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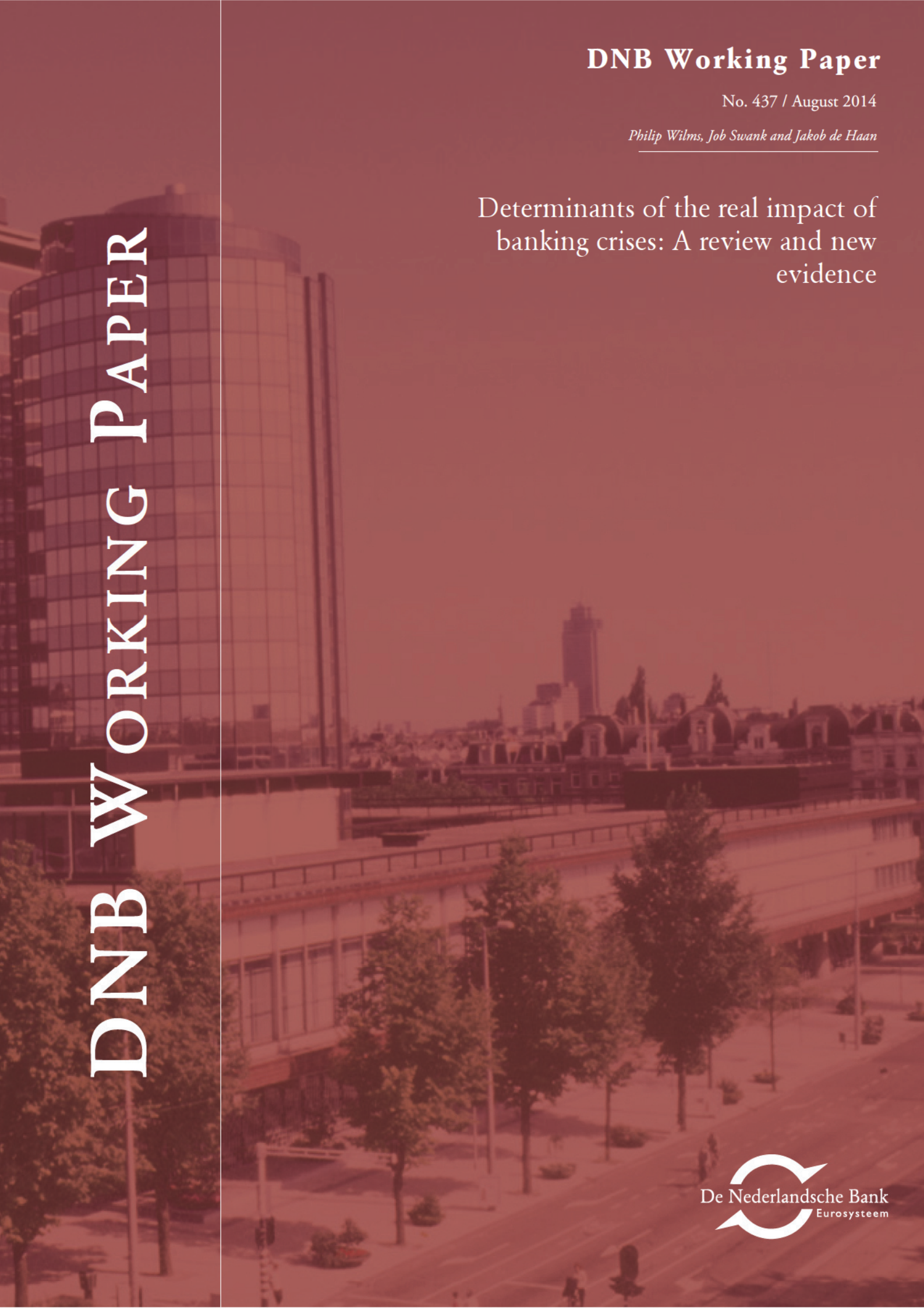

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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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Determinants of the real impact of banking crises: A review and new evidence*

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Abstract

We examine which variables are robust in explaining cross-country differences in the real impact of systemic banking crises. Based on a meta-analysis, we identify 21 variables frequently used as determinants of the severity of crises. Employing nine proxies for crisis severity, we find that large current account imbalances are the most robust determinant of the real impact of banking crises. Countries with a high GDP per capita have more prolonged downfalls after the occurrence of a banking crisis. Exchange rate developments and pre-crisis GDP growth are related to the peak-to-trough impact of a banking crisis.

Keywords: Banking crises, real impact of crises, duration of crises.
JEL classifications: F3, G01, G18.

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1. Introduction

The recent global financial crisis has revived research in banking crises. Most studies in this line of literature examine the drivers of such crises or try to identify early warning indicators of banking crises. A small but rapidly growing subset of the literature analyzes the determinants of the impact of banking crises on the real economy, henceforth referred to as the real impact. This issue is of great importance, as the recent financial crisis has illustrated. Whereas some countries did not face a decline in output during this crisis, others suffered from double-digit output losses (Aiginger, 2011). Likewise, some countries recovered much faster than others (Shehzad and de Haan, 2013). As will be shown in more detail in section 2, studies addressing the determinants of the real impact of banking crises use different proxies for this real impact, such as output loss, the duration of the crisis and the depth of the crisis. In addition, there is no agreement about the variables that affect the real impact of banking crises. This lack of consensus may be the consequence of the use of different proxies for the real impact of banking crises. But it also reflects that most studies do not carefully consider all potential explanatory variables. The purpose of our research is to unravel which macroeconomic variables are robust in explaining cross-country differences in the real impact of systemic banking crises, using several proxies for the severity of these crises.

We rely on the banking crisis database constructed by Laeven and Valencia (2013). These authors define a systemic banking crisis as an event in which there are: "(1) Significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system and/or bank liquidations). (2) Significant banking policy intervention measures in response to significant losses in the banking system" (Laeven and Valencia, 2013, p. 228).

Our starting point is a meta-analysis to filter out the most important variables used in previous studies. Next, we critically assess indicators of the severity of banking crises as used in the literature. We conclude that no superior measure exists. That is why we employ nine proxies in our empirical analysis. Five of these measures are based on cumulative output (or output growth) lost due to the crisis, three refer to the duration of the crisis, and the final measure refers to the depth of the crisis. Then, we try to identify robust determinants of the real impact of banking crises. We conclude that current account imbalances are the most robust determinant of the real impact of banking crises. GDP per capita prolongs the duration of banking crises.

Exchange rate developments and pre-crisis GDP growth are related to the peak-to-trough impact of a banking crisis.

The remainder of this paper is structured as follows. Section 2 reviews relevant studies and offers a meta-analysis to identify the key determinants of banking crisis severity. Section 3 discusses different crisis severity measures. Section 4 presents the empirical analysis, while the final section provides an overview of the main results and discusses possible limitations.

2. Previous studies

In order to identify as many variables as possible that have been considered as determinant of crisis severity, we collected studies on the real impact of all types of financial crises (bank, currency and debt crises). The total number of studies considered is 45.[1] Similar to the survey of the early warning indicators literature of Frankel and Saravelos (2012), we also include non-published studies to overcome the potential bias that significant results may be published more frequently. The meta-analysis of all 45 studies on the real effects of financial crises yields a list of 21 key determinants that will be considered in our empirical analysis (see Table A1 in Appendix 1). The Appendix discusses the theoretical rationale of these variables in some detail. Table 1 summarizes the arguments and shows the expected sign of the variables considered. As outlined in more detail in the Appendix, the expected sign of the variables is often ambiguous.

[1] Several studies focus on the recent financial crisis (e.g. Artha and de Haan, 2011; Claessens et al., 2010 and Rose and Spiegel, 2009). These are not included in our meta-analysis.

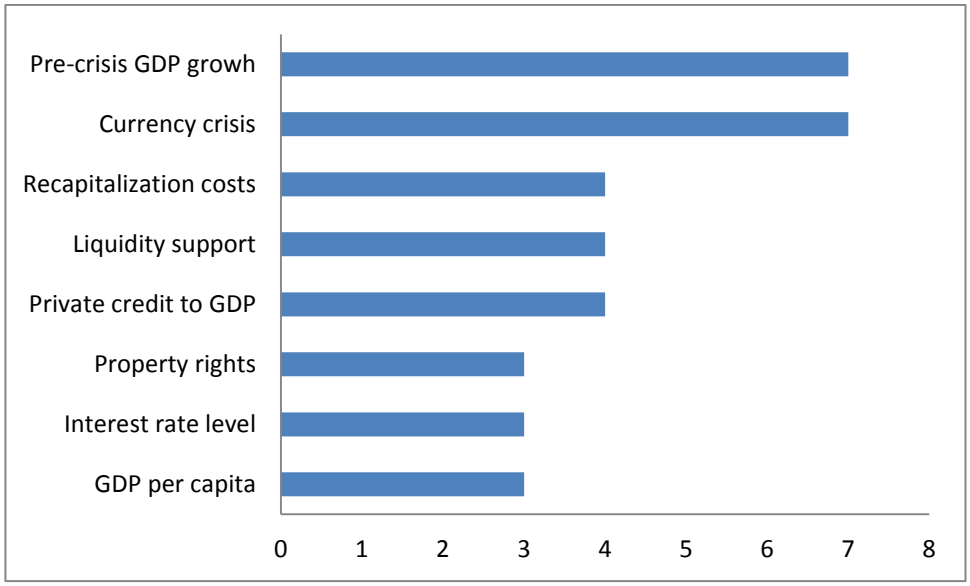
Table 1. Variables considered and expected sign on crisis severity

Variable:	Description:	Expected sign:
Private sector credit	A more developed financial system may be hit harder during a crisis, but a deeper financial system may make it easier to recover from financial shocks	??
Private sector credit growth	Credit boom indicates decline in lending standards and may enable asset and house price bubbles	+
Capital controls	Fewer controls increase countries' access to alternative sources of capital, but may also lead to capital flows and excessive credit growth	??
Financial openness	Reduces the risk of a sudden stop in capital flows and offers risk-sharing opportunities, but integrated financial systems may be more prone to shocks	??
Current account deficit	Requires external financing, which may lead to financial fragility	+
Debt-to-reserves	Reserves enable the rollover of external debt and reduce external vulnerabilities, but use of reserves during crises may be interpreted as a sign of weakness	??
Depreciation	Increases foreign debt servicing costs	+
Interest rate	High interest rates increase funding costs but low real interest rates may indicate a boom in the run-up to a crisis	??
Investment	Unwinding of pre-crisis excessive investment may cause the crisis to be more severe	+
Pre-crisis GDP	Large size of economy may limit the severity of a crisis due to smaller export and import shares or fewer leakages from stimulus packages	-
Pre-crisis GDP growth	Can indicate unbalanced overheating, but may also signal a sustainable catching-up process of emerging economies	??
Pre-crisis GDP per capita	Associated with financial deepening which, in turn, is likely to be significantly related to crisis severity. Governments of relatively rich countries are better able to assist troubled financial institutions	??
Quality of credit regulation	Lax credit regulation may lead to more risk-taking, which, in turn, may induce more severe banking crises	-
Fixed exchange rate	Countries without a fixed exchange rate may be better able to cushion the impact of financial shocks	+
Property rights	Countries with low-quality institutions may be subject to more financial instability	-
Public expenditures	Increase in public expenditures sustains economic growth during a crisis and may also shorten the duration of a crisis	-
Liquidity support	Supports banks but also facilitates financing to non-creditworthy borrowers	??
Recapitalization costs	Unconditional support may intensify crises through perverse incentives, as firms may gamble for resurrection, but it may also restore depositor confidence and buy extra time for economic and financial recovery	??
Trade openness	Open countries are more vulnerable to global trade shocks, but they have more risk sharing opportunities	??
Trading partner growth	Trading partner growth may complement falling domestic demand	-
Currency crisis	Twin crises are associated with disproportionally large output effects	+

Given the focus of our analysis, we now zoom in on studies dealing with banking crises. This reduces the sample size to 17 studies (see Appendix 2 for the studies included). We rank the explanatory variables used in these studies based on the frequency of the significance of a particular variable, applying a minimum of three

studies that include a particular variable. Figure 1 summarizes the variables that are found to be significant most frequently in studies focusing on banking crises.

Figure 1. Most significant drivers of the real impact of banking crises



Note: The ranking of variables is based on the frequency of significance. Variables are only included if considered by at least 3 studies.

3. Capturing crisis severity

Several measures have been used in the literature as a proxy for the real impact of a banking crisis. Our analysis is based on 9 different measures (see Table 2). Five of these measures are based on cumulative output (or output growth) lost due to the crisis, three refer to the duration of the crisis, and the final measure refers to the depth of the crisis. We will illustrate these measures using the representative case of the banking crisis in in 1998 in Ecuador.[2]

[2] According to Laeven and Valencia (2013), the output loss of this crisis was 23.3%, while the average output loss of all banking crises in the Laeven-Valencia database is 23.2%.

Table 2. Measuring the impact of banking crises

Variable	Definition
Crisis Severity 1	Cumulative difference between trend GDP growth and actual GDP growth up to the point where post-crisis GDP growth equals trend GDP growth. Trend is estimated from the 5 pre-crisis years taken from the HP-filtered GDP growth series from 1960 up to each crisis year.
Crisis Severity 2	Cumulative peak-to-trough measure following the triangular approach. The base is the duration, where the end point is when the trough is reached and amplitude is the difference between the pre-crisis peak and the trough as a percentage of the pre-crisis peak.
Crisis Severity 3	Cumulative difference between extrapolated trend GDP and actual GDP up to the point where actual post-crisis GDP crosses trend GDP. Losses are expressed as a percentage of GDP at the first quarter of the banking crisis year (t_c). The extrapolation of the trend is based on the trend for the 5 pre-crisis years. Trend is based on HP-filtered GDP series from 1960 up to each crisis year.
Crisis Severity 4	Cumulative difference between the pre-crisis peak GDP level and the actual GDP levels with cutoff point determined when GDP after the crisis equals pre-crisis peak GDP. It is calculated as a percentage of pre-crisis peak GDP level.
Crisis Severity 5	Cumulative difference between extrapolated trend GDP and actual GDP. The extrapolated trend GDP is found by extrapolation of the HP trend estimated over $T_C - 20$ to $T_C - 1$. The fixed cut off point is $T_C + 3$ and output loss is expressed as a percentage of trend GDP.
Duration 1	Duration associated with the *Crisis Severity 1* variable. Starting point is the point at which GDP growth is lower than average trend GDP growth in the interval T_c to $T_c + 1$. The end point is defined when trend growth is crossed by actual GDP growth values.
Duration 2	Duration associated with the *Crisis Severity 2* variable. Starting point is the highest point in the interval $T_c - 1$ to $T_c + 1$. End point is defined when GDP has reached its trough.
Duration 3	Duration associated with the *Crisis Severity 4* measure. Starting point is the highest point in the interval $T_c - 1$ to $T_c + 1$ .The end point of a crisis is defined when post-crisis GDP level equals the pre-crisis peak GDP level
Peak to trough	Peak point is the highest quarterly value from $T_c - 1$ to $T_c + 1$ and the trough point is the first quarter after which GDP growth is positive. Expressed as a percentage of peak GDP.

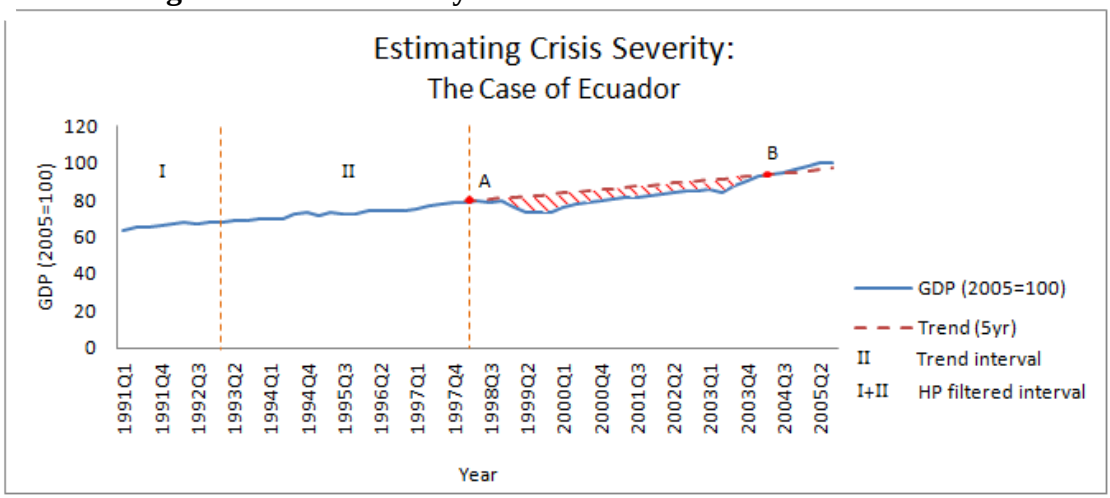
Notes: t_c denotes the first quarter of the crisis year; T_c denotes the crisis year.

We use the updated version of the banking crisis database constructed by Laeven and Valencia (2013) to determine the start of a banking crisis. This database is widely used and identifies the start of 147 banking crises over the period 1970-2011.

We start with Crisis Severity 3 (CS3), as (a variant of) this measure has been widely used in the literature. It is shown in Figure 2. Crisis severity is measured by taking the integral of the area between trend and actual GDP from point A up to the point where actual GDP is back on trend (point B). The sum of the discounted annual

losses is expressed as a percentage of initial GDP (similar to Boyd et al., 2005).[3] Trend GDP is estimated by a Hodrick-Prescott (HP) filter using quarterly GDP from 1960 up to the start of the banking crisis according to Laeven and Valencia (2013). Most studies construct trend GDP after the crisis by extrapolating the pre-crisis trend using time intervals varying from 1 to 20 years. We apply a five-year period before the crisis and extrapolate over 5 years after the start of the crisis.

Figure 2. Crisis Severity 3 illustrated for the case of Ecuador



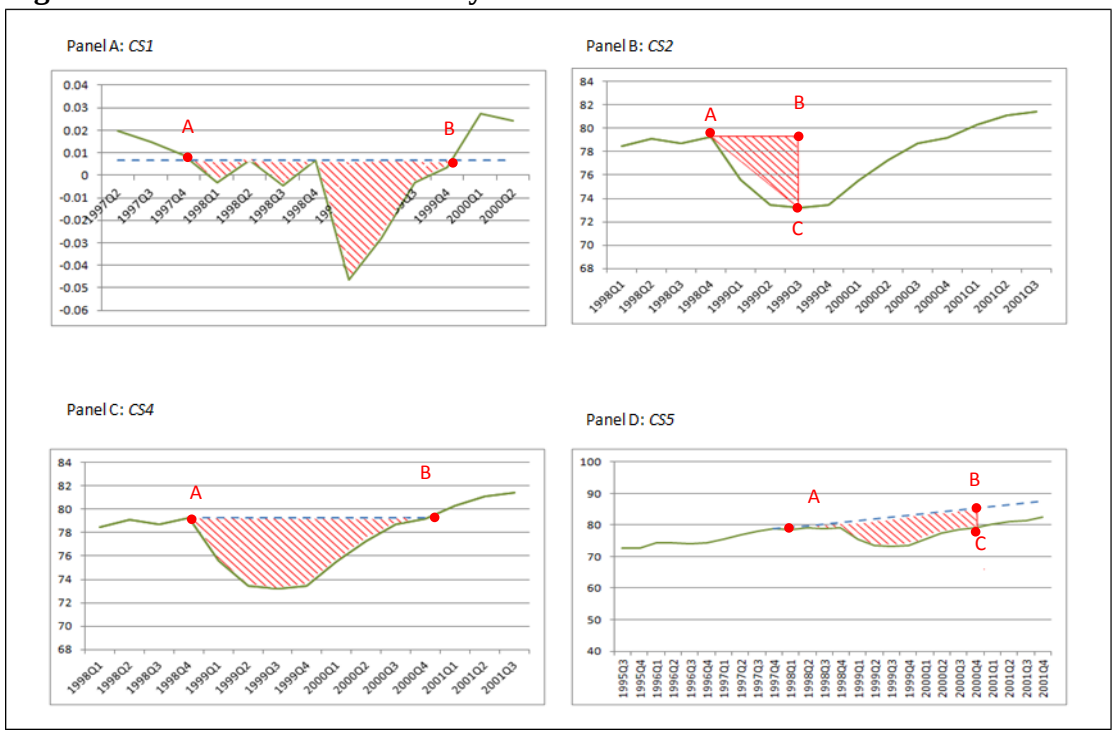
Note: This figure shows real GDP in Ecuador. According to Laeven and Valencia (2013), there was a banking crisis in 1998. The HP-filter is applied to GDP in quarters preceding the crisis, denoted by the blue line. II is the interval on the basis of which the trend is extrapolated. Point A denotes the start of the crisis; point B denotes the end of the period to calculate the output loss. The cumulative (highlighted) area between trend GDP and the actual level of GDP between points A and B is Crisis Severity 3.

The most serious drawback of this method to construct output lost due to the banking crisis is that if the GDP series is non-stationary, extrapolating the trend yields an inaccurate counterfactual, as the series will not return to this trend. To the best of our knowledge, previous research has ignored this problem even though there is strong evidence that GDP is non-stationary (provided in an appendix, which is available on request). The bias induced by the unit root hypothesis can either be positive or negative, dependent on the nature of a post-crisis shock. For example, when output growth would fall (rise) to a lower (higher) trend after a crisis, output losses may be overestimated (underestimated) (Hoggarth et al., 2002). While fully aware of this problem, we use this measure in view of its prominence in the literature.

[3] An annual discount rate of 4% is applied.

A variant of this method (Crisis Severity 5 in Table 1) is used by Laeven and Valencia (2013). It is shown in panel D in Figure 3. This measure differs in three ways from Crisis Severity 3. First, the trend is based on a 20-year pre-crisis window; second, the output losses are all truncated three years after the occurrence of a crisis. Finally, the annual output losses are not discounted. Boyd et al. (2005) criticize this choice, arguing that discounting is needed to make output losses comparable on an inter-temporal basis. Another criticism is that the fixed cutoff point three years after the start of a crisis is rather arbitrary and implies that the output loss may be underestimated.

Figure 3. Alternative crisis severity measures illustrated for the case of Ecuador



Notes: An overview of the crisis severity measures using the Ecuadorian banking crisis of 1998. The crisis according to Laeven and Valencia (2013) occurs in 1998. Panel A: CS1 measure: cumulative difference between (HP) trend GDP growth and actual GDP growth up to the point where post-crisis GDP growth equals trend GDP growth. Panel B: CS2: Triangle determined by duration, where the end point is when the trough is reached and amplitude is the difference between the pre-crisis peak and the trough as a percentage of the pre-crisis peak. Panel C: CS4: Cumulative difference between the pre-crisis peak GDP level and the actual GDP levels (with cutoff point determined when GDP after the crisis equals pre-crisis peak GDP) as percentage of pre-crisis peak GDP level. Panel D: CS5 measure: (non-discounted) cumulative difference between extrapolated trend GDP (determined using 20 year horizon) and actual GDP with a cutoff-point of three years for the duration of the crisis.

The Crisis Severity 1 (CS1) variable measures the cumulative growth loss displayed

in Panel A of Figure 3. The estimate equals the numerical integral[4] between the average 5-year trend growth (the HP-filtered series) and actual GDP growth. The starting point is defined when GDP-growth is lower than the average growth (point A). The end point is defined when GDP-growth intersects the average growth (point B). Duration 1 is defined as the time between points A and B. In our view, this variable is the preferred way of measuring the real impact of a crisis if GDP has a unit root. In that case, shocks have a permanent impact on the level of GDP and only growth rates will return to pre-crisis levels. However, if GDP is I(0), calculating output loss using GDP growth implies that the output loss is underestimated, since GDP is typically still well below its pre-crisis level at the point where growth rates have recovered (Boyd et al., 2005).

Crisis Severity 2 (CS2) is shown in Panel B of Figure 3. Here the starting point is defined as the pre-crisis GDP peak (point A).[5] The end point is defined as the trough of GDP (point C). The horizontal distance between A and B is the duration of the crisis (Duration 2 in Table 1), whereas the vertical distance denotes the depth of a crisis (equal to the *Peak to trough* measure in Table 1). These measures can be thought of as a triangle, with the horizontal distance as a base and the vertical distance as amplitude (Agnello and Nerlich, 2012 and Harding and Pagan, 2002). The Crisis Severity 2 measure corresponds to the surface area of the triangle, expressed as a percentage of the pre-crisis peak GDP. A criticism of this approach is that in the run-up to a banking crisis unsustainable output levels may have been reached (Hoggarth et al., 2002).

Crisis Severity 4 (CS4) is shown in Panel C of Figure 1. It comprises the area between the (constant) pre-crisis peak GDP (A) and actual GDP, up till the point where the two series intersect. The duration between points A and B is called Duration 3 (DUR3). Output losses are computed as a percentage of the pre-crisis peak GDP.

For countries with multiple crises in the interval 1970-2011 a new crisis may be observed before the consequences of a previous crisis are dissipated. In that case the duration of the previous crisis is truncated. This applies to the Argentinean banking crisis of 1995 when Crisis Severity 3 measure is used. Another issue arises

[4] The CS1, CS2 and CS3 measures use the trapezoidal rule to approximate definite integration.
[5] Pre-crisis peak GDP levels are identified in the interval from $T_c - 1$ to $T_c + 1$ following Cecchetti et al. (2009). This is also true for the *CS4* measure.

when a negative trend is observed. Similar to Angkinand (2008), we set trend growth equal to zero in that case.

Table 3 presents descriptive statistics, while Table 4 shows the correlation of the measures used in our analysis.

Table 3. Descriptive statistics of the dependent variables

Variable	Obs.	Mean	St. Dev.	Min.	Max.
CS1	44	14.153	10.177	0.619	46.116
CS2	44	3.110	3.574	0.000	19.676
CS3	44	2425.729	3207.750	0.006	13533.806
CS4	44	72.326	70.473	0.000	289.554
CS5	42	34.788	28.984	0.000	109.300
PT	44	1.522	1.538	0.000	8.053
DUR1	44	7.404	5.921	0.308	34.802
DUR2	44	3.296	2.097	0.000	8.000
DUR3	44	12.740	6.187	0.000	26.781

Table 4. Correlation matrix

	CS1	CS2	CS3	CS4	CS5
CS1	1.0000				
CS2	0.5951	1.0000			
CS3	0.4832	0.2822	1.0000		
CS4	0.7786	0.5715	0.2167	1.0000	
CS5	0.5697	0.4995	0.4618	0.6158	1.0000

	DUR1	DUR2	DUR3
DUR1	1.0000		
DUR2	0.2770	1.0000	
DUR3	0.2072	0.5788	1.0000

It is quite remarkable how low several correlations are. From this perspective, it is not surprising that the results of the studies summarized in Section 2 differ so strongly when it comes to identifying variables which are significantly linked to crisis severity.

4. Empirical Analysis

4.1 Approach

Our sample covers 44 banking crises over 40 countries. The sample size is determined by the availability of quarterly GDP data provided by the International Monetary Fund. Data availability forced us to drop the short-term debt to reserves ratio from our analysis, as it would reduce the sample too much. The remaining 20 explanatory variables show remarkably little correlation, as is evident from Table A3 in Appendix 3. This suggests that our selection of possible determinants of the real impact of banking crisis is sufficiently diverse and does not foreshadow serious multicollinearity problems.

To arrive at our preferred model, we proceed in two steps. First, we use Bayesian model averaging (BMA) to select a base model. Under this method, the results for all possible combinations of the explanatory variables are considered (cf. Abiad *et al.*, 2009).[6] High posterior inclusion probabilities indicate explanatory power for a variable (see Hoeting et al., 1999 and Viallefont et al., 2001 for further details). Only variables with the largest posterior inclusion probabilities are included into the base model (with a maximum of five). Second, from the remaining set of possible regressors, we select the one with the highest significance level. If the regressor is significant at the 10% level or better, it is added to the model. We repeat this procedure until any additional regressor fails to be significant.

4.2 Results: Crisis severity

We use OLS to estimate the relationship between our crisis severity measures and crisis duration measures and their determinants.[7] Table 5 shows the results for the five crisis severity measures. The variables shown in italics are part of the base model. The other variables have been selected according to the specific-to-general approach explained in section 4.1. Overall, the models describe the data quite well, judging from the adjusted R-squared statistics. At the same time, the models for the various crisis severity measures are very different, implying that the choice of a particular

[6] The BMA approach requires a balanced sample. We have therefore initially dropped four variables (exchange rate depreciation, recapitalization costs, the interest rate and the change in public expenditures) when forming our base model. In the second stage of our approach, these variables have been reconsidered as potential regressors.

[7] The average fraction of zeroes for the dependent variables is approximately 6%. Wilson and Tisdell (2002) show that the OLS bias is minor when the fraction of censored observations is less than 15%.

crisis severity measure will affect conclusions about the determinants of crisis severity. None of the potential determinants considered is significant in all regressions. The current account (as a percentage of GDP) is significant in three out of five models. Countries with a high current account surplus are less affected by a banking crisis, which is in line with the discussion in section 2.

For two crisis severity measures, a low real interest rate increases the severity of banking crises. This supports the view that low interest rates signal a pre-crisis boom, leading to bigger losses (Berglöf et al., 2010). Our results also provide some evidence that a pegged exchange rate regime tends to escalate banking crises.

4.3 Results: Crisis duration

Table 6 shows the results when duration and the peak-to-trough measures are used as dependent variable. Similar to the crisis severity regressions, we first obtain the base model using the BMA approach and then follow a specific-to-general approach.[8] Again, the models differ to a great extent. No variable is significant in all three regressions. Initial GDP per capita is significant in two of the three models using duration measures. Countries with a high GDP per capita tend to have more prolonged downfalls after the occurrence of a banking crisis. Also two variables related to the exchange rate are twice significant with a positive coefficient: currency depreciation and the occurrence of a currency crisis. Although these variables are related (a currency crisis coincides with a strong currency depreciation), they are not the same (not all currency depreciations coincide with a currency crisis).

[8] There are no variables with a posterior inclusion probability higher than 0.5 for the DUR1 measure, so that for this measure only the specific-to-general approach is used.

Table 5. Regression results for crisis severity measures

	CS1	CS2	CS3 [a]	CS4	CS5
Liquidity support	0.399***				-0.746**
	(0.103)				(0.312)
Investment	0.417**		445.679***		1.196
	(0.198)		(67.541)		(0.788)
Current account	-0.597***			-4.488***	-1.034*
	(0.170)			(1.491)	(0.517)
Pre-crisis GDP growth	0.137	0.296*			0.377
	(0.510)	(0.164)			(1.660)
Interest rate	*-0.663***			*-3.032***	
	(0.158)			*(1.167)*	
Credit regulation quality	1.651**				
	(0.680)				
Pre-crisis GDP	-1.285*				
	(0.713)				
Fixed exchange rate		0.920		35.055*	22.791***
		(0.775)		(17.738)	(6.960)
Exchange rate depreciation		*0.131***			
		(0.050)			
Pre-crisis GDP per capita				9.804	
				(9.911)	
Financial openness			4.700***		0.183
			(1.315)		(0.113)
Private sector credit growth				1.868	
				(1.506)	
Capital controls				-7.917*	
				(3.882)	
Recapitalization costs					*1.512***
					(0.401)
Trade openness					-0.174*
					(0.091)
No. of crises	31	34	44	30	37
Adj. R-squared	0.711	0.298	0.671	0.599	0.619

Notes: This table shows the estimation results when explanatory variables (as shown in Table A1 in the Appendix) are added to the base model (determined using the BMA approach; variables in the base model are in italics) following a specific-to-general approach. The dependent variables are crisis severity measures as explained in Table 2. All regressions include a constant term, which is not displayed in the table. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[a] Estimated with White heteroskedasticity robust standard errors due to detected heteroskedasticity (Breusch-Pagan-Godfrey test).

The last two variables are also significant in the model with the peak-to-trough measure as dependent variable. The occurrence of a currency crisis, a depreciation of the exchange rate and high pre-crisis GDP growth intensify the peak-to-trough impact of a banking crisis (last column of Table 6). The sign of the currency crisis variable is

in line with theoretical predictions, whereas the signs of the GDP growth rate and the exchange rate depreciation implied by theory were ambiguous. Our results suggest that high pre-crisis GDP growth levels signal unsustainable overheating, while a depreciation of the exchange rate reveals vulnerabilities induced by foreign liabilities rather than a positive demand stimulus.

Table 6. Regression results for duration and peak-to-trough measures

	DUR1[a]	**DUR2**	**DUR3**	**PT**
Interest rate	*-0.087*			
	(0.084)			
Change in public expenditure	*-2.051****			
	(0.735)			
Pre-crisis GDP per capita		1.405***	1.680**	
		(0.455)	(0.643)	
Liquidity support		-0.016		
		(0.031)		
Property rights		-0.786**		
		(0.356)		
Fixed exchange rate		0.513	3.822**	0.177
		(0.615)	(1.632)	(0.286)
Pre-crisis GDP growth		-0.098		0.142**
		(0.132)		(0.061)
Exchange rate depreciation		*0.136****		*0.060****
		(0.039)		*(0.019)*
Currency crisis		1.371*		0.628**
		(0.718)		(0.297)
Current account			-0.269**	
			(0.120)	
Credit regulation quality				-0.120
				(0.083)
No. of crises	31	34	43	34
Adj. R-squared	0.351	0.441	0.315	0.429

Notes: This table shows the estimation results when explanatory variables (as shown in Table A1 in the Appendix) are added to the base model (determined using the BMA approach) following a specific-to-general approach. The dependent variables are duration and peak-to-through measures as explained in Table 1. All regressions include a constant term, which is not displayed in the table. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[a] Estimated with White heteroskedasticity robust standard errors due to detected heteroskedasticity (Breusch-Pagan-Godfrey test).

5. Sensitivity analysis

The results for some of our dependent variables may suffer from an endogeneity problem. As pointed out by Hojar and van Wijnbergen (2013, p. 2), "intervention is endogenous to crisis severity. Governments are more likely to intervene in severe than

in mild crises."[9] Severe banking crises may trigger policies, such as recapitalization and liquidity support (Honohan and Klingebiel, 2003). Similarly, governments may be less likely to put government funds at risk when a crisis is mild (Detragiache and Ho, 2010). To deal with this issue, we follow Detragiache and Ho (2010) who argue that countries with presidential systems and countries with small governments are less inclined to pursue bank support policies. In presidential systems, the accountability to the electorate is higher, which may make it more difficult to implement bank support (Persson et al., 2000). Large governments will be more inclined to politically intervene in markets, rather than relying on free market forces (Gwartney et al., 2012). Hence, the size of a government will likely be correlated with policy responses during a banking crisis. The first instrumental variable captures the political system[10] (source: *World Bank's Political Database*) and the second one captures the size of the government (source: *Fraser Institute*).[11]

We apply instrumental variables in cases where recapitalization costs and/or liquidity support turn out significantly in our previous regressions, i.e. in the regressions of *CS1* and *CS5*. Table 7 provides the two-stage least squares estimates. It turns out that the sign and/or significance of the coefficients of liquidity support and recapitalization for *CS5* change when compared to the estimates reported in Table 5. For *CS5*, support policies are no longer significant, while the results for *CS1* confirm that liquidity support causes crises to be more severe. The latter finding is in line with the results reported by Detragiache and Ho (2010).

[9] All other variables in our analysis - except (by definition) currency crisis, the change in public expenditures and trade growth - have been lagged, which reduces endogeneity (similar to e.g. Agnello and Nerlich, 2012 and Berkmen et al. 2012).

[10] This variable takes on the value of 0 when a presidential regime is in place, the value 1 if a country has an assembly-selected president and a value of 2 when a country has a parliamentary regime.

[11] A valid instrument needs to be exogenous and relevant. Exogeneity requires the instrument to be uncorrelated with the error term in the initial regression (Verbeek, 2008). Relevance requires the instrument to be correlated with the endogenous variable without being a strict linear combination of the other variables of the model. Detragiache and Ho (2010) provide compelling evidence for the validity of these instruments.

Table 7. TSLS for CS1 and CS5 using instruments for government support policies

	CS1	CS5
Liquidity support	0.794**	0.405
	(0.336)	(1.478)
Recapitalization costs		0.045
		(2.415)
Investment	0.707**	3.173
	(0.318)	(2.777)
Current account	-0.604**	-1.140
	(0.219)	(0.863)
Pre-crisis GDP growth	-0.547	-3.460
	(0.857)	(5.569)
Interest rate	-0.776***	
	(0.229)	
Credit regulation quality	2.738**	
	(1.253)	
Pre-crisis GDP	-1.637	
	(1.012)	
Fixed exchange rate		12.071
		(16.933)
Trade openness		-0.038
		(0.222)
Financial openness		0.204
		(0.156)
No. of crises	30	36
Adj. R-squared	0.541	0.350

Notes: This table shows two-stage least squares regression for the same models as in Table 4 using a political system dummy and size of government as instruments for government support policies. Constant included in the regressions (not displayed). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Arguably, our crisis severity measures are censored, as there is a lower bound of zero. Tobit models are particularly suitable to model this kind of variables (Verbeek, 2008). Even though the highest fraction of zeroes in our sample amounts to only 12% (for the *CS2* and *CS5* measure), which will unlikely impose large biases to our OLS estimates (Wilson and Tisdell, 2002), we re-estimated models using Tobit estimates. The results of the Tobit regressions (available on request) are fairly similar as those in Table 5.

6. Conclusions

Several recent papers have examined the drivers of the impact of banking crises. These studies reach very different conclusions. To some extent, these differences reflect that studies use different determinants of the severity of banking crises and different ways to measure this severity, such as output loss, the duration of the crisis and the depth of the crisis. The purpose of our research is to unravel which macroeconomic variables are robust in explaining cross-country differences in the real impact of systemic banking crises, using nine proxies for the severity of these crises. Five of these measures are based on cumulative output (or output growth) lost due to the crisis, three refer to the duration of the crisis, and the final measure refers to the depth of the crisis. We have used 21 potential determinants in our analysis, which were selected on the basis of a meta-analysis.

Several conclusions can be drawn. First, the measures used to capture the real impact of banking crises differ very much. Each of these measures has some limitations. This implies that researchers are well advised to use several crisis severity measures.

Second, the findings as to the most robust drivers of the real impact of banking crises differ across the type of severity measure used. Our results suggest that current account imbalances are the most robust determinant of the real impact of banking crises. GDP per capita prolongs the duration of banking crises. Exchange rate depreciation, pre-crisis GDP growth and the occurrence of a currency crisis exacerbate the peak-to-trough impact of a banking crisis.

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Appendix 1. Variables considered

The level of *private sector credit* provided by banks is used as a proxy for the level of financial development and the size of the financial system (Berglöf et al., 2010 and Giannone et al., 2011). Arguably, a more developed financial system may be hit harder during a crisis. On the other hand, a deeper financial system may make it easier to recover from financial shocks (Berglöf et al., 2010; Yanagitsubo, 2004).

A high rate of *private sector credit growth* preceding a crisis is likely to imply a credit boom, which is often associated with a more severe crisis (Berglöf et al., 2010). Sachs et al. (1996) argue that credit growth is a good proxy for banking system vulnerability, as it is often related to a decline in lending standards. Additionally, high credit growth may enable asset and house price bubbles; the resulting asset price volatility when these bubbles burst may affect crisis severity (Frankel and Saravelos, 2012).

According to Detragiache and Ho (2010), countries having fewer *capital controls* are better able to withstand a crisis because of their access to alternative sources of capital. On the other hand, Gupta et al. (2007) argue that the absence of capital controls might undermine the government's ability to implement counter-cyclical policies or to stop capital outflows. Moreover, the absence of capital controls may stimulate excessive credit growth, which makes a country more prone to a crisis (McKinnon and Pill, 1997).

According to Abiad et al. (2009), more *financial openness* reduces the risk of a sudden stop in capital flows, which may cushion the severity of banking crises. Moreover, financial integration offers risk-sharing opportunities and helps to smooth output and consumption. On the other hand, globally integrated financial systems may be more prone to international financial shocks (Giannone et al., 2011).

When a country spends more abroad than it is earning, it is likely to require external financing. This financial fragility in turn implies that countries with high *current account* deficits may experience more severe crises (Berkmen et al., 2012). Blanchard et al. (2010) argue that the higher the initial current account deficit, the larger the output effect of a financial crisis will be.

The magnitude of the *debt-to-reserves* ratio may also be a significant determinant of crisis severity. Higher reserves enable the rollover of external debt, which mitigates potential effects of liquidity shortages (Frankel and Saravelos, 2012). A high level of reserves also helps in restoring confidence and reducing external

vulnerabilities (Llaudes et al., 2010). However, countries may be reluctant to use reserves during crises, as it may be interpreted as a sign of weakness or countries may fear losing their reserves too early (Blanchard et al., 2010). A high concentration of short-term debt may impose difficulties in rolling over the debt later on, which in turn may exacerbate crises (Frankel and Rose, 1996).

An *exchange rate depreciation* creates a positive demand stimulus. Exchange rate depreciation can rapidly increase foreign debt servicing costs of indebted and non-hedged firms (Stone, 2000). Likewise, financial firms with foreign liabilities denominated in foreign currency will be hurt which may exacerbate the output loss of a banking crisis (Hutchison and McDill, 1999).

High *interest rates* increase funding costs, and reduce investment and consumers' disposable income (Cecchetti et al., 2009). On the other hand, low real interest rates may indicate a boom in the run-up to a crisis (Cecchetti et al., 2009 and Honohan and Klingebiel, 2003).

The pre-crisis *investment* level may reveal imbalances of the financial system. A high level of investment at the onset of a crisis may indicate an investment boom (Yanagitsubo, 2004). The unwinding of pre-crisis excessive investment during a crisis may cause the crisis to be more severe (Abiad et al., 2009).

Pre-crisis GDP is frequently included as a proxy for the economic size of a country (cf. Gupta et al., 2007 and Llaudes et al., 2010). The size of an economy may be positively correlated with output volatility (Giannone et al., 2011). A high GDP level may limit the severity of a crisis due to smaller export and import shares or fewer leakages from stimulus packages (Aiginger, 2011).

High *pre-crisis GDP growth* can indicate unbalanced overheating, but may also signal a sustainable catching-up process of emerging economies (Aiginger, 2011). According to Cecchetti et al. (2009) recession-induced crises are more severe than crises that are preceded by high growth rates.

Pre-crisis GDP per capita captures the general level of economic development (Cecchetti et al., 2009). A high level of GDP per capita is associated with financial deepening which, in turn, is likely to be significantly related to crisis severity (Berglöf et al., 2010). According to Rose and Spiegel (2009), governments of relatively rich countries are better able to assist troubled financial institutions. However, they also argue that the ability of a government to intervene is likely to be correlated with the degree of exposure agents took during the boom years. Arguably,

this makes rich nations more vulnerable.

The *quality of credit regulation* is essential in preventing financial instability. Giannone et al. (2011) argue that it affects banks' performance and competitiveness, which, in turn, determine the resilience of banks to cyclical shocks. Lax credit regulation may lead to more risk-taking, which, in turn, may induce more severe banking crises (Kaminsky and Reinhart, 1999).

Countries without a *fixed exchange rate* may be better able to cushion the impact of financial shocks, so that crises are less severe (Berkmen et al., 2012). On the other hand, a pegged exchange rate regime may cause borrowers to ignore exchange rate risk. This leads to macroeconomic instability, which is hard to address under pegged exchange-rate regimes. However, pegged exchange rate regimes may contribute to monetary discipline, thereby stabilizing expectations and increasing macroeconomic performance (Shimpalee and Breuer, 2006).

Property rights are often used as proxy for the quality of domestic institutions (Angkinand, 2009). Countries with low-quality institutions may be subject to more financial instability, as they provide limited protection to creditors and shareholders (Shimpalee and Breuer, 2006). Additionally, Claessens et al. (2004) argue that the private sector is less able to resolve a crisis in countries with a poor institutional framework.

In a Keynesian framework, an increase of *public expenditures* sustains economic growth during a crisis and may also shorten the duration of a crisis. However, the effect of fiscal policy in limiting the severity of crises may depend on the design of the fiscal policy package and accompanying macroeconomic programs (Baldacci et al., 2009).

Longer and more severe crises are associated with stronger government responses (Bordo et al., 2001). Policy responses may be more likely when the aftermath of a crisis is already severe (Cecchetti et al., 2009). On the other hand, *liquidity support* can implement perverse incentives, such as facilitating a continued flow of financing to non-creditworthy borrowers (Bordo et al., 2001 and Honohan and Klingebiel, 2003). Similarly, *recapitalization costs* in the form of unconditional support may intensify crises through perverse incentives, as firms may gamble for resurrection (Bordo et al., 2001). On the other hand, government interventions may restore depositor confidence and buy extra time for economic and financial recovery (Honohan and Klingebiel, 2003). Hojar and Van Wijnbergen (2013) analyze 68

systemic banking crises from the period 1980-2013 and find that bank recapitalizations substantially reduce recession duration.

Economies with a higher degree of *trade openness* are more vulnerable to global trade shocks (Claessens et al., 2010). Global financial crises lead to a vast decline in global trade, which may severely affect open economies (Levchenko et al., 2009). However, more internationally integrated economies have risk sharing opportunities that can help sustain output and consumption (Giannone et al., 2011). In particular, more open countries have the ability to export goods when domestic demand falters (Gupta et al., 2007).

External demand shocks will likely cushion the negative effects of a domestic crisis (Abiad et al., 2009). *Trading partner growth* may complement falling domestic demand when partner countries are not affected by the crisis.

Currency crises can have a negative effect on output growth when a credit contraction occurs due to balance sheet deterioration of firms with large foreign currency liabilities (Hutchison and Noy, 2005). The occurrence of currency crises together with banking crises (so called twin crises) are associated with disproportionally large output effects (Berg, 1999). Moreover, twin crises might lead to vicious cycles that can exacerbate the output costs (Kaminsky and Reinhart, 1999). A strong depreciation can reduce borrowing capacity and investment. In fact, access to credit can be further limited by a simultaneous banking crisis, aggravating the economic costs (Hutchison and Noy, 2005).

Table A1. Key determinants of the real impact of banking crises

Variable	Time [a]	Definition
Credit		
(1) Private sector credit	T_c -1	Domestic private credit provided by the banking sector as % of GDP. Source: World Development Indicators.
(2) Private sector credit growth	T_c -3 to T_c	Average growth of domestic private credit provided by the banking sector. Source: World Development Indicators.
Financial Openness		
(3) Capital controls	T_c-1	Zero-to-ten rating based on the percentage of capital controls not levied as a share of the total number of capital controls. Hence, a higher value indicates fewer controls. Source: Fraser Institute
(4) Financial openness	T_c -1	The sum of foreign assets and foreign liabilities as a share of GDP. Source: Updated and extended version of external Wealth of Nations dataset by Lane and Milesi-Ferretti (2007)
International Imbalances		
(5) Current account	T_c -1	The sum of net exports of goods, services, net income and net current transfers as a percentage of GDP. Source: World Development Indicators. Source: World Development Indicators
(6) Exchange rate depreciation	T_c -1 to T_c	Change in real effective exchange rate (REER) (2005=100). The REER measures the nominal effective exchange rate divided by an index of costs or a price deflator. Source: World Development Indicators
(7) Short-term debt to reserves	T_c -1	Short-term debt to reserves ratio. Short-term debt includes all debt with maturity of one year or less and interest in arrears on long-term debt. Total reserves include gold. Source: World Development Indicators
Macroeconomic Conditions		
(8) Interest rate level	T_c -1	The lending interest rate adjusted for inflation as measured by the GDP deflator. Source: World Development Indicators
(9) Investment	T_c -3 to T_c	Gross capital formation including outlays on additions to the fixed economy assets plus net changes in the inventory levels. Source: World Development Indicators
(10) Pre-crisis GDP	T_c -1	Log of GDP measured at current US dollars. Source: World Development Indicators
(11) Pre-crisis GDP growth	T_c -1	The growth of GDP based on local currency values. Source: World Development Indicators
(12) Pre-crisis GDP per capita	T_c-1	Log GDP divided by midyear population in current US dollars. Source: World Development Indicators
Policy Framework		
(13) Credit regulation quality	T_c -1	Zero-to-ten rating including ownership of banks, competition, extension of credit and interest rate controls. A higher value corresponds to more economic freedom. Source: Fraser Institute
(14) Fixed exchange rate	T_c -1	Dummy variable taking the value 1 when a country has a de facto pegged exchange rate regime. Source: International Monetary Fund
(15) Property rights	T_c -1	Composite variable of judicial independence, impartial courts, protection of intellectual property, rule of law and political process, lack of military interference and integrity of the legal system. Higher score denotes a higher quality of the legal structure and better security of

		property rights. Source: Fraser Institute
Policy Response		
(16) Change in public expenditures	T_c to T_c+3	Average change of general government total expenditures consisting of total expense and net acquisition of non-financial assets. Source: World Economic Outlook
(17) Liquidity support	T_c to T_c +3	Ratio of central bank claims on deposit money banks to total deposits and liquidity support from the treasury to total deposits and liabilities to non-residents. Source: Laeven and Valencia (2013)
(18) Recapitalization costs	T_c to T_c +5	Gross (ignoring potential recovery of the costs) recapitalization costs to the government as a percentage of GDP. Source: Laeven and Valencia (2013)
Trade Linkages		
(19) Trade openness	T_c -1	Sum of exports and imports of goods and services as a percentage of GDP. Source: World Development Indicators
(20) Trading partner growth	T_c -2 to T_c +2	The average shock in GDP growth from T-2 to T+2 from a country's three largest trading partners (measured in value of exports). Source: Direction of trade statistics and World Development Indicators
Twin Crises		
(21) Currency crisis	T_c-1 to T_c +1	Dummy variable taking the value 1 when a currency crisis occurred in the interval T-1 to T+1. Laeven and Valencia (2013) define a currency crisis when the depreciation of a currency vis-à-vis the US dollar is at least 30% and is also at least 10 percentage points higher than the depreciation in the year before. Source: Laeven and Valencia (2013)

[a] T_c denotes the year in which the crisis started.

Appendix 2. Studies on impact of banking crises

Table A2. Studies included in the meta-analysis

Studies included:	Variables considered[a]:	Measure used[b]:
Abiad et al. (2009)	(1), (4), (5), (6), (8), (9), (10), (12), (16) (20), (21)	Output at T_c +7 in percent of the pre-crisis trend
Angkinand (2009)	(1), (3), (8), (11), (12), (13), (15), (21)	CS3
Angkinand and Willett (2008)	(2), (5), (11), (12), (21)	CS1; CS3
Baldacci et al. (2009)	(2), (16), (17), (18)	Average GDP growth during 5 years after the end of a crisis, Duration based on Laeven and Valencia (2013)
Boyd et al. (2005)	(17), (18), (21)	CS3
Cecchetti et al. (2009)	(1), (2), (5), (8), (11), (12), (15), (17), (18), (20), (21)	CS4; CS5; Peak-to-trough and a Duration 3 measure
Claessens et al. (2004)	(2), (15), (17)	CS1
De Gregorio and Lee (2004)	(6), (9), (11), (15), (16), (19), (20)	CS1
Detragiache and Ho (2010)	(1), (3), (11), (12)	GDP growth over the period T_c , T_c +2, Duration 3, CS4 CS5, the minimum GDP growth rate experienced during the crisis
Frydl (1999)	(1), (8)	CS5, Duration 1
Furceri and Zdzienicka (2012)	(2), (4), (6), (9), (10), (11), (21)	Output growth
Hoggarth et al. (2002)	(1), (2), (10), (11)	CS1, CS3, Fiscal costs, Duration 1
Hoggarth et al. (2005)	(1), (21)	CS1, Fiscal costs
Honohan and Klingebiel (2003)	(2), (5), (8), (11), (17), (18), (20)	CS1, Fiscal costs
Hutchison and Noy (2005)	(21)	GDP growth
Serwa (2010)	(2)	GDP growth
Winkler (2006)	(2), (11)	CS3

Appendix 3.
Table A3. Correlation matrix of explanatory variables

	(1) PC	(2) PS	(3) CC	(4) FO	(5) CA	(6) ED	(7) IR	(8) IN	(9) PG	(10) GG	(11) GC	(12) CQ	(13) FE	(14) PR	(15) PE	(16) LS	(17) RC	(18) TO	(19) TG	(20) CR
(1) Private sector credit (PC)	1.00																			
(2) Private sector credit growth (PS)	-0.19	1.00																		
(3) Capital controls (CC)	0.39	-0.44	1.00																	
(4) Financial openness (FO)	0.52	-0.20	0.16	1.00																
(5) Current account (CA)	-0.08	-0.60	0.38	0.23	1.00															
(6) Exchange rate depreciation (ED)	-0.52	-0.13	0.17	0.05	0.56	1.00														
(7) Interest rate level (IR)	-0.31	0.49	-0.30	-0.29	-0.42	-0.18	1.00													
(8) Investment (IN)	0.22	-0.06	-0.14	-0.12	-0.20	-0.17	-0.13	1.00												
(9) Pre-crisis GDP (PG)	0.39	-0.60	0.51	0.10	0.41	0.01	-0.72	-0.15	1.00											
(10) Pre-crisis GDP growth (GG)	0.02	0.11	-0.28	0.04	0.03	-0.06	0.02	0.48	-0.20	1.00										
(11) Pre-crisis GDP per capita (GC)	0.67	-0.61	0.47	0.60	0.34	-0.11	-0.61	-0.01	0.58	-0.33	1.00									
(12) Credit regulation quality (CQ)	0.35	-0.01	0.19	0.47	0.19	-0.07	-0.12	-0.16	-0.03	-0.11	0.47	1.00								
(13) Fixed exchange rate (FE)	-0.10	-0.18	0.26	0.05	0.11	0.31	-0.20	-0.05	0.05	-0.55	0.37	0.38	1.00							
(14) Property rights (PR)	0.63	-0.48	0.44	0.51	0.29	-0.10	-0.58	0.18	0.40	-0.25	0.87	0.39	0.31	1.00						
(15) Change in public expenditures (PE)	-0.39	0.26	-0.34	-0.33	-0.29	-0.11	0.06	-0.06	-0.15	0.16	-0.47	-0.67	-0.32	-0.31	1.00					
(16) Liquidity support (LS)	-0.28	0.01	-0.50	0.01	-0.02	-0.01	0.36	-0.02	-0.27	0.45	-0.23	-0.33	-0.36	-0.25	0.32	1.00				
(17) Recapitalization costs (RC)	0.55	0.04	-0.17	0.30	-0.45	-0.54	0.01	0.67	-0.21	0.43	0.23	0.06	-0.14	0.32	0.02	0.19	1.00			
(18) Trade openness (TO)	0.03	0.04	-0.02	0.44	0.17	0.31	-0.24	0.39	-0.17	0.26	0.13	0.35	0.33	0.20	-0.30	-0.09	0.21	1.00		
(19) Trading partner growth (TG)	-0.41	0.14	-0.24	-0.17	0.07	0.21	0.32	0.20	-0.43	0.34	-0.55	-0.46	-0.16	-0.53	0.26	0.27	-0.08	0.23	1.00	
(20) Currency crisis (CR)	-0.08	0.34	-0.19	-0.25	-0.47	-0.16	0.29	0.49	-0.45	0.19	-0.32	-0.33	-0.10	0.01	0.30	0.17	0.42	-0.02	0.22	1.00

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