				
Deposits (real y-o-y)				
NFA domestic banks (% GDP)				
NPL (% portfolio)				
Loan to deposit ratio				
Bank stock exchange (% 3M change)				
Domestic bank ext.debt spread (3M change)				
Short term interbank rate				
Lending - deposits interest rate				
Banking Sector Risk (BICRA)				
Banking sector Risk (IHS)				
Current account balance (% GDP)				
FDI (%GDP)				
External debt (% GDP)				
Short term external debt (% Reserves)				
Reserves (% GDP)				
External debt service (% exports)				
Portfolio inflows (% GDP)				
GDP pc (% change)				
Political risk (IHS)				
GPR index				
Sovereign rating				
Doing business (percentile)				
Stability and absence of violence (%)				

SOURCE: Own calculations.

Was this pressure on the lira and the peso anticipated by the vulnerability dashboard? The answer would be affirmative for the peso, but not so clear for the lira. In Argentina (Table 4) the percentile of risk for fundamental variables stood at 57% in April 2018, although the percentile for the public sector (88%) and for real indicators (67%) might have set off alarms.

Table 6

PERU: VULNERABILITY DASHBOARDS IN FEBRUARY 2021

Peru shows low vulnerabilty in aggregate terms, although fiscal variables are stressed in historical terms.

	Time series			Cross-section		
	2019	2020	21	2019	2020	21
Percentile	J F M A M J J A S O N D	J F M A M J J A S O N D	J F	J F M A M J J A S O N D	J F M A M J J A S O N D	J F
Sovereign spread (bp)						
Stock exchange (% 3M change)						
Exchange rate vs USD (% 3M change)						
Sov.spread (% 3M change)						
GDP (y-o-y)						
Inflation (CPI % y-o-y)						
Industrial production (% 12M change)						
NEER deviation (mean trend)						
Public sector balance (% GDP)						
Public debt (% GDP)						
Credit to non fin.private sector (real y-o-y)						
Deposits (real y-o-y)						
NFA domestic banks (% GDP)						
NPL (% portfolio)						
Loan to deposit ratio						
Bank stock exchange (% 3M change)						
Dom. bank ext.debt spread (3M change)						
Short term interbank rate						
Lending - deposits interest rate						
Banking Sector Risk (BICRA)						
Banking sector Risk (IHS)						
Current account balance (% GDP)						
FDI (%GDP)						
External debt (% GDP)						
Short term external debt (% Reserves)						
Reserves (% GDP)						
External debt service (% exports)						
Portfolio inflows (% GDP)						
GDP pc (% change)						
Political risk (IHS)						
Sovereign rating						
Doing business (percentile)						
Stability and absence of violence (%)						

SOURCE: Own calculations.

In a cross-country comparison, the average risk was 65% (against 61% a year earlier), with external sector variables at the 69% percentile of risk. On the contrary, in Turkey (Table 5), the average percentile of fundamental variables in the time series heatmap stood at just 51%, close to the median and improving on a year ago (54%). Turkey's fundamentals were slightly more deteriorated than those of its peers (57%), a worse record than a year earlier

(53%), but in any case the figures were not very striking. Nevertheless, some red flags were up, mainly in the banking sector, as strongly negative net foreign assets of domestic banks combined with a higher-than-ever loan-to-deposit ratio indicated that banks were increasing credit funded via wholesale markets, especially in international markets. This was also reflected in increasing external debt and short-term external debt. Finally, political risk remained very high. Looking at the cross-section vulnerability dashboard, the situation was the same, with fundamental risk standing at 56% and domestic banks' net foreign assets, short-term external debt and political risks flashing, and a high inflation rate. This example shows that the vulnerability dashboards could be interpreted as a flag-raising exercise that complements the country's expert judgement, which has to assess the real situation.[21] But overall it could be a very useful tool as it presents all the relevant information in a friendly, easily readable and updatable manner.

A recent example of the use of these dashboards is shown in Table 6 for a randomly selected country, Peru. We can readily see how Peru underwent a huge contraction in activity and soaring public deficit at the end of the period examined in historical terms, but in comparison with its peers the only variable of concern would be a high loan-to-deposit ratio. Finally, although our objective is to present the development of all indicators separately, the use of this methodology enables us to summarise the degree of vulnerability for each country at the aggregate level, or for each region or group of indicators. Then we can compare and rank them, simply averaging the percentiles at each moment of time (see annex for an example).

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5 Conclusions

Monitoring risks of the main emerging economies is key in an increasingly globalised world. Financial and economic spillovers and spillbacks from emerging economies to advanced economies have become a source of concern, and therefore financial or economic crises in one these countries can affect financial stability in Spain. Also, the economic consequences of the Covid-19 pandemic and the high costs of overcoming it have underscored the importance of monitoring vulnerabilities and of knowing each country's room for maneouvre to implement fiscal and monetary policies. In this Occasional Paper we present a transparent, visual and readily tool: the vulnerability dashboards. These dashboards are built on the extensive literature on Early Warning Systems and heatmaps widely used by organisations such as the OECD.

The vulnerability dashboards proposed, which identify risks depending on the percentile of the 34 variables on their historical and cross-section frequency distributions previously purged from crisis times, have some interesting features for policy purposes. First, they distinguish between a cross-section and a time series analysis in order to assess which countries could be more vulnerable to global turbulences and to detect imbalances arising from a worsening of domestic conditions. Second, the dashboards combine high-risk and low-risk indicators, leaving room for the analyst's judgement and the use of more sophisticated approaches to vulnerability. Third, we use a model-free approach and we do not aggregate indicators in order to avoid masking key indicators. Finally, we use a broad framework since the aim is to include all the indicators that might detect in advance any type of crisis (sovereign, currency or banking) and not only those closely related to banking sector performance.

As we show in the paper, these heatmaps could have been very useful for detecting the build-up of vulnerabilities months before the eruption of a crisis, such as Argentina in December 2001, or, on the contrary, for evaluating vulnerabilities before the non-occurrence of a crisis, as in Brazil in the summer of 2002. Nevertheless, the dashboards are simply a flag-raising exercise that needs to be complemented by expert judgement and other tools.

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Appendix

1.1 EMEs and EMEs examined in the vulnerability dashboard

Chart A.1
EMERGING ECONOMIES

EMEs ANALYSED
OTHER EMEs
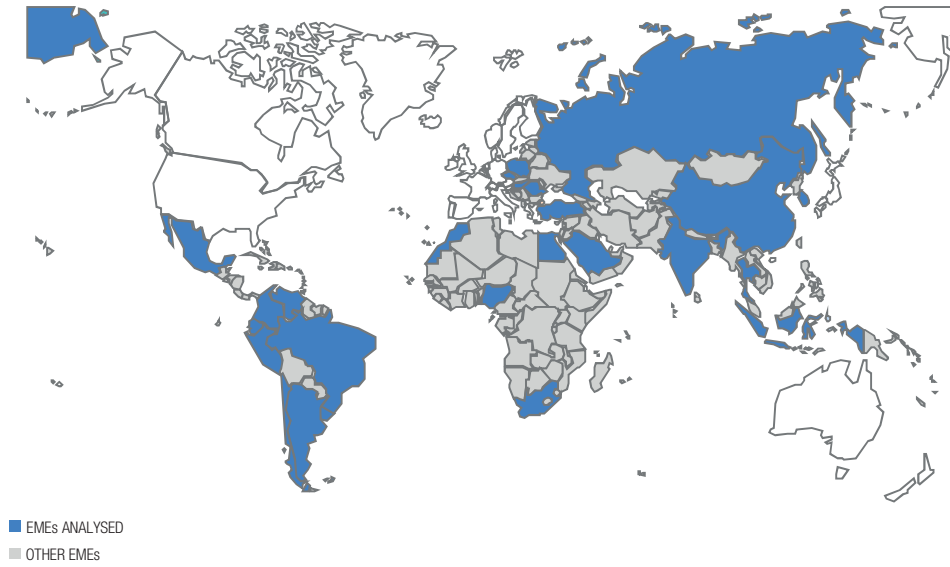
SOURCE: Own calculations.

1.2 Crisis times excluded from the frequency distributions

Table A.1
CRISIS TIMES

Years excluded from frequency distributions of the heatmaps, as the country register some kind of crisis (sovereign defaults, currency crashes or banking crisis).

Country	Years excluded
Argentina	1994 to 1996 and 2000 to 2002
Algeria	1993 to 1995 and 1998 to 2000
Brazil	1993 to 1995 and 1998 to 2000
China	1997 to 1999
Chile	---
Colombia	1997 to 1999
Czech Republic	1995 to 1997
Ecuador	1997 to 2000
Egypt	---
Hungary	---
India	1993 to 1994
Indonesia	1996 to 2000
Korea	1996 to 1999
Mexico	1993 to 1996
Morocco	---
Nigeria	1996 to 1998
Perú	---
Poland	1993
Romania	1995 to 1997
Russia	1997 to 1999
South Africa	---
Thailand	1996 to 1999
Tunisia	---
Turkey	1999 to 2002
Uruguay	2001 to 2003
Venezuela	1993 to 1995, 2001 to 2003 and 2017 to 2020

SOURCE: Own calculations.

1.3 Aggregation of risks

DIFFERENT MEASURES OF AGGREGATE VULNERABILITY AND COUNTRY RANKINGS

1 MEAN PERCENTILE HISTORICAL DISTRIBUTION: BY REGION

Level (0-1)

ALL EME — LATIN AMERICA — ASIA — EASTERN EUROPE — REST
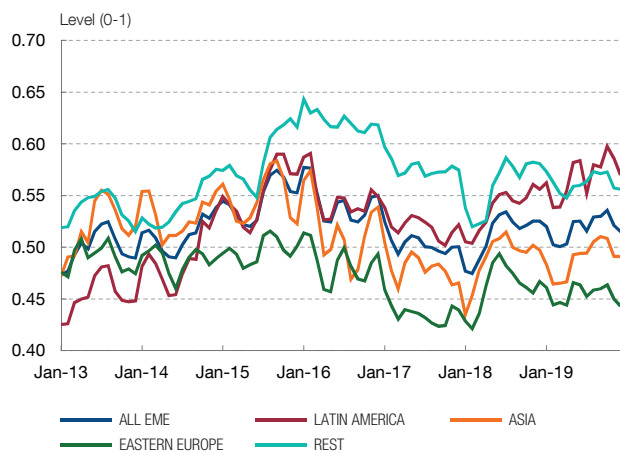
2 MEAN PERCENTILE HISTORICAL DISTRIBUTION: ALL EME BY INDICATOR

Level (0-1)

MARKETS — REAL — PUBLIC SECTOR — BANKS — EXTERNAL — INSTITUTIONS — POLITICAL
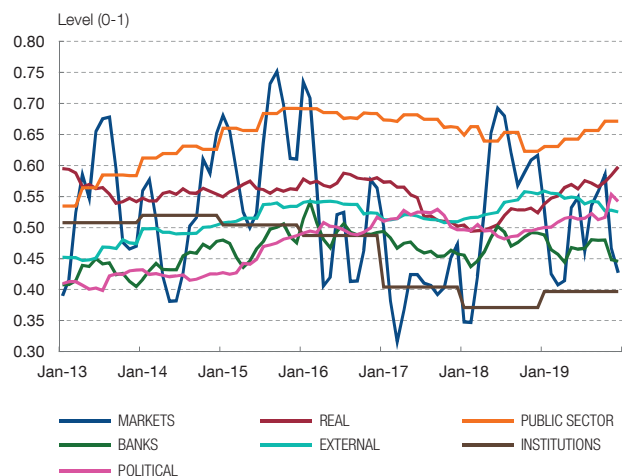
3 VULNERABILITY RANKINGS: TIME SERIES

Level (0-1)
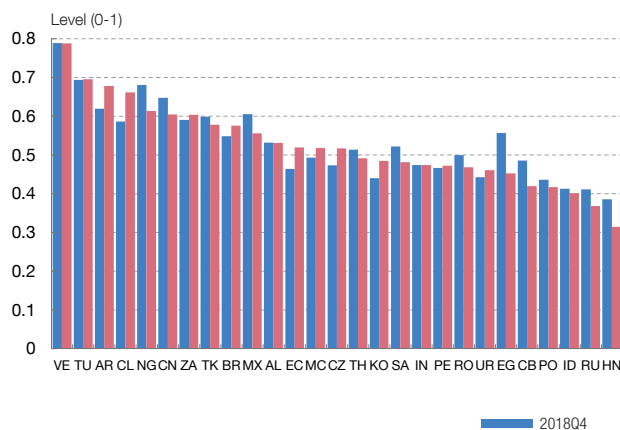
4 VULNERABILITY RANKINGS: CROSS-SECTION

Level (0-1)

2018Q4 — 2019Q4
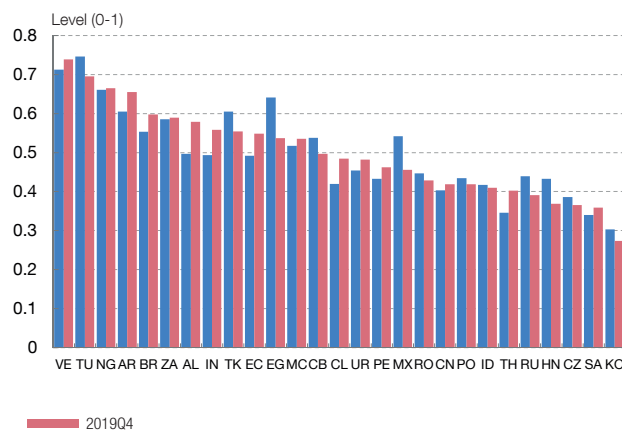
SOURCE: Own calculations.

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