Weathering the financial crisis: policy decisions or luck?

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The economic performance of individual economies varied markedly during the 2007–09 global financial crisis. We examine what can explain economies' performance, relative to what would be expected based on past co-movement with the global business cycle. Was it the result of pre-crisis policy decisions or just luck? We find that better-performing economies – whether advanced or emerging market economies (EMEs) – featured lower rates of private sector credit-to-GDP growth in the years before the crisis, lower loan-to-deposit ratios and a current account surplus. But the level of income also played an important role, with lower income economies generally out-performing higher income ones. For advanced economies, a parsimonious model of credit growth, U.S. holdings of short-term debt and the current account can explain most of the variation in cross-country performance. In contrast, the relative performance of EMEs defies any simple characterization. Our study suggests that sound institutions and policy decisions pre-crisis reduced economies' vulnerability to the 2007-09 crisis. In other words, not everything was luck.

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1. Introduction

The global financial crisis of 2007–09 was the result of a cascade of financial shocks that threw many economies off course. The economic damage has been extensive, with few countries spared – even those far from the source of the turmoil. As with many economic events, the impact has varied from country to country. China's growth, for example, never dipped below 6% and Australia's worst quarter was one with no growth. The economies of Japan, Mexico and the United Kingdom, however, suffered GDP contractions of 5–10% at an annual rate for up to seven quarters in a row. We examine what factors can account for the variation in national outcomes. Was the relatively good economic performance of some economies a consequence of policy frameworks, institutions and decisions made prior to the crisis? Or was it just luck?

We address this question in three steps. First, we develop a measure of idiosyncratic economic performance during the crisis for 46 advanced and emerging market economies (EMEs) – the largest sample for which our data is available. Our measure is based on a principal components analysis of seasonally-adjusted quarter-over-quarter real GDP growth rates from 1990 to 2009. We extract the first principal component, which explains 39.4% of the variation in an economy's output on average. We sum the residuals after subtracting this global factor over 2008 to 2009 and use this cumulative GDP gap (CGAP) as a measure of country-specific outcomes. This measure highlights how each economy performed taking into account what might have been expected based on past co-movements with the global business cycle. Our focus on a country's relative performance complements existing studies that use absolute measures, such as GDP growth or deviation from growth forecasts.

Second, we assemble a broad set of candidate variables that might explain the variation in cross-country experiences, similar to Berkmen et al. (2012), Frankel and

Saravelos (2012), Lane and Milesi-Ferretti (2011, 2012) and Rose and Spiegel (2010, 2011, 2012), among others. We extend the scope of the existing literature to include two dimensions that have been discussed but not tested directly, namely the structure of an economy's banking sector and details on cross-border bilateral portfolio flows to and from the United States.[1] These variables prove to be important for explaining the variation in idiosyncratic performance for our sample economies.

Third, we examine what pre-crisis conditions were associated with an economy's positive economic performance relative to its peers. Similar to other studies in this literature, we face the problems of limited sample size, incomplete data availability and high multicollinearity among potential explanatory variables. We use two novel approaches to address this problem. First, we test for differences in the median idiosyncratic performance between two groups of countries created based on each of our explanatory variables. This univariate analysis generates surprisingly strong insights, some of which have not been documented before. Next, we use a statistical data-mining technique from the natural sciences known as Least Angle Regressions (LARS) to identify which variables best explain the cross-country variation in relative performance. LARS identify a parsimonious set of variables that explain most of the variation in our idiosyncratic measure. We verify the importance of the variables identified using OLS regressions.

Many researchers have studied the cross-country incidence of the 2007-2009 crisis to understand what caused some economies to be more vulnerable or resilient to the financial shock.[2] Broadly speaking, a consensus has emerged that a few economic relationships

[1] Two exceptions are Popov and Udell (2012) who provide a micro-founded study stressing the importance of bank capital on credit availability during the crisis, and Fratzscher (2012) who uses high-frequency cross-border portfolio flows by mutual funds to trace the transmission of the financial shock.

[2] Rose and Spiegel (2011) and Frankel and Saravelos (2012) summarize existing studies. A number of key papers appeared in special issues of the IMF Economic Review in 2010 and 2011. Country case studies are available in Bordo et al. (2011) for Canada, Connor et al. (2012) for the U.S. and Ireland, Sentence et al. (2012) for the United Kingdom and Carbó-Valverde et al. (2012) for Spain.

explain a considerable share of variation in crisis impact and resilience (see the appendices for details on existing studies). Countries with higher GDP per capita, stronger pre-crisis credit growth and higher short-term debt fared worse, while countries with a current account surplus were more resilient. These variables are consistently supported across studies, including our own. There is considerable disagreement, however, on the importance of many other variables such as the choice of exchange rate regime, the level of FX reserves and the extent of trade or financial openness.

We show that some of the disagreement may be explained by the different samples used. Specifically, we document that a number of important relationships vary systematically between advanced economies and EMEs. To take one example, studies using only EMEs by Berkmen et al. (2012) and Blanchard et al. (2010) find that the level of pre-crisis FX reserves is not important for explaining outcomes, whereas studies by Dominguez et al. (2012) and Frankel and Saravelos (2012) using a much larger sample that includes advanced economies find this variable is important.[3] We show that FX reserves are only important for advanced economies, not EMEs. This distinction is not picked up when simply controlling for GDP per capita. We find similar differences for manufacturing as a share of exports, financial openness and government short-term debt-to-GDP.

Many researchers find that the level of income is important for explaining outcomes (Claessens et al. 2010; Frankel and Saravelos 2012; Lane and Milesi-Ferretti 2011; Rose and Spiegel 2011, 2012). GDP per capita matters but there is little discussion elsewhere of why, and how. Didier et al (2012) disagree and argue that the EMEs suffered similar growth deceleration to advanced economies, but EMEs recovered quicker. They suggest that the key

[3] Rose and Spiegel (2011) show results for high income countries and a sample excluding advanced economies, but find FX reserves is not important.

difference this time when compared to past crises was the ability of EMEs to implement credible countercyclical policies.

This observation motivated us to look more closely at what distinguishes the performance of advanced economies vs. EMEs. We find that three-quarters of the variation in the CGAP measure for advanced economies is explained by just three variables (in order of importance): pre-crisis credit growth, U.S. holdings of a foreign economy's short-term debt and the country's current account. There is no such simple model to explain the performance of EMEs: they exhibit greater variation with eight variables required to explain the same amount of variation. Different variables are important for different EMEs, with trade channels important for some while credit market regulation is more important for others. The contrasting results for advanced vs. EMEs helps explain some of the mixed results documented by existing studies.

We explore two potential channels of crisis propagation that have been relatively understudied, namely: the state of a country's banking system and the extent of its bilateral exposures to the U.S. financial system. Studies by Cetorelli and Goldberg (2011, 2012) and Kalemli-Ozcan et al. (2013) focus on the cross-border bank lending channel. Cetorelli and Goldberg (2011, 2012) trace out how global and domestic banks contracted lending in response to the global shock, particularly banks that were more dependent on funding from more vulnerable banking systems. They also show that bilateral linkages with the U.S. banking sector increased the transmission of the financial shock. Other studies discuss the importance of the banking system more generally, although they do not test banking sector characteristics directly (Claessens et al. 2010; Giannone et al. 2011; Imbs 2010; Lane and

Milesi-Ferretti 2011).[4] At the BIS, we were motivated by the negotiations over the revised banking regulations (Basel III) to understand how factors such as bank capitalization, funding and supervision explained the cross-country incidence of the crisis. We find robust evidence that better-performing economies featured lower loan-to-deposit ratios, with a more limited role for the degree of bank capitalization and prior experience with a banking crisis.

Following Lane and Milesi-Ferretti (2007, 2011), many researchers study countries' international investment positions, particularly their gross and net foreign assets and liabilities. The orthodox view is that financial openness and portfolio flows may have transmitted the global shock (Fratzscher 2012). Surprisingly, Blanchard et al. (2010), Giannone et al. (2011), Lane and Milesi-Ferretti (2011) and Rose and Spiegel (2010, 2012) find no role for financial openness. We re-examine this channel using disaggregated data on cross-border portfolio flows to and from the U.S., as reported in the Treasury International Capital (TIC) dataset. By distinguishing bilateral holdings of debt and equity, we can explain significant variation in crisis outcomes. In particular, we find that higher U.S. holdings of foreign short- and long-term debt are associated with *better* performance for EMEs, but *worse* performance for advanced economies. Mirroring this finding, higher foreign holdings of U.S. long-term debt are associated with better outcomes for EMEs, but do not explain outcomes for advanced economies. This finding may be due to the greater exposure of EMEs to US Treasuries and agency securities, and their lower exposure to riskier private-label asset backed securities (Bertaut et al. 2012).

Our study makes four contributions to the existing literature. First, we examine a novel measure of each economy's idiosyncratic (or relative) economic performance in response to the crisis. Our CGAP measure is robust to trend growth rates prior to the crisis

[4] Eichengreen et al. (2012) use bank credit default swap spreads to trace the transmission of the crisis, but not to explain variation in economic outcomes.

and takes into account the degree to which economies tend to co-move with the global business cycle (Imbs 2010). It does not depend on a single year as a benchmark and it can be summed over different horizons, capturing the full impact for economies where the impact was delayed. It complements existing studies that use absolute measures of output performance and provides a different perspective on what explains the cross-country variation in outcomes.[5]

Second, we focus on characteristics of the banking system and bilateral, disaggregated exposures to the U.S. financial system through cross-border equity and debt holdings. We test directly whether the resilience of economies is related to the level of capital in the banking system, the funding profile of banks, the institutional features of banking supervision and prior experience with banking crises. To our knowledge, no other macro studies have examined these variables. We take into account patterns of cross-border bank borrowing and lending but supplement this analysis with disaggregated data measuring each foreign economy's portfolio exposures to U.S. securities (and vice versa). We confirm the importance of cross-border portfolio flows during the crisis (Fratzscher 2012).

Third, our study resolves some of the debate on what factors explain crisis outcomes. Existing studies disagree on the importance of a number of important policy variables (see Appendix). We are able to explain some of this disagreement by showing how some variables matter only for advanced economies while others are specific to EMEs.

Fourth, we employ a novel statistical technique that is designed for situations featuring few observations, a large number of explanatory variables, and high multicollinearity among potential regressors. LARS is more computationally efficient than stepwise regression and does not throw out candidate variables due to multicollinearity with

[5] Our CGAP measure is only correlated 0.677 with real GDP growth rates over the same two year crisis period from 2008-2009.

existing regressors in the model. We use LARS to identify a small set of variables that best explain the variation in idiosyncratic performance and confirm the importance of these variables using OLS regressions.

The paper proceeds as follows. Section 2 reviews the impact of the crisis on GDP, explains our measure of idiosyncratic performance and describes the cross-country variation in our sample. The CGAP measure clearly shows the timing and extent of the unexpected decline in GDP for each country in response to the global shock. Section 3 discusses factors that may explain the cross-country variation, namely: income level, banking system structure, credit, trade openness, financial openness and monetary and fiscal policy frameworks. Section 4 presents univariate and multivariate analysis of the impact of these factors on outcomes. Section 5 concludes.

2. Measuring the impact of the crisis

In this section, we examine the impact of the global financial crisis on real GDP growth across a range of economies. We first measure the impact on the typical economy, highlighting the global nature of the crisis. We then identify each economy's idiosyncratic economic performance relative to what can be explained by the global business cycle during the crisis. We document considerable variation across economies.

2.1. Impact on absolute GDP growth

The U.S. subprime turmoil that first emerged in August 2007 and morphed into an international financial crisis following the bankruptcy of Lehman Brothers in September 2008 was a shock that affected output globally (BIS 2009; Imbs 2010). The fall in U.S. housing prices starting in 2006 generated large losses in late 2007 and early 2008 on bank holdings of subprime-related assets. These losses were propagated to European banks directly through their subprime investments, and indirectly through their counterparty exposures to

U.S. banks and currency and funding mismatches. Central banks responded to the disruption in bank funding markets with unconventional policies designed to provide extraordinary liquidity to banks. Despite these interventions, access to credit became constrained as banks reduced corporate lending in many economies (Cetorelli and Goldberg 2011, 2012).

Outside the U.S., Europe and Japan, the channels of propagation of the crisis were different. EMEs that had strengthened bank capital levels in the aftermath of banking crises in the 1990s experienced no financial crisis per se. There were, however, knock-on effects through financial and trade channels (Blanchard et al. 2010; Chor and Manova 2012; Claessens et al. 2010; Didier et al. 2012). Along with the disruption to global financial markets, for example, came a decline in cross-border financial flows (Berkmen et al. 2012; Claessens et al. 2010; Didier et al. 2012) and a collapse in manufactured exports (Berkmen et al. 2012; Lane and Milesi-Ferretti 2011). Countries that experienced an unexpected decline in trading-partner GDP growth (Blanchard et al. 2010; Lane and Milesi-Ferretti 2011) or had closer trade linkages with the U.S. economy (Chor and Manova 2012; Rose and Spiegel 2010, 2012) were worse hit.

We begin by documenting the absolute growth experience of key countries over this period. Figure 1 plots the year-on-year seasonally-adjusted real GDP growth rates for 12 major economies starting in 1Q 2006. The vertical line in each panel marks 3Q 2008 when Fannie Mae and Freddie Mac were taken into conservatorship, Lehman filed for bankruptcy and AIG was rescued. From this point onwards, the crisis worsened considerably.

[Enter Figure 1 here]

The global nature of the crisis is immediately apparent. In the U.S., Germany, the United Kingdom and Japan growth turned negative immediately and output continued to shrink through 2009. But the slowdown clearly extended beyond the economies whose banks were directly affected. Countries heavily exposed to the U.S., such as Canada and Mexico,

had dramatic slowdowns. And in EMEs far from the epicenter of the crisis, the impact was seen as a slowing of growth in China, Indonesia and India or as negative growth in Brazil and Russia. While the global nature of the slowdown is clear from looking across the panels of the graph, so is the fact that there was widespread variation in GDP performance across economies. We exploit this variation to examine whether an economy's performance over the crisis period was the result of pre-crisis policy decisions or just luck.

2.2. Principal components analysis

Before turning to possible explanations for the variation in outcomes, we need to measure the impact of the crisis itself. Ideally researchers would like a measure that captures the degree to which output declined as a result of the crisis. Studies in this literature do not agree on a single measure. Most studies employ annual or quarterly GDP-based measures (Berkmen et al. 2009; Blanchard et al. 2010; Claessens et al. 2010; Didier et al. 2012; Devereux and Yetman 2010; Dominguez et al. 2012; Giannone et al. 2011; Rose and Spiegel 2010, 2012), while others use monthly industrial production (Imbs 2010; Rose and Spiegel 2011). Given that a crisis-free counterfactual is impossible to construct, some studies use a range of measures including consumption, domestic demand, changes in asset prices and exchange rate returns (Claessens et al. 2010; Frankel and Saravelos 2012; Lane and Milesi-Ferretti 2011; Rose and Spiegel 2012). This variety in approaches is both a strength and a weakness of this literature, as it is leads to sometimes conflicting results across studies.

We propose an alternative measure of each economy's relative GDP growth performance using the methodology utilized by Ciccarelli and Mojon (2010) to measure global inflation. We extract the first principal component of the quarter-on-quarter growth rate in seasonally-adjusted real GDP across 46 economies. Principal component analysis identifies a set of orthogonal variables that best explain the variation in the sample data. The first principal component corresponds to a line that passes through the multi-dimensional

mean of the data and minimizes the sum of squares of the distances of the points from that line. More formally, a country's predicted GDP growth is:

$$y_{it} = \Lambda y_{Gt} + \varepsilon_{it}, \quad (1)$$

where y_{it} is the actual quarter-on-quarter growth rate for country i in quarter t, y_{Gt} is the typical country's GDP growth as measured by the first principal component, Λ is the vector of factor loadings for each country on the first principal component and ε_{it} is the residual or unexplained component. The percentage of variation in each country's GDP growth explained by the first principal component depends on the factor loadings. Countries whose growth closely tracks the global economy will have high factor loadings and small residuals.

Principal components analysis requires a balanced panel, which restricts the start of our sample to 1Q 1998. We conclude our panel in 4Q 2009 – after the effects of the 2007-09 crisis on growth rates had substantially diminished but before the subsequent European sovereign debt crisis was fully underway.

2.3. Measuring idiosyncratic performance

Our objective is to examine whether policies adopted prior to the crisis can explain the variation in economic performance across countries. We wish to understand what explains each country's relative, rather than absolute, performance. This view is motivated by Imbs (2010), who documents an unprecedented international correlation in national business cycles since the end of 2008 relative to the prior three decades, with both goods and assets trade contributing to this increased synchronization.[6] Given this increased correlation of economies, we seek to identify what factors explain *why some economies fared better or worse than others in response to this global shock.*

[6] Kalemli-Ozcan et al. (2013) develop and calibrate a simple general equilibrium model of international business cycles with banks to test whether this increased synchronization is due to the growth of global banking.

For each economy, the fitted values of equation (1) are used as an estimate of each country's predicted GDP growth in each quarter based on their historical co-variance with the global business cycle. The residuals during the crisis period are the idiosyncratic – or *relative* – performance that we wish to explain. We explore what variables explain cross-country variation in this measure in response to the 2007-09 crisis.

We construct each economy's CGAP measure as the sum of output residuals from 1Q 2008 to 4Q 2009. The CGAP measure is attractive for a number of reasons. First, our measure should not be unduly sensitive to the stage of an economy's business cycle going into the crisis. An economy that was overheating prior to 2008 would tend to have a positive unexplained component (after extracting the global factor) at that point in time, but it is only the unexplained component *during the crisis itself* that is considered in our analysis. Second, this measure should be robust to differences in underlying growth rates, since relative performance is based on a country's deviation from what would be expected, given historical co-variances in GDP growth with the global business cycle. And third, the measure can be taken at each point in time, or summed over time, allowing for an assessment of different explanatory variables during different phases of the crisis.

2.4. Sample composition and characteristics

Table 1 provides an overview of the 46 economies in our sample, as well as key characteristics at year-end 2007. The sample economies are chosen based on data availability and consist of 29 advanced economies and 17 EMEs, including 18 of the G20 members.[7] We use the IMF classification to identify advanced economies vs. EMEs. This sample is the

[7] The two missing G20 members are Saudi Arabia, as no GDP data is available, and the European Union. 21 of the 27 member states of the European Union are included individually.

largest available given that we require a balanced panel of quarterly GDP to estimate the CGAP variable.

[Enter Table 1 here]

The size of the economies varies from very small (the Baltic countries) to very large (United States, China and Japan). The average ratio of total capital to risk-weighted assets for banks in 2007 was 13.2%. Between 1990 and 2007, 28 economies in our sample experienced a domestic banking crisis (Laeven and Valencia 2008). The average total capital ratio for banks in these countries was 14.4% in 2007, statistically higher than the average of 11.3% for the remaining countries (p-value 0.07). In 25 of the 46 economies, the central bank had sole responsibility for banking supervision in 2007. Eleven economies had exchange rate pegs while 30 had explicit inflation targets as guides for monetary policy. Around half of the economies featured current account deficits, with a range from a deficit of 22.3% in Latvia to a surplus of 26.7% in Singapore. The average government debt-to-GDP ratio was 46.7%, with the highest in Japan (187.7%) and the lowest in Hong Kong (1.4%). Private credit-to-GDP averaged 95.0%, ranging from 12.5% (Argentina) to 202.5% (Denmark). The loan-to-deposit ratio for banks varied widely, from 53% in the Philippines to 325% in Denmark.

Next we examine the relative economic performance across our sample. As discussed, we extract the first principal component of real GDP growth using equation 1, which explains 39% of the total variation in growth rates across our sample of 46 economies. The second principal component adds another 9.1% of variation, while the third explains 5.4%. Table 2 provides details on this principal component analysis, with the appendix displaying a screeplot of the eigenvalues of the components (Appendix: Figure A).

[Enter Table 2 here]

We only use the first principal component when generating our CGAP measure as we wish to retain as much cross-country variation as possible that may be related to pre-crisis

policy decisions and economic conditions. The plot of individual country loadings on the first two principal components (Appendix: Figure B) reveals that many Asian EMEs load more than the sample average on the second principal component including India, Indonesia, Malaysia, Thailand, Philippines, Korea, Singapore and Hong Kong. Employing two or more components to generate our CGAP measure would remove important variation that we wish to explain in our analysis.

Figure 2 displays the first principal component of global GDP growth, normalized to have a mean of zero and standard deviation of one. The figure shows the magnitude and timing of the global business cycle from 1998 to 2010. Following the bursting of the dotcom bubble in 2000–01, the global business cycle fell to around half of one standard deviation below the mean. By contrast, our estimates show that the response to the recent financial crisis was much more severe, with the global business cycle falling to more than four standard deviations below the mean in the first quarter of 2009 before recovering rapidly.

[Enter Figure 2 here]

Figure 3 shows that the ability of the first principal component to explain the economic performance of the sample economies varies considerably. Advanced economies are shown with darker bars, and EMEs with lighter bars. Some of the largest EMEs appear on the left of the figure, indicating that they exhibit highly idiosyncratic business cycles. Over this period India, Indonesia and Latvia were the least correlated with the average growth rate of the sample economies; the first principal component explains less than 7% of the variation in their GDP growth. A number of advanced economies are highly correlated with the first principal component and appear on the far right; Italy (81%), Finland (80%), and the United Kingdom (73%) are the most highly correlated. Many of the Euro economies lie to the right of the figure.

[Enter Figure 3 here]

2.5. Cross-country variation from 2006 to 2010

Figure 4 plots the idiosyncratic GDP growth of 12 major economies after subtracting the first principal component. What is striking is the different picture it presents of economic performance compared with Figure 1, which plots absolute real GDP growth for the same economies. There is wide variation in both the timing and severity of the crisis impact across countries. The North American economies, together with Japan, were the poorest performers early on, as seen by their negative output deviations during 2006–07. Brazil and Indonesia significantly outperformed many other economies throughout the crisis period. While Russia performed relatively well in late 2008 (when oil prices peaked at close to $150 per barrel), it exhibited the weakest relative performance of these 12 economies during 2010. These diverse experiences suggest that a variety of country-specific factors may be important in explaining the response of different economies to the crisis.

[Enter Figure 4 here]

Figure 5 plots the CGAP measure for each economy summed over the crisis period from 2008 to 2009. A positive value indicates that an economy performed better than would be expected based on past co-movements with the global business cycle, while a negative value indicates underperformance. A value of 10%, for example, implies an economy's cumulative real GDP growth was 10% higher than might have been expected over the 2008-09, given the path of the global economy. This period includes the worst stages of the crisis, both for those economies severely impacted by Lehman's failure and for those economies affected later when global trade contracted significantly (Chor and Manova 2012).

[Enter Figure 5 here]

Malaysia, Brazil and Indonesia are the best performers, with CGAPs of +7% or greater. Latvia, Estonia and Ireland are the worst, with measures below –8%. Since the measure is based on eight quarters of quarterly GDP growth, a CGAP of +7% corresponds to

annual real GDP growth outperformance of 3.5% relative to the global benchmark, while -8% corresponds to 4.0% annual underperformance. By construction, the sample is split between economies that outperformed and economies that underperformed. Some of the economies with a CGAP close to zero – Austria, Italy and the Netherlands – followed the global cycle most closely over this period. The United States does poorly, finishing 36th out of the 46 economies, well behind Japan (15th), China (17th) and Germany (20th).

3. Factors explaining cross-country variation over the crisis

Having ranked countries by their idiosyncratic performance during the crisis, we explore possible explanations for the cross-economy variation in the CGAP measure.

Table 3 summarizes the 35 explanatory variables used in our analysis, which include the most important variables from existing studies (Appendix C) as well as a number of variables related to banking system structure and bilateral portfolio exposures to the United States. Appendix A describes the sources and calculation for these variables. We categorize the explanatory variables under six headings: income level, banking system structure, credit, trade openness, financial openness, and monetary and fiscal policy. All variables are measured at year-end 2007 unless noted otherwise. The remainder of this section explains why these variables may contribute to cross-country differences in economic performance.

[Enter Table 3 here]

3.1. Income level

A number of studies find that income level is an important predictor of vulnerability or resilience during the crisis. We consider three measures of income level: a dummy variable set to one if the economy is an EME (as classified by the IMF), and zero otherwise; GDP per capita at market exchange rates; and GDP per capita at PPP exchange rates.

3.2. Banking system structure

The 2007-09 crisis was the result of a cascade of shocks that originated in the U.S. financial sector. It makes sense, therefore, to ask how the structure of a country's banking sector affected its vulnerability or resilience. Deposits are thought to be a relatively stable source of bank funding (Demirgüç-Kunt and Huizinga 2010). Economies where banks have relatively low pre-crisis loan-to-deposit ratios may therefore be more robust.

Similarly, better capitalized banks were better able to absorb losses while maintaining the supply of funding to support the real economy (Popov and Udell 2012). We measure the regulatory capital ratio for the average bank in each country at year-end 2007. Given the different instruments that qualified as regulatory capital under Basel II, we focus on the broadest measure of capitalization, namely the ratio of total capital-to-risk weighted assets.

Based on Laeven and Valencia (2008), we find that 28 of the economies in our sample experienced banking crises between 1990 and 2007. Such a crisis may have led policymakers to introduce reforms to reduce the financial sector's vulnerability. Consistent with this view, we find that economies with recent experience of a banking crisis have statistically higher total capital ratios than others in our sample.

While there is no theory that predicts such a relationship, the crisis provides an opportunity to test whether the structure of banking supervision matters. We split our sample between economies where the central bank is solely responsible for banking supervision (25 economies) and jurisdictions where this responsibility is either shared or falls wholly to another supervisory authority (21 economies). For example, banking supervision was the responsibility of the central bank in Israel and New Zealand, but was outside the central bank in Australia, China, Ireland and the UK. The structure of banking supervision is not statistically related to either the degree of banking concentration (measured using a Herfindahl index of bank assets) or past experience with a banking crisis.

Finally, it is unclear a priori how concentration of the banking sector may affect outcomes. On one hand, distress at one bank may lead to troubles at other domestic banks, leading more concentrated banking sectors to be more vulnerable. On the other hand, it may be easier for supervisors to effectively monitor the activities of a smaller number of banks, leading to the opposite outcome. The net effect is an empirical question.

3.3. Credit

Countries with higher credit growth pre-crisis or higher levels of credit-to-GDP may be more vulnerable to negative shocks. Table 3 shows that private sector credit-to-GDP averaged 95% of GDP for our sample, with the highest values for Denmark (202%), Ireland (198%) and the UK (187%) and the lowest for Argentina (12%), Mexico (17%), the Philippines (24%) and Indonesia (25%). Perhaps more importantly, in the period leading up to the crisis, private sector credit grew rapidly in many economies, especially in Turkey and in Central and Eastern Europe. Private sector credit growth averaged 6.8% per annum over 2005 to 2007, and 4.2% per annum over 2000 to 2006. We report results based on these two different measures to allow comparisons with existing studies that use these two periods.

Giannone et al. (2010) argue that policies that favor credit market liberalization are negatively correlated with countries' resilience to the recent recession. They use an index of credit market regulation from the Fraser Institute, where higher values represent greater liberalization. The index has an average of 7.2 in our sample, and ranges from a low of 4.8 in Brazil to a high of 8.7 in Hong Kong. Rose and Spiegel (2011) confirm the importance of this index for a large sample of economies, but Blanchard et al. (2010) find it is not statistically significant for their sample of EMEs.

3.4. Trade openness

An economy's trade patterns create one channel for the cross-border transmission of shocks. Chor and Manova (2012), for example, study the collapse of international trade flows during the global financial crisis and show how the shock was transmitted through this channel via the cost of financing. Countries where trade financing became relatively more expensive were hit harder during the crisis, particularly economies concentrated in sectors that require extensive external financing. Trade openness, measured by the sum of exports plus imports-to-GDP, captures the size of trade. The average ratio in our data is 106.1% of GDP, but the standard deviation of 85.2 percentage points implies a wide distribution. While the average economy in our data had a current account very close to zero in 2007, the range is large. Manufacturing may have suffered more due to the shock than services, particularly as global trade slowed sharply as the crisis worsened. Manufactures represented 52.9% of exports on average.

Finally, a country's natural endowment may play a role in its economic performance. Of the 46 economies in our sample, 8 are significant commodity exporters, whether of oil and natural gas (Norway, Russia), precious or base metals (Brazil, Chile, South Africa), agricultural products (New Zealand) or some combination of the above (Australia, Canada).

3.5. Financial openness

An economy's integration into the global financial system provides another channel for the transmission of global shocks. We use Lane and Milesi-Ferretti's (2007) updated external wealth of nations dataset, which measures gross and net foreign assets (NFA). The average economy in our data had a negative NFA position in 2007, with gross foreign liabilities exceeding gross foreign assets. Lane and Milesi-Ferretti (2011) note that these net figures mask even greater variation of gross exposures, which can be seen by summing foreign assets and foreign liabilities to create a measure of financial openness. Gross

positions for the average economy at end-2007 represented 443% of GDP, with a standard deviation of 526%. Small economies with large financial centers had very large positions, led by Ireland (2573% GDP), Hong Kong (2390%), Switzerland (1357%) and Singapore (1039%). At the other extreme, the least open economies on this measure were Mexico (84%), India (85%) and Indonesia (87%). Given this wide variation, we use the natural log of financial openness in our analysis.

The BIS Consolidated Banking Statistics provide data on the exposure of foreign banks to a given economy for 25 of the 46 economies in our sample. This data is exploited by Cetorelli and Goldberg (2011, 2012), Imbs (2010) and Kalemli-Ozcan et al. (2013). Banks resident in the United States accounted for an average 9% of consolidated foreign claims in the other 24 economies (measured on either an immediate borrower or an ultimate risk basis). Foreign banks, by contrast, accounted for an average 3.8% of consolidated foreign claims on U.S. residents, with the largest claims for banks headquartered in the UK (20%), Switzerland (17%), Germany (14%), Japan (12%) and France (11%). Together, banks headquartered in these countries accounted for close to three quarters of consolidated foreign claims on U.S. residents at end-2007. Kalemli-Ozcan et al. (2013) argue that these bilateral banking exposures with the U.S. provided a channel for the transmission of the U.S. shock to foreign economies. While we cannot study this channel for all countries in our sample, we are able to test this transmission mechanism for the subset of economies for which data is available.

Cross-border securities holdings provide another potential channel for financial (and ultimately real) contagion (Fratzscher 2012; Kamin and DeMarco 2012). The U.S. Treasury International Capital (TIC) reporting system measures the investments of foreigners (both public and private sector) in U.S. securities and the investments of U.S. residents abroad (Bertaut et al. 2006, 2012). The TIC data is disaggregated by country and breaks down investments into short-term and long-term debt and equities. Prior to the crisis, the TIC data

show a large increase in foreign investment in corporate asset-backed securities, mortgage-backed securities and asset-backed commercial paper (Bertaut et al. 2012). By mid-2007, foreign investors held $4.8 trillion of U.S. debt securities and $2.2 trillion of U.S. equities. For their part, U.S. residents held close to $6 trillion of foreign securities by year-end 2007. To put these sums into perspective, the average foreign economy's residents held U.S. equities and debt securities equivalent to 20% of foreign GDP while U.S. residents held securities equivalent to 16% of foreign GDP. Table 3 provides details on foreign holdings of U.S. long-term and short-term debt and equities, and US holdings in foreign countries.

Figure 6 shows the change over time of these U.S. and foreign cross-border holdings. U.S. portfolios of foreign securities grew steadily prior to the crisis and fell sharply in 2008 before recovering from 2009 onwards. Foreign holdings of U.S. securities also grew at a similar pace, although there is little evidence of a correction over the crisis. Bertaut et al. (2012) explain that foreign investors substituted riskier debt securities, such as corporate bonds, with lower-risk U.S. government securities, with little noticeable reduction in equity holdings. These aggregate totals, however, conceal considerable variation across countries that we exploit in our analysis below.

[Enter Figure 6 here]

3.6. Monetary and fiscal policy

Monetary and fiscal policies are powerful tools for responding to shocks to the real economy. Of potential importance is the policy framework, which determines the tools policymakers have at their disposal, and the policy settings at the start of the crisis, which influences the scope for future policy actions.

In terms of monetary policy, 11 out of the 46 economies had some form of fixed exchange rate regime. This group includes countries with currency boards (e.g. Estonia, Hong Kong), conventional fixed pegs (e.g. euro area countries) and crawling pegs (e.g. China). The

remaining 35 economies had either a freely floating exchange rate, as in Japan and the U.S., or a managed floating exchange rate, as in Singapore. The average economy had foreign exchange reserves equivalent to 16% of GDP in 2007. Economies with an exchange rate peg had average foreign exchange reserves of 35%, significantly higher than the 11% average for economies with a floating exchange rate (p-value 0.001). Out of the 35 economies with floating exchange rates, 30 had an explicit inflation targeting framework.[8] CPI inflation in 2007 averaged 4.4% in our sample, with inflation targeters having statistically lower average inflation (p-value 0.05) and countries with an exchange rate peg having statistically higher average inflation (p-value 0.005).

Turning very briefly to fiscal policy, we include information on the size of the government budget surplus, the share of government revenues and expenditures to GDP, the level of central government debt-to-GDP at year-end 2007 and the share of government short-term debt-to-GDP. High levels of government revenues and expenditures before the crisis may reduce policymakers' flexibility to respond to shocks.

4. Empirical results

We now explore possible explanations for the varying economic performance across our sample. We begin with univariate tests of the difference in medians, then estimate bivariate relationships using OLS, and conclude by estimating multivariate models using LARS and OLS regressions.

4.1. Tests of the difference in medians across groups

We test for differences in the median CGAP across country groups using the non-parametric Wilcoxon rank-sum test. It tests the hypothesis that two independent (i.e.

[8] In our sample, only India had capital controls in 2007 so this variable is not considered in our analysis.

unmatched) samples are drawn from populations with the same distribution. We divide our countries into two groups based on each explanatory variable, and calculate the median CGAP for each group. In the case of a dummy (or dichotomous) variable such as the EME dummy, the demarcation between groups is clear. For continuous variables, we divide the sample at the median into two halves: economies where the explanatory variable is above the median are in group 1, and the remainder in group 0. We then test whether the median CGAPs for each group are statistically different from each other.[9]

Table 4 provides the rank-sum test for the 35 explanatory variables from Table 3, with the number of countries in each group, the median CGAP for each group, and the difference in medians shown for each explanatory variable. A positive CGAP represents outperformance relative to the sample average, and a negative CGAP underperformance.

[Enter Table 4 here]

We highlight the most robust results across the six categories of variables. The first row shows the sample is split between 29 advanced economies and 17 EMEs. The median CGAP for an EME was 3.2% vs. –0.7% for advanced economies. These medians are statistically different from each other at the 1% level. The difference of 3.9 percentage points indicates EMEs outperformed advanced economies by around 2% per year over 2008-2009. This relationship is confirmed when using GDP per capita (both market and PPP exchange rates).

Of the banking system variables, economies with a lower loan-to-deposit ratio and better capitalized banks performed better by 4.0% and 2.1%, respectively. Economies that experienced a banking crisis between 1990 and 2007 fared better by 3.3%. The location of bank supervision and degree of banking concentration do not explain outcomes.

[9] Tests of differences at the mean based on a parametric t-test provide similar results, and are available upon request.

Regarding credit, economies with lower pre-crisis levels or growth rates of private sector credit-to-GDP did significantly better. Economies in the lower half of credit-to-GDP had a median CGAP of +1.4% vs. –0.6% for economies in the upper half. The difference in median CGAP is largest when comparing credit growth over the longer period from 2000-2006. Greater liberalization of credit markets was not statistically important.

On trade openness, the median economy with a current account surplus outperformed the median with a current account deficit by 3.6%. Surprisingly, countries with higher share of manufacturing in exports in our sample outperformed by 2.9%. The ratio of exports plus imports-to-GDP and the dummy variable for commodity exporters are not significant.

On financial openness, economies with greater financial openness fared worse by 3.9%. For the 25 economies where BIS data is available, countries dependent on U.S. banks for a larger share of private sector credit fared better. Foreign economies holding short- and long-term U.S. debt above the median outperformed those below the median by 3.5%.[10] Economies with higher U.S. holdings of foreign short-term debt fared worse. Cross-border holdings of equity securities do not distinguish outcomes.

Of the monetary policy variables, countries with a larger stock of FX reserves-to-GDP outperformed. Economies in the upper half of this variable had a median CGAP of +2.9% versus –0.7% for economies in the bottom half, a difference of 3.5%. None of the other monetary policy variables are associated with statistically different CGAPs across groups.

Of the fiscal policy variables, countries with a small government outperformed, whether measured by low government revenues or expenditures-to-GDP. Countries with lower levels of short-term debt-to-GDP proved more resilient, with the median CGAP of the

[10] This relationship with foreign holdings of US short-term debt does not appear to be related to the level of foreign exchange reserves (correlation -0.465), the use of an exchange rate peg (-0.076), a current account surplus (0.017) or the presence of positive net foreign assets (0.130).

lower half around 3.0% vs. -0.7% for the upper half. Finally, countries with lower short-term debt-to-GDP outperformed those in the upper half by 4.0%.

4.2. Bivariate regressions

Having identified a number of significant relationships using the difference-of-median tests, we now explore whether these relationships are present when running linear OLS regressions. We regress CGAP on each explanatory variable plus a constant. Table 5 shows the results of these regressions. The first two columns are estimated using the full sample of 46 economies. In the first column we use no controls. In the second column we control for GDP per capita. The third and fourth columns split the sample between 29 advanced economies and 17 EMEs, respectively.[11] The reported coefficients are standardized to show the impact of a one standard deviation change in the explanatory variable on idiosyncratic performance. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively, based on robust standard errors.

[Enter Table 5 here]

The first column confirms the key relationships from Table 4 with many variables exhibiting either a statistically significant positive or negative relationship with CGAP. For example, the positive coefficient on the EME dummy confirms that EMEs outperformed advanced economies by 1.9% on average, and the difference is statistically significant at the 1% level. The second column shows that the estimated coefficient on the EME dummy is not statistically significant when controlling for GDP per capita, likely due to the correlation between these two variables of -0.86 (p-value 0.000). When used alone, GDP per capita,

[11] Rose and Siegel (2011) show a similar split for 51 high income economies (2008 GNI of $11,906 or greater) and a second category "No advanced", which generates a mix of 74 EMEs and low income economies.

computed using either market or PPP exchange rates, is statistically significant at the 1% level.

The following relationships, reported in columns 1 and 2 of Table 5, are generally robust to controlling for GDP per capita and consistent with the results in Table 4: bank loan-to-deposit ratios, private sector credit-to-GDP, credit growth over 2005-07 or 2000-06, the current account, net foreign assets, US banks' share of foreign credit, US holdings of foreign short-term debt, FX reserves-to-GDP, government revenues or expenses-to-GDP and short-term debt-to-GDP.

The results so far generally accord with the existing studies of Didier et al (2012), Frankel and Saravelos (2012), Lane and Milesi-Ferretti (2011) and Rose and Spiegel (2011). The final two columns of Table 5 show the results when the sample is split between advanced economies and EMEs. The results are surprisingly strong, particularly in light of the small sample sizes. First, EMEs that experienced a prior banking crisis outperformed during the crisis. Supervisors in these countries appear to have taken steps to reduce the vulnerability of their banking systems, including raising total capital levels. Second, Table 5 shows that the current account balance is statistically important, both for the full sample and for advanced economies and EMEs separately. Third, more measures of financial openness are statistically significant for EMEs than for advanced economies. In particular, a one-standard deviation increase in financial openness decreased CGAP by 1.6%. Three of the TIC variables help to identify EMEs that outperformed, against just one for advanced economies. More notably, the estimated effect of US holdings of foreign short-term debt flips signs; larger US holdings were associated with superior performance for EMEs, but poorer performance for advanced economies. Overall these results using TIC data confirm – using a different dataset – Fratzscher's (2012) finding that cross-border equity and bond mutual fund flows respond to

different push and pull factors during the crisis depending on whether the sample is advanced economies or EMEs.

Under the monetary policy variables, we see that FX reserves are positive only for advanced economies and not for EMEs. This result may explain why this variable is important for the large samples of Dominguez et al. (2012) and Frankel and Saravelos (2012) but not for the EME samples employed by Berkmen et al. (2012) and Blanchard et al. (2010). Higher inflation is associated with underperformance for both advanced economies and EMEs when tested separately, although the evidence in the joint sample is weak. For the fiscal policy variables, overall debt levels don't appear to matter but higher short term debt has a negative sign for EMEs. On closer examination, a number of EMEs with the highest debt levels in 2007 also had the lowest share of short-term debt-to-GDP, namely: Mexico, India, Brazil, Indonesia and Argentina. By having issued a debt stock with long average maturity, these countries proved to be more resilient to the global shock than countries such as the Baltics, Hungary and Slovenia where short-term debt levels were the highest. This result points to the importance of debt maturity management for increasing a country's resilience.

4.3. Least Angle regressions

In line with the existing literature, we now examine whether a combination of these variables can explain the variation in an economy's idiosyncratic performance. With only 46 observations and many candidate regressors (shown in Table 3), we need to be cautious about the degrees of freedom.[12] Multicollinearity among the regressors is also a potential problem, with absolute correlations greater than 0.650 for a number of variables (see Appendix B).

[12] We exclude foreign bank exposures from the multivariate analysis, as this variable is only available for 25 economies.

To address these shortcomings, we employ a statistical data-mining technique known as Least Angle Regression (LARS) that considers parsimony as well as prediction accuracy in fitting data (Efron et al. 2004). LARS is similar to forward stepwise regression, but more computationally efficient. Recall that forward stepwise regression starts with all coefficients equal to zero. In the first step, it finds the explanatory variable from the set of co-variates that is most correlated with the dependent variable, and adds it to the model. In the next iteration, it adds the explanatory variable that is next-most correlated with the residuals from the first step. This process continues until all explanatory variables that meet some condition (e.g. significant at the 10% level) are included in the model. A key feature of forward stepwise regression is that the decision to include a variable is discrete – a variable is either added or dropped from the model. Small changes in the data can therefore result in very different models being selected (Tibshirani 1996). Forward stepwise regression is also 'greedy' – it tends to throw out candidate variables that are not orthogonal with existing model regressors. This property means the order that variables enter the model matters.

LARS follows the same general approach but, unlike stepwise regression, LARS does not add an explanatory variable fully into the model. LARS minimizes the sum of squared residuals subject to the sum of the absolute value of coefficients being less than some constant (or tuning parameter) c. The coefficient of a given predictor is increased only until that predictor is no longer the one most correlated with the residuals; LARS therefore generates smaller absolute coefficients than OLS methods. LARS does not automatically throw out any remaining variables that might be correlated with the existing regressors, but instead looks for better combinations that explain the total variation in the sample. One implication of these two properties is that the solution will contain many coefficients that are exactly zero and hence the estimated model will be parsimonious. LARS also improves prediction accuracy. The downside is that the LARS procedure does not generate the same estimated coefficients as an OLS model. The LARS coefficients are a non-linear and non-

differentiable function of the dependent variable subject to the tuning parameter *c*. This statistical property makes it difficult to estimate standard errors and challenging to interpret the statistical significance of the estimated coefficients in the traditional sense (Tibshirani 1996).

In our study, we run LARS in Stata using both the Lasso and Forward Stagewise algorithms.[13] The Lasso algorithm constrains the sum of the absolute value of the regression coefficients to be less than some constant. The explanatory variables enter the regression sequentially as the constant is increased. Forward Stagewise regression is similar to forward stepwise regression but moves forward in many more, smaller steps and avoids throwing out regressors too hastily. We find that both algorithms generate very similar results so only report the Lasso results. Efron et al. (2004) describe both methods in detail.

Table 6 shows the results of the LARS regressions using the Lasso algorithm. LARS requires a balanced panel, so we drop the United States (as there are no observations for the TIC data by design, since the United States is the numeraire country). We also drop the BIS Consolidated Banking Statistic variables (US share of foreign credit, foreign share of US credit) as they are only available for 25 countries. We are left with a balanced panel of 33 explanatory variables for 45 economies. To estimate LARS, the CGAP variable must be demeaned while the explanatory variables are demeaned and normalized to have mean zero and unit Euclidean length. Many of the variables are close substitutes (e.g. GDP per capita at market vs. PPP exchange rates) or correlated with each other. LARS determines which variables to use and estimates the coefficient to best fit the data. Table 6 shows the first twenty coefficients selected and deselected for three samples: the 45 economies, the 28 advanced economies and the 17 EMEs.

[13] Lasso stands for "least absolute shrinkage and selection operator" (Tibshirani 1996). We are grateful to Adrian Mander of the University of Cambridge for providing his Stata code for running LARS.

[Enter Table 6 here]

Focusing on the full sample, the first variable selected is the bank loan-to-deposit ratio, which – based on the estimated coefficient – explains 12% of the variation in CGAP. The next four most important variables are: the current account, credit growth over 2000-06, government short-term debt-to-GDP and U.S. holdings of foreign short-term debt. These five variables explain 57% of the variation in CGAP. The model fit increases much less for the next five variables added: the EME dummy, the index of credit market regulation, trade openness, financial openness and private sector credit-to-GDP. These five variables account for an additional 13% of variation in CGAP, raising the R-squared to 70%.

When running LARS using only the advanced economies, Table 6 shows there are notable differences in variables selected. The first variable chosen is credit growth over 2005-07, with loan-to-deposit ratio not picked up until the 7th variable. U.S. holdings of foreign short-term debt jumps into second position, followed by credit growth over 2000-06. The current account balance and the inflation rate round out the top five variables which, all together, explain three-quarters of the variation in relative performance. Notice that government short-term debt does not make the top 20 variables selected for the sample of advanced economies, whereas it entered 4th for the full sample.

The far right panel of Table 6 shows the LARS results estimated using only EMEs. Credit growth over 2000-06 is the first variable to enter, followed by the current account, the loan-to-deposit ratio and foreign holdings of US short-term debt. In the 5th step, government short-term debt is added but the current account is removed. Together, close to half of the variation in CGAP is explained after 5 steps.

One key difference between these results is that a relatively parsimonious LARS model, consisting of credit growth, U.S. holdings of foreign short-term debt and the current account, can explain more than two thirds of the total variability in the performance of

advanced economies during the crisis. (As we will see, if we use OLS regression, the variation explained by the same four variables exceeds four-fifths). The much lower R-squared measures at each stage in the right-hand column of Table 6 indicates that no such parsimonious explanation exists for the relative performance of EMEs.

Table 7 shows the coefficient estimated using LARS in Panel A and the same regressions estimated using OLS regressions with robust standard errors in Panel B. The OLS regressions replicate the same ordering of LARS variables for ease of comparison. Notice that the estimated coefficients generally have the same sign, but the magnitude of the LARS coefficients is smaller than under OLS. This difference is best seen in the lower sum of the absolute coefficients for the equivalent specifications.[14] While the OLS coefficients include asterisks for statistical significance, no such measure is shown for the LARS coefficients due to their statistical properties, as explained earlier.

[Enter Table 7]

Panel B of Table 7 shows that some of the variables selected by LARS are not statistically different from zero when estimated using OLS. For example, credit growth over 2000-06 is never significant even though it is found to be important in the difference-in-medians tests in Table 5 and the bivariate regressions in Table 6. The reason is multicollinearity. In our sample, credit growth over 2000-06 has a high, positive correlation of 0.68 (p-value 0.000) with the loan-to-deposit ratio. But LARS identifies both variables as important for explaining the variation in outcomes across countries, something that would have been missed using forward stepwise regressions.

Table 8 shows the results of OLS regressions when the sample is split between advanced economies and EMEs. For ease of comparison, we do not show the LARS

[14] The sum of the absolute values of the coefficients using LARS is always smaller than the equivalent OLS regression by construction.

coefficients, although the selection of variables is shown in Table 6. Panel A confirms that a few variables can explain much of the variation in idiosyncratic performance for the advanced economies. Higher credit growth over 2005-07 and (separately) over 2000-06, higher US holdings of foreign short-term debt and the current account are significant and explain 81% of the variation in CGAP. Additional variables have more modest effects on explanatory power.

Panel B of Table 8 again illustrates the difficulty in explaining outcomes for EMEs. The coefficient on the first variable to enter, credit growth over 2000-06, changes sign from negative positive and back again, and is insignificant at many of the steps. In general, few variables are significant for the EMEs. This finding highlights how the importance of different variables changes based on their combination, with different variables important for different EMEs in the sample.

[Enter Table 8]

5. Conclusion

The economic performance of individual economies varied markedly during the 2007–09 global financial crisis. We exploit this cross-country variation to examine whether a country's economic performance over 2008-2009 was the result of pre-crisis policy decisions or just luck. The answer is a bit of both. Better-performing economies – whether advanced or emerging market economies – featured lower rates of private sector credit-to-GDP growth in the years before the crisis, lower loan-to-deposit ratios and a current account surplus.

The level of income plays an important role in explaining relative performance, with low income economies generally out-performing higher income ones. When examining advanced economies and EMEs separately, we find that different variables explain the greater vulnerability or resilience of economies. Private sector credit-to-GDP growth in the years

before the crisis, lower loan-to-deposit ratios and a current account surplus can explain 75% of the cross-country variation in our measure of idiosyncratic (relative) performance for advanced economies. In contrast, EME relative performance defies such simple explanation.

Overall, sound pre-crisis policy decisions and institutions reduced a country's vulnerability to the financial crisis, but luck also played a part. The absence of a parsimonious model for EMEs suggests that luck played a more important role for these economies than for the advanced economies.

Some caveats are important in drawing policy implications from these results. First, we have examined each country's idiosyncratic performance after removing the effects of a global factor; we have not studied a country's absolute GDP performance. We would caution against generalizing these results to other performance measures. Second, we have focused on the benefits of different measures during a specific crisis episode. Our results have not been backtested on prior crises.[15] Finally, we do not attempt to identify a desired set of policies or to develop an early warning system. Determining optimal policy would depend on a careful analysis of the costs and benefits of policy measures under the full range of possible outcomes.

[15] Didier et al. (2012) test their results against the Asian and Russian crises of 1990s. Rose and Spiegel (2011) test whether the current crisis results can explain global slowdowns in 1991-92 and 2001-02. Generally, the authors find that the current shock was unique in magnitude and causes.

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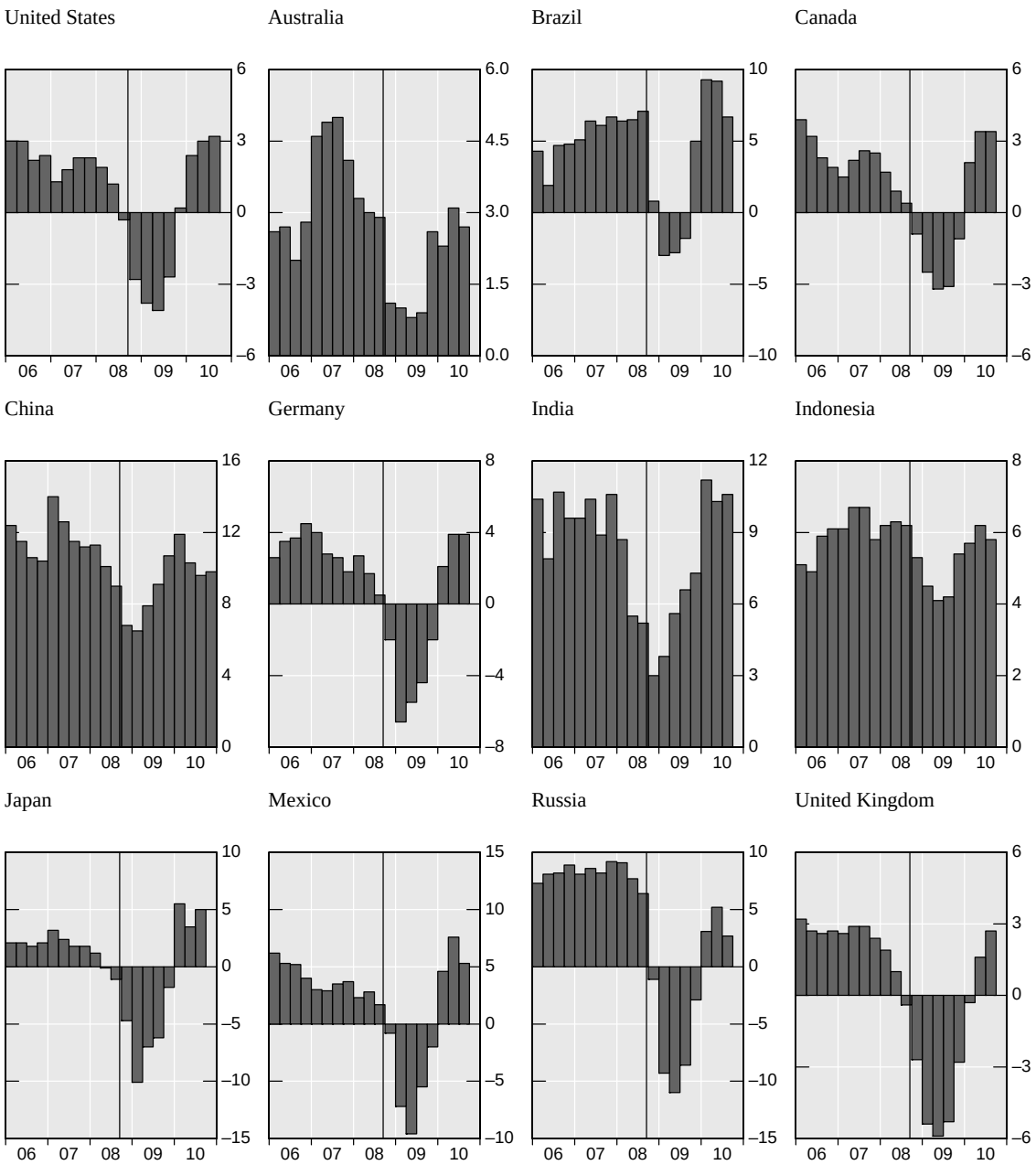
Figure 1: Year-on-year real GDP growth across countries

In per cent



Vertical line marks 15 September 2008, the date on which Lehman Brothers filed for Chapter 11 bankruptcy protection.
Sources: DataStream; IMF IFS; OECD; authors' calculations.

Figure 2: Global GDP growth: first principal component

In per cent

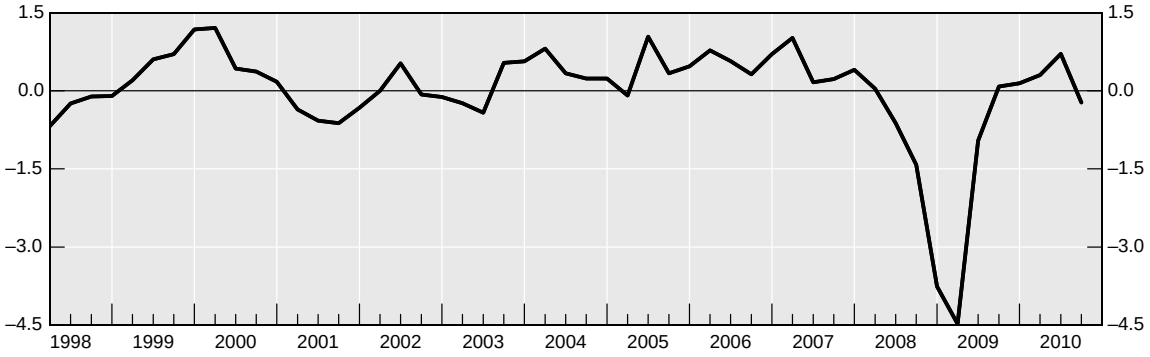


Figure 3: Variation explained by first principle component

In per cent

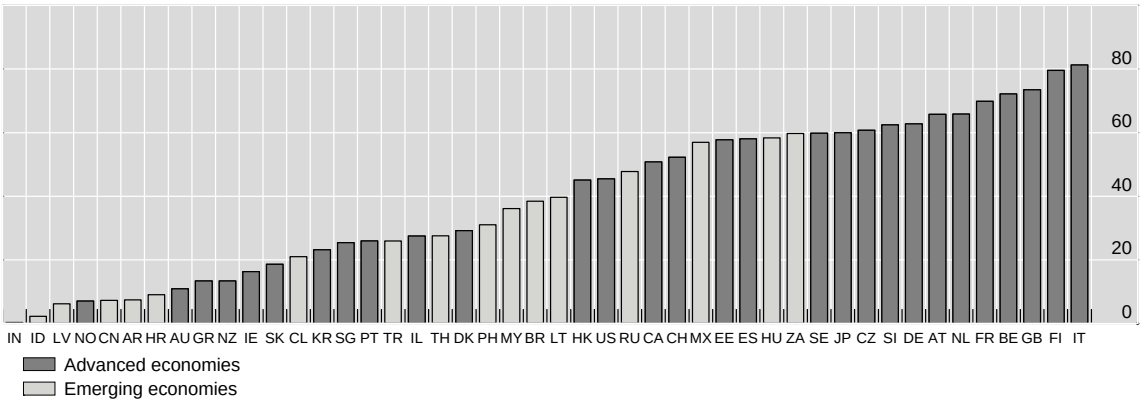
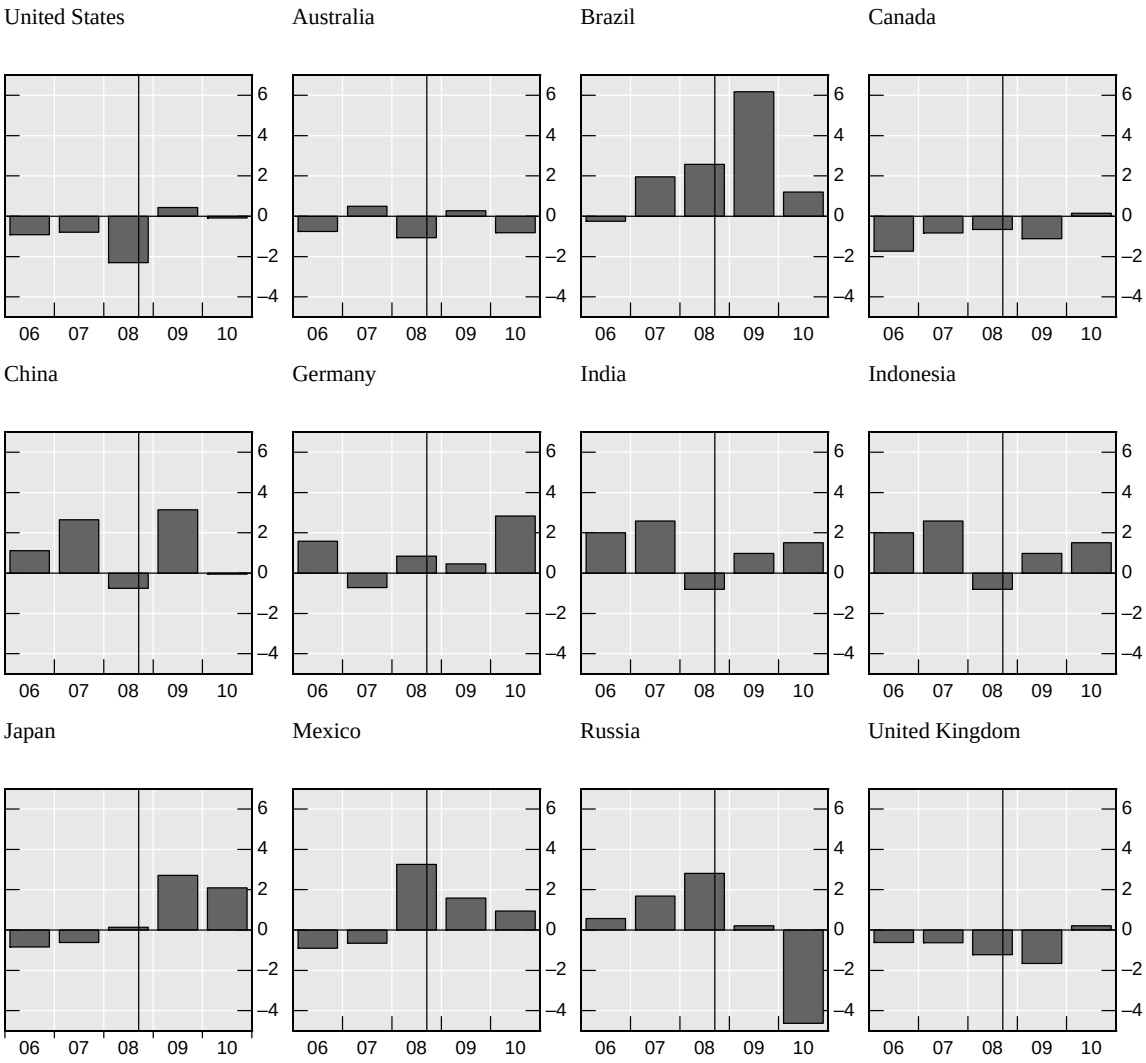


Figure 4: Idiosyncratic component of real GDP growth

In per cent



The vertical line in each panel marks 2008, the year when the financial crisis worsened and spread globally. For 2010, residuals are only available for the first three quarters. These are scaled by 4/3 to enable comparison with other years.

Figure 5: Relative economic performance, 2008 Q1–2009 Q4

In per cent

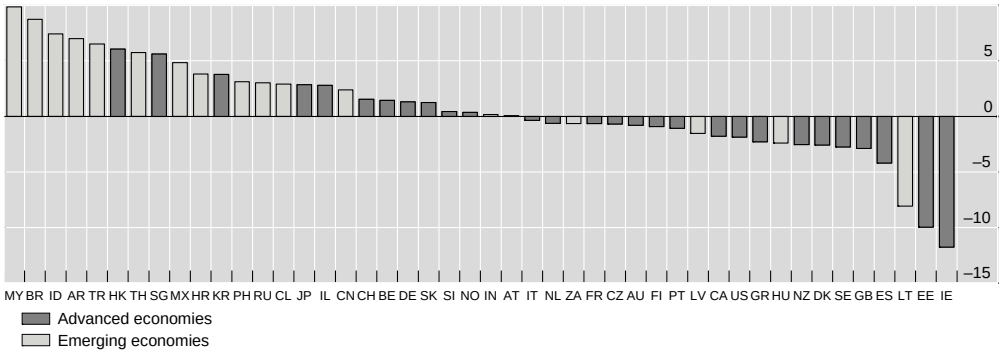
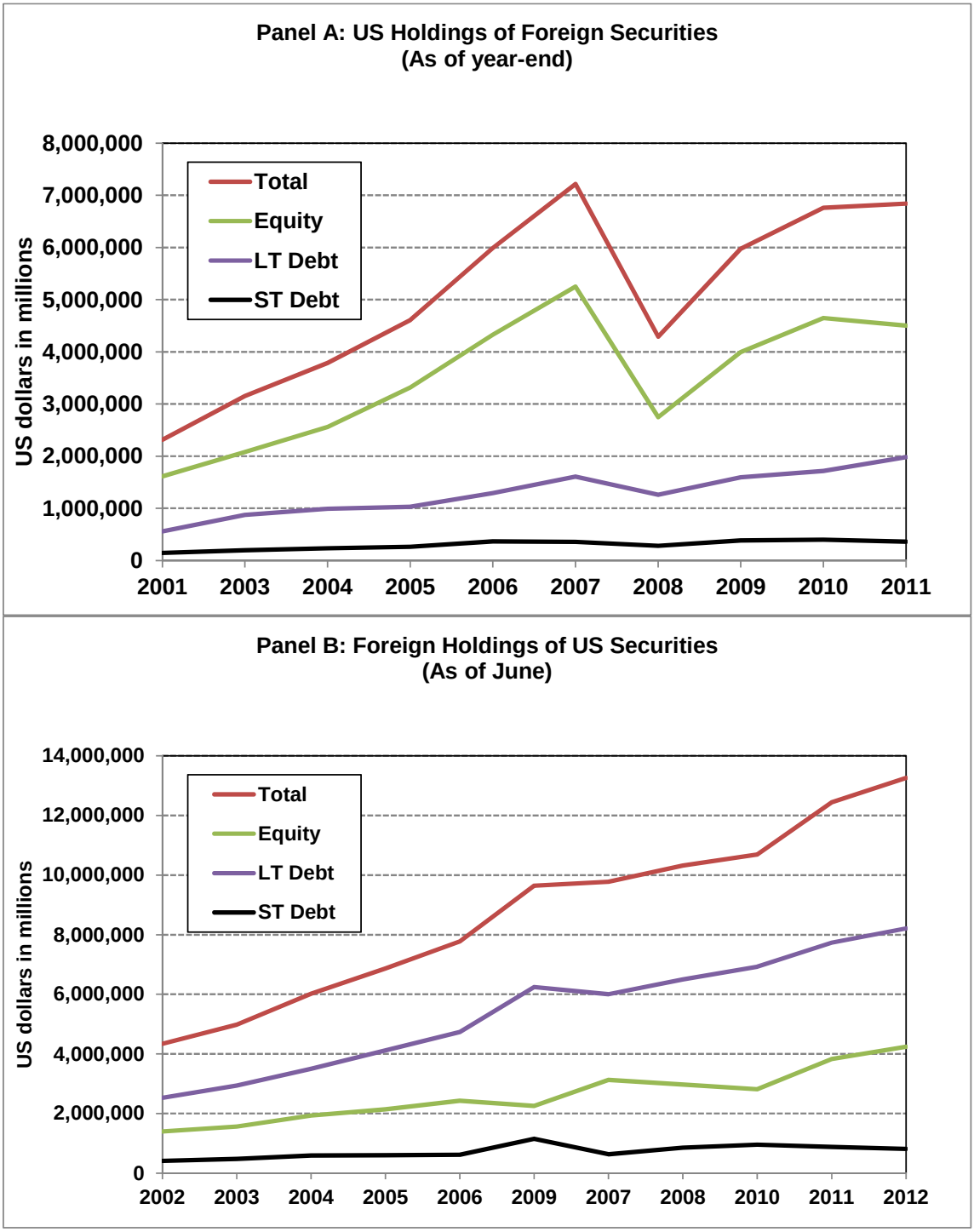


Figure 6: U.S. holdings of foreign securities and foreign holdings of U.S. securities



Source: U.S. Treasury International Capital (TIC) data.

Table 1: Countries in sample

This table provides an overview of the sample and key variables, all at year-end 2007. Appendix A provides the description of variables and sources.

Country	ISO code	EME[1]	Banking crisis, 1990-2007	CB bank supervisor	FX peg	Inflation target	Bank total capital ratio	Current account / GDP	Debt / GDP	Credit / GDP	Loan / deposit[2]
Argentina [3]	AR	1	1	1	1	0	8.8	2.3	67.9	12.5	87.1
Australia	AU	0	0	0	0	1	9.9	-6.2	9.5	117.3	166.6
Austria	AT	0	0	0	0	1	11.1	3.5	59.2	114.6	139.1
Belgium	BE	0	0	0	0	1	15.3	1.6	82.8	90.3	118.6
Brazil	BR	1	1	1	0	1	16.6	0.1	65.2	42.1	105.1
Canada	CA	0	0	0	0	1	11.5	0.8	65.1	125.2	77.1
Chile	CL	1	1	0	0	1	10.7	4.5	4.1	73.9	114.3
China	CN	1	1	0	1	0	10.3	10.6	19.8	107.5	75.0
Croatia	HR	1	1	1	1	0	13.2	-7.6	33.2	63.1	100.2
Czech Republic	CZ	0	1	1	0	1	18.3	-3.3	29.0	48.0	74.6
Denmark	DK	0	0	0	1	0	16.7	1.6	34.1	202.5	325.0
Estonia	EE	0	1	0	1	0	14.6	-17.2	3.7	92.7	184.3
Finland	FI	0	1	0	0	1	15.3	4.3	35.2	79.6	155.5
France	FR	0	0	1	0	1	9.2	-1.0	63.8	103.6	136.4
Germany	DE	0	0	0	0	1	19.0	7.6	64.9	103.9	143.7
Greece	GR	0	0	1	0	1	11.9	-14.4	95.6	90.9	111.7
Hong Kong	HK	0	0	1	1	0	15.1	12.3	1.4	139.7	54.8
Hungary	HU	1	1	0	0	1	13.8	-6.5	65.8	61.8	138.0
India	IN	1	1	1	0	0	11.6	-0.7	72.9	45.2	80.0
Indonesia	ID	1	1	1	0	1	12.9	2.4	36.9	25.5	64.7
Ireland	IE	0	0	0	0	1	11.6	-5.3	25.0	198.5	160.5
Israel	IL	0	1	1	0	1	10.7	2.9	77.6	87.9	83.8
Italy	IT	0	0	1	0	1	10.8	-2.4	103.5	100.2	164.3
Japan	JP	0	1	0	0	0	10.1	4.8	187.7	98.2	70.8
Korea	KR	0	1	0	0	1	11.8	0.6	29.7	99.6	144.5
Latvia	LV	1	1	0	1	0	14.6	-22.3	7.8	88.7	139.4
Lithuania	LT	1	1	1	1	0	10.4	-14.6	16.9	60.0	149.3
Malaysia	MY	1	1	1	0	0	18.6	15.9	42.7	105.3	76.4
Mexico	MX	1	1	0	0	1	14.2	-0.8	38.2	17.2	96.6
Netherlands	NL	0	0	1	0	1	10.9	8.6	45.5	184.2	135.1
New Zealand	NZ	0	0	1	0	1	10.1	-8.0	17.4	140.7	145.1
Norway	NO	0	1	0	0	1	16.5	14.1	58.6	91.6	178.7
Philippines	PH	1	1	1	0	1	21.1	4.9	47.8	23.8	52.9
Portugal	PT	0	0	1	0	1	9.6	-9.0	62.7	160.7	156.9
Russia	RU	1	1	1	1	0	16.4	5.9	8.5	38.2	120.6
Singapore	SG	0	0	1	1	0	15.0	26.7	86.0	89.2	76.7
Slovakia	SK	0	1	1	1	0	15.7	-5.3	29.3	44.2	76.3
Slovenia	SI	0	1	1	0	1	18.6	-4.8	23.3	78.7	137.0
South Africa	ZA	1	0	1	0	1	12.2	-7.2	27.4	77.5	111.6
Spain	ES	0	1	1	0	1	10.9	-10.0	36.1	183.6	174.1
Sweden	SE	0	1	0	0	1	9.3	8.4	40.1	121.5	239.8
Switzerland	CH	0	0	0	0	0	16.8	9.0	43.6	173.6	94.2
Thailand	TH	1	1	1	0	1	8.9	6.3	38.3	91.8	90.3
Turkey	TR	1	1	0	0	1	15.9	-5.9	39.4	29.5	66.7
United Kingdom	GB	0	0	0	0	1	11.9	-2.6	43.9	187.3	126.6
United States	US	0	1	1	0	0	10.9	-5.1	62.1	60.4	108.7

1. Based on the IMF classification of advanced and emerging market economies.

2. Loan-to-deposit shown is before taking the natural logarithm.

3. The IMF reclassified Argentina from a pegged exchange rate to a floating one in October 2008.

Table 2: Principal component analysis of quarterly GDP, 1Q 1998 to 3Q 2010

This table shows the principal components estimated using a balance panel of quarterly real GDP, seasonally adjusted, for 46 countries from 1Q 1998 to 3Q 2010. Principal component analysis is a statistical technique used for data reduction. The leading eigenvectors from the eigen decomposition of the correlation or covariance matrix of the variables describe a series of uncorrelated linear combinations of the variables that contain most of the variance.

Component	Eigenvalue	Proportion of variation explained	Cumulative proportion of variation explained
1	18.10	0.394	0.394
2	4.17	0.091	0.484
3	2.49	0.054	0.538
4	2.38	0.052	0.590
5	1.83	0.040	0.630
6	1.72	0.037	0.667
7	1.50	0.033	0.700
8	1.44	0.031	0.731
9	1.31	0.028	0.759
10	1.07	0.023	0.783
Quarters	51		
Countries	46		

LR test for independence: $\chi^2(1,035)= 2273.84$, Prob. > χ^2 = 0.0000

LR test for sphericity: $\chi^2 (1,080)= 2316.88$, Prob. > χ^2 = 0.0000

Table 3: Variables that may explain cross-country variation in performance

This table provides descriptive statistics for the six categories of variables that may explain the variation in crisis outcomes by country. All variables are measured at year-end 2007 except where otherwise stated. We take the natural log of some variables to reduce the impact of outliers. We use Ln(1+x) as some variables take on a value of zero for some observations.

Description	Units	Obs	Mean	Standard deviation	Median
1. Income level					
Emerging market economy = 1	dummy variable	46	0.4	0.5	0.0
GDP per capita at market rates	Ln(US $)	46	9.8	1.0	10.1
GDP per capita at PPP rates	Ln(US $)	46	10.0	0.7	10.2
2. Banking system structure					
Loan / Deposit ratio	Ln(%)	46	4.7	0.4	4.8
Total capital ratio	% of RWA	46	13.2	3.2	12.1
Banking crisis 1990–2007 = 1	dummy variable	46	0.6	0.5	1.0
CB bank supervisor = 1	dummy variable	46	0.5	0.5	1.0
Banking concentration (Herfindahl)	%	46	21.5	15.8	17.3
3. Credit					
Private sector credit	% of GDP	46	95.0	49.6	91.2
Credit growth, 2005-07	% per annum	46	6.8	7.1	6.2
Credit growth, 2000-06	% per annum	46	4.2	8.1	3.2
Index of credit market regulation	1=low, 10=high	46	7.1	0.9	7.2
4. Trade openness					
Current account	% of GDP	46	0.0	9.1	0.3
Exports + Imports	Ln(% of GDP)	46	4.5	0.6	4.4
Manufacturing / Exports	%	46	52.9	20.3	56.0
Commodity exporter = 1	dummy variable	46	0.2	0.4	0.0
5. Financial openness					
Net foreign assets	% of GDP	46	-15.4	66.5	-21.5
Financial openness	Ln(% of GDP)	46	5.7	0.8	5.5
Foreign banks' share of US credit[1]	Ln(% of total claims)	25	0.9	1.1	0.4
US banks' share of foreign credit[1]	Ln(% of total claims)	25	2.1	0.7	1.9
Foreign holdings of US long-term debt[2]	Ln(% of GDP)	45	1.9	1.1	1.9
Foreign holdings of US short-term debt[2]	Ln(% of GDP)	45	0.6	0.6	0.5
Foreign holdings of US equity[2]	Ln(% of GDP)	45	1.3	1.2	0.8
US holdings of foreign long-term debt[2]	Ln(% of foreign GDP)	45	1.1	0.8	0.9
US holdings of foreign short-term debt[2]	Ln(% of foreign GDP)	45	0.3	0.6	0.0
US holdings of foreign equity [2]	Ln(% of foreign GDP)	45	2.1	1.1	2.1
6. Monetary and fiscal policy					
Exchange rate peg = 1	dummy variable	46	0.2	0.4	0.0
Foreign exchange reserves	Ln(% of GDP)	46	2.3	1.2	2.5
Inflation target = 1	dummy variable	46	0.7	0.5	1.0
Inflation rate	%	46	4.4	2.6	3.5
Government budget balance	% of GDP	46	0.8	4.2	-0.1
Government revenue	% of GDP	46	36.2	10.3	36.4
Government spending	% of GDP	46	35.4	10.4	35.7
Government debt	Ln(% of GDP)	46	3.6	0.9	3.7
Government short-term debt	Ln(% of GDP)	46	3.4	1.3	3.5

1. The BIS Consolidated International Banking statistics only report data for 25 countries in our sample. Data is not available for: AR, BE, CN, CZ, EE, HR, HU, ID, IL, KR, LT, LV, MY, NZ, PH, RU, SI, SK, TH, US, and ZA. 2. Excludes United States.

Table 4: Tests of the difference in median CGAP across groups

This table reports non-parametric rank-sum tests of the difference in means across unbalanced groups. We divide the sample economies into two groups based on each explanatory variable and calculate the median CGAP for each group. In the case of dummy (or dichotomous) variables, the left group has dummy set to 0 and the right set to 1. For continuous variables, economies where the explanatory variable is below the median are in group 0 and above the median in group 1. The rank-sum test tests whether the median CGAP for group 0 is statistically different from group 1. A positive CGAP represents economic outperformance relative to the sample average, and a negative CGAP underperformance. The difference in the medians (group 1 minus group 0) is shown with the superscripts ***, ** and * indicating statistical significance at the 1%, 5% and 10% levels, respectively.

	Observations		Median CGAP		
Description	0	1	0	1	Difference in medians
1. Income level					
Emerging market economy = 1	29	17	-0.7	3.2	3.9***
GDP per capita at market rates	23	23	3.0	-0.7	-3.7**
GDP per capita at PPP rates	23	23	3.0	-0.6	-3.6**
2. Banking system structure					
Loan / Deposit ratio	23	23	3.1	-0.9	-4.0***
Total capital ratio	23	23	-0.7	1.4	2.1**
Banking crisis 1990–2007 = 1	18	28	-0.7	2.6	3.3*
CB bank supervisor = 1	21	25	0.1	0.4	0.4
Banking concentration	23	23	0.4	-0.6	-1.0
3. Credit					
Private sector credit	23	23	1.4	-0.6	-2.0*
Credit growth, 2005-07	23	23	1.5	-0.7	-2.2**
Credit growth, 2000-06	23	23	2.8	-1.1	-3.9***
Index of credit market regulation	23	23	1.3	-0.7	-2.0
4. Trade openness					
Current account	22	24	-0.8	2.8	3.6***
Exports + Imports	23	23	0.2	0.4	0.2
Manufacturing / Exports	23	23	-1.4	1.5	2.9***
Commodity exporter = 1	38	8	0.3	-0.2	-0.5
5. Financial openness					
Net foreign assets	23	23	-0.7	1.3	2.0
Financial openness	23	23	3.0	-0.9	-3.9***
Foreign banks' share of US credit	13	12	0.4	-0.7	-1.1**
US banks' share of foreign credit	13	12	-0.7	2.2	2.8*
Foreign holdings of US long-term debt	23	22	-0.7	2.8	3.5**
Foreign holdings of US short-term debt	23	22	-0.7	2.8	3.5*
Foreign holdings of US equity	23	22	1.3	-0.2	-1.5
US holdings of foreign long-term debt	23	22	1.4	-0.7	-2.1
US holdings of foreign short-term debt	23	22	3.1	-0.7	-3.8***
US holdings of foreign equity	23	22	0.4	-0.1	-0.6
6. Monetary and fiscal policy					
Exchange rate peg = 1	35	11	0.1	2.4	2.4
Foreign exchange reserve	23	23	-0.7	2.9	3.5**
Inflation target = 1	16	30	2.0	-0.5	-2.5
Inflation rate	23	23	0.4	0.2	-0.2
Government budget balance	23	23	1.2	-0.6	-1.9
Government revenue	23	23	3.1	-0.7	-3.8***
Government spending	23	23	3.0	-0.7	-3.7***
Government debt	23	23	0.4	0.2	-0.2
Government short-term debt	23	23	3.1	-0.9	-4.0***

Table 5: OLS regression analysis of CGAP on pre-crisis characteristics

This table reports the standardized coefficients from regressions of CGAP (summed over Q1 2008 to Q4 2009) on each explanatory variable. The reported coefficient on the explanatory variable is normalized to indicate the estimated effect of a one-standard deviation increase in the explanatory variable on CGAP. Each row reports the results from four specifications: (i) full sample with a constant, (ii) full sample with a constant plus GDP per capita at PPP exchange rates, (iii) advanced economies with a constant, and (iv) emerging market economies with a constant. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively, based on robust standard errors.

Description	Full Sample (46 obs)		Advanced economies (29 obs)	EMEs (17 obs)
	Coefficient + constant	Coefficient, constant + GDP per capita PPP		
1. Income level				
Emerging market economy = 1	1.87***	1.56	n.a.	n.a.
GDP per capita at market rates	-1.85***	n.a.	-0.34	-0.80
GDP per capita at PPP rates	-1.65***	n.a.	0.62	-0.83
2. Banking system structure				
Loan / Deposit ratio	-2.73***	-2.51***	-2.02***	-2.76**
Total capital ratio	1.06*	0.94	0.75	1.25
Banking crisis 1990–2007 = 1	1.12*	0.41	-0.04	0.98***
CB bank supervisor = 1	1.06	0.65	0.82	0.72
Banking concentration	-0.71	-0.71	-0.65	-0.56
3. Credit				
Private sector credit	-2.03***	-1.62**	-1.30*	-0.84
Credit growth, 2005-07	-2.01***	-1.85**	-2.75***	-2.07
Credit growth, 2000-06	-2.56***	-2.27***	-2.29***	-3.00***
Index of credit market regulation	-1.41**	-0.74	-0.04	-1.66
4. Trade openness				
Current account	2.44***	2.57***	2.37***	2.95***
Exports + Imports	-0.19	0.23	0.84	-1.39
Manufacturing / Exports	0.52	0.61	1.52***	-0.15
Commodity exporter = 1	0.22	0.22	-0.20	0.26
5. Financial openness				
Net foreign assets	1.49***	2.17***	2.19***	1.77*
Financial openness	-1.60*	-0.87	-0.27	-1.61*
Foreign banks' share of US credit	-0.85	-0.44	0.05	0.94
US banks' share of foreign credit	1.83**	1.53**	1.06	-1.75
Foreign holdings of US long-term debt	0.92	1.48*	0.82	2.59**
Foreign holdings of US short-term debt	-0.05	0.16	-0.52	1.46
Foreign holdings of US equity	-0.74	0.59	0.42	0.66
US holdings of foreign long-term debt	-0.72	-0.06	-0.93	1.99*
US holdings of foreign short-term debt	-2.07***	-1.68**	-2.05***	1.48***
US holdings of foreign equity	0.44	1.18	1.06	1.67
6. Monetary and fiscal policy				
Exchange rate peg = 1	-0.04	-0.13	0.36	-1.54
Foreign exchange reserves	2.17***	1.80***	1.92***	0.10
Inflation target = 1	-0.37	-0.23	-0.66	1.01
Inflation rate	-0.35	-1.29*	-1.89***	-2.08***
Government budget balance	0.08	0.72	0.83	-0.19
Government revenue	-1.92***	-1.47**	-0.97	-1.29
Government spending	-1.93***	-1.47***	-1.29**	-1.15
Government debt	0.67	0.77	0.76	1.45
Government short-term debt	-2.19***	-2.35**	-0.54	-2.75**

Table 6: Least Angle Regressions on cumulative GDP gap (CGAP)

This table reports the explanatory variables selected at each step of Least Angle Regressions (LARS) on the cumulative GDP gap (summed over Q1 2008 to Q4 2009) for a balanced panel of 45 countries. The LARS are run using the Lasso algorithm (Efron et al. 2004). The CGAP variable is normalized to have mean zero. All explanatory variables are normalized to have mean zero and unit Euclidean length. At each step, a new variable is either added or subtracted. The R-squared reports the model fit at each step. These regressions exclude the USA as there are no observations for the Treasury International Capital (TIC) variables by design. We also exclude the BIS Consolidated Banking variables, which are only available for 25 economies.

	All 45 economies (excl. USA)		**28 Advanced economies (excl. USA)**		**17 Emerging market economies**	
Step	**R^2**	**Action**	**R^2**	**Action**	**R^2**	**Action**
1	0.12	+ Loan / Deposit ratio	0.31	+ Credit growth, 2005-07	0.07	+ Credit growth 2000-06
2	0.16	+ Current account	0.31	+ US holdings of foreign short-term debt	0.22	+ Current account
3	0.26	+ Credit growth, 2000-06	0.48	+ Credit growth, 2000-06	0.22	+ Loan / Deposit ratio
4	0.33	+ Government short-term debt	0.68	+ Current account	0.28	+ Foreign holdings of US long-term debt
5	0.57	+ US holdings of foreign short-term debt	0.75	+ Inflation rate	0.47	+ Government short-term debt
						- Current account
6	0.62	+ Emerging market economy = 1	0.75	+ Foreign exchange reserves	0.59	+ US holdings of foreign short-term debt
7	0.67	+ Index of credit market regulation	0.80	+ Loan / Deposit ratio	0.59	+ Manufacturing / Exports
8	0.68	+ Exports + Imports	0.82	+ Banking concentration	0.63	+ Index of credit market regulation
9	0.69	+ Financial openness	0.82	+ Manufacturing / Exports	0.64	+ US holdings of foreign long-term debt
10	0.70	+ Private sector credit	0.82	+ US holdings of foreign long-term debt	0.66	+ Exports + Imports
11	0.72	+ Foreign holdings of US long-term debt	0.83	+ CB bank supervisor = 1	0.66	+ Government debt
12	0.73	+ Total capital ratio	0.85	+ Private sector credit	0.67	- US holdings of foreign long-term debt
						+ GDP per capita at market rates
13	0.73	+ Foreign holdings of US short-term debt	0.85	+ Foreign holdings of US short-term debt	0.78	+ Exchange rate peg = 1
14	0.74	+ Inflation rate	0.85	+ Inflation target = 1	0.84	+ Inflation target = 1
						- Index of credit market regulation
15	0.74	+ Inflation target = 1	0.85	+ Government spending	0.91	+ Inflation rate
16	0.74	+ Manufacturing / Exports	0.88	+ Net foreign assets	0.92	+ Financial openness
						- Government short term debt
17	0.75	+ Banking concentration	0.89	+ Government revenue	0.92	+ Foreign holdings of US equity
				- Government spending		
18	0.76	+ CB bank supervisor = 1	0.91	+ Total capital ratio	0.96	+ Total capital ratio
						- Credit growth 2000-06
19	0.76	+ GDP per capita at PPP rates	0.93	+ Foreign holdings of US long-term debt	0.97	+ Foreign exchange reserves
				- Credit growth, 2000-06		
20	0.78	+ Foreign exchange reserves	0.94	+ Exports + Imports	0.99	+ Private sector credit

Table 7: Multivariate regressions on CGAP, 45 countries

This table reports the coefficients from regressions on cumulative GDP gap (CGAP), summed over Q1 2008 to Q4 2009, for 45 countries. Panel A reports coefficients from Least Angle Regressions using the Lasso algorithm, while Panel B reports coefficients from OLS regressions. These regressions exclude the USA as there are no observations for the Treasury International Capital (TIC) variables by design. We also exclude the BIS Consolidated Banking variables, which are only available for 25 countries. All variables are normalized to have mean zero and unit Euclidean length. For the OLS regressions, ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively, based on robust standard errors.

Panel A: Coefficient estimates from Least Angle Regressions (LARS) using Lasso

Step	1	2	3	4	5	6	7	8
Loan / Deposit ratio	-3.15	-3.69	-5.07	-5.35	-5.79	-5.48	-5.36	-5.44
Current account		0.54	2.00	3.03	7.65	8.96	10.38	10.80
Credit growth, 2000-06			-0.38	-0.58	-1.36	-2.14	-2.91	-2.95
Government short-term debt				-1.06	-3.88	-3.72	-3.00	-2.59
US holdings of foreign short-term debt					-3.27	-4.37	-5.38	-5.74
Emerging market economy = 1						1.35	2.72	3.06
Index of credit market regulation							-1.10	-1.13
Exports + Imports								-0.50
N	45	45	45	45	45	45	45	45
R^2	0.12	0.16	0.26	0.33	0.57	0.62	0.67	0.68
Sum of abs(coefficients)	3.1	4.2	7.4	10.0	21.9	26.0	30.9	32.2

Panel B: Coefficient estimates from OLS regressions

Steps	1	2	3	4	5	6	7	8
Loan / Deposit ratio	-18.4***	-14.8***	-13.4***	-7.98*	-6.38	-4.41	-5.10	-6.35*
Current account		11.7***	10.7***	12.9***	13.9***	13.5***	13.6***	15.6***
Credit growth, 2000-06			-2.63	-2.49	-2.43	-4.81	-4.64	-3.42
Government short-term debt				-11.2***	-7.69**	-3.17	-1.39	2.03
US holdings of foreign short-term debt					-7.69**	-8.15**	-7.66*	-9.83***
Emerging market economy = 1						6.03	5.79	6.88*
Index of credit market regulation							-3.58	-1.41
Exports + Imports								-6.13*
N	45	45	45	45	45	45	45	45
R^2	0.39	0.53	0.53	0.64	0.69	0.70	0.71	0.74
F	26.9	23.0	14.6	11.6	13.4	11.6	9.6	10.0
Sum of abs(coefficients)	18.4	26.5	26.7	34.6	38.1	40.0	41.7	51.7

Table 8: Multivariate regressions on CGAP for EMEs and Advanced Economies

This table reports the coefficients from OLS regressions on the cumulative GDP gap (CGAP), summed over Q1 2008 to Q4 2009. Panel A reports coefficients for 28 advanced economies and Panel B for 17 EMEs. The variables shown were selected by Least Angle Regressions using the Lasso algorithm. The OLS regressions are estimated with robust standard errors. These regressions exclude the USA as there are no observations for the Treasury International Capital (TIC) variables by design. We also exclude the BIS Consolidated Banking variables, which are only available for 25 countries. All variables are normalized to have mean zero and unit Euclidean length. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Advanced economies only

Step	1	2	3	4	5	6	7	8
Credit growth, 2005-07	-14.6***	-13.3***	-11.3***	-6.51**	-4.70	-4.46	-4.13	-4.58
US holdings of foreign short-term debt		-8.27***	-7.25***	-8.37***	-8.76***	-8.23***	-8.20***	-7.81***
Credit growth, 2000-06			-4.47**	-4.06**	-4.03***	-3.69**	-2.37	-2.29
Current account				6.63***	6.27***	5.09*	5.36*	4.46
Inflation					-3.67	-4.51	-4.70	-4.65
Foreign exchange reserves						2.29	1.94	2.80
Loan / Deposit ratio							-1.90	-1.69
Banking concentration								-2.29
N	28	28	28	28	28	28	28	28
R^2	0.54	0.72	0.76	0.81	0.83	0.84	0.84	0.86
F	16.3	42.7	19.8	16.5	25.5	23.1	24.6	19.6

Panel B: EMEs only

Step	1	2	3	4	5	6	7	8
Credit growth, 2000-06	-12.0***	7.21*	-4.36	-7.55	-3.95	-1.76	-2.58	-4.48
Current account		6.18	5.60	-0.81				
Loan / Deposit ratio			-4.86	-3.99	-2.75	-2.69	-5.29	-4.90
Foreign holdings of US long-term debt				6.86	7.07*	6.41	6.98*	6.16*
Government short-term debt					-5.05	-7.13	-4.63	-1.37
US holdings of foreign short-term debt						4.07*	4.41**	5.57**
Manufacturing / Exports							-5.46*	-5.92*
Index of credit market regulation								-4.38
N	17	17	17	17	17	17	17	17
R^2	0.44	0.48	0.52	0.59	0.62	0.66	0.73	0.76
F	10.8	5.2	3.7	5.6	5.1	10.4	14.3	12.0

Appendix A: Data sources

Description	Source	Description
Banking concentration	Bankscope	2007 Herfindahl index based on total bank assets
Banking crisis 1990–2007 = 1	Laeven and Valencia (2008)	Dummy set to 1 if banking crisis between 1990 and 2007
CB bank supervisor = 1	BIS	Dummy set to 1 if central bank is solely responsible for bank supervision, 0 if shared or not responsible
Commodity exporter = 1	Authors' calculation	Dummy set to 1 for commodity exporters, 0 otherwise
Credit growth, 2000-06	Authors' calculation	Compound annual growth rate, Q4 1999 – Q4 2006
Credit growth, 2005-07	Authors' calculation	Compound annual growth rate, Q4 2004 – Q4 2007
Current account	IMF IFS	2007 current account to GDP (gross)
Emerging market economy = 1	IMF WEO	2013 WEO
Exchange rate peg = 1	IMF	2007 Annual Report on Exchange Arrangements.
Financial openness	Lane and Milesi-Ferretti (2007)	2007 (Gross foreign assets + gross foreign liabilities) to GDP
Foreign banks' share of US credit	BIS Consolidated Banking Statistics	2007 share of consolidated foreign claims on immediate risk basis vis-à-vis the US by banks headquartered in a given country of all reporting countries
Foreign exchange reserves	IMF IFS	2007 Line 1d.d International Liquidity: Total reserves minus gold, as per cent of GDP.
Foreign holdings of US equity	US Treasury	2007 Treasury International Capital System
Foreign holdings of US long-term debt	US Treasury	2007 Treasury International Capital System
Foreign holdings of US short-term debt	US Treasury	2007 Treasury International Capital System
GDP per capita at market rates	IMF WEO	2007 Natural log of GDP per capita at market exchange rates
GDP per capita at PPP rates	IMF WEO	2007 Natural log of GDP per capita at purchasing power parity exchange rates
Government budget balance	IMF IFS, OECD	2007 IMF IFS net operating balance; OECD code: NLG to GDP
Government debt	IMF IFS	2007 general government debt to GDP (gross)
Government revenue	IMF IFS	2007 As a ratio of GDP
Government short-term debt	IMF IFS	2007 As a ratio of GDP
Government spending	IMF IFS	2007 As a ratio of GDP
Index of credit market regulation	Fraser Institute	2007 See: Economic Freedom of the World dataset
Inflation rate	IMF IFS	2007 Line 64 Consumer prices. Quarterly index. Take quarter to quarter change, sum four quarters.
Inflation target = 1	IMF	2007 Dummy set to 1 if monetary authority has explicit inflation target in 2007, 0 otherwise. See: Annual Report on Exchange Arrangements.
Loan / deposit ratio	IMF IFS	2007 Aggregate loans (net) / customer deposits
Manufacturing / Exports	World Bank	2007 Share of manufacturing goods in exports
Net foreign assets	Lane and Milesi-Ferretti (2007)	2007 Foreign assets – foreign Liabilities to GDP
Private sector credit	IMF IFS	2007 Line 32d in IMF IFS (domestic credit to private sector) to GDP
Quarterly real GDP, S.A.	IMF IFS	Deflate nominal GDP by GDP deflator to get real GDP; Calculate year-over-year (4 quarter) change
Total capital ratio	Bankscope	2007 Total capital ratio of median bank
US banks' share of foreign credit	BIS Consolidated Banking Statistics	2007 Share of consolidated foreign claims on immediate risk basis in a given country by US headquartered banks of all reporting banks
US holdings of foreign equity	US Treasury	2007 Treasury International Capital System
US holdings of foreign long-term debt	US Treasury	2007 Treasury International Capital System
US holdings of foreign short-term debt	US Treasury	2007 Treasury International Capital System

Appendix B: Sample correlations among explanatory variables

The table below shows selected bivariate correlations for the 35 explanatory variables in our sample. Correlations greater than 0.650 or less than -0.650 are shown in bold and underlined. Columns/rows not shown correspond to variables where no values meet these criteria.

#	Variable	1	2	3	4	5	7	9	10	11	13	14	15	16	17	18	19	21	22	23	24	25	26	27	28	29	30	31	32	33
1	Emerging market economy = 1																													
2	GDP per capita at market rates	**-0.86**																												
3	GDP per capita at PPP rates	**-0.86**	**0.98**																											
4	Loan / Deposit ratio	-0.37	0.44	0.30																										
5	Total capital ratio	0.16	0.02	0.02	-0.12																									
7	CB supervisor = 1	0.00	-0.30	-0.23	-0.18	-0.17																								
9	Private sector credit	**-0.70**	0.63	0.59	0.44	-0.57	0.41																							
10	Credit growth, 2005-07	0.38	-0.19	-0.29	0.23	0.35	-0.09	-0.06																						
11	Credit growth, 2000-06	-0.14	0.15	0.03	**0.68**	-0.08	-0.02	0.40	0.46																					
13	Current account	-0.14	0.23	0.32	-0.19	0.00	0.17	-0.06	**-0.65**	0.42																				
14	Exports + Imports	-0.37	0.36	0.49	-0.11	-0.42	0.33	0.33	-0.46	0.54	0.65																			
15	Manufacturing / Exports	-0.19	0.12	0.16	-0.27	-0.10	0.18	0.02	-0.22	0.06	0.23	0.22																		
16	Commodity exporter = 1	0.25	-0.05	-0.07	-0.01	0.20	-0.20	-0.24	0.02	0.01	0.04	-0.31	**-0.65**																	
17	Net foreign assets	-0.21	0.23	0.35	-0.43	-0.20	0.31	0.09	-0.63	0.54	**0.83**	**0.69**	0.34	-0.08																
18	Financial openness	**-0.71**	**0.68**	**0.72**	0.16	-0.60	0.49	**0.74**	-0.30	0.54	0.36	**0.74**	0.19	-0.32	0.53															
19	Foreign banks' share of US credit	-0.41	0.38	0.34	-0.07	-0.34	0.20	0.43	-0.28	0.24	0.08	-0.10	0.37	-0.17	0.18	0.29														
21	Foreign holdings of US long-term debt	-0.20	0.37	0.44	-0.25	-0.22	0.32	0.33	-0.26	0.61	0.59	0.54	0.18	0.07	**0.71**	0.59	0.26													
22	Foreign holdings of US short-term debt	0.07	0.07	0.12	-0.29	-0.07	0.23	0.21	0.02	0.44	0.20	0.42	0.00	0.05	0.39	0.44	0.19	**0.73**												
23	Foreign holdings of US equity	-0.52	0.64	**0.68**	0.04	-0.45	0.42	0.53	-0.45	**0.80**	0.63	0.65	0.04	0.08	0.63	**0.72**	0.05	**0.81**	0.53											
24	US holdings of foreign long-term debt	-0.30	0.48	0.46	0.32	-0.27	-0.04	0.47	0.01	0.52	0.14	0.23	-0.23	0.29	-0.02	0.37	0.09	0.49	0.42	**0.67**										
25	US holdings foreign short-term debt	-0.36	0.46	0.39	0.38	-0.20	0.04	0.50	0.17	0.32	-0.03	0.12	-0.14	0.04	-0.05	0.48	-0.14	0.45	0.50	0.53	**0.73**									
26	US holdings of foreign equity	-0.42	0.41	0.46	-0.22	-0.29	0.51	0.33	-0.37	0.56	0.51	0.47	0.24	-0.04	**0.66**	0.60	0.10	**0.66**	0.32	**0.70**	0.26	0.28								
27	Exchange rate peg = 1	-0.18	0.14	0.25	-0.09	-0.30	0.10	0.20	-0.35	0.44	0.50	**0.68**	0.13	-0.18	0.62	0.38	0.10	0.38	0.07	0.38	0.00	-0.20	0.36							
28	Foreign exchange reserves	0.33	-0.30	-0.18	-0.51	0.31	-0.02	-0.37	-0.37	0.25	**0.69**	0.33	0.11	0.11	**0.72**	-0.07	0.56	0.43	0.18	0.21	-0.25	-0.33	0.30	0.61						
29	Inflation target = 1	0.05	0.14	0.06	0.36	0.08	-0.24	-0.11	0.47	-0.38	-0.46	-0.36	-0.26	0.28	**-0.66**	-0.18	-0.37	-0.38	-0.17	-0.29	0.30	0.26	-0.41	**-0.66**	**-0.72**					
30	Inflation rate	**0.71**	-0.61	-0.57	-0.29	0.31	-0.22	-0.38	0.42	-0.24	-0.23	-0.02	-0.28	0.07	-0.21	-0.30	0.25	-0.16	0.25	-0.35	-0.06	-0.08	-0.39	-0.03	0.12	0.17				
31	Government budget balance	-0.18	0.37	0.42	0.12	0.15	0.07	0.05	-0.30	0.43	**0.67**	0.53	-0.30	0.37	0.54	0.33	-0.06	0.38	0.21	0.51	0.23	0.06	0.30	0.44	0.47	-0.17	-0.10			
32	Government revenue	-0.55	0.63	0.50	**0.77**	-0.16	-0.02	0.38	0.10	-0.10	-0.04	-0.10	-0.12	0.05	-0.25	0.22	-0.63	-0.24	-0.39	0.09	0.21	0.30	-0.08	-0.16	-0.47	0.38	-0.50	0.19		
33	Government spending	-0.45	0.44	0.28	**0.69**	-0.23	-0.06	0.34	0.24	-0.30	-0.36	-0.35	0.03	-0.13	-0.50	0.06	-0.58	-0.42	-0.48	-0.15	0.09	0.27	-0.22	-0.37	**-0.69**	0.45	-0.44	-0.29	**0.88**	
35	Government short-term debt	**-0.82**	**0.77**	**0.78**	0.28	**-0.65**	0.45	**0.83**	-0.25	0.50	0.22	0.56	0.18	-0.35	0.39	**0.95**	-0.57	0.49	0.29	**0.66**	0.37	0.54	0.51	0.26	-0.22	-0.11	-0.44	0.22	0.39	-0.14

Appendix C: Selected studies examining crisis impact across countries

Study (sample)	Description	Explanatory variables	Worse outcomes	Other notes
Berkmen et al. (2012) Sample: EMEs (43)	• Regress error in average 2009 WEO forecast compared to actual outturn.	• 41 variables classified as: trade linkages, financial linkages, financial structure, policy framework.	• Higher leverage in domestic financial system • Higher short-term debt/GDP • More trade openness • Higher manufacturing share in exports • Pegged exchange rate • Fiscal deficits	• Forecasts, not actual; 2009 only • Regressions 29-33 observations for macroeconomic variables, 86-121 observations for trade variables • Financial openness strongest, but trade also important • Do not test trade and monetary or fiscal variables in same specification • No role for FX reserves
Blanchard et al. (2010) Sample: EMEs (29)	• Examine GDP growth forecast errors over 4Q 2009-1Q 2009. • Use simple open economy model to generate predictions. • Includes case studies of Latvia, Russia and Chile.	• 14 variables classified as: trade linkages, financial linkages and exchange rate regime.	• Higher short-term external debt • Higher exports / GDP • Lower unexpected trading-partner GDP growth • Higher current account deficit	• No role for FX reserves, exchange rate regime, manufactures / GDP, financial openness (net capital flows). • Giannone et al. (2011) index for credit market regulation not significant. • Sample possibly influenced by Eastern European economies.
Cetorelli and Goldberg (2011) Sample: EMEs (94)	• Study transmission of crisis via global banks in 17 advanced economies to 94 EMEs using BIS Banking Statistics and IMF data. • Disentangle loan demand from supply using identification strategy from Kwaja and Mian (2008).	• International (cross-border) banking claims, local claims in local currency, measure of banking sector dollar vulnerability, and bank balance sheet characteristics	• Greater reliance on foreign banks, whether cross-border or via local affiliates • More lending from banks with greater US dollar shortage • Domestic banks that were more dependent on funding from more vulnerable banking systems	• Identify contraction in: (i) cross-border lending by global banks, (ii) local lending by foreign affiliates, and (iii) local loans by domestic banks. • Exposure of domestic banks to cross-border funding is not a problem, only if the exposure is to banking systems that suffered USD dollar shortages.
Claessens et al. (2010) Sample: OECD, EMEs (58)	• Categorize 58 countries into 5 groups based on quarter when entered recession. Study impact on 3 crisis measures (duration of recession; severity of income loss; change in average growth rate 2003-07 vs. 2008-09) plus a financial stability index.	• 9 variables measuring: domestic economic conditions, financial linkages, trade, and other real linkages.	• Higher GDP/capita • Greater house price appreciation • Stronger growth in bank credit/GDP • Larger current account deficits • More trade openness • Higher share of foreign bank claims	• Both advanced and EMEs • Maximum 24-56 observations in regressions; never more than 2 explanatory variables. • No discussion of non-recession countries • Not significant: credit/GDP, mortgage debt/GDP, bank wholesale funding dependence, fiscal balance. • Bank capital mentioned but not tested

Study (sample)	Description	Explanatory variables	Worse outcomes	Other notes
Didier et al. (2012) Sample: OECD, EMEs, other (183)	• Compare real GDP growth in 2009 vs. 2007 ("growth collapse") and speed of recovery to pre-crisis industrial production growth ("growth recovery"). Benchmark 2007-09 performance vs. Asian and Russian crises of 1990s.	• 5 trade and financial variables plus country dummies.	• EMEs suffered similar growth deceleration to advanced economies, but EMEs recovered quicker • Larger current account deficits • More trade openness • Higher credit growth • Higher foreign assets + liabilities	• Key difference vs. past experience was ability of EMEs to implement credible countercyclical policies. • Log GDP/capita is not a significant explanatory variable due to u-shaped pattern. • FX reserves not significant
Dominguez et al. (2012) Sample: OECD, EMEs, other (185)	• Study pre-crisis reserve accumulation and reserves policy to explain cross-country GDP performance post-crisis. Key dependent variable is country-specific post-crisis GDP growth (trough to 4Q 2010).	• 6 variables: international reserves /GDP, pre-crisis GDP growth, exchange rate change during crisis, interest differentials, short-term debt/GDP, and terms of trade.	• Lower pre-crisis reserves • Lower pre-crisis GDP growth • Less exchange rate depreciation during crisis (EMEs only)	• Use IMF data on international reserves (including FX, gold and SDRs). • Sample for regressions only 23 to 67 observations. • Do not test exchange rate peg directly.
Frankel and Saravelos (2012) Sample: OECD, EMEs, other (122)	• Regress variables, individually and jointly with log GDP/capita, on 5 crisis outcome variables: local currency change vs. USD, equity market returns, percentage change in GDP from 2Q 208 to 2Q 2009; percentage change in industrial production, and IMF bailout dummy.	• 61 variables in 17 categories: FX reserves, REER, GDP, credit, current account, money supply, trade, inflation, equity returns, interest rate, debt composition, legal / business, capital flows, external debt, exchange rate regime, and country dummies.	• REER overvaluation • Lower FX reserves • Higher pre-crisis credit growth • Current account deficits • Lower savings rates • Higher external debt • Higher short-term debt	• Samples vary from 58 to 122 countries based on data availability. • Quarterly data • No consistent role for: trade variables, stock market, money supply, and the exchange rate peg.
Giannone et al. (2011) Sample: OECD, EMEs, other (102)	• Regress five indices of country risk on real GDP growth over 2008-2009. Use OLS with controls entered individually, then Bayesian model averaging to test all variables jointly.	• 5 indices measuring: regulation of credit, labor markets and business; political risk; economic indicators; and economic freedom. • Use 21 control variables, individually and jointly, measuring: population and log GDP/capita; trade and financial openness; financial development; and bank risk taking.	• Countries with greater credit market liberalization. • Current account deficits • More developed financial sector • Higher bank net interest margins or overhead (less efficiency or competition) • Higher bank assets /deposits • Higher external debt	• Trade and financial openness do not matter • No tests of bank capital or supervisory regime • Index of private sector credit not significant

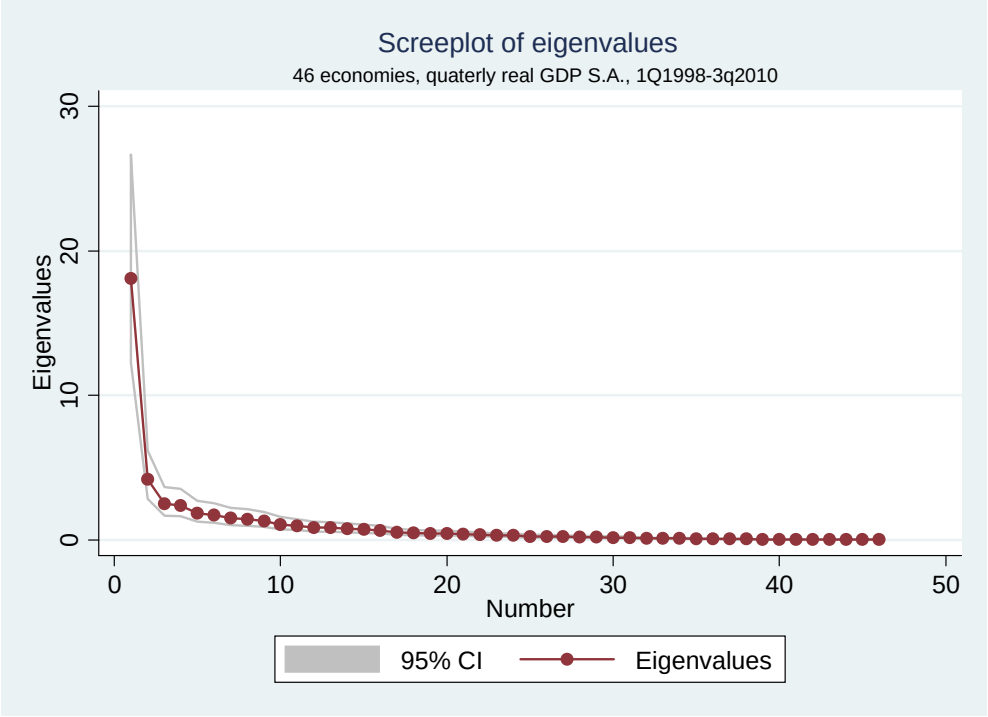
Study (sample)	Description	Explanatory variables	Worse outcomes	Other notes
Imbs (2010) Sample: OECD, EMEs (44)	• Examine increased correlation of industrial production across OECD and non-OECD countries using monthly data from Jan 1980 - May 2009. • Check robustness using quarterly GDP data from 1Q 1980 - 2Q 2009	• 2 variables: trade intensity (based on bilateral merchandise trade), and financial linkages (based on BIS banking data).	• Among OECD countries, greater financial flows (cross-border banking) • Among non-OECD, higher bilateral trade intensity	• Sample limited by data availability; monthly ends May 2009, quarterly ends 2Q 2009 • Industrial production is imperfect measure of economic activity as misses non-traded goods • Banking data not bilateral.
Lane and Milesi-Ferretti (2011) Sample: OECD, EMEs, other (162)	• Run multivariate regressions to explain cross-country variation in four measures: GDP growth, demand growth, consumption growth and total domestic demand growth over 2008-09.	• 11 control variables: pre-crisis GDP growth 2005-07, trend growth over 1990-2007, trade openness, manufacturing share, oil dummy, change in private credit /GDP, current account /GDP, exchange rate peg, financial openness), and GDP/capita.	• Current account deficits • Higher pre-crisis credit growth • Higher credit/GDP • Higher GDP per capita • Lower trading-partner growth	• Annual data. Number of observations from 87 to 162 • No evidence for: trade openness, oil exporters, financial openness, change in fiscal balance , output volatility. • Significance of following varies when using output growth vs. demand growth: pegged exchange rate, manufacturing / GDP. • Short-term debt works for smaller sample, but not larger.
Rose and Spiegel (2011): An update Sample: OECD, EMEs, other (106)	• Update results from R&S (2012) to establish robustness of earlier findings. • Test findings from competing papers using 7 proxies of crisis intensity regressed on nine key variables, individually and jointly. • Test whether current results can explain global slowdowns in 1991-92 and 2001-02.	• 9 key variables: exchange rate regime, current account, trading partner growth, credit market regulation, short-term debt, housing prices, growth of bank credit, credit /GDP, foreign exchange reserves.	• Current account deficits • Higher bank credit growth • More liberal credit market regulation • Higher GDP per capita • More short-term debt	• Update Rose and Spiegel (2012) and test variables from other studies. • Use GDP estimates from EIU • Sample varies from 28 to 106 based on data availability • Most variables lose significance when used jointly • No evidence of thresholds or non-linearity • No role for exchange rate regime, FX reserves, trading partner growth, credit/GDP
Rose and Spiegel (2012): Early Warning Sample: OECD, EMEs, other (109)	• Use MIMIC model to test whether crisis variables can explain cross-country crisis intensity for early warning system.	• 60 variables measuring: size and income, financial policies, financial conditions, asset prices, international imbalances, macroeconomic policies, institutional factors, and geography.	• Higher GDP per capita • Large run-ups in assets prices (stock market) • Closer trade linkages to USA	• Use data as of April 2009 • Find most variables not robust over time • No evidence that international linkages have impact • Used 2008 calendar year as crisis; imprecise and missed 2009 output declines • No role for FX reserves, ER peg

Appendix D: Key variables explaining cross-country variation in crisis intensity

Explanatory variable	Studies that find statistical significance	Studies that find no statistical significance
Asset price inflation (house prices, stock market)	Claessens et al. (2010), Rose and Spiegel (2011, 2012)	Frankel and Saravelos (2012)
Credit / GDP	Lane and Milesi-Ferretti (2011)	Claessens et al. (2010), Giannone et al. (2011), Rose and Spiegel (2011)
Credit growth pre-crisis (e.g. 2005-07, 2000-06)	Claessens et al. (2010), Didier et al. (2012), Frankel and Saravelos (2012), Lane and Milesi-Ferretti (2011), Rose and Spiegel (2011)	
Credit market regulation	Giannone et al. (2011), Rose and Spiegel (2011)	Blanchard et al. (2010)
Current account	Blanchard et al. (2010), Claessens et al. (2010), Didier et al. (2012), Frankel and Saravelos (2012), Giannone et al. (2011), Lane and Milesi-Ferretti (2011), Rose and Spiegel (2011)	
Exchange rate peg	Berkmen et al. (2012)	Blanchard et al. (2010), Rose and Spiegel (2011), Frankel and Saravelos (2012)
External debt / GDP	Frankel and Saravelos (2012), Giannone et al. (2011)	Lane and Milesi-Ferretti (2011)
Financial openness, cross-border banking	Berkmen et al. (2012), Cetorelli and Goldberg (2011), Claessens et al. (2010), Didier et al. (2012), Imbs (2010)	Blanchard et al. (2010), Giannone et al. (2011), Lane and Milesi-Ferretti (2011), Rose and Spiegel (2010, 2012)
Fiscal balance	Berkmen et al. (2012)	Claessens et al. (2010)
Foreign exchange reserves	Dominguez et al. (2012), Frankel and Saravelos (2012)	Berkmen et al. (2012), Blanchard et al. (2010), Didier et al. (2012), Rose and Spiegel (2011)
GDP per capita	Claessens et al. (2010), Frankel and Saravelos (2012), Lane and Milesi-Ferretti (2011), Rose and Spiegel (2011, 2012)	Didier et al. (2012)
Manufacturing / exports, manufacturing /GDP	Berkmen et al. (2012)	Blanchard et al. (2010)
Short-term debt / GDP, short-term debt / Reserves	Berkmen et al. (2012), Blanchard et al. (2010), Frankel and Saravelos (2012), Lane and Milesi-Ferretti (2011), Rose and Spiegel (2011)	Lane and Milesi-Ferretti (2011)
Trade openness, Exports + Imports / GDP	Berkmen et al. (2012), Blanchard et al. (2010), Claessens et al. (2010), Didier et al. (2012), Imbs (2010)	Frankel and Saravelos (2012), Giannone et al. (2011), Lane and Milesi-Ferretti (2011), Rose and Spiegel (2011, 2012)
Trading partner growth	Blanchard et al. (2010), Lane and Milesi-Ferretti (2011)	Rose and Spiegel (2011)

Appendix: Figure A

Screeplot of eigenvalues from principal components analysis
With 95% confidence interval (CI)



Appendix: Figure B

Loading by country on first and second principal components