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by Jonas Dovern and Nils Jannsen

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Abstract:
During the ongoing financial crisis the analysis of similar historical crises has gained more and more attention among economic researchers and forecasters. Existing studies, however, do not tackle the immense heterogeneity that is present in cross-country samples in a formal and consistent way. In this paper, we propose a standardization approach to estimate the typical impact of economic crises. We show that our approach leads to estimates that are much less dependent on the sample used to estimate the typical shape and, hence, should give more reliable information about the typical macroeconomic impact of economic crises.

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Jonas Dovern
KIEL ECONOMICS Research & Forecasting
Fraunhoferstr. 13
24118 Kiel, Germany
Phone: +49 (0) 431-5303497
jonas.dovern@kiel-economics.de

Nils Jannsen
Kiel Institute for the World Economy
24100 Kiel, Germany
Phone: +49 (0) 431-8814 298
nils.jannsen@ifw-kiel.de

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Jonas Dovern[†] and Nils Jannsen[‡]

1. Introduction

During the ongoing financial crisis the analysis of similar historical crises has gained more and more attention among economic researchers and forecasters. The most prominent approach that has been applied in many studies is to estimate the typical behaviour of important macroeconomic indicators during phases of financial crisis based on data from many countries from the early 20th century up to now.

Prominent examples in the literature that use this approach include a number of papers that have been written against the background of the current financial crisis. Reinhart and Rogoff (2008a, 2008b, 2008c, 2009) analyze the typical development of several major macro-economic indicators during banking crises. Dovern and Jannsen (2008) and Jannsen (2009) explore the business cycle effects of housing crises. Claessens et al. (2008) investigate the economic impact of recessions, credit crunches and asset price busts. Finally, the IMF (2008, 2009) uses the approach to extract information about the typical shape of recessions and financial stress episodes from a large cross-country data set.

This movement has been mainly driven by two facts. First, financial crises are rare events. Therefore, there are usually not enough observations per country to fit time series models to the country data, and to estimate the typical impact of a financial crisis on a particular country. Second, during prolonged and deep economic downturns, which are usually found to accompany financial crises, time series models are not able to capture the dynamics appropriately, since it is usually not possible to fit a model to the non-linearities inherent to such events.

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[†] KIEL ECONOMICS Research & Forecasting, Kiel.

[‡] Corresponding author: Kiel Institute for the World Economy (IfW), nils.jannsen@ifw-kiel.de.

None of the studies mentioned above does, however, tackle the immense heterogeneity that is present in cross-country samples in a formal and consistent way. Instead, usually the characteristic behaviour of macroeconomic variables during crises is calculated simply as the mean or median over a panel of crises—disregarding that the panel is prone to exhibit considerable heterogeneity, since macroeconomic conditions and institutions differ substantially across countries and, even more important, across time. In this paper, we propose to standardize the data by variables that reflect the macroeconomic environment prior to estimating the typical shape of the macroeconomic variables around financial crises. We show that our approach leads to estimates that are much less dependent on the sample used to estimate the typical shape and, hence, should give more reliable information about the typical macroeconomic impact of financial crises.

The remainder of the paper is structured as follows. In Section 2, we describe how we standardize the macroeconomic variables. In Section 3, we briefly describe the data set and show which statistics we use to capture the strength of a crisis. In Section 4, we provide evidence for the relevance of standardizing the data. In Section 5, we apply our method to estimate the consequences of a banking crisis in the United States. Finally, Section 6 concludes the paper.

2. Theoretical Framework

So far researchers have calculated simple mean or median statistics when estimating the typical shape of recessions caused by financial crises based on international historical observations. Consider a variable of interest y_{it} (usually the growth rate of GDP or the output gap) that is observed for different countries i over different time periods t. Furthermore, assume that in the past C crises have been observed. Denote as $i(c)$ and $t(c)$ the country and time at which crisis c occurred. The typical shape of y_{it} in a window of size $2S+1$ around a crisis has been estimated as

$$\hat{y}_s = \frac{1}{C}\sum_{c=1}^{C} y_{i(c),t(c)+s}, \text{ for } s = -S,...,S.^{1} \qquad (1)$$

[1] We present our approach in terms of the mean but all results carry over to the case, where the median serves as the preferred measure.

This approach disregards the fact that usually the economic crises in the sample occurred under fundamentally different macroeconomic regimes. We show below that differences across these regimes influence how strongly the economy is affected by a financial crisis. Consequently, the estimates $\hat{y}_s$ are sensitive to the composition of the sample. If for instance the sample covers a lot of emerging markets, then the estimated typical trend rate of economic growth around a financial crisis will most certainly be higher than if the majority of crises in the sample occurred in industrialized countries. Likewise the volatility of GDP growth and the estimated effect of a financial crisis on GDP growth are supposable higher based on a sample dominated by observations from the seventies than based on a sample with predominately more recent observations from the "post Great Moderation era". Now, if one is interested in forecasting the most likely path of output (or any other variable) for a specific country in a specific situation, one would like to have an estimate at hand that is unaffected by the composition of the historical sample and appropriate to the economic environment of that country.

To this end, we recommend to first standardize $y_{i,t}$ by a scale factor that captures the local macroeconomic conditions. We propose to subtract from $y_{i,t}$ the "local" mean of GDP growth $\bar{y}^{w}_{i(c),t(c)}$ and then divide by the "local" standard deviation $\sigma^{w}_{i(c),t(c)}$, each calculated over the w periods before the beginning of the crisis c.[2] The standardized typical shape of y can then be obtained by

$$\tilde{y}_s = \frac{1}{C}\sum_{c=1}^{C} \frac{\left(y_{i(c),t(c)+s} - \bar{y}^{w}_{i(c),t(c)+s} \right)}{\sigma^{w}_{i(c),t(c)+s}} \text{, for } s = -S,...,S \,. \qquad (2)$$

If we now face a new financial crisis, $C+1$, for which we want to estimate the path of $y_{i(C+1),t(C+1)}$ for $s = -S,...,S$ that would be in line with the average historical behaviour of this variable around other financial crises, we can calibrate the standardized path $\tilde{y}_s$ to the specific situation by estimating the "local" mean $\bar{y}^{w}_{i(C+1),t(C+1)}$ and standard deviation $\sigma^{w}_{i(C+1),t(C+1)}$ over the most recent w periods and calculate

$$\hat{y}_{i(C+1),t(C+1)+s} = \tilde{y}_s \cdot \sigma^{w}_{i(C+1),t(C+1)} + \bar{y}^{w}_{i(C+1),t(C+1)} \text{, for } s = -S,...,S \,. \qquad (3)$$

[2] See Section 4 for a justification of those choices for the standardization factors.

In the next sections, we demonstrate the relevance of our approach using a large cross-country data set and an example from the most recent financial crisis.

3. Data

For the analysis we employ yearly GDP per capita data for 40 countries between 1900 and 2006 provided by Barro and Usura (2008). To identify banking crises we make use of the dating scheme described in Reinhardt and Rogoff (2008b). Overall we have 122 banking crises in our data set. Besides a view on the evolution of GDP per capita growth around the period of banking crises, the strength of each crisis can be described by a set of summary statistics. We use three measures to document the strength of each crisis. First, we compute the maximum decline of GDP per capita during the ten years after the start of the crisis from the pre-crisis-peak (Depth I). Second, we compute the minimum value of the output gap during the ten years after the start of the crisis (Depth II). Finally, we compute the total output loss triggered by the crisis as the integral over the output gap for the period, over which the output gap is in negative territory after the start of the crisis (Output Loss).

4. The Relevance of Standardization

We provide evidence for the relevance of standardization in two dimensions. First, we demonstrate that there is a significant relationship between the strength of a crisis and the overall macroeconomic conditions measured by the "local" mean and standard deviation of the underlying GDP series in a certain time span. Second, we draw random subsamples from our sample of crises and illustrate that the standard deviation of the strength-of-the-crises-measures based on the standardized data is significantly smaller than the standard deviation of those based on the non-standardized data.

A linear regression shows that the measures that we use to standardize the data are indeed appropriate; the mean and the standard deviation, calculated over the 20 periods before the crisis starts, are highly significant in explaining each of the three strength-of-the-crisis measures (Table 1).[3] Moreover, the fit of these regressions is surprisingly high; the macroeconomic conditions are sufficient to explain roughly 50 percent of the variation of the strength of a banking crisis. Thus, beside an idiosyncratic component, the strength of a banking crisis seems to be strongly dependent on the underlying macroeconomic conditions.

[3] This result holds also for other plausible choices of the window size *w*.

Table 1: Macroeconomic Conditions and the Strength of a Crisis

	Depth I	t-stat.	Depth II	t-stat.	Output Loss	t-stat.
Constant	-10.6	(-12.2)	-6.2	(-13.6)	-10.5	(-8.2)
StDev. of GDP-growth	-1.3	(-4.4)	-0.6	(-3.6)	-1.4	(-3.2)
Mean of GDP-growth	-8.4	(-8.0)	-5.1	(-9.3)	-17.1	(-11.0)
R-squared	0.45		0.49		0.56	
# of Observations	103		103		103	

Notes: Regression is based on mean adjusted independent variables. For 19 of the identified banking crises the output gap does not turn negative after the beginning of the crisis. We exclude these crises from the linear regression, since a priory it is not clear over which intervals the measures should be calculated.

The importance of the standardization can also be demonstrated by a simple simulation exercise. If the strength of a crisis depends on macroeconomic conditions, the typical consequences of an economic crisis—estimated as an average over a number of crises—depend on the underlying sample. To illustrate this, we randomly draw 50 crises from our sample of 122 banking crises and calculate the average value of the strength-of-the-crisis measures over this sub-sample for the standardized and non standardized data.[4] We draw 500 replications and measure the dispersion of the results by their standard deviation. Since, by construction, the magnitude of the results calculated on the standardized data is smaller, we adjust the standard deviation by dividing through the mean and multiplying with 100 to compare the results. Table 2 shows that the relative standard deviation of the strength-of-the-crisis measures based on the standardized data is significantly smaller than those based on the non-standardized data. In fact, not even one draw of a standard deviation based on the standardized data lies in the interval of the results based on the non-standardized data. Thus, the standardization of the data makes the results much less dependent on the available sample of crises.

Table 2: Relative Standard Deviation for Standardized and non-Standardized Data

	non-Standardized Data			Standardized Data		
	minimum	mean	maximum	minimum	mean	maximum
Depth II	-12.0	-11.5	-11.0	-10.5	-9.8	-8.9
Output Loss	-20.4	-19.6	-18.7	-16.3	-15.4	-14.2

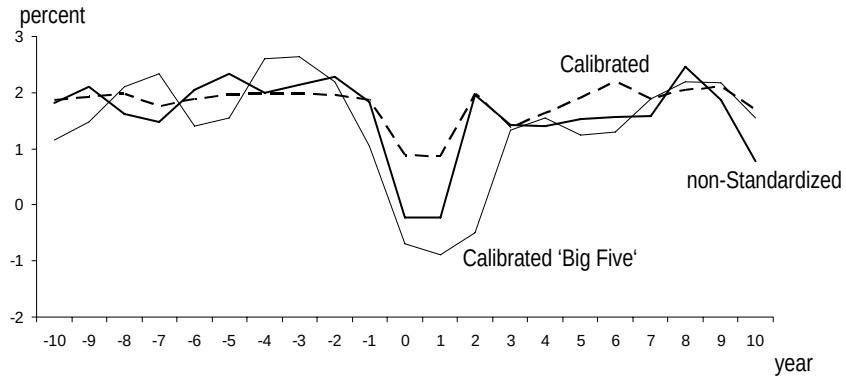
Notes: Each relative standard deviation is based on a simulation with 500 replications. Minima, maxima and means are calculated based on 500 replications of those simulations.

[4] For these exercises we concentrate on the measures Depth II and Output Loss.

5. An Application to the United States

We use our new approach to illustrate what economic consequence the current banking crisis should have in the United States if it followed the average historical pattern. To this end, we calculate the average development of GDP growth during a banking crisis as well as the measures *Depth II* and *Output Loss*. Then we calibrate the results based on the standardized data to the current macroeconomic conditions in the United States as described in Section 2. Figure 1 shows that our results concerning the development of GDP growth based on the non-standardized data are similar to those obtained by Reinhart and Rogoff (2008b). For the United States the calibrated results point to a much less severe impact of a typical banking crisis in the current environment. The length of the negative impact of the crisis is estimated to be quite similar in both cases. Because, at first, this result is surprising given the severe economic contraction that we observed in the US during the most recent quarters, we apply our method to the sample of the "Big Five" crisis identified by Reinhardt and Rogoff (2008b).[5] While one could still argue that the current financial crisis in the US is even worse than this collection of crises, especially given spillover effects due to the global nature of the current crisis, the figure shows that the calibrated results are closer to the current economic development in the US.

Figure 1: Typical evolution of GDP Growth during a Banking Crisis in the United States



Notes: Beginning of the banking crises in year zero. Calibration based on data from 1987 to 2006, with a mean value of annual GDP growth per capita of 1.9 percent and a standard deviation of 1.2 percentage points. The "Big Five" crises refer to Spain (starting year 1977), Norway (1987), Finland (1991), Sweden (1991) and Japan (1992) (Reinhart and Rogoff 2008b).

[5] The "Big Five" crises refer to Spain (starting year 1977), Norway (1987), Finland (1991), Sweden (1991) and Japan (1992).

The two strength-of-the-crisis measures *Depth II* and *Output Loss* confirm the result that a simple historical comparison, which does not take the macroeconomic conditions into account explicitly, tends to overstate the costs of an average banking crisis in case of the United States (Table 3). Both statistics are roughly half as big compared to the non-standardized results, once we adjust for macroeconomic conditions and calibrate the standardized data to the current situation in the United States. Again, if we base the calibrated results on the "Big Five" crisis only, the results suggest a much more detrimental economic impact of the ongoing financial crisis.

Table 3: Strength-of-the-Crisis Measures in case of a Banking Crisis in the United States

	non-Standardized	Calibrated	Calibrated 'Big Five'
Depth II	-4.9	-2.3	-3.5
Ouput Loss	-8.9	-4.2	-13.7

Notes: Calibration based on data from 1987 to 2006 with a mean value of the output gap of 0.2 percent and a standard deviation of the output gap of 1.6 percentage points. Calibrated 'Big Five' is based on the mean value of standardized data for the 'Big Five' crises except Japan (1992), because for this crisis the output gap turned not negative after the beginning of the crisis.

6. Conclusion

In this paper, we propose a standardization approach, by which the impact of severe economic crises can be made comparable across countries and time. We demonstrate that the macroeconomic implications of banking crises are highly correlated with macroeconomic conditions – measured in terms of the "local" mean and standard deviation of GDP growth in a certain time span before each of the crises. Furthermore, we show that the estimate of the typical shape of a banking crisis is less dependent on the sample of crises once we apply the proposed approach. The application of our method should be of considerable interest to macroeconomic analysts that assess the severity of the current financial crisis or that have to come up with macroeconomic forecasts for countries that are currently affected by such crisis.

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