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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 costs of banking crises. We identify 21 variables frequently used as determinants of the severity of banking crises. After a discussion of five measures based on cumulative output (or output growth) lost after a banking crisis, we examine the drivers of the real impact of banking crises for two preferred measures. Our results suggest that fixed investment and financial openness affect losses in output levels, while fixed investment, the current account balance, liquidity support, monetary policy and financial freedom affect losses in output growth after banking crises.

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 (see, for instance, [Klomp, 2010](#) and references cited therein). 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 global financial crisis has illustrated. Whereas some countries did not face a decline in output during this crisis, other countries suffered from double-digit output losses ([Aiginger, 2011](#)). Likewise, some countries recovered much faster than other countries ([Shehzad & de Haan, 2013](#)).

It is widely believed that banking crises are followed by recessions. Bank failures reduce credit supply, which may in turn limit both fixed investment and consumption and thereby lead to a recession ([Serwa, 2010](#)). However, in the theoretical model of [Rancière, Tornell, and Westerman \(2008\)](#), long-run growth and banking crises can be positively related. This result builds on the literature showing a positive relationship between financial development and economic growth. In the model of Rancière et al., credit growth finances economic growth but is subject to downside risk. Banking crises are the realization of that downside risk. If the impact of financial development on long-run growth exceeds the short-run negative impact of banking crises, there will be a positive relationship between growth and banking crises. Another warning that banking crises may not always cause recessions comes from [Dwyer, Devereux, and Baier \(2013\)](#). Using long-term data for 21 economies from around the world, these authors report substantial diversity in the effect of banking crises on real GDP per capita. Most strikingly, twenty-five percent of the banking crises are not associated with a decrease in real GDP per capita in the year of the crisis or in the following two years. Still, also these authors report that—on average—banking crises are associated with a decline in real GDP per capita in the year of the crisis and the year thereafter and that these decreases are large: real GDP per capita falls by 0.34 percent per year in the year of a crisis and 1.04 percent per year in

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the following year. Likewise, Claessens, Kose, and Terrones (2012) find that recessions associated with financial disruptions are often longer and deeper than other recessions.

The economic costs of a banking crisis can be defined as the loss of present and future discounted consumption in a particular country. To measure this directly is difficult and most studies addressing the determinants of the real impact of banking crises therefore use a proxy, such as the cumulative output losses following a banking crisis.¹ There is no agreement in the literature 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 identify potential drivers of the relationship between lost output (growth) and banking crises. The purpose of our research is therefore 1) to critically assess several proxies for the output loss due to banking crises as used in the literature and 2) to unravel which macroeconomic variables are robust in explaining cross-country differences in the real impact of systemic banking crises, using two preferred proxies for the real impact of crises.

We rely on the banking crisis database constructed by Laeven and Valencia (2013).² 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 & Valencia, 2013, p. 228).

Our main contributions to the literature are as follows. First, whereas previous studies mostly focus on one particular measure of crisis severity, we critically assess five widely used indicators of the output loss of banking crises. We conclude that each of these measures has serious conceptual shortcomings, but that two measures are to be preferred. These measures are used in our subsequent analysis of the drivers of the real impact of banking crises. Second, in contrast to most previous studies, we consider a long list of variables identified in previous studies as potential drivers of the real impact of banking crises. Third, whereas in previous studies the selection of variables included in the model explaining crisis severity seems rather ad hoc, we follow a more systematic approach to deal with the problem of model uncertainty. To identify which variables are robust, we proceed in two steps. In the first stage, we use Bayesian model averaging (BMA) to select a base model. Only variables with the largest posterior inclusion probabilities are included into the base model. In the second stage, we select from the remaining set of possible regressors the ones with the highest significance level. Using our preferred measures of crisis severity, our results suggest that fixed investment and financial openness affect losses in output levels, while fixed investment, the current account balance, liquidity support, monetary policy and financial freedom affect losses in output growth due to banking crises.

The remainder of the paper is structured as follows. Section 2 critically discusses different crisis severity measures and focuses on some studies using these measures. Section 3 reviews relevant determinants of banking crisis severity as identified in previous studies. Section 4 presents our empirical analysis. The final section provides an overview of the main results and discusses possible limitations.

2. Capturing the real impact of crises

Several measures have been used in the literature as a proxy for the real impact of a banking (or financial) crisis. Section 2.1 discusses five different measures of output loss due to a banking crisis. We illustrate these measures using the representative case of the banking crisis in 1998 in Ecuador.³ Section 2.2 critically assesses these measures.

2.1. Measuring output loss

We use 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. Table 1 describes the output loss measures discussed.⁴

We start our discussion of the measures shown in Table 1 with Crisis Severity 3 (CS3), as (a variant of) this measure has been widely used in the literature (see Appendix 1 for an overview of relevant studies). It is shown in Fig. 1. 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

¹ A notable exception is Cecchetti, Kohler, and Uppel (2009), who (also) use a proxy for the length of the crisis, i.e. the number of quarters it takes for output to recover to its pre-crisis level. They find that the length of the contraction following systemic banking crises is strongly related to: the growth of GDP in the year before the crisis (higher growth implies a shorter contraction); the presence of a currency crisis (*longer* by more than five quarters, on average); the presence of a sovereign debt crisis (*shorter* by more than seven quarters, on average); and whether an asset management company has been set up (*longer* by more than five quarters). Reinhart and Rogoff (2014) also consider the length of the crisis, defined as the number of years it takes to reach the prior peak in real per capita income.

² Chaudron and de Haan (2014) compare several banking crises datasets using the frequency of bank failures and the costs of banking crisis. These authors conclude that the Laeven and Valencia dataset is the most reliable source.

³ 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%.

⁴ In our sample, the growth rate is already back at its pre-crisis level after 8 quarters. This is similar to the finding of Abiad, Balakrishnan, Brooks, Leigh, and Tytell (2009), who conclude that annual growth tends to fall substantially below the pre-crisis trend during the first two years of the crisis, but it is statistically indistinguishable from the pre-crisis trend thereafter. At the same time, there is a lot of cross-country variability. For example, while the change in output relative to trend following banking crises has a mean of –11 percent after 4 quarters, its standard deviation is 10 percent. Similarly, while growth tends to return to the pre-crisis trend rate after 8 quarters on average, the standard deviation is 2.84.

Table 1
Measuring the impact of banking crises.

Variable	Definition
Crisis Severity 1 (CS1)	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 (CS2)	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 (CS3)	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 (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. It is calculated as a percentage of pre-crisis peak GDP level
Crisis Severity 5 (CS5)	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

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

Fig. 1. 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 real GDP in quarters preceding the crisis, denoted by the blue line. II is the interval on the basis of which the trend is extrapolated. I is the period between the start of our sample period until II. 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 (CS3).

B). The sum of the discounted annual losses is expressed as a percentage of initial GDP (similar to [Boyd, Kwak, & Smith, 2005](#)).⁵ 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.

A variant of this method (Crisis Severity 5 (CS5) in [Table 1](#)) is used by [Laeven and Valencia \(2013\)](#). It is shown in panel D in [Fig. 2](#). This measure differs in three ways from Crisis Severity 3. First, the trend is based on a 20-year pre-crisis window; second, output losses are truncated three years after the occurrence of a crisis. Finally, annual output losses are not discounted. [Boyd et al. \(2005\)](#) rightly criticize this choice, arguing that discounting is needed to make output losses comparable on an inter-temporal basis.

The Crisis Severity 1 (CS1) variable measures the cumulative growth loss displayed in Panel A of [Fig. 2](#). The estimate equals the numerical integral⁶ 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).

Crisis Severity 2 (CS2) is shown in Panel B of [Fig. 2](#). Here the starting point is defined as the pre-crisis GDP peak (point A).⁷ The end point is defined as the trough of GDP (point C). This measure can be thought of as a triangle, with the horizontal distance as a base and the vertical distance as amplitude ([Agnello & Nerlich, 2012](#) and [Harding & 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.

Crisis Severity 4 (CS4) is shown in Panel C of [Fig. 2](#). It comprises the area between the (constant) pre-crisis peak GDP (A) and actual GDP, up till the point where the two series intersect. 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

⁵ An annual discount rate of 4% is applied.

⁶ The CS1, CS2 and CS3 measures use the trapezoidal rule to approximate definite integration.

⁷ 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.

Fig. 2. Alternative crisis severity measures illustrated for the case of Ecuador (output growth in panel A and output levels in panels B through D). 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.

Table 2
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

1995 when Crisis Severity 3 measure is used. Another issue arises when a negative trend is observed. Similar to [Angkinand \(2008\)](#), we set trend growth equal to zero in that case.

[Table 2](#) presents descriptive statistics, while [Table 3](#) shows the correlation of the measures used in our analysis.

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

2.2. Critical discussion

There are three related issues in assessing the reliability of the measures discussed in the previous section: the selection of the end of the banking crisis, the potential impact of banking crises on the level or growth rate of (trend) output, and whether or not output (growth) is stationary.

First, like most recent studies we rely on the Laeven-Valencia banking crises dataset. However, this database only provides the beginning of the crisis. That is why all the measures introduced in the previous section rely on some ad hoc solution for dating the end of the crisis. This is not a trivial matter, notably for the most recent financial crisis. Although it is often declared over, output in many countries has not reached pre-crisis levels (see also [Reinhart & Rogoff, 2014](#)). And even if it has, one may wonder whether that is convincing evidence to conclude that we are back to normal in view of the monetary and fiscal policy stance in many advanced economies.

All measures discussed use a rather arbitrary endpoint of the banking crises. Under CS1, the crisis ends when the growth rate of

Table 3
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

output is back at the 5-year average output growth rate before the crisis. In other words, it is assumed that trend growth before the banking crisis will be resumed after the crisis, which may not be the case (see below).⁸ Another drawback of this approach is that a temporary increase in the growth rate above the average would trigger the end point of the crisis, even if this high growth rate only lasts for one quarter and is followed by quarters with low growth.⁹

Under CS2, the crisis is supposed to be over after output has reached its trough following the start of the banking crisis. In other words, under this criterion the recovery phase is not taken into account. In our view, this is a serious drawback.

Under CS3, the crisis is assumed to be over when the level of output is back on its pre-crisis trend thereby assuming that output is trend stationary, which may not be true (see below). The latter measure assumes that if output does not return to trend during the sample period, there will be an infinite sum of output losses. As [Boyd et al. \(2005, p. 984\)](#) argue: “output losses are attributed in each post-crisis year until the actual path crosses the trend path from below. After that, no further losses are attributed. Often, however, this never occurs and in those cases an infinite sequence of losses is attributed.”¹⁰ As pointed out by [Boyd et al. \(2005, p. 986\)](#): “The inclusion of output losses after the breakpoint presumes that there can be a permanent level effect associated with a banking crisis, an assumption that may or may not be plausible, but this method can be regarded as providing an upper bound.”

Under CS4, the crisis is assumed to be over once output is back at its pre-crisis peak. So also under this measure output is assumed to be trend stationary. In addition “it ignores the growth of the trend, which occurs even when the economy is in a recession. Obviously, as long as trend growth continues during a recession, reaching the level of output of the previous peak is not enough to return the economy back to trend or full employment. Despite this criticism, the measure has been used probably because of its simplicity and easiness to produce a measure of “returning to normal” ([Fatás & Mihov, 2013, p. 11](#)). So the first four measures use the end of the consequences of the crisis rather than the end of the crisis itself. If one is interested in examining the consequences of a crisis, it is problematic to define the length of the crisis on the basis of its impact as it creates some kind of circular reasoning.

Finally, under CS5 the banking crisis is arbitrarily assumed to last three years. The case of Japan shows that this is a highly dubious assumption. We therefore consider this measure unreliable.

Second, does the crisis affect output (growth)? To calculate the output loss, all measures come up with some counterfactual what output (growth) would have been without the banking crisis, for which usually some trend measure is used. But in doing so, most measures assume that the trend of output (growth) is not affected by the banking crisis. And this may be problematic in view of the outcomes of research on the impact of financial crises on growth (below we will discuss studies on the impact of crises on trend growth). For instance, in their seminal paper, [Cerra and Saxena \(2008\)](#) conclude that output does not rebound quickly from recessions caused by financial crises. Crises tend to have a permanent effect on output. These authors estimate an autoregressive panel model, augmented by crisis dummies, to explain GDP growth rates. The average effect of a crisis is then evaluated by calculating the impulse response function from the estimated coefficients. [Candelon, Carare, and Miao \(2016\)](#) augment [Cerra and Saxena's \(2008\)](#) analysis by extending the data until 2010 and by taking globalization and contagion effects into account. The authors find that the declines in output growth rates following currency, banking and stock market crises are much larger in the sample ending in 2010, than in the one ending in 2001.¹¹

However, not all research comes to the conclusion that banking crises affect output growth. For instance, [Romer and Romer \(2015\)](#) examine financial distress in 24 OECD countries for the period 1967–2007 and find that in modern advanced countries, declines in output after a financial crisis are on average only moderate and often temporary. However, there were very few banking

⁸ As pointed out by one of the referees, another issue is that CS1 may suffer from the problem that a temporary increase in the growth rate above the average would trigger the end point of the crisis, even if the high growth rate is only one quarter and is followed by many quarters of very low growth. However, in our sample this does not seem to be an issue.

⁹ We thank one of the referees for pointing this out. In Section 4.2 we examine whether this issue affects our main findings about the drivers of the real impact of banking crises.

¹⁰ If output does not cross trend from below, CS3 is calculated using the following formula:

$$CS3 = \frac{\int_{T_0}^{T_{last}} \left[\frac{\tau(t) - Y(t)}{(1+r)^{t-t_c}} \right] dt + \frac{\tau(T_{last}) - Y(T_{last})}{r} - \int_{t_c}^{T_{last}} \left[\frac{\tau(T_{last}) - Y(T_{last})}{(1+r)^{t-t_c}} \right] dt}{Y_0}$$

T_0 is the point at which trend is higher than actual GDP in the interval T_c and $T_c + 1$. T_{end} is determined when the trend line $\tau(t)$ is crossed from below. T_{last} is the quarter of the last available data-point. Y denotes the GDP series, r denotes the discount rate and t denotes time, t_c is the first quarter of the crisis year. Calculations are done by numerical integration (trapezoidal rule). Similar to [Hoggarth, Reis, and Saporta \(2002\)](#), we use the definite integral notation.

¹¹ Likewise, in earlier research, [Dell'Ariccia, Detragiache, and Rajan \(2008\)](#) used panel data from 41 countries from 1980 to 2000 and concluded that bank distress has an adverse effect on growth, as banks must cut back their lending. They find that this effect is stronger in developing countries (where alternatives to bank financing are more limited), in countries with less access to foreign finance, and where bank distress is more severe.

crises in advanced countries prior to 2008 (see [Appendix 4](#)), so that it is not clear how reliable these findings are.

A related problem is that the high pre-crisis level of output (growth) may be caused by the same factors that led to the banking crisis, so that pre-crisis trend growth is overestimated. As [Ollivaud and Turner \(2014, p. 44\)](#) put it: “Using actual GDP growth rates is likely to bias upwards implicit estimates of both the pre-crisis growth rate and the pre-crisis level of GDP which is sustainable, and hence lead to an exaggerated estimate of the post-crisis loss in output. This is because prior to a financial crisis, there is typically an extended period of above average growth, usually associated with a number of symptoms of over-heating”. Indeed, there is evidence suggesting that banking crises are credit booms turned sour ([Schularick & Taylor, 2011](#)).

Relatedly, as pointed out by [Hoggarth et al. \(2002\)](#), banking crises often occur in, and indeed may be caused by, business cycle downturns (cf. [Kaminsky & Reinhart, 1999](#)). Some of the estimated decline in output (output growth) relative to trend during the banking crisis would therefore have occurred in any case and should not be ascribed to the crisis.

Third, is output trend stationary? As pointed out, several measures presume that output is trend stationary. However, if the GDP series is non-stationary, extrapolating the trend yields an inaccurate counterfactual, as the series will not return to this trend. The bias induced by a unit root can either be positive or negative, depending 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](#)).

In an appendix, which is available on request, we have examined this issue for the countries in our sample. The outcomes are rather mixed, although for many countries our results suggest that output is non-stationary.¹² This finding may, however, also reflect the relatively short sample period for which data are available. It is well known that the power of unit root tests depends on the span of the data rather than the number of observations ([Shiller & Perron, 1985](#)). For illustrative purposes only, we have therefore examined this issue in more detail for the U.S. for which we have a long time series (1945–2006).¹³ This is also useful to show how sensitive the outcomes may be for the selected trend. We have estimated the following model:

$$\Delta y_t = -\eta y_{t-1} + \sum_{i=1}^m \alpha_i \Delta y_{t-i} + \alpha_0 + \beta_1 t + \beta_2 t^2 + e_t$$

where y is the log of real annual GDP and t is a time trend. This yields:

$$\Delta y_t = \underset{(6.2)}{-0.42 y_{t-1}} + \underset{(3.0)}{0.30 \Delta y_{t-1}} + \underset{(6.2)}{2.85} + \underset{(6.7)}{0.02 t} - \underset{(3.7)}{0.04 t^2 / 1000}$$

T-values are shown in parentheses. The t-statistic of 6.2 for the lagged level of GDP suggests that non-stationarity can be rejected. This model is used to determine trend GDP. [Fig. 3](#) suggests that output growth in the US was not exceptionally high before the crisis despite the credit and housing booms. The figure also shows that since the crisis, GDP has been much lower than trend GDP in the US. Consequently, the deviations from trend are very high (see [Fig. 4](#)).

This analysis suggests that the damage to the US economy of the recent financial crisis is large. But, like in most previous studies on the real impact of financial crises as summarized in [Appendix 1](#), it does not take the potential impact of crises on trend (or potential) output fully into account. Some recent studies suggest, however, that crises may affect trend output as well, although results as to whether crises lead to higher or lower trend/potential output differ across studies. Based on a simple model in which the trend variable is interacted with a crisis dummy, [Cecchetti et al. \(2009\)](#) find that the estimated trend growth rates tend to be *higher* after the crisis, but this is significant in only about half of the cases. Other studies report that crises have a negative effect on potential output. For instance, [Furceri and Mourougane \(2009\)](#) apply the methodology of [Cerra and Saxena \(2008\)](#) to data for potential output growth rates taken from the OECD Economic Outlook database, where potential output is derived from a production function approach. Using an unbalanced panel of annual observations from 1960 to 2008 for 30 OECD economies, they report that financial crises have a negative and persistent effect on potential output. The effect lies in general between 1.5 and 2.4%, but a much more pronounced effect is observed for deep and severe financial crises.

Two recent studies focus on the impact of the global financial crisis on potential output. [Ollivaud and Turner \(2014\)](#) estimate potential output losses from this crisis by comparing recent OECD published projections with a counter-factual assuming a continuation of pre-crisis productivity trends and a trend employment rate which is sensitive to demographic changes. The authors report for the 19 OECD countries that experienced a banking crisis over the period 2007–11 a median loss in potential output in 2014 of about 5½ per cent, compared with a loss in aggregate potential output across all OECD countries of about 3½ per cent. The authors argue that these numbers are relatively low because other studies tend to over-estimate the pre-crisis trend growth rate as a basis for the counter-factual against which output losses are evaluated. However, if crises also affect trend (potential) output, it may also be argued that these costs should also be taken into account in calculating the real costs of a crisis. [Ball \(2014\)](#) compares estimates of

¹² There is a large literature on the question of whether output has a unit root, which has not reached clear-cut conclusions. In their seminal paper, [Nelson and Plosser \(1982\)](#) present statistical evidence that supports the hypothesis of a unit root in the autoregressive representations of a dozen macroeconomic time series for the US, including GNP. However, several subsequent studies come to different conclusions. For instance, [Perron \(1989\)](#) argues that the unit root hypothesis can be rejected for US postwar quarterly real GNP when a one-time change in the slope of the trend function is taken into account. [Zelhorst and de Haan \(1994\)](#) present similar results for 12 OECD countries using long-term time series. Using different methods, [Solis \(2004\)](#) also concludes that the unit root hypothesis can be rejected for the US. The purpose of our analysis is not to present new evidence on this issue but to show that whether or not output has a unit root may seriously affect the estimates of the output loss of a banking crisis.

¹³ Data are available for a longer time span (1926–2006), but several tests indicated a structural break in 1945. For most other countries in our sample we do not have consistent and long-term time series.

Fig. 3. Trend and actual GDP in US, 1945–2014. Note: This figure shows trend GDP estimated by the model explained in the main text and actual GDP, using data for the US.

Fig. 4. Deviations of output from trend in the US, 1945–2014. Note: This figure shows the difference between trend GDP estimated by the model explained in the main text and actual GDP, using data for the US.

potential output from the OECD and IMF with estimates which were made in 2007 in order to compute the damage the crisis has done to potential output. He finds an average loss, weighted by economy size, across OECD countries of 8.4%. However, both the OECD and the IMF have tended to revise down estimates of both the level and growth rate of pre-crisis potential output, as there was more over-heating going on than was recognized at the time so that the adverse effects from the crisis on potential output are likely to be exaggerated by comparing different vintages of projections (Ollivaud & Turner, 2014).

In our view, none of the measures used in the literature to capture the real costs of banking crises is optimal in view of the problems pointed out above. Still, in our view, the CS1 criterion 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 the (log) level of GDP is trend stationary, calculating output loss based on 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). As an alternative we therefore also consider CS3 in our empirical analysis. As explained above, the other measures suffer from even more drawbacks, so that we do not discuss which of the potential drivers as discussed in the next section has a significant relationship with these proxies of the severity of banking crises (but Appendix 6 show the results).

3. Potential drivers of output loss due to banking crisis

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). Based on those studies, we identified 21 key determinants that will be considered in our empirical analysis (see Table A1 in Appendix 2). Appendix 1 discusses the theoretical rationale of these variables in some detail. Table 4 summarizes the arguments and shows the expected sign of the variables considered. As outlined in more detail in Appendix 1, the expected sign of the variables is often ambiguous.

4. Empirical analysis

4.1. Approach

Our sample covers 44 banking crises across 40 countries (see Appendix 4). The sample size is determined by the availability of

Table 4
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 fuel 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	??
Financial freedom	Lack of 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 disproportionately large output effects	+

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 [Appendix 5](#). 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](#)).¹⁴ High posterior inclusion probabilities indicate explanatory power for a variable (see [Hoeting, Madigan, Raftery, & Volinsky, 1999](#) and [Viallefont, Raftery, & Richardson, 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 higher, it is added to the model. We repeat this procedure until any additional regressor fails to be significant.

4.2. Results

We use OLS to estimate the relationship between our crisis severity measures and crisis duration measures and their determinants.¹⁵ [Table 5](#) shows the results for our preferred measures for the real impact of banking crises (CS1 and CS3).¹⁶ The variables shown in italics are part of the base model. The other variables have been selected according to the 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 selection of explanatory variables differs markedly between the two crisis severity measures. As a consequence, the choice of a particular crisis severity measure will affect conclusions about the determinants of crisis severity. In fact, the only variable that turns out to be significant in both models is investment. This finding is in line with results reported by [Abiad et al. \(2009\)](#). For CS3, the only other significant variable (with a positive coefficient) is financial openness, suggesting that countries with a high level of financial openness

¹⁴ 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 specifying our base model. In the second stage of our approach, these variables have been reconsidered as potential regressors.

¹⁵ 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%.

¹⁶ In [Appendix 6](#) we show the results for the other crisis severity measures considered. In line with the findings for our preferred measures, it turns out that the variables that are significantly related to the other crisis severity measures differ strongly across measures.

Table 5
Regression results for crisis severity measures.

	CS1	CS1	CS1	CS3 ^a
Liquidity support	0.399*** (0.103)	0.794*** (0.287)	0.400*** (0.115)	
Investment	0.417*** (0.198)	0.707** (0.273)	0.481** (0.209)	445.679*** (67.541)
Current account	−0.597*** (0.170)	−0.604*** (0.188)	−0.637*** (0.194)	
Pre-crisis GDP growth	0.137 (0.510)	−0.547 (0.733)	0.245 (0.562)	
Interest rate	−0.663*** (0.158)	−0.776*** (0.196)	−0.561*** (0.134)	
Financial freedom	1.651*** (0.680)	2.738** (1.073)	1.678** (0.785)	
Pre-crisis GDP	−1.285* (0.713)	−1.637* (0.866)	−0.601* (0.302)	
Financial openness				4.700*** (1.315)
No. of crises	31	30	28	44
Adj. R-squared	0.711	0.652	0.688	0.671

Notes: This table shows the estimation results when explanatory variables (as shown in [Appendix 3](#)) 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 CS1 and CS3 as explained in [Table 1](#). The regression in column (2) shows two-stage least squares regression for the same models as in column (1), using a political system dummy and size of government as instruments for government support policies. The regression in column (3) drops observations for which CS1 may be biased due to the end-point problem as discussed in the main text. All regressions include a constant term, which is not displayed in the table. Standard errors are in parentheses. ***p < .01, **p < .05, *p < .1.

^a Estimated with White heteroskedasticity robust standard errors to allow for detected heteroskedasticity (Breusch-Pagan-Godfrey test).

suffer higher output losses after a banking crisis. Similar results are reported by [Abiad et al. \(2009\)](#). However, before we draw conclusions about the drivers of the output growth loss after a banking crisis, we first examine potential endogeneity issues.

The results for liquidity support 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.”¹⁷ Severe banking crises may trigger policies, such as recapitalization and liquidity support ([Honohan & Klingebiel, 2003](#)). Similarly, governments may be less likely to put government funds at risk when a crisis is mild ([Detragiache & 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, Roland, & Tabellini, 2000](#)). Large governments will be more inclined to politically intervene in markets, rather than relying on free market forces ([Gwartney, Lawson, & Hall, 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 system¹⁸ (source: *World Bank's Political Database*) and the second one captures the size of the government (source: *Fraser Institute*).¹⁹

We apply instrumental variables for liquidity support. Column (2) in [Table 5](#) provides the two-stage least squares estimates. It turns out that the results confirm that liquidity support causes the output growth lost due to banking crises to be higher. The latter result is in line with the finding of [Detragiache and Ho \(2010\)](#) that bank-support policies that commit government resources tend to be associated with worse economic outcomes, but [Furceri and Zdzienicka \(2012\)](#) report that liquidity support policies attenuate the effect of banking crises.

The results for the other variables are similar to those in column (1), suggesting that, apart from investment and liquidity support, also the current account balance, interest rates, and financial freedom significantly affect the loss of output growth after a banking crisis. More in detail, we find that a high current account surplus reduces the severity of the real impact of a banking crisis. This is in line with the findings of [Abiad et al. \(2009\)](#) and [Furceri and Zdzienicka \(2012\)](#). More financial freedom causes banking crises to have a bigger real impact. This finding is consistent with the result reported by [Angkinand \(2009\)](#) that in countries having stricter bank regulation, the output costs of banking crises are less severe. For our CS3 measure, we do not find a significant effect of financial freedom.

A higher real interest rate reduces the output growth loss due to a banking crisis. This result is in contrast to [Angkinand \(2009\)](#), who does not find a significant effect of real interest rates on the output costs of banking crisis. However, [Furceri and Zdzienicka \(2012\)](#) report that expansionary monetary policy significantly reduces output growth losses after a banking crisis.

As pointed out in [Section 2.2](#), one drawback of CS1 is that a temporary increase in the growth rate above the average would trigger the end point of the crisis, even if this high growth rate occurs in only one quarter and is followed by quarters with low growth. Column (3) of [Table 5](#) shows the results if we drop countries for which this issue matters (Hungary, Iceland and Japan). The results are very similar to those reported in column (1).

Finally, we examine to what extent the results of our preferred methodology to assess the impact of banking crisis on the real

¹⁷ 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 & Nerlich, 2012](#) and [Berkmen, Gelos, Rennhack, & Walsh, 2012](#)).

¹⁸ This variable takes on the value 0 when a presidential regime is in place, the value 1 if a country has an assembly-selected president and the value 2 when a country has a parliamentary regime.

¹⁹ 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. The Wu-Hausman test (2.82) suggests that we cannot reject the hypothesis that the variables are exogenous, albeit only at the 10% significance level.

Table 6
Panel regressions results.

Variable:	Coefficient:	Interaction:
Liquidity support	−0.023 (0.414)	0.025 (0.414)
Investment	−0.072** (0.023)	−0.116* (0.044)
Current account	0.035 (0.023)	0.077* (0.045)
Interest rate	0.033*** (0.009)	−0.032 (0.020)
Financial freedom	0.102 (0.184)	0.467 (0.363)
Pre-crisis GDP	−0.427* (0.229)	0.828** (0.370)
Financial openness	0.047 (0.239)	0.270 (0.451)

Notes: This table shows the estimation results when explanatory variables found to be significant in Table 5 are used to estimate Eq. (1). The table only shows the coefficients on the variables and the interaction of the variables and the dummy crisis. The dummy crisis is one in a year if there is a systemic banking crisis in that year according to the database of Laeven and Valencia (2013). Standard errors are in parentheses. ***p < .01, **p < .05, *p < .1.

economy yields different results when a panel model with a banking crisis dummy is estimated. We follow a similar approach as Candelon et al. (2016) for the countries in our sample. The model estimated is:

$$y_{i,t} = \alpha_{i,t} + \sum_1^4 \beta_j y_{i,t-j} + \gamma D + \delta Driver + \theta(D * Driver) + \eta_i + \varepsilon_{i,t} \quad (1)$$

where $y_{i,t}$ is the growth rate of real GDP for country i at time t , D is a dummy variable that takes the value equal to 1 if a banking crisis occurred in country i at time t and 0 otherwise, $Driver$ are the variables we found to be significant in Table 5 and η_i are country-fixed effects included to account for different growth trends among countries. Some, but not all, results are similar to those reported in Table 5. For instance, the panel regressions suggest that high levels of investment reinforce the negative effect of a banking crisis on GDP growth, while a high current account balance and a high level of pre-crisis GDP have the opposite effect. The coefficients on some other variables that turned out to be significant in Table 5 are insignificant. This may not come as a surprise. After carefully discussing the pros and cons of the main approach applied in this paper and the approach as used in Table 6 in which a dummy variable in cross-section time-series regressions is included to capture the effects of banking crises on output, Angkinand (2008, p. 10) concludes against the latter as the dummy variable approach can “identify only the averaged magnitude of growth contraction associated with crises for all countries in a sample. It does not take the extent of the crisis severity for an individual crisis episode into account.”

5. 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. 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 five proxies for the severity of these crises based on cumulative output (or output growth) lost due to 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. Based on our assessment, we prefer using the cumulative difference between trend GDP growth and actual GDP growth up to the point where post-crisis GDP growth equals trend GDP growth 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 the level of GDP is trend stationary, 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. In that case it is better to use the cumulative difference between extrapolated trend GDP and actual GDP up to the point where actual post-crisis GDP crosses trend GDP. In our empirical analysis we employ both proxies for the real costs of banking crises.

Second, our results suggest that investment and financial openness affect the output loss of banking crises, while the capital account balance, investment, liquidity support, monetary policy and financial freedom affect the output growth loss of banking crises. To be more precise, we find that low current account deficits reduce output growth lost due to a banking crisis. More financial freedom and higher investment cause banking crises to have a higher output growth loss. Finally, expansionary monetary policy reduces the output growth lost due to a banking crisis, whereas liquidity support to banks increases these costs.

Third, more generally, our analysis shows that conclusions about factors affecting the economic severity of banking crises are highly measure-specific. This not only holds for our preferred measures, but also for other proxies for the real costs of banking crises used in the literature that we have discussed.

Our analysis suggests some useful avenues for future research. The most important issue is how to determine the counterfactual, i.e. what would output (growth) have been in the absence of a banking crisis. All measures used in previous studies (including the ones we consider best and which have been used in our analysis) suffer from some drawbacks as discussed in the paper. In our view, a useful approach would be to follow the approach suggested by Fatás and Mihov (2013). These authors propose a method for establishing a proper definition and timing of the recovery phase in a business cycle. Recently, Ambrosius (2017) employed

event–history analysis on 138 banking crises between 1970 and 2012 to examine economic recoveries after banking crises. He finds that the simultaneous occurrence of currency crises, large financial sectors, overvalued currencies, large primary deficits a low growth of world trade and indicators of uncertainty in financial markets are correlated with later recovery, i.e. the time it takes to recover to pre-crisis levels of per capita income. It would be very interesting to examine to what extent differences between recoveries following a banking crisis and ‘normal’ recoveries can be associated with the variables considered in our study.

Another issue that deserves attention is the nature of the banking crisis. Serwa (2010) examined whether the size of the crisis (measured by the fall in domestic credit, deposits, or the monetary base) matters, but it would be interesting to expand this analysis by considering the level of non-performing loans during the crisis and to take into account whether or not several countries at the same time face a banking crisis.

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Appendix 1. Summary of studies

Studies:	Variables considered ^a :	Measure used ^b :	Crisis examined ^c :
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	BC and CC
Angkinand (2009)	(1), (3), (8), (11), (12), (13), (15), (21)	CS3	BC
Angkinand and Willett (2008)	(2), (5), (11), (12), (21)	CS1; CS3	BC
Baldacci, Gupta, and Mulas-Granados (2009)	(2), (16), (17), (18)	Average GDP growth during 5 years after the end of a crisis, Duration based on Laeven and Valencia (2013)	BC
Boyd et al. (2005)	(17), (18), (21)	CS3	BC
Cecchetti et al. (2009)	(1), (2), (5), (8), (11), (12), (15), (17), (18), (20), (21)	CS4; CS5	BC
Claessens, Klingebiel, and Laeven (2004)	(2), (15), (17)	CS1	BC
De Gregorio and Lee (2004)	(6), (9), (11), (15), (16), (19), (20)	CS1	BC and Balance of payments crisis
Detragiache and Ho (2010)	(1), (3), (11), (12)	GDP growth over the period T_c, T_c+2 , CS4CS5, the minimum GDP growth rate experienced during the crisis	BC
Frydl (1999)	(1), (8)	CS5	BC
Furceri and Zdzienicka (2012)	(1), (5), (8), (12), (14), (19)	Output growth	BC
Hoggarth et al. (2002)	(1), (2), (10), (11)	CS1, CS3	BC
Hoggarth, Jackson, and Nier (2005)	(1), (21)	CS1	BC
Honohan and Klingebiel (2003)	(2), (5), (8), (11), (17), (18), (20)	CS1	BC
Hutchison and Noy (2005)	(21)	GDP growth	BC and CC
Serwa (2010)	(2)	GDP growth	BC
Winkler (2006)	(2), (11)	CS3	BC

^aThe numbers refer to variables described in Appendix 3.

^bVariables are described in Table 1.

^cBC is banking crisis and CC is currency crisis.

Appendix 2. 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, Korniyenko, Plekhanov, & Zettelmeyer, 2010 and Giannone, Lenza, & Reichlin, 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, Tornell, and Velasco (1996) argue that credit growth is a good proxy for banking system vulnerability, as it is often related to a decline in lending standards. In addition, high credit growth may fuel asset and house price

bubbles; the resulting asset price volatility when these bubbles burst, may affect crisis severity (Frankel & 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, Mishra, and Sahay (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 & 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, Faruquee, and Das (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 & Saravelos, 2012). A high level of reserves also helps in restoring confidence and reducing external vulnerabilities (Llaudes, Salman, & Chivakul, 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 & 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 & 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 & 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 support 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.

Financial freedom, i.e. lack of regulation, may cause financial instability, as it may lead to more risk-taking, which, in turn, may induce more severe banking crises (Kaminsky & 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 & 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 & 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, Eichengreen, Klingebiel, & Martinez-Peria, 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 & 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 & 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, Dell'Ariccia, Igan, & Laeven, 2010). Global financial crises lead to a vast decline in global trade, which may severely affect open economies (Levchenko,

Lewis, & Tesar, 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 & Noy, 2005). The occurrence of currency crises together with banking crises (so called twin crises) are associated with disproportionately large output effects (Berg, 1999). Moreover, twin crises might lead to vicious cycles that can exacerbate the output costs (Kaminsky & 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 & Noy, 2005).

Appendix 3. Key determinants of the real impact of banking crises

Variable	Time ^a	Definition
<i>Credit</i>		
(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.
<i>Financial Openness</i>		
(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)
<i>International Imbalances</i>		
(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
(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
<i>Macroeconomic Conditions</i>		
(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
<i>Policy Framework</i>		
(13) Financial freedom	$T_c - 1$	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
<i>Policy Response</i>		
(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)
<i>Trade Linkages</i>		

(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
<i>Twin Crises</i>		
(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 4. List of banking crises considered

Argentina 1995
 Argentina 2001
 Austria 2008
 Belgium 2008
 Bolivia 1994
 Colombia 1998
 Croatia 1998
 Denmark 2008
 Ecuador 1998
 Finland 1991
 France 2008
 Germany 2008
 Greece 2008
 Hungary 2008
 Iceland 2008
 Ireland 2008
 Israel 1977
 Italy 2008
 Japan 1997
 Korea South 1997
 Latvia 1995
 Latvia 2008
 Luxembourg 2008
 Malaysia 1997
 Mexico 1994
 Netherlands 2008
 Norway 1991
 Peru 1983
 Philippines 1997
 Portugal 2008
 Russia 2008
 Slovak Republic 1998
 Slovenia 2008
 Spain 1977
 Spain 2008
 Sweden 1991
 Sweden 2008
 Switzerland 2008
 Thailand 1997
 Turkey 2000
 Ukraine 2008
 United Kingdom 2007
 United States 1988
 United States 2007

Appendix 5. Correlation matrix of explanatory variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
PC	1.00																			
(1) Private sector credit (PC)																				
(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

Appendix 6. Results for other measures

	CS2	CS4	CS5
Liquidity support			−0.746 ** (0.312)
Investment			1.196 (0.788)
Current account		−4.488 *** (1.491)	−1.034 * (0.517)
Pre-crisis GDP growth	0.296 * (0.164)		0.377 (1.660)
Interest rate		−3.032 ** (1.167)	
Credit regulation quality			
Pre-crisis GDP			
Fixed exchange rate	0.920 (0.775)	35.055 * (17.738)	22.791 *** (6.960)
Exchange rate depreciation	0.131 ** (0.050)		
Pre-crisis GDP per capita		9.804 (9.911)	
Financial openness			0.183 (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)
Number of crises	34	30	37
Adj. R-squared	0.298	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) following a specific-to-general approach. The dependent variables are crisis severity measures as explained in [Table 2](#). All regressions are performed with a constant term which is not displayed in the table. Standard errors are in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$.

^aEstimated with White heteroskedasticity robust standard errors due to detected heteroscedasticity (Breusch-Pagan-Godfrey test).

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