Larger crises cost more: impact of banking sector instability on output growth

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Abstract:

Several studies have calculated the fiscal and macroeconomic costs suffered by countries during banking crises. However, it remains unclear whether it is crises that cause macroeconomic slowdowns and recessions, or whether the recessions themselves initiate banking crises and are responsible for all costs to the economy. In the latter scenario, crises do not have any effect on economic growth beyond that caused by recessions. We propose a simple method for calculating the macroeconomic costs of banking crises that controls for the impact of recessions. In contrast to earlier research, we estimate the cost of crises based on the size of banking crises. The extent of a crisis is measured using banking sector aggregates. The results, based on our method and data from over 100 banking crises, suggest that the size of a crisis matters for economic growth. Lower credit, deposit and money growth during crises cause GDP growth to decline.

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Introduction

Considerable attention has been paid by a number of interested parties in recent years to analyzing the damaging impact of banking crises on the economy. Economists are concerned about the causal relationship between recessions and banking crises. International investors would like to predict output growth more accurately, given a banking crisis in the country in which they are investing. Banking supervisory authorities are interested if their instruments to sustain financial stability are required for stable output growth, while policymakers need to assess to what extent liberal policies promoting lending and investments increase the probability of financial instability and possible losses.

The relationship between banking crises and economic growth has been extensively investigated in the literature. Two main areas of specific interest are fiscal costs and output losses suffered by economies during crises (Dell'Ariccia, Detragiache, and Rajan, 2005; Gupta, 2005). Some research has analyzed the fiscal costs associated with crisis resolutions and found them to be extremely high in many cases, although they are difficult to calculate and compare across countries (e.g. the database of Caprio and Klingebiel, 2003). Alternatively, declines in output growth during banking crises have often been investigated. Output growth is an important economic activity measure, comparable across countries, and should contain the effects of fiscal costs on the economy.

The average estimated output losses associated with banking crises varied considerably in different studies, depending on the sample and the estimation method, from less than 1 up to 8 percentage points of output growth for each year of a crisis (Barro, 2001; Hutchison and Noy, 2005), and from 4 to 20 percent of cumulative GDP loss or more during a crisis (Barro, 2001; Demirgüç-Kunt, Detragiache, and Gupta, 2006; Hoggarth, Reis, and Saporta, 2002; Boyd, Kwak, and Smith, 2005; Hutchison and Noy, 2005). However, the above studies were generally unable to identify whether output losses were caused by banking crises, or vice versa. In the latter case, it could be recessions and not banking crises that caused lower GDP growth.

This study analyses the impact of banking crises on GDP growth. It extends earlier research in four ways. First, it empirically analyses the costs of banking crises after controlling for the downward impact of recessions on banking activity. To do so, we use a multiple-equation identification and estimation technique which is novel to studies of the costs of banking crises.

Second, it proposes several variables to control for the macroeconomic significance of crises, with the aim of analyzing how the size of a crisis, measured in macroeconomic terms, affects economic growth.[1] This fills a clear gap in the literature, as earlier studies purely distinguish between systemic and non-systemic crises or identify policies used to resolve the crises to calculate their costs.

Third, our study uses macroeconomic measures of the extent of crises in order to analyze the two main paths whereby banking crises may affect output growth, i.e. the credit and monetary channels. In this way our paper bridges the gap between research on the credit–output relationship and the monetary transmission mechanism, and studies on the costs of banking crises (e.g. Loayza, Rancière, 2005; Psaradakis, Ravn and Sola, 2005).

Finally, this study applies the event-study approach, which uses a large database of banking crises in developed and emerging markets from the late 1970s to the first years of the new century, as developed by Caprio and Klingebiel (2003). We construct a set of variables calculated with a yearly frequency preceding and following the crisis dates by zero up to seven years. In this way we are able to compare the properties of macroeconomic variables before and after the crises.

[1] Ranciere, Tornell and Westermann (2005) use variables related to credit growth to compare long-run economic growth in countries with stable financial systems, and countries suffering from systemic financial crises.

The paper is organized as follows. The method of calculating the impact of banking crises on output growth is presented in Section 2. Section 3 contains empirical results. Finally, Section 4 concludes.

2. Methodology

In this section we describe the method used to measure the impact of banking crises on the economy. We propose macroeconomic measures to determine the magnitude of banking crises, examine the relationship between such crises and output growth, and then explain our econometric method used to estimate how these measures affect output growth.

2.1 Measures to determine the size of a banking crisis

In this paper we follow Caprio and Klingebiel (2003) and define banking crises as "much or all of bank capital being exhausted". Such crises typically comprise large-scale bank failures, depositor runs, the high level of non-performing loans, or some emergency actions of the government (deposit freezes, nationalizations, recapitalization plans etc.) (e.g. Demirgüç-Kunt, Detragiache and Gupta, 2006).

Previous studies have estimated the average impact of banking crises on GDP growth or production growth in selected sectors of the economy, taking into account crisis length, resolution policies, evidence of twin crises, i.e. joint currency and banking crises, and triple crises when sovereign debt is also involved (e.g. IMF, 1998; Frydl, 1999; Honohan and Klingebiel, 2000; Bordo, Eichengreen, Klingebiel and Soledad Martinez-Peria, 2001; Hoggarth, Reis and Saporta, 2002). Moreover, these studies usually distinguish between systemic and non-systemic crises, and measure the fiscal costs of some crises, but none have attempted to measure the size of individual crises in terms of macroeconomic variables such as the fall in domestic credit, deposits, or the monetary base.

We propose four measures of the extent of a banking crisis. First, the percentage change in real credit is used to account for a drop in credit supply due to multiple bank failures, more restrictive credit rationing policies of commercial banks, losses and increased capital provisions lowering capital base and limiting the credit supply in line with regulatory capital requirements (e.g., Ranciere, Tornell, and Westermann, 2005). The choice of this variable is motivated by the literature on a credit channel in the monetary transmission mechanism and the existence of a financial accelerator amplifying real economic fluctuations (e.g., threshold effects in the US - Balke, 2000, in the UK – Atanasova, 2003, and in the EU – Calza and Sousa, 2005).

We also experimented with the spread between the lending interest rate and the policy rate as our measure of credit rationing during crises. This variable increases two years before the crisis and then falls during the crisis to its pre-crisis level. Therefore, the spread appears to be a superior predictor of banking crises, but is less useful as a measure of crisis extent.[2]

Second, we use changes in aggregate deposits after controlling for the impact of interest paid on these deposits to measure the extent of banking crises. Let r_t denote the deposit interest rate at time t and d_t be the net deposit inflows as percentage of old deposits, i.e. the difference between new deposit inflows and deposit withdrawals at time t, divided by the value of deposits at time t-1 (e.g., Willis, 1960). The aggregate deposits D_t at time t depend on the value of deposits from time t-1, new deposit inflows, old deposit outflows, and the interest paid on old deposits:

$$D_t = D_{t-1} + D_{t-1} \cdot d_t + D_{t-1} \cdot r_{t-1} \qquad (1)$$

From equation (1) we find the net deposit inflows as a percentage of old deposits to equal:

$$d_t = \frac{D_t - D_{t-1}}{D_{t-1}} - r_{t-1}. \qquad (2)$$

Lower values of d_t during banking crises describe investors' flight to liquidity (e.g., Gupta, 2005). The more severe the crisis, the higher the probability of bank runs and the lower

[2] Other measures of credit rationing are also available (e.g., Bernanke, Gertler and Gilchrist, 1996; Balke, 2000). However, data for such variables are not available in many developing countries from our dataset.

propensity to keep deposits in banks. In extreme cases the value of d_t could become negative if there were less new deposits than deposit withdrawals or the percentage increase in aggregate deposits was lower than the deposit interest rate.

The third measure of banking crises, b_t, is the difference between changes in the money supply and changes in the amount of cash in circulation. Here, we also take into account the increase in the money supply due to the interest paid on demand, time, savings, and foreign currency deposits. The percentage growth of money supply is given by:

$$h_t = \frac{M_t - M_{t-1}}{M_{t-1}} - k \cdot r_{t-1}, \qquad (3)$$

where M_t is the money supply at time t. Since the money aggregate contains cash in circulation G, interest is paid only to the part of the money supply. Thus, we use the parameter k that belongs to the interval (0, 1) to proxy an average interest rate $k \cdot r_t$ of the money aggregate.[3] Then the third variable is calculated using the following expression:

$$b_t = h_t - \frac{G_t - G_{t-1}}{G_{t-1}}. \qquad (4)$$

Like the second measure, this third measure may be used to proxy the propensity to save during calm and crisis periods. This is analogous to the change in a cash-deposit ratio used by Gupta (2005), who notes that this ratio increases during banking crises. Therefore the deposit and money aggregates grow slower in comparison to cash during crises.

The fourth measure used in our investigation is the percentage change in real money. The rate of money growth decreases during crises because of credit rationing and investor flight from the banking system. This measure is especially interesting, because it allows for a comparison with other studies of the money – output relationship. Empirical research has found that such relationship is usually significant in both directions. Output growth causes changes in the money supply, and increases in money have an impact on output growth

[3] k is lower than 1, because the market interest rate r is higher than the interest rates of deposits and other components from the money aggregate.

(Bernanke, 1986; Christiano, Ljungquist, 1988; Stock, Watson, 1996; Psaradakis, Ravn and Sola, 2005; and others).

2.2 Relationship between banking crises and output growth

Output growth can be affected by banking crises in at least six different ways (e.g., Hoggarth, Reis and Saporta, 2002). First, a number of bank failures reduces credit and money supply and may lead to a recession. Falling credit supply can force companies and households to limit both investment and consumption, which will result in a decrease of output in the short run. Second, in the long run lower investments reduce capital growth and productivity. Third, bank failures can generate the loss of information about customers, hinder obtaining credit elsewhere, and as a result increase the costs of economic activity. Fourth, preventive policies of banks restrict credit only to firms in a relatively good shape and cause weaker firms to go bankrupt. More restrictive credit limits may also force companies to cut trade credits to their customers and subsequently to reduce output (e.g., Love, Preve and Sarria-Allende, 2007). Fifth, depositors may lose confidence in banks, or banks may lose confidence in other banks, causing the payment system to malfunction, and destroying trade. Finally, banking crises may also be accompanied by debt and currency crises. Such “twin” or “triple” crises will lead to even stronger contractions in economic activity, e.g. via balance sheet effects (e.g., Hutchison and Noy, 2005).

There is also another side to the relationship: falling output growth has an impact on different banking crisis measures, such as credit growth or deposit growth. Recessions cause non-performing loans of companies to grow rapidly and consequently cause bank losses and increase capital provisions. Increased provisions in turn limit the credit rationing activity of banks. Declining asset prices during recessions also reduce the value of firms and their collateral required to obtain credit. Less collateral means that firms receive less credit. More restrictive lending policies on the part of banks make credit unavailable to weaker companies. Additionally, companies with balance sheet problems may reduce their demand for bank loans during recessions. Severe bank losses and reduced economic activity can in addition lead to illiquidity problems or defaults, and reduce aggregate credit growth.

A recession or economic slowdown affects money and deposits. Households may save less during recessions due to declining earnings and greater unemployment. Liquidity problems may also lead to bank runs, reducing deposits and savings even further. The empirical literature confirms that the fall in output among other factors is a good predictor of banking crises (e.g., Demirgüç-Kunt and Detragiache, 1998; Kaminsky and Reinhart, 1999).

2.3 Econometric approach

To estimate the relationship between the extent of the crisis and output growth, we employ an event-study method. A typical event-study employs one-equation models to check for the dependence of a selected variable on a specific event. However, in the case of a banking crisis, the variables to measure the crisis and output growth affect each other in the sample. In such circumstances the standard event-study using one-equation estimation methods would provide biased results due to omitted bidirectional dependence (e.g., Rigobon and Sack, 2004).

A straightforward solution to this problem is to employ a system of equations, where both output growth and the banking crisis variable affect each other in separate equations. We build the following two-equation model describing the link between crisis measure and output growth:

$$\begin{aligned} c_{it} &= \alpha y_{it} + A x_{it} + \varepsilon_{it} \\ y_{it} &= \beta c_{it} + B x_{it} + \eta_{it} \end{aligned}, \qquad (5)$$

where c_{it} denotes the crisis size variable (e.g., credit growth) in country *i* at time *t*, and y_{it} represents output growth. x_{it} is a column vector of exogenous factors including a constant term that influences both endogenous variables, A and B are row vectors of structural parameters, and ε_{it} and η_{it} are independent disturbance shocks. The parameter α describes the impact of output on the size of the crisis. A 1 percentage point fall in output growth increases the size of a crisis (e.g., decreases the credit growth) by α percentage points.

Similarly, the parameter β denotes fall in output growth (in percentage points) after the 1 percentage point fall in credit growth or another measure of the extent of the crisis. Thus, the parameter β measures the average effect of banking crises on output growth after controlling for the impact of changes in output growth on crisis measures. If banking crises matter for output growth, the parameter β should be significantly different from zero.

To assess how banking crises reduce output growth, one needs to identify and estimate the parameters of an output growth equation. However, the output equation is not identifiable, unless one proposes an exogenous variable that influences directly credit growth, but not output growth. This task is difficult due to the lack of such variables that are available for approximately 100 countries in our sample. When the ordinary least squares method (OLS) is applied to the output growth equation, i.e. when the identification problem is ignored, the estimate of β will be biased.

This identification problem is an important issue in studies analyzing costs of banking crises. Some researchers argue that their calculations estimate output losses during the crisis rather than the loss in output "caused" by the crisis (e.g., Boyd, Kwak, Smith, 2005). Others attempt to identify the costs of banking crises by comparing the behavior of crisis countries with neighboring countries that did not face the crisis (Hoggarth, Reis and Saporta, 2002) or by comparing the performance of firms more dependent on external finance with those less dependent (Dell'Ariccia, Detragiache and Rajan, 2005). In a different context, Levine, Loayza and Beck (2000) use lagged values of credit and deposits as instruments and estimate the impact of financial development on economic growth.

We deal with the identification problem by defining a set of the econometric instruments that are correlated with our banking crisis measures but not correlated with the disturbance shock η_{it} in the output growth equation in model (5). We use the "identification through heteroscedasticity" (IH) method, proposed by Rigobon (2003) and Rigobon and Sack (2004) and the analogous "identification through changes in mean" (ICM) technique to estimate the impact of banking crises on output growth.

Let the variance of the disturbance shock ε_{it} to the crisis measure change between the two sub-samples T_1 and T_2. There are N_1 observations of ε_{it} in the sub-sample T_1 and N_2 observations in the sub-sample T_2. The whole sample consists of $N = N_1+N_2$ observations of analyzed variables. The variances of the disturbance shock η_{it} and the exogenous variables x_{it} remain constant in these sub-samples. The valid instruments for the crisis variable c_{it} in model (5) are:

$$vc_{it} = \begin{cases} \dfrac{c_{it}}{N_1} & when \quad it \in T_1 \\ -\dfrac{c_{it}}{N_2} & when \quad it \in T_2 \end{cases} \tag{6}$$

and

$$vy_{it} = \begin{cases} \dfrac{y_{it}}{N_1} & when \quad it \in T_1 \\ -\dfrac{y_{it}}{N_2} & when \quad it \in T_2 \end{cases}. \tag{7}$$

Additionally, when there is a negative or positive shock to the crisis equation that changes the mean of our crisis measure c_{it} in one of the sub-samples T_1 and T_2 without affecting the disturbance shock η_{it} or exogenous variables x_{it}, then another instrument may be used:

$$m_{it} = \begin{cases} \dfrac{1}{N_1} & when \quad it \in T_1 \\ -\dfrac{1}{N_2} & when \quad it \in T_2 \end{cases}. \tag{8}$$

This instrument is analogous to the dummy variable indicating crisis periods, used by Demirgüç-Kunt, Detragiache and Gupta (2006) in the regressions explaining output growth. However, they use the OLS method to estimate output growth during crises.

All instruments vc_{it}, vy_{it} and m_{it} enable us to identify the output equation and to estimate the parameter β in model (5) consistently using the generalized method of moments (GMM).[4] Although the instruments have a clear interpretation in our investigation, the validity of overidentification restrictions imposed by these instruments can be tested using the Sargan-Hansen *J*-statistic.

We justify the use of the identification method in the following way. We note that means and variances of the crisis measures may change during the calm and banking crisis periods or may depend on the given country's economic and financial development.

First, the banking aggregates are not only affected by macroeconomic variables and recession during crises, but also by idiosyncratic shocks that are specific to the banking sector and independent from real business cycles. Such shocks include financial problems and failures of banking institutions caused by bad management, insufficient supervisory regulations, frauds, contagion from other institutions or other events not related to the economic slowdown. All of these shocks reduce credit, deposit and money growth even further than the real business cycle does.

Second, the levels of financial and economic development also determine pace of credit, deposit, and money growth. This pace may be higher and more volatile in countries with less developed financial sectors due to the low initial level of credit and deposits, immature supervisory regulations, foreign investments (large in relation to the size of the local financial sectors), and other factors related to the catching-up process. Undeveloped countries often conduct less reliable economic policies resulting in high inflation rates that decrease credit and deposit growth, measured in real terms.

[4] The crisis measure equation in (5) remains unidentifiable, i.e. it cannot be estimated. We explain the derivation of instruments in the IH and ICM methods in Appendix 1.

3. Data and empirical results

3.1 Data

The first important part of the investigation is the identification of banking crisis episodes. We utilize the most comprehensive database of systemic and borderline banking crises constructed by Caprio and Klingebiel (2003), which includes 168 crisis events from over 100 countries. Caprio and Klingebiel argue that some judgment has gone into compilation of their list; however, systemic crises are generally defined as "much or all of bank capital being exhausted". The starting dates of most crises are also taken from this database, with a few others chosen using the information from Hoggarth, Reis and Saporta (2002) and macroeconomic data.[5]

All variables in our investigation are observed in a 14-year window from seven years before the crisis to seven years after. In this way we can compare the behavior of macroeconomic variables before and during the crisis. For example, the difference between the rate of credit growth during the crisis and before the crisis may indicate how significant the banking crisis was (Demirgüç-Kunt, Detragiache and Gupta, 2006).

The ending dates of banking crises are usually more difficult to identify. In order to overcome this problem, we measure the effects of crises over different time horizons. Our idea is to analyze data with different frequencies. Changes in output, credit and other variables are analyzed and compared from one year up to seven years. For each crisis the variables are measured twice: during the pre-crisis period and during the crisis period.

Since the somewhat imprecise definition of a crisis used by Caprio and Klingebiel (2003) makes the choice of some crises rather problematic, the choice of crisis-extent measures becomes a major issue. As reported in the previous section, we use percentage changes in real credit, net deposit inflows (as percentage of old deposits), differences between

[5] When the exact starting dates were unknown, they were set as years when credit and other banking aggregates started to fall or changed their trends. The periods of banking crises are presented in Table A1.

money supply changes and changes of cash in circulation, and percentage increases of real money. The percentage changes of the respective variables are approximated by increases in their log values.

The data for output growth and crisis instruments were gathered from the International Financial Statistics (IFS) database of the International Monetary Fund. Some observations come from the ECOWIN database, when IFS data were unavailable. In addition we exclude a few crises for which data could not be obtained, and we have removed data for some countries that changed their definitions in the sample.

The output growth is calculated as an increase in the log-value of real GDP. In rare cases, when the GDP deflator was not available for some observations, nominal GDP was deflated with the consumption price index (CPI). Deposits are demand deposits, money aggregate is M2 (money plus quasi-money) in the IFS database, credit is the domestic credit and cash is defined as the currency outside banks in the IFS database.

Changes in the real effective exchange rate and the real interest rate are used as the main explanatory variables for output growth and banking aggregates changes. These data also come from the IFS database. An appreciating exchange rate may decrease the value of credit and deposits denominated in foreign currencies and worsen the balance of foreign trade and GDP growth. Higher interest rates reduce investment and output growth, increase deposits, decrease demand for credit and increase the interest paid on loans.

The values of deposit interest rates, which are used in two crisis measures described by formulas (2) and (4), were not available for all countries in the dataset. Therefore we employed a fraction of a short-term market interest rate as a proxy for the deposit rate in all countries.[6] We also experimented with the inflation rate and different fractions of a short-term market interest rate and received similar results.

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[6] The deposit rate is calibrated to equal one-half of the market rate, with the parameter k equal 0.3 in formula (3). The general results do not change when we use other values of these parameters.

We construct indicators of the level of democracy for each country using the POLITY IV database.[7] Such a variable could possibly have an impact on output growth and credit growth as a proxy for the political impact on financial markets and the real economy. As many examples of communist and other authoritarian regimes suggest, autocracy and dictatorship hinder economic activity, so the level of democracy may point to the level of economic development in a country. Similarly, Gross National Income (GNI) per capita for each country is used as another proxy for the long-term level of economic development.[8]

The following distinct binary variables are employed to denote periods of currency crises in some countries and to identify cases of systemic crises, respectively. The variable $currcrisis_{it}$ takes on value 1 in the periods (crisis or calm), where the real effective exchange rate falls by more than 25% during at least one year, and 0 in other periods. As Kaminsky and Reinhart (1999) note, banking crises accompanied by currency crises (twin crises) have a more significant impact on economic growth than individual banking crises. The variable $systemic_{it}$ equals 1 in both calm and crisis periods related to the crises that are systemic according to Caprio and Klingebiel (2003). This variable equals 0 for borderline crises. Similarly, the variable $debtcrisis_{it}$ equals 1 when there is a debt crisis in a country and 0 otherwise. The periods of sovereign debt crises are taken from Manasse, Roubini and Schimmelpfennig (2003).

The effect of currency and debt crises on economy may depend on the foreign exchange regime, therefore we also define the variable $fxregime_{it}$ that takes on value 1 in the fixed exchange rate regime, 2 in the regime with a fixed peg or pegged within a horizontal band, 3 in the regimes with crawling peg, crawling band, and dirty float, and 4 in the floating

[7] The POLITY IV database is maintained through a partnership between the University of Maryland's Center for International Development and Conflict Management and the George Mason University Center for Global Policy.

[8] We obtained GNI per capita for the year 1975 from the World Bank database. Since the analysis focuses on the short-term (up to seven years) costs of banking crises, the year of an observation for the long-term development indicator should have a limited impact on our results.

exchange rate regime. We use data on currency regimes from Levy-Yeyati, Sturzenegger (2005) and Babula and Ötker-Robe (2002).

3.2 Empirical results

Our analysis focuses on the impact of banking crises on output growth after controlling for the influence of recessions and other macroeconomic shocks. We start by presenting differences between the values of crisis instruments in pre-crisis and crisis periods, and then show key estimates from the event study method.

We calculate values of the four crisis measures and output growth in different time horizons, and investigate one-year up to seven-year changes in real credit for the pre-crisis and crisis periods, averaged over all banking crises. Similar calculations are conducted for changes in deposits, for differences between changes of money and changes in cash, and for real money increases. In order to compare the behavior of banking crisis measures and output growth, we also analyze the accumulated GDP growth over the same time horizons. Figure 1 presents differences between the values of the instruments in pre-crisis and crisis periods in panel A and the analogous results for output growth in panel B.

[Figure 1 around here]

Two main findings can be deduced from these results. First, most of the crisis measures take on lower values during banking crises than before crises. The average real credit grows until one year before the crisis and then stagnates until the third year of a crisis. Deposits and money supply also increase much slower during the whole crisis period than during the pre-crisis period. However, the difference between money growth and the growth of cash is only lower during the first three years of an average crisis than before it. In the longer term, the difference is larger in the crisis period than in the period of calm.

Second, output growth behaves like the four crisis instruments in our analysis. Real GDP grows more rapidly during periods of calm than during the periods of crisis. The difference in the rate of output growth between the two regimes varies from two percentage points for the one-year event window up to nine percentage points for the seven-year event window. This outcome is in line with Demirgüç-Kunt, Detragiache, and Gupta (2006).

These results indicate how macroeconomic variables change their values during banking crises, but they cannot provide any information on the effects of banking crises on economic growth. Therefore, we utilize the IH and ICM methods and estimate different specifications of the output equation in model (7) to measure how the size of a crisis impacts economic growth.

The identification methods used in our investigation require sub-samples T_1 and T_2 to be constructed. There are three different ways in which the estimation sample is divided into sub-samples in our investigation. We distinguish between calm and crisis periods, developed and undeveloped economies, developed and undeveloped financial sectors. For each crisis event we select a period t_{calm} before the crisis and a period t_{crisis} after the start of the crisis. The whole sample consists of calm and crisis periods for each of N_{crisis} crisis events. Therefore we have $N=2N_{crisis}$ observations in the estimation sample.

The measure of economic development is Gross National Income per capita in each country in the year 1975 and the measure of financial development is the ratio of deposits to money supply in each country (averaged over the pre-crisis and crisis period).[9] In order to obtain sub-samples with the same number of observations we use the median of the development measures to divide the sample into two sub-samples. Detailed formulas are presented in Table 1.[10]

[Table 1 around here]

Table 1 reports means and variances of the output growth and crisis measures in each sub-sample. The analyzed variables often exhibit significant differences both in mean and in variance across sub-samples, which allows us to construct 18 distinct instruments in line with

[9] We also experimented with GNI per capita in the year 2000 and seven years before the crisis. The results were very similar.

[10] The number of observations is usually less than N and the sub-samples have approximately the same number of observations due to missing values of variables in some periods.

formulas (6), (7) and (8). The values of the respective banking crisis measures are utilized to build these instruments, as explained in Subsection 2.3. The names of the constructed instruments (in the fourth and seventh column) are presented in the same rows as their corresponding banking crisis measures in Table 1.

Ideal instruments should be correlated with our crisis measures, but uncorrelated with the error term η_{it}. Therefore, for each of the crisis measures we select a set of instruments that are strongly correlated with the banking crisis variable and only modestly correlated with the output growth. Table 2 presents correlations between econometric instruments and analyzed variables. The instruments selected for each banking crisis measure are denoted with "*". Then we use the Sargan-Hansen test of overidentifying restrictions and eliminate some instruments if the test rejects the restrictions imposed by these instruments.

[Table 2 around here]

For each of the crisis variables we employ four different specifications of the model (7). In the first specification, S1, the vector of exogenous variables, x_{it}, contains only the constant term. In the second version of the model, S2, the vector x_{it} contains also changes in the real effective exchange rate and the real interest rate. Specification S3 includes additional binary exogenous variables: $currcrisis_{it}$, $debtcrisis_{it}$ and $systemic_{it}$, which identify currency crises, debt crises and systemic banking crises, respectively. The variable $fxregime_{it}$ classifying the foreign exchange rate regime in each country is also included in the specification S3. Finally, in the last and most general version of our model (7), S4, the vector x_{it} includes three measures of economic, political, and financial development aside from the already mentioned variables. These are GNI per capita in a country in 1975, the level of autocracy in a country at time t, and the ratio of cash in circulation to money supply, respectively. The first measure is a long-term variable that does not change over time; the latter two variables are allowed to change due to new political regimes and financial development.

Estimates from different specifications may be treated as a robustness check of our analysis. One-year up to seven-year-long horizons are investigated for all specifications and instruments to observe the reaction of output growth in different time horizons. We also consider horizons equal to the length of the crises.

[Table 3 around here]

Table 3 presents results from these specifications of the model, where the real credit growth is a measure of crisis extent. Estimates of the β parameter in different specifications are displayed in rows, and the results for different time horizons are given in columns. The values in parentheses denote the t-statistics of the parameter estimates.

The parameter β indicates how much output growth will change on average after a 1 percentage point increase in the value of a crisis measure (e.g., credit growth). For example, the value 0.130 in the second column, corresponding to the specification S2, denotes that a drop in the real credit growth rate by 1 percentage point causes the real GDP growth rate to decline on average by 0.130 percentage points over a two-year period.

The change in credit growth has usually a significant impact on the real output growth regardless of the investigated specification and the time horizon. All estimates of the parameter β are greater than zero, and range between 0.011 (for the specification S1 and a time horizon dependent on the length of each crisis) and 0.249 (for the specification S2 and a time horizon of seven years).

According to Frydl (1999), an average banking crisis typically does not last longer than four years. In our sample, Figure 1 suggests that accumulated credit growth was lower on average by 12.5 percentage points during the four years of a crisis than in the four-year period preceding a crisis. From estimates in Table 3, it is possible to calculate that declining credit growth reduced real GDP growth by 3.0 percentage points during the four years of a typical crisis.

[Table 4 around here]

In Table 4 the estimated parameters indicate reactions of the real GDP growth to changes in net deposit inflows in an analogous way to Table 3. The values of β parameters are generally significantly greater than zero for time horizons longer than one year, which suggests that the declining deposits also slow down economic growth during crises.

The values of β differ considerably for different time horizons. They range between -0.131 (for the specification S1 and the one-year horizon) and 0.185 (for the specification S4 and the time horizon equal to the length of each crisis). However, during the first year of a crisis deposits grow at the same rate as one year before the crisis, and the overall impact of deposit runs on economic growth is negligible at this time.

Even for a small value of the β parameter in the four-year horizon, there is some impact on real output growth. The average deposit growth rate is 10.2 percentage points lower during an average crisis than before a crisis. Such a drop causes the real GDP growth rate to decrease by 1.0 percentage point during a four-year crisis.

[Table 5 around here]

Table 5 provides information about the impact of changes in the third crisis measure on real economic growth. The third measure is the difference between percentage changes in money supply and percentage changes of cash in circulation, as described by formula (4). The slower the increase of money relative to the growth rate of cash, the more significant the impact of a banking crisis on output growth should be.

Unlike the results from previous tables, the parameters are rarely significantly greater than zero, especially in the specifications S3 and S4. For time horizons between four and six years the values of parameters are even smaller than zero. This outcome is strongly related to the definition of the crisis variable and its behavior in our sample. As discussed earlier, our third measure of crisis extent indicates that crises last three years on average, and that in the fourth year their effect vanishes (see Figure 1).

[Table 6 around here]

The last instrument employed in our analysis is a percentage change in real money. The impact of this measure on output growth is also statistically significant for most specifications and time horizons. In specification S4 the β parameter is insignificant in several cases, but it is always greater than zero. The values of the parameter range between 0.012 and 0.265, and they are greater for longer time horizons. For example, selecting a five-year horizon and the specification S3 leads to the conclusion that the money growth rate was on average 7.9 percentage points lower during crisis periods than before crises. The declining money growth reduced real GDP growth by 1.6 percentage points.

Generally, these results suggest that banking aggregates have a significant impact on output growth during banking crises. Although the values of the β parameters in models depend on time-horizons and model specifications, these values are typically greater than zero.

The change in parameter values depending on the time horizon can be attributed to two aspects. One is the possibility that output effects last longer than crises. Some measures of the extent of banking crises may affect output growth with a lag. Therefore, even when the crisis fades, output growth will still fall. Then the parameters β for longer periods will have higher values, because the accumulated impact of the already terminated crisis on the falling GDP growth will be stronger. The second reason is the fact that the number of crises for which longer time series are available is limited. The longer the time horizon, the less data are available.

The change in parameter values depending on the specification (S1, S2, S3, and S4) can be explained by the fact that some significant variables could be omitted in some more restricted specifications (like S1) and some insignificant variables could be included in more general specifications (like S4). Nevertheless, the impact of banking crises on output growth is significant in most specifications.

As a robustness check to our event-study method, we also considered the dynamic panel data models similar to those considered by Levine, Loayza, and Beck (2000) and found that our two main crisis indicators, i.e. changes in real credit and changes in real money, significantly affect output growth during banking crises. More details are presented in Appendix 2.

Finally, it is worth noting that all four crisis measures are correlated with each other. Therefore the overall effect on output growth cannot be calculated by summing the individual effects of the respective measures. We purely seek to show how individual banking sector variables influence economic growth. However, future analyses could construct a cumulative measure of the extent of a crisis and measure its impact on GDP growth.

Conclusions

In answer to the main questions whether banking crises cause economic slowdown and to what extent the size of a crisis affects GDP growth, we conclude that even after controlling for the impact of recessions on the size of crises, banking crises cause output growth to slow down.

We obtain our results by proposing a technique that is novel in the area of banking crisis research. Our method uses an event-study approach and multi-equation models, and applies measures of banking crises constructed from banking sector aggregates, employing a large dataset of over 100 banking crises.

Although the precise impact of some crisis measures is difficult to assess, the typical decelerations in growth of credit cause a reduction in accumulated four-year GDP growth by around 3 percentage points. Significant relationship between credit and money dynamics, and output growth suggests that the credit and monetary transmission channels are responsible for transferring banking crises to real economy.

Some economists argue that countries experiencing occasional crises grow faster than countries with stable financial systems (e.g., Ranciere, Tornell, and Westermann, 2005), but others point to significant slow down of economies during crises. Our findings support the view that crises are costly for economies, at least in the short-term. The results related to banking crises are also similar to those obtained for other types of crises, e.g. currency and political crises (Cerra, Saxena, 2005; Hutchison, Noy, 2005).

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Appendix 1

In this Appendix, we explain the derivation of instruments (6), (7) and (8) in the "identification through heteroscedasticity" method developed by Rigobon and Sack (2004) and the analogous "identification through changes in mean" method. The model describing the link between the crisis measure c_{it} and output growth y_{it} is given by:

$$\begin{aligned} c_{it} &= \alpha y_{it} + Ax_{it} + \varepsilon_{it} \\ y_{it} &= \beta c_{it} + Bx_{it} + \eta_{it} \end{aligned}, \tag{A1}$$

From the reduced form of the model (A1):

$$\begin{aligned} c_{it} &= \frac{1}{1-\alpha\beta}\left[(A+\alpha B)x_{it} + \varepsilon_{it} + \alpha\eta_{it}\right] \\ y_{it} &= \frac{1}{1-\alpha\beta}\left[(\beta A+B)x_{it} + \beta\varepsilon_{it} + \eta_{it}\right] \end{aligned} \tag{A2}$$

we can derive the covariance matrices of the variables c_{it} and y_{it}, in the subsamples T_1 and T_2, $\Omega^{T_1} = E\left(\begin{bmatrix} c_{it} & y_{it} \end{bmatrix}' \begin{bmatrix} c_{it} & y_{it} \end{bmatrix} \mid it \in T_1\right)$ and $\Omega^{T_2} = E\left(\begin{bmatrix} c_{it} & y_{it} \end{bmatrix}' \begin{bmatrix} c_{it} & y_{it} \end{bmatrix} \mid it \in T_2\right)$:

$$\Omega^{T_1} = \frac{1}{(1-\alpha\beta)^2}\begin{bmatrix} (A+\alpha B)\Omega_x^{T_1}(A+\alpha B)' + \sigma_\varepsilon^{T_1} + \alpha^2\sigma_\eta^{T_1} & (A+\alpha B)\Omega_x^{T_1}(\beta A+B)' + \beta\sigma_\varepsilon^{T_1} + \alpha\sigma_\eta^{T_1} \\ \cdot & (\beta A+B)\Omega_x^{T_1}(\beta A+B)' + \beta^2\sigma_\varepsilon^{T_1} + \sigma_\eta^{T_1} \end{bmatrix}$$

$$\Omega^{T_2} = \frac{1}{(1-\alpha\beta)^2}\begin{bmatrix} (A+\alpha B)\Omega_x^{T_2}(A+\alpha B)' + \sigma_\varepsilon^{T_2} + \alpha^2\sigma_\eta^{T_2} & (A+\alpha B)\Omega_x^{T_2}(\beta A+B)' + \beta\sigma_\varepsilon^{T_2} + \alpha\sigma_\eta^{T_2} \\ \cdot & (\beta A+B)\Omega_x^{T_2}(\beta A+B)' + \beta^2\sigma_\varepsilon^{T_2} + \sigma_\eta^{T_2} \end{bmatrix}$$

where $\Omega_x^{T_i}$ is the covariance matrix of the exogenous variables x_{it} in the subsample T_i, $\sigma_\varepsilon^{T_i}$ is the variance of ε_{it} in the subsample T_i, $\sigma_\eta^{T_i}$ is the variance of η_{it} in the subsample T_i. We note that $\Omega_x^{T_1} = \Omega_x^{T_2}$ and $\sigma_\eta^{T_1} = \sigma_\eta^{T_2}$, but $\sigma_\varepsilon^{T_1} \neq \sigma_\varepsilon^{T_2}$. Rigobon and Sack (2004) propose to calculate the difference between the two covariance matrices to identify the parameter β:

$$\Delta\Omega = \Omega^{T_2} - \Omega^{T_1} = \frac{(\sigma_\varepsilon^{T_2} - \sigma_\varepsilon^{T_1})}{(1-\alpha\beta)^2}\begin{bmatrix} 1 & \beta \\ \beta & \beta^2 \end{bmatrix}. \tag{A3}$$

Let $\Delta\Omega_{ij}$ be the (i, j) element of the matrix $\Delta\Omega$. We obtain the value of the parameter β by dividing the respective elements of the matrix $\Delta\Omega$:

$$\beta = \frac{\Delta\Omega_{12}}{\Delta\Omega_{11}} \tag{A4}$$

or

$$\beta = \frac{\Delta\Omega_{22}}{\Delta\Omega_{12}}. \tag{A5}$$

Rigobon and Sack show that two alternative estimates of the parameter β, analogous to expressions (A4) and (A5), are given by:

$$\hat{\beta} = \frac{\frac{1}{N_2}(\mathbf{c}_{T_2})'\mathbf{y}_{T_2} - \frac{1}{N_1}(\mathbf{c}_{T_1})'\mathbf{y}_{T_1}}{\frac{1}{N_2}(\mathbf{c}_{T_2})'\mathbf{c}_{T_2} - \frac{1}{N_1}(\mathbf{c}_{T_1})'\mathbf{c}_{T_1}}, \tag{A6}$$

$$\hat{\beta} = \frac{\frac{1}{N_2}(\mathbf{y}_{T_2})'\mathbf{y}_{T_2} - \frac{1}{N_1}(\mathbf{y}_{T_1})'\mathbf{y}_{T_1}}{\frac{1}{N_2}(\mathbf{c}_{T_2})'\mathbf{y}_{T_2} - \frac{1}{N_1}(\mathbf{c}_{T_1})'\mathbf{y}_{T_1}}, \tag{A7}$$

where $\mathbf{c}_{T_i} = [c_{it}]_{N_i}$ and $\mathbf{y}_{T_i} = [y_{it}]_{N_i}$ are vectors containing observations of the respective variables from the subsample T_i. N_i is the number of observation in the subsample T_i. The formulas (A6) and (A7) are equivalent to estimating β with the use of instrumental variables vc_{it} and vy_{it}:

$$\hat{\beta} = (\mathbf{vc}'\mathbf{c})^{-1}(\mathbf{vc}'\mathbf{y}), \tag{A8}$$

$$\hat{\beta} = (\mathbf{vy}'\mathbf{c})^{-1}(\mathbf{vy}'\mathbf{y}), \tag{A9}$$

where $\mathbf{vc} = [vc_{it}]_N$, $\mathbf{vy} = [vy_{it}]_N$, $\mathbf{c} = [c_{it}]_N$ and $\mathbf{y} = [y_{it}]_N$ are vectors containing all observations of the respective variables from our sample.

Similarly, if we assume that the means of the variables x_{it} and η_{it} do not change between the subsamples T_1 and T_2 and only the disturbance shock ε_{it} changes its mean, we can derive the difference between the expected values of the variables c_{it} and y_{it}, in each subsample as:

$$\Delta E\begin{pmatrix} c_{it} \\ y_{it} \end{pmatrix} = \frac{E^{T_2}(\varepsilon_{it}) - E^{T_1}(\varepsilon_{it})}{1-\alpha\beta}\begin{bmatrix} 1 \\ \beta \end{bmatrix} \quad , \tag{A10}$$

where $E^{T_i}(\varepsilon_{it})$ is the expected value of the disturbance shock ε_{it} in the subsample T_i. Now, the appropriate formula to estimate β is:

$$\hat{\beta} = \frac{\frac{1}{N_2}\mathbf{e}'\mathbf{y}_{T_2} - \frac{1}{N_1}\mathbf{e}'\mathbf{y}_{T_1}}{\frac{1}{N_2}\mathbf{e}'\mathbf{c}_{T_2} - \frac{1}{N_1}\mathbf{e}'\mathbf{c}_{T_1}}, \tag{A11}$$

where **e** is the vector of ones. This is equivalent to using the instrument m_{it} defined by (8) in the instrumental variable estimation formula:

$$\hat{\beta} = (\mathbf{m}'\mathbf{c})^{-1}(\mathbf{m}'\mathbf{y}), \tag{A12}$$

where $\mathbf{m} = [m_{it}]_N$ is the vector containing all observations of m_{it}. In the generalized method of moments all instruments vc_{it}, vy_{it} and m_{it} are used simultaneously to estimate β.

Appendix 2

As a robustness check to the event study method, we also consider the following dynamic panel data model and use the general method of moments (GMM) to estimate its parameters:

$$y_{it} = \delta y_{it-1} + \beta c_{it} + Bx_{it} + \eta_{it}\,. \tag{A13}$$

A transformation is applied to the specification of this model to remove cross-section fixed effects. We use both “first differences” and “orthogonal deviations” transformations (Arellano, Bond, 1991; Arellano, Bover, 1995). The GMM estimator is the Arellano-Bond 2-step estimator with White serial-correlation robust standard errors. We employ lagged values of the variables y_{it} and c_{it} as dynamic panel instruments for y_{it} and c_{it}, as proposed by Arellano and Bond (1991). In this case we use 14 yearly observations of the respective variables from the calm and crisis periods for each of N crisis events.

The estimates presented in Table A2 suggest that two main crisis indicators, i.e. changes in real credit and changes in real money, significantly affect output growth. In most cases the values of the parameter β are significantly larger than zero regardless of the specification and the estimation method. The Sargan-Hansen tests (*J*-statistic) of over-identifying restrictions also indicate that the over-identifying restrictions are valid in our specifications.

These results are in line with those obtained by Levine, Loayza and Beck (2000), who use the same methodology, but different measures of changes in credit and liabilities, as well as a different set of countries and a different sample period. In contrast to their study, we check if the causation effects from credit and liabilities to output growth are present during banking crises.

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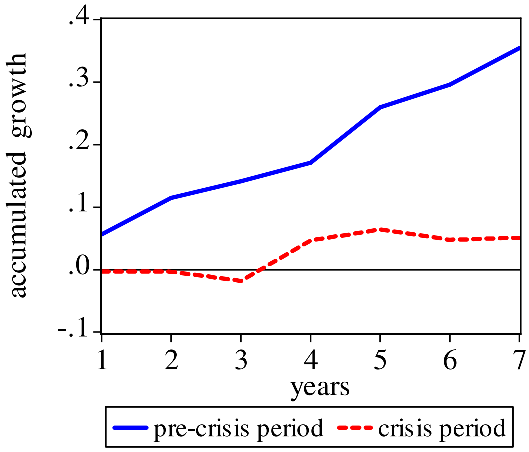
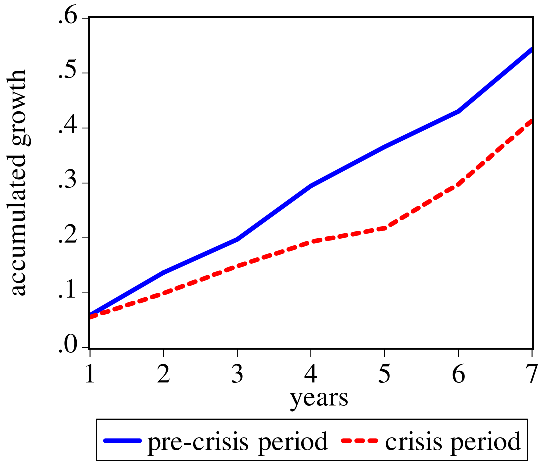
Figure 1: Behavior of macroeconomic variables in pre-crisis and crisis periods

Panel A: Growth rates of banking sector aggregates accumulated over years

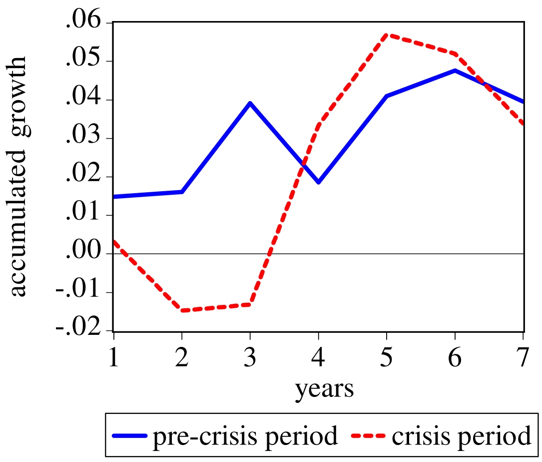
1.1 Real credit growth



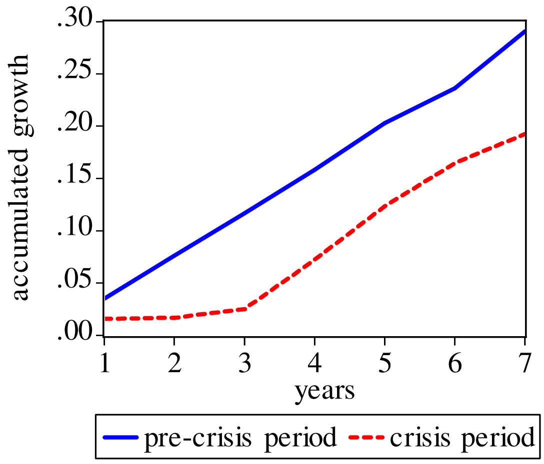
1.2 Net deposit inflows as percentage of old deposits



1.3 Difference between money growth and growth of cash in circulation



1.4 Real money growth



Panel B: Accumulated growth of GDP during pre-crisis and crisis periods

1.5 Real GDP growth

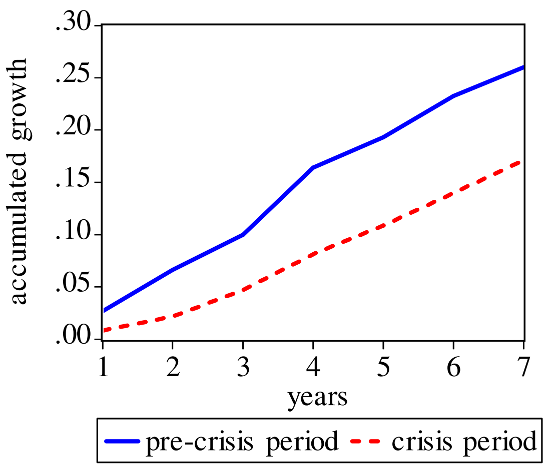


Table 1: Means and variances of the output growth and crisis measures in different sub-samples (three-year calm and crisis periods)

	Mean		Name of the constructed instrument	Variance		Name of the constructed instrument
	Sub-sample T_1	Sub-sample T_2		Sub-sample T_1	Sub-sample T_2	
	Sub-sample T_1 when $d_i \le median(d_i)$, sub-sample T_2 when $d_i > median(d_i)$					
real GDP	0.07	0.06	m_{it}^{d}	0.12	0.13	vy_{it}^{d}
real credit	0.14	-0.05	m_{it}^{d}	0.46	0.52	$vc1_{it}^{d}$
new deposits	0.13	0.04	m_{it}^{d}	1.31	0.49	$vc2_{it}^{d}$
money-cash	-0.02	-0.07	m_{it}^{d}	0.39	0.33	$vc3_{it}^{d}$
real money	-0.38	-0.19	m_{it}^{d}	1.66	0.69	$vc4_{it}^{d}$
	Sub-sample T_1 when $GNI_i \le median(GNI_i)$, sub-sample T_2 when $GNI_i > median(GNI_i)$					
real GDP	0.08	0.06	m_{it}^{GNI}	0.10	0.11	vy_{it}^{GNI}
real credit	-0.03	0.17	m_{it}^{GNI}	0.49	0.33	$vc1_{it}^{GNI}$
new deposits	-0.08	0.18	m_{it}^{GNI}	0.65	0.98	$vc2_{it}^{GNI}$
money-cash	-0.01	-0.02	m_{it}^{GNI}	0.34	0.33	$vc3_{it}^{GNI}$
real money	-0.10	-0.33	m_{it}^{GNI}	0.86	1.35	$vc4_{it}^{GNI}$
	Sub-sample T_1 when calm period, sub-sample T_2 when crisis period					
real GDP	0.08	0.05	m_{it}^{crisis}	0.15	0.12	vy_{it}^{crisis}
real credit	0.15	-0.05	m_{it}^{crisis}	0.50	0.47	$vc1_{it}^{crisis}$
new deposits	0.08	0.09	m_{it}^{crisis}	0.78	1.15	$vc2_{it}^{crisis}$
money-cash	-0.01	-0.07	m_{it}^{crisis}	0.28	0.43	$vc3_{it}^{crisis}$
real money	-0.25	-0.29	m_{it}^{crisis}	1.20	1.29	$vc4_{it}^{crisis}$

Note: The variable "real GDP" is the growth rate of real GDP, "real credit" is the growth rate of real credit, "money-cash" is the difference between the growth rates of money and cash, and "real money" is the growth rate of real money. The variable d_i is a measure of financial development (deposits divided by money aggregate) in country i, GNI_i is a measure of economic development (GNI per capita in 1975).

Table 2: Pairwise correlations between instruments and crisis measures and output growth (three-year calm and crisis periods)

Instrument	real GDP	real credit	new deposits	money-cash	real money
vy_{it}^{d}	0.19	0.00	0.11	-0.08	-0.01
$vc1_{it}^{d}$	0.06	0.11	0.17	-0.19*	-0.09
$vc2_{it}^{d}$	0.15	0.16	-0.75*	0.33*	0.76*
$vc3_{it}^{d}$	-0.05	-0.16*	0.34*	-0.12	-0.43*
$vc4_{it}^{d}$	-0.04	-0.05	0.75*	-0.40*	-0.69*
m_{it}^{d}	-0.05	-0.19*	-0.05	-0.06*	0.07*
vy_{it}^{GNI}	0.06	-0.03	0.11	-0.03	-0.08
$vc1_{it}^{GNI}$	-0.21	-0.33*	-0.03	0.14	-0.21
$vc2_{it}^{GNI}$	0.01	-0.04	0.32	0.02	-0.36*
$vc3_{it}^{GNI}$	-0.02	0.13	0.01	-0.04	0.20*
$vc4_{it}^{GNI}$	-0.01	-0.24*	-0.37*	0.19	0.42*
m_{it}^{GNI}	-0.07	0.23*	0.16	-0.01	-0.10*
vy_{it}^{crisis}	-0.21	-0.10	-0.14	-0.08	-0.04
$vc1_{it}^{crisis}$	-0.02	-0.08	-0.22	0.02	0.12
$vc2_{it}^{crisis}$	-0.18	-0.23	0.37	-0.29	-0.27
$vc3_{it}^{crisis}$	-0.02	0.05	-0.29*	0.41*	0.11
$vc4_{it}^{crisis}$	0.01	0.16*	-0.26*	0.13*	0.07
m_{it}^{crisis}	-0.13	-0.20*	0.00	-0.09*	-0.01

Note: All names of instruments and other variables are explained in Table 1. The correlations corresponding to the variables that are used as econometric instruments for respective crisis measures are denoted with "*".

Table 3: Output growth reactions to one percentage point increase of real credit at different time horizons

		1 year	2 years	3 years	4 years	5 years	6 years	7 years	Length of the crisis
S1	β	0.073*	0.036	0.056*	0.095***	0.091**	0.098**	0.161***	0.011
	$t(\beta)$	(1.738)	(0.910)	(1.764)	(2.854)	(2.140)	(2.361)	(3.198)	(0.406)
	N	185	183	181	169	163	151	130	152
	J(d.f.)	0.052	0.029	0.027	0.030	0.034	0.042	0.068	0.078
	d.f.	7	4	4	4	4	4	7	7
S2	β	0.077	0.130***	0.166***	0.215***	0.212***	0.067***	0.249***	0.102*
	$t(\beta)$	(1.624)	(3.269)	(4.356)	(4.943)	(3.091)	(2.623)	(3.165)	(1.712)
	N	177	165	159	143	129	109	79	137
	J(d.f.)	0.057	0.053	0.070	0.073	0.058	0.076	0.056	0.073
	d.f.	7	7	7	7	5	7	7	6
S3	β	0.116**	0.131***	0.120***	0.235***	0.187***	0.070**	0.242***	0.050*
	$t(\beta)$	(2.168)	(3.409)	(2.383)	(5.354)	(3.895)	(2.531)	(2.987)	(1.648)
	N	172	160	154	142	128	108	78	134
	J(d.f.)	0.051	0.062	0.004	0.062	0.070	0.082	0.072	0.073
	d.f.	7	7	3	7	7	7	7	7
S4	β	0.093	0.157***	0.160***	0.240***	0.144***	0.057**	0.073*	0.047
	$t(\beta)$	(1.606)	(3.405)	(3.553)	(4.688)	(3.669)	(2.394)	(1.812)	(1.554)
	N	172	160	154	140	126	108	78	134
	J(d.f.)	0.045	0.048	0.066	0.046	0.065	0.073	0.109	0.063
	d.f.	7	7	7	7	7	7	7	7

Note: Degrees of freedom, d.f., denote the number of instruments minus 1. The instruments $\{m^d, vc4^{crisis}, m^{GNI}, vc4^{GNI}, m^{crisis}, vc3^d, vc1^{GNI}\}$ are ranked from these most correlated with the crisis measure and least correlated with the output growth to those least correlated with the crisis measure and most correlated with the output growth. If less instruments are used, as indicated by the degrees of freedom, then only those instruments with the highest rank are included. $t(\beta)$ is the t-statistic testing the null hypothesis that $\beta = 0$, J(d.f.) is the Sargan-Hansen statistic testing the null hypothesis that the GMM overidentifying restrictions are valid. The symbols *, **, and *** denote significance of the statistics at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Table 4: Output growth reactions to one percentage point increase of deposits at different time horizons

		1 year	2 years	3 years	4 years	5 years	6 years	7 years	Length of the crisis
S1	β	-0.131*	0.177*	0.128***	0.071*	0.067	0.134**	0.036	0.034*
	$t(\beta)$	(1.737)	(1.808)	(2.937)	(1.656)	(1.514)	(2.092)	(0.826)	(1.914)
	N	179	177	171	155	145	125	101	155
	J(d.f.)	0.027	0.020	0.012	0.056	0.041	0.020	0.055	0.033
	d.f.	5	5	5	5	5	5	5	5
S2	β	-0.089	0.149	0.127**	0.106*	0.049	0.112*	0.074	0.145*
	$t(\beta)$	(1.475)	(1.375)	(1.984)	(1.917)	(1.077)	(1.763)	(1.362)	(1.674)
	N	179	167	161	145	131	111	79	137
	J(d.f.)	0.043	0.028	0.016	0.038	0.045	0.027	0.062	0.024
	d.f.	5	5	5	5	5	5	5	5
S3	β	-0.100	0.236*	0.104**	0.100*	0.047	0.112*	0.077	0.154*
	$t(\beta)$	(1.188)	(1.710)	(2.091)	(1.861)	(1.198)	(1.850)	(1.500)	(1.799)
	N	174	162	156	144	130	110	78	134
	J(d.f.)	0.037	0.019	0.021	0.033	0.040	0.028	0.058	0.021
	d.f.	4	5	5	5	5	5	5	5
S4	β	-0.014	0.150*	0.079**	0.095**	0.076*	0.087*	0.067	0.185**
	$t(\beta)$	(0.225)	(1.912)	(2.158)	(2.028)	(1.970)	(1.687)	(1.365)	(2.089)
	N	174	162	156	142	128	110	78	134
	J(d.f.)	0.047	0.031	0.020	0.031	0.020	0.014	0.049	0.013
	d.f.	5	5	5	5	5	5	5	5

Note: Degrees of freedom, d.f., denote the number of instruments minus 1. The instruments $\{vc4^{d}, vc4^{GNI}, vc3^{crisis}, vc4^{crisis}, vc3^{d}, vc2^{d}\}$ are ranked from these most correlated with the crisis measure and least correlated with the output growth to those least correlated with the crisis measure and most correlated with the output growth. If less instruments are used, as indicated by the degrees of freedom, then only those instruments with the highest rank are included. $t(\beta)$ is the t-statistic testing the null hypothesis that $\beta = 0$, J(d.f.) is the Sargan-Hansen statistic testing the null hypothesis that the GMM overidentifying restrictions are valid. The symbols *, **, and *** denote significance of the statistics at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Table 5: Output growth reactions to one percentage point increase of the difference between growth of money and growth of cash at different time horizons

		1 year	2 years	3 years	4 years	5 years	6 years	7 years	Length of the crisis
S1	β	0.481**	0.117***	0.398***	-0.059	-0.078	0.402	0.356***	-0.053
	$t(\beta)$	(2.526)	(2.840)	(4.095)	(1.540)	(1.236)	(1.210)	(4.323)	(0.531)
	N	177	175	169	153	145	125	98	152
	J(d.f.)	0.018	0.043	0.042	0.047	0.041	0.036	0.094	0.045
	d.f.	6	4	6	4	4	3	6	4
S2	β	0.437**	0.066*	0.339***	-0.048	-0.068	-0.004	0.374***	0.004
	$t(\beta)$	(2.358)	(1.719)	(3.644)	(1.510)	(1.272)	(0.069)	(3.731)	(0.081)
	N	177	165	159	143	131	109	79	137
	J(d.f.)	0.019	0.045	0.048	0.054	0.064	0.091	0.071	0.064
	d.f.	6	4	6	4	5	6	6	6
S3	β	0.362**	0.019	-0.015	-0.040	-0.063	0.008	0.402***	-0.029
	$t(\beta)$	(2.550)	(0.620)	(0.454)	(1.131)	(1.139)	(0.164)	(3.517)	(0.478)
	N	172	160	156	142	130	108	78	134
	J(d.f.)	0.047	0.062	0.027	0.043	0.071	0.085	0.067	0.058
	d.f.	6	6	2	4	6	6	6	6
S4	β	0.214*	-0.016	-0.031	-0.074	-0.032	-0.006	0.320***	-0.013
	$t(\beta)$	(1.560)	(0.463)	(0.926)	(1.652)	(0.719)	(0.120)	(3.407)	(0.233)
	N	172	160	154	140	128	108	78	134
	J(d.f.)	0.048	0.063	0.028	0.010	0.067	0.076	0.070	0.056
	d.f.	6	6	4	4	5	6	6	6

Note: Degrees of freedom, d.f., denote the number of instruments minus 1. The instruments $\{ vc3^{crisis}, vc4^{d}, vc4^{GNI}, vc2^{d}, vc1^{d}, m^{crisis}, m^{d} \}$ are ranked from these most correlated with the crisis measure and least correlated with the output growth to those least correlated with the crisis measure and most correlated with the output growth. If less instruments are used, as indicated by the degrees of freedom, then only those instruments with the highest rank are included. $t(\beta)$ is the t-statistic testing the null hypothesis that $\beta = 0$, J(d.f.) is the Sargan-Hansen statistic testing the null hypothesis that the GMM overidentifying restrictions are valid. The symbols *, **, and *** denote significance of the statistics at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Table 6: Output growth reactions to one percentage point increase of money supply at different time horizons

		1 year	2 years	3 years	4 years	5 years	6 years	7 years	Length of the crisis
S1	β	0.083**	0.072***	0.128**	0.039**	0.165***	0.094***	0.225***	0.110**
	$t(\beta)$	(2.009)	(3.190)	(2.205)	(2.536)	(3.644)	(3.185)	(4.080)	(2.118)
	N	179	177	171	155	145	125	101	155
	J(d.f.)	0.053	0.043	0.014	0.071	0.059	0.060	0.042	0.059
	d.f.	7	7	3	7	7	7	7	7
S2	β	0.111**	0.060**	0.123**	0.039**	0.152***	0.046**	0.260***	0.070*
	$t(\beta)$	(2.141)	(2.079)	(2.065)	(2.200)	(3.268)	(2.083)	(4.279)	(1.743)
	N	179	167	161	145	131	111	79	137
	J(d.f.)	0.055	0.054	0.013	0.068	0.066	0.081	0.046	0.077
	d.f.	7	7	3	7	7	7	7	7
S3	β	0.085*	0.061*	0.066*	0.029	0.208***	0.189***	0.265***	0.096***
	$t(\beta)$	(1.954)	(1.838)	(1.866)	(1.226)	(3.509)	(3.550)	(4.382)	(2.583)
	N	174	162	156	144	130	110	78	134
	J(d.f.)	0.051	0.066	0.047	0.070	0.054	0.067	0.038	0.051
	d.f.	7	7	5	6	7	7	7	7
S4	β	0.055	0.062	0.030	0.012	0.040	0.052*	0.260***	0.069**
	$t(\beta)$	(1.274)	(1.530)	(1.552)	(0.498)	(1.433)	(1.841)	(4.354)	(2.453)
	N	174	162	156	142	128	110	78	134
	J(d.f.)	0.034	0.030	0.056	0.034	0.031	0.062	0.034	0.026
	d.f.	7	7	7	7	7	7	7	7

Note: Degrees of freedom, d.f., denote the number of instruments minus 1. The instruments $\{ vc4^d, vc4^{GNI}, vc3^d, vc2^{GNI}, vc3^{GNI}, m^d, m^{GNI}, vc2^d \}$ are ranked from these most correlated with the crisis measure and least correlated with the output growth to those least correlated with the crisis measure and most correlated with the output growth. If less instruments are used, as indicated by the degrees of freedom, then only those instruments with the highest rank are included. $t(\beta)$ is the t-statistic testing the null hypothesis that $\beta = 0$, J(d.f.) is the Sargan-Hansen statistic testing the null hypothesis that the GMM overidentifying restrictions are valid. The symbols *, **, and *** denote significance of the statistics at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Table A1: Periods of banking crises

Developed countries:

Australia 1989-1992 (1989),Canada 1983-1985 (1983), Denmark 1987-1992 (1987), Finland 1991-1994 (1991), France 1994-1995 (1994), Germany late 1970s-late 1970s (1977), Greece 1991-1995 (1991), Hong Kong 1982-1983 (1982), Hong Kong 1998-1998 (1998), Iceland 1985-1986 (1985), Iceland 1993-1993 (1993), Italy 1990-1995 (1990), Japan 1991-2003+ (1991), Korea 1997-2003+ (1997), New Zealand 1987-1990 (1987), Norway 1987-1993 (1987), Spain 1977-1985 (1977), Sweden 1991-1991 (1991), United Kingdom 1974-1976 (1974), United Kingdom 1980s-1990s (1990), United States 1984-1991 (1986),

Developing countries:

Algeria 1990-1992 (1990), Argentina 1980-1982 (1980), Argentina 1989-1990 (1989), Argentina 1995-1995 (1995), Argentina 2001-2003+ (2001), Azerbaijan 1995-? (1995), Bangladesh late 1980s-1996 (1989), Benin 1988-1990 (1988), Bolivia 1986-1988 (1986), Bolivia 1994-? (1994), Botswana 1994-1995 (1994), Brazil 1990-1990 (1990), Brazil 1994-1999 (1994), Bulgaria 1995-1997 (1995), Burkina Faso 1988-1994 (1988), Burundi 1994-? (1994), Cameroon 1987-1993 (1987), Cameroon 1995-1998 (1995), Central Africa Republic 1988-1999 (1988), Chad 1992-1992 (1992), Chile 1976-1976 (1976), Chile 1981-1986 (1981), Colombia 1982-1987 (1982), Congo, Democratic Republic of (former Zaire) 1991-1992 (1991), Congo, Republic of 1992-2003+ (1992), Costa Rica 1987(?)-? (1987), Costa Rica 1994-? (1994), Cote d'Ivoire 1988-1991 (1988), Croatia 1996-1996 (1996), Ecuador early 1980s-? (1982), Ecuador 1996-1997 (1991), Ecuador 1998-2003+ (1998), Egypt 1991-1995 (1991), El Salvador 1989-1989 (1989), Ethiopia 1994-1995 (1994), Gabon 1995-? (1995), Gambia 1985-1992 (1985), Ghana 1982-1989 (1982), Guinea-Bissau 1995-? (1995), Hungary 1991-1995 (1991), India 1993-2003+ (1993), Indonesia 1994-1994 (1994), Indonesia 1997-2003+ (1997), Israel 1977-1983 (1977), Jamaica 1994-1994 (1994), Jordan 1989-1990 (1989), Kenya 1985-1989 (1985), Kenya 1992-1992 (1992), Kenya 1996-? (1996), Kuwait 1980s-1980s (1980), Latvia 1995-2003+ (1995), Lesotho 1988-? (1988), Lithuania 1995-1996 (1995), Madagascar 1988-1988 (1988), Mali 1987-1989 (1987), Malaysia 1985-1988 (1985), Malaysia 1997-2003+ (1997), Mauritius 1996-1996 (1996), Mexico 1981-1991 (1981), Mexico 1994-1997 (1994), Morocco early 1980s-? (1981), Mozambique 1987-1995(?) (1987), Myanmar 1996-? (1996), Nepal 1988-1988 (1988), Niger 1983-? (1983), Nigeria 1997-1997 (1993), Panama 1988-1989 (1988), Papua New Guinea 1989-? (1988), Paraguay 1995-1999 (1995), Paraguay 2001-2003+ (2001), Peru 1983-1990 (1983), Philippines 1981-1987 (1981), Philippines 1998-2003+ (1998), Poland 1990s-1990s (1993), Romania 1990-2003+ (1990), Russia 1995-1995 (1995), Russia 1998-1999 (1998), Rwanda 1991-? (1991), Senegal 1988-1991 (1988), Sierra Leone 1990-2003+ (1990), Singapore 1982-1982 (1982), Slovenia 1992-1994 (1992), South Africa 1977-1977 (1977), South Africa 1989-? (1989), Sri Lanka 1989-1993 (1989), Swaziland 1995-1995 (1995), Tanzania late 1980s-1990s (1989), Thailand 1983-1987 (1983), Thailand 1997-2003+ (1997), Togo 1993-1995 (1993), Trinidad and Tobago 1982-1993 (1982), Tunisia 1991-1995 (1991), Turkey 1982-1985 (1982), Turkey 1994-1994 (1994), Turkey 2000-2003+ (2000), Uganda 1994-2003+ (1994), Ukraine 1997-1998 (1997), Uruguay 1981-1984 (1981), Uruguay 2002-2003+ (2002), Venezuela late 1970s-1980s (1980), Venezuela 1994-1995 (1994), Vietnam 1997-2003+ (1997), Zambia 1995-1995 (1995), Zimbabwe 1995-2003+ (1995).

Note: the symbol "?" denotes unknown date, "+" denotes that the crisis was not over in 2003. The starting dates of crisis used in our empirical analysis are presented in parentheses. Data from Caprio and Klingebiel (2003) and Hoggarth, Reis and Saporta (2002).

Table A2: Robustness check - the GMM estimation of the dynamic panel data model

Measure of crisis extent[a]	Specification of the instrumental variables[b]	Estimation method[c]	Period dummies	Model specification[d]	Parameter β [e]	Std. errors. of β [f]	Sargan J statistic [g]	p-value of the J statistic
credit	i=1	*difference*	yes	S4	0.008**	0.0010	95.52	0.495
credit	i=1	*difference*	no	S4	0.010**	0.0005	102.37	0.609
credit	i=1	*difference*	no	S2	0.007**	0.0002	112.43	0.418
credit	i=1	*difference*	no	S1	0.019**	0.0001	119.75	0.464
credit	i=1	*orthogonal*	yes	S4	0.009**	0.0011	94.99	0.510
credit	i=1	*orthogonal*	no	S4	0.011**	0.0003	109.89	0.405
credit	i=1	*orthogonal*	no	S2	0.010**	0.0003	110.56	0.467
credit	i=1	*orthogonal*	no	S1	0.016**	0.0001	119.67	0.466
credit	i=2	*difference*	yes	S4	0.004**	0.0012	93.27	0.560
credit	i=2	*difference*	no	S4	0.005**	0.0011	102.19	0.613
credit	i=2	*difference*	no	S2	-0.002**	0.0002	112.89	0.406
credit	i=2	*difference*	no	S1	0.008**	0.0002	118.77	0.489
money	i=1	*difference*	yes	S4	0.030**	0.0016	95.38	0.556
money	i=1	*difference*	no	S4	0.035**	0.0004	109.19	0.477
money	i=1	*difference*	no	S2	0.037**	0.0002	113.35	0.446
money	i=1	*difference*	no	S1	0.062**	0.0003	121.75	0.464
money	i=1	*orthogonal*	yes	S4	0.036**	0.0015	102.86	0.349
money	i=1	*orthogonal*	no	S4	0.041**	0.0005	109.94	0.457
money	i=1	*orthogonal*	no	S2	0.042**	0.0005	111.63	0.492
money	i=1	*orthogonal*	no	S1	0.059**	0.0001	120.24	0.502
money	i=2	*difference*	yes	S4	-0.006**	0.0022	94.33	0.586
money	i=2	*difference*	no	S4	-0.001	0.0009	108.32	0.500
money	i=2	*difference*	no	S2	-0.005**	0.0010	113.53	0.442
money	i=2	*difference*	no	S1	0.021**	0.0006	122.95	0.433

Note: (a) *credit* is defined as the log change in real credit, money is defined as the log change in real money; (b) i=1 and i=2 denote that all valid lags in the dynamic panel instruments up to t-i for the observation t of the crisis variable are used in the Arellano-Bond method; (c) *difference* is the Arellano-Bond first-differences estimator, *orthogonal* is the orthogonal deviations estimator, as proposed by Arellano and Bover (1995); (d) model specifications are analogous to those in previous tables. However, the GNI per capita, $currcrisis_{it}$, $fxregime_{it}$, $debtcrisis_{it}$ and $systemic_{it}$ are not used in the specifications S2 and S4. Instead period dummy variables are used. (e) The β parameter measures impact of the crisis variable on GDP growth. Symbol * denotes significance of the parameter at the 5% level and ** denotes significance at the 1% level. (f) White period robust standard errors are computed; (g) The Sargan-Hansen test (J-statistic) of overidentifying restrictions.