

# Do financial crises discipline future credit growth?

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## Abstract:

The frequency of major crises suggests that financial markets often fail to provide strong *ex-ante* warnings. However, they might exert a secondary form of discipline and prompt needed adjustments once a crisis has occurred. We test this hypothesis on credit growth, a frequent contributor to banking crises. In a sample of 72 banking crises from 1977 to 2010, we found that real credit growth fell substantially (relative to the average) by about 8% points from pre- to post-crisis. However, the strength of this effect varied across episodes. To explore mechanisms, we found that financial regulatory regimes tend to be strengthened.

**Keywords:** Market Discipline; Credit Booms; Financial Crises; Financial Regulations

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## 1. Introduction

It has frequently been argued that financial markets can provide strong discipline over the financial behavior of governments and central banks. This view is personified in the comment made by a former presidential advisor in the United States that if he were reincarnated he'd like to come back as the financial market because then he could scare anyone. To many, such discipline would be a good thing, helping to offset various biases toward excessive financial laxity discussed in the literatures on time inconsistency problems, political business cycles, etc. To others, generally from the left of the political spectrum, such discipline is seen as being excessively harsh, forcing governments to curtail desirable actions.

Both of these frequently expressed views share the assumption that for good or ill, financial markets do provide considerable discipline over the decision making of public officials. Recent

analysis, however, suggests that such discipline is often lacking. Indeed the frequency of financial crises themselves suggests the limitations of this discipline hypothesis, at least in its strong form that market discipline will force governments to correct policies that are heading toward crises.

Two things are required for this strong form of the discipline hypothesis to work: that markets give early warning signals that government policies are heading towards problems *and* that governments then respond to these signals. As documented in Willett, Chiu, and Walter (2014) there are many cases in which financial markets have failed to give any substantial early warning signals. The failure of interest rate premia to rise substantially on government debt of countries such as Greece before the outbreak of the euro crises is an important recent example. Similarly Prabha, Wihlborg, and Willett (2012) found little evidence of strongly rising risk premia on the debt of the major commercial banks before the US subprime crisis.

Once the euro crisis broke out, however, it appears that financial markets “woke up” and at least until the time of the ECB’s commitment to do whatever it takes to save the euro, they reacted sensitively to the policies being adopted. Indeed some have argued that during the height of the euro crisis the markets imposed excessively harsh discipline on governments. While much more detailed analysis is necessary these developments suggest that there is likely a good bit of truth to the discipline *during* crises hypothesis.

In this paper we explore a third type of discipline hypothesis: Do painful financial crises induce governments and private sector decision makers to adopt more prudent policies for the future? In other words, is there learning from the mistakes associated with crises? While such learning behavior seems quite plausible it is not obvious how strong the effect will be. In some countries special interest forces may continue to generate excessive credit creation even in the face of public demands for reform. Regulatory reforms that are undertaken may prove to be largely ineffective in the face of such pressures. There may also be considerable disagreement about the major causes of crises and hence what lessons should be learned. For example, at the political level the right in the United States has frequently argued that the major cause of the subprime crisis was excessive government interference in the housing markets while many on the left have blamed excessive financial deregulation.<sup>1</sup>

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<sup>1</sup> This divide is reflected among others in the Final Report of the National Commission of the Causes of the Financial and Economic Crisis in the US (Angelides and Thomas 2011). The majority report (chaired by Phil Angelides, a Democrat) included two dissenting statements from Republican members of the commission: one written by Wallis and another by Henessey, Holtz-Eakin, and Thomas.

There is also a well-known tendency for memories to be short. This isn't always the case. The horrors of the German hyperinflation still influence the anti-inflation attitudes of the German officials and the general public. Still tendencies to lapse into past excesses cannot be fully discounted and our analysis found a number of examples of such failures.

Our focus is on the extent to which banking crises tend to provide future discipline in the form of lower rates of credit growth than those prior to the crisis. Bank credit tends to fall while a crisis is in process and this is typically the result more of the direct effects of the crisis than better disciplined policies. Thus we compare rates of credit growth after, not during, the crisis period with those that preceded the crisis.<sup>2</sup>

Of course, excessive credit growth is not the only cause of banking crises so comparing before and after rates of credit growth does not capture the full range of possible discipline effects but there has been considerable research on the relationship between credit growth and banking crises. Credit booms are neither a necessary nor sufficient condition for banking crises but there is a positive relationship. The general conclusion of this research is that while many credit booms do not end in banking crises a majority of banking crises are preceded by credit booms. For example, Mendoza and Terrones (2008) found slightly over half of crises in their sample are preceded by credit booms while Elekdag and Wu (2011) found 69 percent of crises were preceded by booms in their sample.

High credit growth is the result of a combination of financial sector and government decisions and regulations. For example, in the US subprime crisis, excessive risk taking by banks played a major role, while Alan Greenspan's belief that competition in the banking sector would provide sufficient discipline (such that little regulatory oversight was needed) proved to be false. Many argue that the low interest rate policy of the Federal Reserve also contributed importantly to the buildup of the housing and credit bubble. For the most part regulators had the ability to offset these factors but failed to do so. Thus the bubble was the result of the interaction of a number of government and private sector policies. The first task, on which we focus, is to determine to what extent future credit growth was disciplined, i.e., what are the basic facts.

A follow on task is to investigate the various channels through which discipline may occur. While we will likely never be able to fully accurately assign relative weights to the various factors that contribute to these outcomes, it is possible to explore some aspects of these composite effects.

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<sup>2</sup> We also note that discipline effects can be attributed to supply-side discipline (e.g., do bankers extend less risky loans after a crisis?) or demand-side discipline (e.g., would borrowers be more prudent in their demand for loans?)

We undertake an initial investigation of one possible channel, specifically strengthening of financial regulation and supervision.<sup>3</sup>

This study examines 72 banking crisis (country-year) episodes, the onset years of which occurred between 1980 and 2008. We focus particularly on a sub-set of 55 credit-growth driven banking crises. Our primary analysis looks at bank credit but we are also able to look at the growth of non-bank credit for a smaller sample of countries. The results for both measures are generally the same.

We found that while on average rates of credit growth fall and financial supervision was strengthened following crises there were substantial differences across countries in the responses of both credit growth and strengthening of financial supervision. Roughly two-thirds of our sample showed drops in credit growth, but in one third of our sample there was no such fall. Thus it becomes important to attempt to understand the major factors that influence these differences.

The paper is organized as follows. In section 2, we describe the data on credit growth and banking crisis, and we explain how we set up the data for analysis. In section 3 we present cross-country comparisons of changes in credit growth from the pre- to the post-crisis periods. Section 4 looks at changes in the strength of regulation and supervision after banking crises. Section 5 offers concluding comments.

## **2. Set up and data description**

This study examines 72 banking crisis (country-year) episodes, the onset years of which occurred between 1980 and 2008. We excluded crisis episodes preceded by negative credit growth (e.g. Russia 1998; Venezuela 1994) and thus focused on a sub-set of 55 crisis episodes that were preceded by positive pre-crisis credit expansion, following the suggestion of Takats and Upper (2013).<sup>4</sup> Our main variables of interest are credit growth, banking crisis, capital regulation and

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<sup>3</sup> Some studies have looked at the effects of crises on financial liberalization more generally (e.g. Mian et al. 2014; Rosas et al. 2013). However, it is not clear whether more financial liberalization unambiguously enhances post-crisis discipline effects. For example, financial liberalization that is accompanied by stronger capital regulation and supervision should reduce the likelihood of banking crises (e.g. Angkinand et al. 2010). Thus we focus on strengthening of prudential supervision which should unambiguously be associated with more discipline. It should be noted, however, that strengthening of formal financial oversight does not always translate into more effective supervision in practice. For example the high scores that the US received in the standard measures of quality of regulation (Abiad et al. 2010) did not keep regulators from failing to take sufficient actions to head off the US sub-prime crisis. Likewise we found for our sample that increased regulation after crises is not associated with larger drops in the rate of credit creation.

<sup>4</sup> Contrary to popular view, there are indeed episodes of systemic banking crises which are not preceded by strong credit growth. The dynamics of credit bust (if any) would therefore be very different if we include

supervision (CRS). CRS is proxied by a score measuring countries' compliance with international standards of banking supervision taken from Abiad et al. (2010). A more detailed explanation of this data is found in section 4.

Banking crisis data was taken from Laeven and Valencia (2012), who document occurrences of systemic banking crisis worldwide<sup>5</sup>. In this data set,<sup>6</sup> a country experiences the onset of a banking crisis in a particular year if there is either a significant bank run or a substantial government intervention to rescue the banking sector (bank holiday, deposit freeze, liquidity support, or outright bank takeovers). This data set was chosen because it has the widest country and period coverage of all existing data sets (it covers 145 countries with over 150 crisis episodes).

In attempts to capture what constitutes "excessive" credit growth, scholars have used a number of different measures of private credit growth with varying results. The two main underlying measures are growth in real credit and growth in credit/GDP. Each of these measures is designed to take into account one of the important factors that should influence the rate of non-excessive credit growth. Ideally one would like to compare actual credit growth with the results of a well-specified equation indicating what rate of credit growth is appropriate. Unfortunately, there is no agreement in the literature on how such appropriate levels of credit growth should be estimated. This is reflected in the various measures that have been used to identify periods of credit booms<sup>7</sup>. Thus we have adopted the cruder measures that have been used in the recent literature. In our preliminary analysis, we chose real growth of credit instead of growth of credit/GDP, since the latter measure does not account for the possibility that credit and GDP could have very different trends and recovery patterns after the crisis. In other words, we might face a situation where credit and GDP are falling individually; however, the growth in credit/GDP might go up because the fall in credit is smaller in magnitude than the fall in GDP.

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these 16 episodes where cumulative credit growth was negative before the crisis. For example, using real credit growth as a measure, the average pre-crisis CG is actually lower than non-tranquil years CG (3.61% vs 5.83%), which is puzzling.

<sup>5</sup> Another widely-used data set for banking crises is Reinhart and Rogoff (2011), which uses a smaller sample of countries.

<sup>6</sup> We largely used banking crisis data from Laeven and Valencia (2012) in its original form, with some modifications. First, the authors code Brazil 1990 and 1994 as two separate cases of banking crisis. We exclude Brazil 1990 as an episode, given the authors' of the data set consider this a borderline crisis. Second, we exclude Chile 1976, given that the closure of banks only happened on a large scale in 1981.

<sup>7</sup> For further discussion and references to the literature see Amri, Richey, and Willett (2016).

For this reason, in our main analysis we followed the recent trend in the literature and used the growth of real credit<sup>8</sup> as our measure, although we also conducted sensitivity analyses using the other frequently used credit measure, the ratio of credit to GDP.<sup>9</sup> We used the criterion that real credit growth before a crisis be positive and this condition was met for 55 of the 72 advanced and emerging market countries for which we were able to obtain a complete set of data. The argument is that when high credit growth has not preceded a crisis then there would seem to be no major reason to curb future credit growth. It is only when prior credit growth has been seen to be excessive that we would expect that there might be a learning experience that leads to reductions in future credit growth.<sup>10</sup>

### ***2.1 Pre- and post-crisis sample periods: choosing a time window***

As our main data analysis compares time plots of growth rates of credit before and after the onset of banking crisis episodes, one important point regarding the data setup is the time window to choose as our pre-crisis sample and post-crisis sample. Previous research suggests that it takes a few years of high credit growth to generate crises (Caprio and Klingebiel 1997; Dell’Ariccia et al. 2012). Behind a credit-growth induced banking crisis is a high number of bad loans. It could take a number of years for bad loans to accumulate and become evident that they need to be written-off. However, Amri et al. (2013) found that the preceding year or two is more substantively significant in explaining banking crises, compared to cumulative credit growth over 3-4 years preceding the crisis.

Given the foregoing, we took a conservative approach and used a four-year window for our average pre-crisis credit growth rates.<sup>11</sup> For the crisis period, examination of the data suggested that a conservative window to capture the declines in credit growth that usually occur during crises was again three years. Thus we began our post crisis period at  $t+4$  years and again used a four-year window to compute average post-crisis credit growth. In other words, taking  $t$  as the onset year of a

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<sup>8</sup> Private credit data is taken from International Financial Statistics. We operationalize credit growth as the annual change in the natural log of real credit (the natural log of real credit in year  $t$  minus the natural log of real credit in year  $t-1$ ). Following Beck et al. (2000) and Mendoza and Terrones (2008), real credit is the average of two contiguous end-of-year values of nominal credit, deflated by the end-of-year consumer price index.

<sup>9</sup> Other variables that are used are growth rates of the ratio of real bank credit to real GDP and real bank credit per capita.

<sup>10</sup> That real credit growth be positive is a fairly weak criterion for inclusion and may bias the analysis against finding discipline effects.

<sup>11</sup> Mian et al. (2014) apply a similar method and use five years before the onset year and five years after the last year of crisis as their pre- and post-crisis samples.

banking crisis, years  $t-3$  to years  $t$  make up the pre-crisis sample period, while years  $t+4$  to  $t+7$  comprise the post-crisis sample period. Our choice was broadly in line with similar research that looked at how credit behaves after financial crises (i.e. during output recovery periods). For example, Takats and Upper <sup>12</sup>(2013) found that credit drops after a crisis tend to level off within two years, which strengthens our case for deleting the 3-year period immediately after the onset of a banking crisis.

One point to acknowledge is that even after deleting the three-years immediately after the onset of a banking crisis, there are potential biases. One is that as a country recovers from a banking crisis, sharp drops in credit growth *during* the crisis may be so substantial that above average credit growth might be appropriate for a year or two. This would create a bias against finding discipline. Thus we believe that our estimates for cases of post-crisis discipline are conservative.

One way to allay concerns regarding this type of potential bias is to calculate how long it takes for credit to return to its “normal” levels. Yet defining what “normal” is would be difficult. Clearly, what we observe in one or two years before the crisis is not normal, as this is the period where credit overshoots (hence a credit boom). In fact, if the immediate pre-crisis credit growth is too high (and thus problematic), this is not the ideal level to which we would want to return. Table 1 reports the average trend of credit and GDP during and after banking crises. The second column reports average deviation of the log of real credit from its trend, using a Hodrick Prescott filter.<sup>13</sup> Nevertheless, the figures cited here suggest that our choice of time-window discussed in the previous paragraph is reasonable. For example, as seen from Column 3, in the pre-crisis period ( $t-3$  to  $t$ ) we see that real credit grows sharply, enters negative territory *during* the crisis and recovery period ( $t+1$  to  $t+3$ ) and in the post crisis period ( $t+4$  to  $t+7$ ), average real credit growth is no longer negative and starts to resemble the average figures observed before the crisis.

**Table 1. Credit and GDP growth around and during banking crises**

	Average Deviation of Real Credit from Trend*	Average Annual Real Credit Growth	Average Annual Real GDP Growth	Average Annual Credit/GDP Growth
t-3	0.72%	3.19%	3.05%	2.72%
t-2	0.36%	3.92%	2.61%	4.94%
t-1	4.67%	8.32%	2.26%	9.40%

<sup>12</sup> This paper also excludes financial crises that were not preceded by strong increase in credit and those that occurred in an environment of hyperinflation.

<sup>13</sup> We follow the filtering method suggested by Mendoza and Terrones (2008) and Elekdag and Wu (2011).

t	7.51%	7.22%	0.58%	6.86%
t+1	3.93%	-1.20%	-0.76%	2.93%
t+2	-3.45%	-4.33%	2.58%	0.86%
t+3	-4.57%	0.87%	3.83%	-0.74%
t+4	-3.38%	4.04%	3.84%	1.41%
t+5	-3.99%	2.76%	3.87%	0.43%
t+6	-3.32%	4.64%	4.34%	2.10%
t+7	-2.0%	6.28%	3.19%	4.77%

Note: \*Deviation from trend is the percentage point difference between the variable log of real credit and its (HP Filtered) trend. *t* is the onset year of banking crisis.

### 3. Banking crisis as a potential source of future discipline: examining credit growth before and after financial crises

In this section we examine patterns in the changes in annual growth of real credit before and after banking crises episodes. We analyze 55 credit-growth driven banking crisis episodes<sup>14</sup>, out of the 72 advanced and emerging market countries for which we were able to obtain a complete set of data and present the results in Table 2 below. Based on this sample, in the pre-crisis period (t-3 to t), average annual growth of real credit is 9.68% (std. deviation 6.9%). In the post-crisis period (t+4 to t+7), average annual growth of real credit is 1.48 % (std. deviation 12.4%). The average difference between pre-crisis to post-crisis is -8.20 percentage<sup>15</sup> points, a very substantial drop.

The average annual growth of real credit during “tranquil times”, defined as all periods outside our pre- and post-crisis periods, was 6.82%. Forty-one of the 55 cases (75 percent) were followed by lower credit growth, and in 38 out of those 41 cases, the drop in credit growth was greater than 3 percentage points. In 9 of those 41 cases (most of which were from the emerging market economy group, particularly from Latin America. The two non-emerging market cases were Ireland 2008 and Spain 2008), the drop was greater than twenty percentage points. With the exception of Ecuador 1982, it appears that the distribution of the drop in credit growth across these 38 sub-sample episodes was quite even.<sup>16</sup> Thus on average, the countries examined here

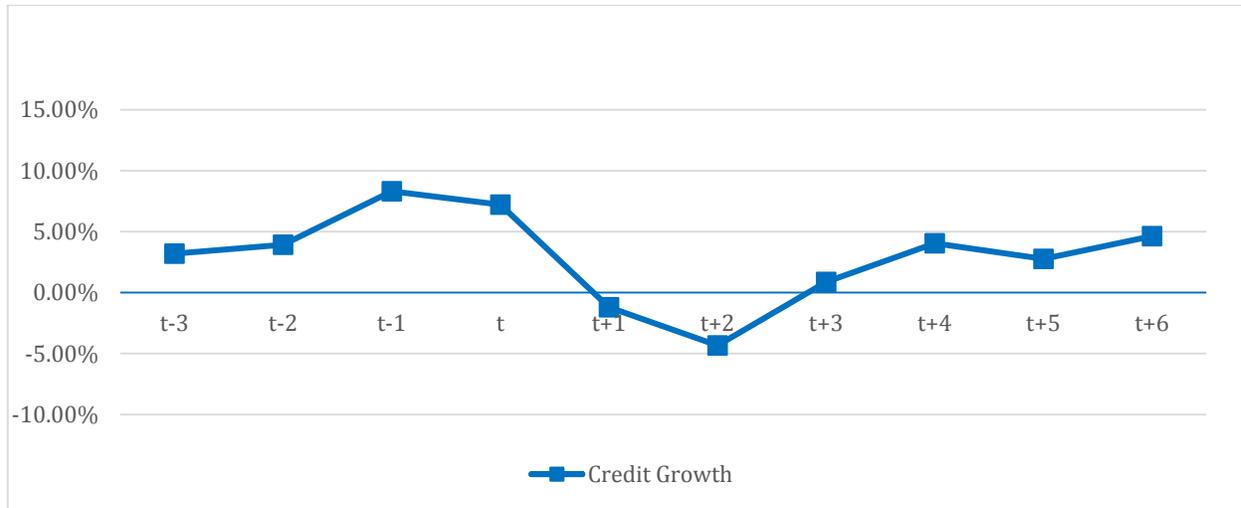
<sup>14</sup> These 55 country-year episodes occurred in 44 countries from 1980-2008. The first crisis episode in the sample is Argentina 1980. Taking the pre- and post-crisis periods defined as 4 year windows, the entire sample period for our analysis is 1977-2015.

<sup>15</sup> If Argentina 2001 is taken out of the sample, the average change in credit growth from pre- to post-crisis is 7.84 percentage points. Inclusion of Argentina 2001 could potentially bias calculations given that Argentina has had continuous banking crisis throughout the 1990s and 2001, which seems to be a clear case of lack of discipline.

<sup>16</sup> Ecuador 1982 seems to be an outlier, with a particularly strong drop in credit growth from pre- to post-crisis, which is 62.5%. Without Ecuador, the average range in pre-to post crisis credit growth is 5.9% points.

experienced a substantially *lower* average real credit growth after the banking crisis compared to tranquil times. This is illustrated in Figure 1 below.

**Figure 1. Annual real credit growth, before, during, and after a banking crisis, where  $t$  is the onset year of the banking crisis**



In Table 2 below we summarize the changes in real credit growth from pre- to post-crisis by country group<sup>17</sup>. The emerging markets group, the largest of the sample--with twenty nine of the fifty five episodes, showed the sharpest drop from pre-to post crisis periods by decreasing 9.78%. The advanced economies group, which is comprised of sixteen of the fifty five episodes, closely resembled the emerging economies average by dropping 9.14% from pre-to post crisis. Not surprisingly, the least-developed country group showed the smallest change from pre-to post crisis. In this group, which consists of ten of the fifty five episodes, credit growth only decreased 2.11% from pre-to post crisis.

**Table 2. Real credit growth from pre to post-crisis period – country group summary**

Group	Tranquil Years	Pre Crisis (t-3 to t)	Post Crisis (t+4 to t+7)	Before-After Difference
ALL	6.82%	9.68%	1.48%	-8.20%
EMG	7.27%	11.21%	1.43%	-9.78%
ADV	3.10%	7.06%	-3.07%	-9.14%
LDC	7.45%	9.44%	7.33%	-2.11%

<sup>17</sup> For complete results of the fifty five episodes, see Table A1 in the Appendix.

As a robustness check, we also compared these figures using the growth in credit/GDP as our indicator of credit growth.<sup>18</sup> To be precise, it is the annual growth in real credit/real GDP. We stress this because credit and GDP are deflated using different price indexes: real credit is deflated using Consumer Price Index, while real GDP is deflated using a GDP deflator. We also conducted a sensitivity analysis with non-bank credit. The pre-crisis average non-banking credit growth was 11.81% and the post-crisis average credit growth was 2.52%. Thus the drop in non-bank credit from pre to post-crisis periods was 9.3 percentage points, slightly higher than the corresponding the 8.20 percentage-point drop experienced by bank credit.

One argument against simply looking at real credit growth is that high credit growth by itself is not a cause of concern if credit is being used to finance a growing real economy. Therefore, we examined whether the 55 episodes summarized in Table 2 also experienced a positive growth in credit/GDP during the pre-crisis period (see Table A2 in the Appendix). The average change in the growth of credit/GDP from pre- to post- crisis was -8.12%, consistent with the results from using real credit growth. It should be noted that when using credit/GDP over the same sample of 55 cases, five crisis episodes were preceded by a negative growth in credit/GDP, even though both credit and GDP rose during this period. These are Costa Rica (1987, 1994), Egypt (1980), India (1993) and Mexico (1981).<sup>19</sup> In these five episodes, while credit and GDP both went up, the average growth in credit/GDP was negative because the increase in GDP (the denominator) was greater in magnitude than the increase in real credit (the numerator). This illustration stresses that both indicators have their own strengths and weaknesses.

We further test for the significance of the change in credit growth from pre- to post-crisis, as reported in Table 2. We conducted Kolmogorov-Smirnov tests for equality in distributions, as reported in Table 3. The null of equality of distributions is rejected at the 10% level according to a Kolmogorov-Smirnov test.

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<sup>18</sup> Another alternative to real credit growth is growth of nominal bank credit. We excluded this measure given that several of these banking crisis episodes were accompanied by hyperinflation (e.g. Brazil and Argentina), which would yield an upward-bias in nominal credit figures. Using measures such as real credit and real credit/real GDP partly deals with the banking crises that involved cases of hyperinflation.

<sup>19</sup> Meanwhile, we also have cases of negative growth in real credit but a positive growth in credit/GDP during the pre-crisis period such as Russia 1998 and Bolivia 1986.

**Table 3. Pre-and post-crisis real credit growth: equality of distribution test**

	Kolmogorov-Smirnov tests for the equality of two distributions		
	Pre-crisis average Credit Growth (t-3 to t)	Post-crisis average Real Credit Growth (t+4 to t+7)	Before-After Difference
Sub-sample (55)	9.68%	1.48%	-8.20%*

Note: \*The difference is significant at the 10% level.

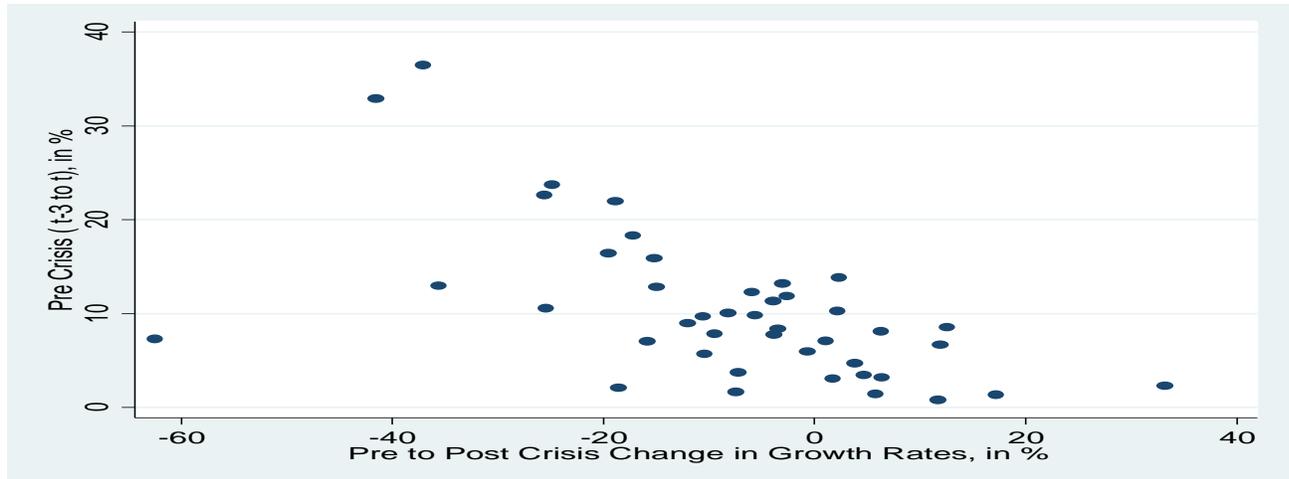
As shown in Table 3, the change in real credit growth from pre- to post-crisis period was significant for the 55 cases of banking crises that were preceded by positive pre-crisis period credit growth. Not surprisingly we found that the difference is not significant if we included the entire sample of 72 crisis episodes<sup>20</sup> that consisted of both positive and negative pre-crisis period credit growth. Not only is there less scope for decreases in credit growth for the countries that did not have pre-crisis real credit growth, but it is also more likely that authorities and bankers would see no reason to try to lower future credit growth as credit growth wouldn't appear to have been a major cause of their banking crises.

In Figure 2 below we show the relationship between the pre-crisis rates of growth (Y-axis) and the change in the growth rates before and after a banking crisis (X-axis). The plots indicate a strong negative relationship: the higher the pre-crisis credit growth, the smaller the change in growth rates after the banking crisis. This suggests the possibility that those countries with the highest pre crisis rates of credit growth have weak political, and/or institutional situations that made it difficult to make adjustments in the wake of crises. If correct, this would imply that crises fail to impose substantial discipline for the cases where it was needed most. We investigate these concerns in section 4.

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<sup>20</sup> The test of difference in distributions for the entire sample of 72 crisis episodes is not included here.

**Figure 2. Pre-crisis real credit growth and change in growth rates after the crisis**



On a final note, several countries in our sample had notably high credit growth in the onset year of the crisis, such as Malaysia 1997 (20.5% annual growth in real credit), and Chile 1981 (19.5% annual growth in real credit). This jump in annual credit growth during the onset year may have been a result of public sector intervention to rescue the banking sector. Diaz-Alejandro (1985) and Velasco (1987) have both noted that the bailout of the banking system may have contributed to acceleration in credit creation, as central banks provided subsidized lines of credit to back the financial system’s rescheduling of loans, and sectoral lines of credit under soft financial conditions. Since we only have annual data for banking crises, it is also possible that high rates of credit growth in the first part of a year were followed by crises toward the end of the year.

In summary<sup>21</sup>, the majority of the banking crises episodes we examined showed large and statistically significant reductions in credit growth from before to after crises. As suggested in the introduction, this drop can be attributed to a combination of different factors besides discipline and what we are likely capturing is the composite of all these effects. However, by excluding the periods immediately following the crises, we believe that we have abstracted from some of the most important of these other influences. Thus our calculations are likely to have captured a substantial element of pure discipline.

<sup>21</sup> While our analysis captures the behavior of bank credit immediately before and following a banking crisis, there has been an interest in investigating how these two credit growth variables behave in these non-crisis or tranquil periods, where countries are nowhere near a banking crisis. In sum, average real credit growth in the pre-crisis years is quite a bit higher compared to non-tranquil years (9.76% in non-tranquil years for real credit growth compared to 6.82%), while considerably lower during the credit-bust years (2.55% in non-tranquil years for real credit growth versus 6.82%).

#### 4. Changes in regulation and supervision

In this section, we examine the extent to which one of the possible channels of discipline, “regulatory discipline” — the strengthening of bank regulation and supervision— played a role in explaining the drop in credit growth in the post-crisis period. More effective banking supervision, such as on-site audits is a way to discipline banks and prevent excessive credit growth, as the information gained by bank supervisors enables them to more effectively impose remedial measures on imprudent banks (Delis and Staikouras 2011).

We can only obtain data on regulatory discipline up to 2010. We examined a sample of 58<sup>22</sup> crisis episodes from 1980-2003, and calculated changes in national scores of bank capital regulation and supervision (henceforth CRS) that took place during or following a banking crisis. We also included separate figures for the smaller (sub) sample of 42 banking crises with positive pre-crisis credit growth. The data was taken from the Financial Reform Dataset by Abiad et al. (2010) and was constructed based on whether a country has adopted international standards of financial supervision (i.e. Basel Standards of Effective Supervision).

Each country’s score is the sum of the following dimensions: 1) stringency of capital adequacy ratios, 2) independence of regulatory authorities from executive influence, 3) effectiveness of on-site and off-site monitoring, and 4) the universality of types of financial institutions that fall under the purview of the official supervisory agency. The index has four possible values/categories: unregulated (0), less regulated (0.33), largely regulated (0.67), and highly regulated (1).<sup>23</sup> Abiad et. al.'s coding is based on their judgments, based on various official and unofficial country policy reports, legal documents, as well as expert opinion reports.

Such data sets are of course far from perfect proxies, but they have been used in a number of studies (e.g. Ongena et al. 2013; Copelovitch and Singer 2014), and we believe are worth using. Among competing data sets<sup>24</sup> on banking regulation and supervision, this CRS index has the most extensive cross-country and time-series coverage. Another advantage is that it includes information on the effectiveness of on-site and off-site bank monitoring, items which several important studies (e.g. Jackson and Roe 2009; Quintyn and Taylor 2002) argue are excellent ways to capture supervisory effectiveness. One interpretation that has emerged is that the CRS index is a good proxy

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<sup>22</sup> This includes countries that had negative and positive credit growth before the crisis.

<sup>23</sup> Based on the authors’ original classifications, we rescaled the values to be between 0 and 1.

<sup>24</sup> To name a few: Barth et al. (2011), IMF’s Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), and a recently published data set by Jordana and Rosas (2014) on the degree of autonomy of banking regulators .

for “regulatory independence” (see e.g. Masciandaro et al. 2011). The main caveat<sup>25</sup> however, is that there is no compelling evidence that high compliance with international standards of capital stringency is always effective in reducing the likelihood of financial crises, as the 2008 global financial crisis attests (see e.g. Barth et al. 2006; Wilf 2016). Alternative and more comprehensive data sets on bank regulation and supervision do exist,<sup>26</sup> however they are only available since the late 1990s and only for particular years.

We begin our specific data analysis by reporting the proportion of countries that improved CRS after a banking crisis versus the countries that remained in a regulatory status quo. Out of the 58 country-year banking crisis episodes in our sample, 26 cases (45%) were followed by an increase in regulatory and supervisory strength within five years<sup>27</sup> after a banking crisis. The results were very similar with the sub sample of 42 banking crisis episodes. There was variation across different income groups, as shown in Table 4 below. The initial or pre-crisis values for CRS were substantially higher in advanced economies compared to emerging markets and the less developing economies group. The differences in the magnitude of post-crisis regulatory reform (CRS score change) were however, less stark. Advanced economies experienced on average a 0.40 increase in the regulatory and supervisory score (compared to an initial CRS score of 0.33), which was equivalent to over a 100% improvement in CRS. An increase in CRS of a similar magnitude was observed in emerging markets, where the average CRS score went up from 0.12 to 0.26. Meanwhile, less developing economies increased their post-crisis CRS scores from 0.09 to 0.21.

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<sup>25</sup> There are other weaknesses of this data set in our view, one among which is the numerical score for each observation has been rescaled by the authors. Originally, a highly regulated financial sector would have a final score that adds up to 6. However, in the dataset this figure is rescaled to be between 0 and 3. The problem arises when interpreting changes in CRS scores from 0 to 1 (e.g. Thailand 1995). We cannot ascertain from which dimension the change originated (capital stringency or effectiveness of on-site monitoring). Another limitation is that this data set does not capture whether there is *de facto* regulatory strengthening. Among countries that reported *de jure* compliance with Basel 1’s 8% capital requirement later on turned out to have a lot of poorly-capitalized banks (See Demirgüç—Kunt et al. 2008.)

<sup>26</sup> Barth et al. (2011) has a very wide scope (more than 100 dimensions) ranging from limitations on bank activity, entry regulations, as well as the regulatory features of deposit insurance system.

<sup>27</sup> We also conducted a Kolmogorov-Smirnov test to compare CRS scores from pre-crisis and post-crisis sample periods and found that the difference is significant (p-value=0.0001). We choose these six years as a sample period because most regulatory reforms take place from the onset year up to 5 years after the onset.

**Table 4. Changes in capital regulation and supervision (CRS) after a banking crisis, by income group**

	Group	Average Initial CRS Score	Number of countries in group	Average change in CRS score from pre to post crisis*
1	Advanced Economies	0.33	5	0.40
2	Emerging Market Economies	0.12	34	0.14
3	Less Developed Economies	0.09	19	0.12

We also investigate whether there was any relationship between a country’s initial (i.e. pre-crisis) regulatory regime and the changes that countries made from pre- to post-crisis periods? The initial level of regulatory stringency did seem to matter. Compared to countries that had some initial level of substantive regulation (a score of 0.33 or 0.67), countries that started with a score of 0 (which is considered “unregulated”), tended to have somewhat less improvement in CRS after the crisis (see Table 5). To be precise, the proportion of initially “unregulated” countries which had improved CRS scores after a crisis was 44% (18 episodes out of 40), while the proportion of countries with higher initial CRS scores which improved CRS scores after the crisis was 55% (10 episodes out of 18). However, there was little difference in average post-crisis CRS score changes for the two groups. Out of the 26 episodes which were followed by an increase in CRS, the average score change for the initial unregulated group was 0.35, while the average score change for the higher initial CRS group was 0.33.

**Table 5. Distribution of initial level CRS with changes in CRS post-crisis**

	Number of crisis episodes with average post-crisis CRS scores 0 or greater than 0		
Number of crisis episodes with initial CRS Scores of 0 or greater than 0	0 (“Unregulated”)	0.33-0.67 (“Less to largely regulated”)	Total (episodes)
0 (“Unregulated”)	22 episodes	18 episodes	40
0.33-0.67 (“less to largely regulated”)	10 episodes	8 episodes	18

Note: The numbers reported are the number of crisis episodes which fit the appropriate categories. For example, 22 out of 40 (56%) of the countries that an initial level of CRS equals to zero did not experience a change in CRS scores after a crisis.

In summary although the majority of the banking crises episodes in our sample (55% for the sample of 58 crises and 57% for the sub-sample of 42 episodes with positive pre-crisis credit growth) were not followed by a change in CRS scores, a substantial minority were. In fact, on average, post-crisis CRS scores improved by 0.16, and some countries (e.g. Sweden) went from a pre-crisis score of 0 to 0.67. Moreover, among the reformers, there was a good deal of variability in the initial pre-crisis CRS scores, and also in the speed with which they adopted regulatory reforms.

## 5. Concluding comments

The frequency of major financial crises demonstrates that there are often serious deficiencies in the provision of *ex ante* discipline over financial behavior. In this paper we investigated whether crises themselves provide some degree of *ex post* discipline. Our primary focus is on rates of credit growth, which have been found to be an important determinant of financial crises. While changes in the rate of credit growth after crises may be influenced by many factors, we believe that discipline effects are a major influence on the changes in before and after rates of credit growth that we calculate, especially as we deleted the periods immediately following crises, where the disruptive effects of the crises generally lead to sharp declines in the provision of credit. Our results show that on average rates of credit growth fell following financial crises, and that these changes were large and generally statistically significant. There was also a great deal of variability across regions and countries, however.

Discipline effects may come both from changes in government policies and from increased prudence in private sector behavior. As a start at attempting to unbundle these various effects, we investigated the impact of crises on changes in government financial supervision and regulation. There was a tendency for the levels of supervision and regulation to increase. Surprisingly however we found that the relationship between changes in regulation and changes in credit growth was positive rather than negative (See Table A3 in the Appendix). This obviously needs further investigation. At this point we do not know to what extent this result reflects imperfections in the regulatory proxy versus the failure of regulation to be effective.

Another puzzle is that while we found evidence that on average, crises were associated with lower rate of future credit growth, Aizenman and Noy (2013) found no learning behavior in terms of banking crises leading to fewer future crises. Indeed they found a positive association. These differences clearly warrant further investigation.

The substantial variability of responses in future credit growth and the degree of regulation and supervision found across both regions and levels of economic development raises the issue of what factors influence these differences. For this question a focus on political and institutional factors will be essential. IMF programs also appear to be associated with more discipline. There are a number of different measures of democracy and factors such as the rule of law are also likely to be important. Thus there is a rich research agenda on these questions. The analysis can also be extended to the possible discipline effects of other types of crises on policies such as monetary and fiscal policies.<sup>28</sup>

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<sup>28</sup> As noted previously Aizenman and Noy (2013) found that banking crises are not associated with fewer banking crises in the future. It will be important to investigate the possible reasons for this finding given that we do find substantial reductions on average in credit growth. This will involve investigating other causes of banking crises.

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## Appendix

### A1. Real credit growth from pre to post-crisis period – episodes arranged in descending order of pre-crisis credit growth

No.	Country	Region	Year of BC Onset	Pre Crisis ( t-3 to t)	Post Crisis( t+4 to t+7)	Before-After Difference
1	Chile	LAC*	1981	36.48%	-0.55%	-37.03%
2	Russian Federation	Europe & Central Asia	2008	26.40%	9.32%	-17.08%
3	Philippines	East Asia	1997	23.75%	-1.07%	-24.82%
4	Mexico	LAC	1994	22.64%	-2.89%	-25.53%
5	Bolivia	LAC	1994	21.96%	3.10%	-18.86%
6	Malaysia	East Asia	1997	18.31%	1.13%	-17.18%
7	Uruguay	LAC	1981	16.45%	-3.06%	-19.51%
8	Thailand	East Asia	1997	15.87%	0.71%	-15.16%
9	Ireland	Europe & Central Asia	2008	15.75%	-9.74%	-25.48%
10	Spain	Europe & Central Asia	2008	14.10%	-9.29%	-23.39%
11	Nepal	South Asia	1988	13.83%	16.18%	2.35%
12	Indonesia	East Asia	1997	13.20%	10.13%	-3.07%
13	Peru	LAC	1983	12.95%	-22.63%	-35.58%
14	Paraguay	LAC	1995	12.82%	-2.13%	-14.95%
15	Dominican Republic	LAC	2003	12.29%	6.34%	-5.95%
16	Hungary	Europe & Central Asia	2008	12.04%	-8.08%	-20.13%
17	Uruguay	LAC	2002	11.85%	9.26%	-2.59%
18	Korea, Rep.	East Asia	1997	11.36%	7.45%	-3.91%
19	Argentina	LAC	1980	10.56%	-14.86%	-25.42%
20	China	East Asia	1998	10.26%	12.46%	2.20%
21	Sweden	Europe & Central Asia	1991	10.07%	1.88%	-8.19%
22	Egypt, Arab Rep.	MENA*	1980	9.82%	4.19%	-5.63%
23	Burkina Faso	Sub-Saharan Africa	1990	9.70%	-0.87%	-10.57%
24	Sweden	Europe & Central Asia	2008	8.98%	3.47%	-5.51%
25	Finland	Europe & Central Asia	1991	8.96%	-3.07%	-12.03%
26	Costa Rica	LAC	1994	8.53%	21.09%	12.56%
27	Philippines	East Asia	1983	8.38%	4.92%	-3.46%
28	Uganda	Sub-Saharan Africa	1994	8.09%	14.40%	6.31%
29	Colombia	LAC	1982	7.84%	-1.57%	-9.41%
30	United States	North America	1988	7.76%	3.94%	-3.82%
31	Ecuador	LAC	1982	7.30%	-55.16%	-62.46%
32	Argentina	LAC	1989	7.11%	8.21%	1.10%
33	Argentina	LAC	1995	7.05%	-8.77%	-15.82%
34	France	Europe & Central Asia	2008	6.68%	0.20%	-6.48%
35	Thailand	East Asia	1983	6.67%	18.60%	11.93%
36	Italy	Europe & Central Asia	2008	6.63%	-2.81%	-9.44%
37	Portugal	Europe & Central Asia	2008	6.63%	-6.99%	-13.62%

38	United States	North America	2007	6.32%	1.78%	-4.54%
39	Colombia	LAC	1998	5.95%	5.29%	-0.66%
40	United Kingdom	Europe & Central Asia	2007	5.81%	-2.60%	-8.41%
41	Brazil	LAC	1994	5.69%	-4.72%	-10.41%
42	Costa Rica	LAC	1987	4.71%	8.53%	3.82%
43	Austria	Europe & Central Asia	2008	4.63%	-2.11%	-6.74%
44	Mexico	LAC	1981	3.74%	-3.47%	-7.21%
45	Netherlands	Europe & Central Asia	2008	3.60%	-0.97%	-4.57%
46	Belgium	Europe & Central Asia	2008	3.59%	2.39%	-1.19%
47	India	South Asia	1993	3.42%	8.11%	4.69%
48	Jordan	MENA	1989	3.18%	9.58%	6.40%
49	Morocco	MENA	1980	3.04%	4.81%	1.77%
50	Sri Lanka	South Asia	1989	2.31%	35.46%	33.15%
51	Japan	East Asia	1997	2.06%	-16.50%	-18.56%
52	Jamaica	LAC	1996	1.64%	-5.80%	-7.44%
53	Norway	Europe & Central Asia	1991	1.43%	7.22%	5.79%
54	Argentina	LAC	2001	1.37%	18.61%	17.24%
55	Kenya	Sub-Saharan Africa	1992	0.81%	12.49%	11.68%

\*LAC=Latin America and the Caribbean, \*\* MENA=Middle East and North Africa

## A2. Annual growth of Credit/GDP pre to post-crisis period based on the 55 episodes

No.	Country	Region	BC Onset	Pre Crisis (t-3 to t)	Post Crisis (t+4 to t+7)	Before-After Difference
1	Chile	LAC	1981	39.91%	-7.45%	-47.36%
2	Mexico	LAC	1994	23.21%	-4.96%	-28.17%
3	Bolivia	LAC	1994	22.63%	1.69%	-20.94%
4	Philippines	East Asia	1997	19.47%	-5.71%	-25.19%
5	Uruguay	LAC	2002	18.66%	1.43%	-17.23%
6	Argentina	LAC	1995	18.07%	-4.82%	-22.89%
7	Ireland	Europe & Central Asia	2008	16.24%	-9.04%	-25.29%
8	Uruguay	LAC	1981	15.76%	-8.73%	-24.50%
9	Russian Federation	Europe & Central Asia	2008	15.58%	9.79%	-5.79%
10	Peru	LAC	1983	14.30%	-15.89%	-30.19%
11	Argentina	LAC	1980	14.06%	-4.14%	-18.20%
12	Uganda	Sub-Saharan Africa	1994	12.61%	7.28%	-5.33%
13	Paraguay	LAC	1995	12.40%	-1.61%	-14.01%
14	Spain	Europe & Central Asia	2008	11.76%	-7.35%	-19.11%
15	Thailand	East Asia	1997	11.45%	-4.26%	-15.71%
16	Brazil	LAC	1994	11.23%	-6.95%	-18.18%
17	Hungary	Europe & Central Asia	2008	10.97%	-9.58%	-20.55%
18	Sweden	Europe & Central Asia	1991	9.49%	-2.42%	-11.91%
19	Finland	Europe & Central Asia	1991	9.40%	-8.76%	-18.16%

20	Malaysia	East Asia	1997	8.77%	-3.00%	-11.77%
21	Nepal	South Asia	1988	7.76%	13.27%	5.51%
22	Colombia	LAC	1998	6.45%	1.31%	-5.14%
23	China	East Asia	1998	6.28%	0.63%	-5.65%
24	Italy	Europe & Central Asia	2008	6.18%	-1.11%	-7.29%
25	Philippines	East Asia	1983	6.04%	-1.57%	-7.61%
26	United Kingdom	Europe & Central Asia	2007	6.00%	-6.01%	-12.00%
27	Sweden	Europe & Central Asia	2008	5.93%	1.60%	-4.33%
28	Portugal	Europe & Central Asia	2008	5.63%	-5.21%	-10.84%
29	Colombia	LAC	1982	5.60%	n/a	n/a
30	France	Europe & Central Asia	2008	4.89%	0.08%	-4.82%
31	Thailand	East Asia	1983	4.57%	7.01%	2.44%
32	Indonesia	East Asia	1997	4.55%	5.27%	0.71%
33	Dominican Republic	LAC	2003	4.51%	-2.42%	-6.93%
34	Kenya	Sub-Saharan Africa	1992	4.48%	-1.09%	-5.56%
35	United States	North America	1988	4.38%	1.67%	-2.71%
36	Ecuador	LAC	1982	3.82%	-13.05%	-16.87%
37	United States	North America	2007	3.59%	-1.88%	-5.47%
38	Argentina	LAC	2001	3.52%	6.55%	3.03%
39	Jordan	MENA	1989	3.36%	5.80%	2.44%
40	Korea, Rep.	East Asia	1997	3.31%	3.71%	0.40%
41	Burkina Faso	Sub-Saharan Africa	1990	3.18%	-2.68%	-5.85%
42	Austria	Europe & Central Asia	2008	2.19%	-2.20%	-4.39%
43	Jamaica	LAC	1996	1.94%	-7.46%	-9.41%
44	Belgium	Europe & Central Asia	2008	1.83%	1.08%	-0.75%
45	Argentina	LAC	1989	1.81%	11.49%	9.68%
46	Norway	Europe & Central Asia	1991	1.37%	3.13%	1.76%
47	Japan	East Asia	1997	1.20%	-5.96%	-7.16%
48	Morocco	MENA	1980	0.51%	-16.23%	-16.74%
49	Sri Lanka	South Asia	1989	0.40%	41.57%	41.17%
50	Netherlands	Europe & Central Asia	2008	0.33%	-0.02%	-0.35%
51	Egypt, Arab Rep.	MENA	1980	-0.73%	4.45%	5.19%
52	Costa Rica	LAC	1987	-0.85%	-1.94%	-1.09%
53	Costa Rica	LAC	1994	-1.94%	17.92%	19.86%
54	India	South Asia	1993	-3.55%	5.36%	8.91%
55	Mexico	LAC	1981	-5.31%	-3.58%	1.72%

**A3. Variations in changes in credit growth across countries that do and do not strengthen regulation and supervision after a crisis**

<b>Based on 58 cases</b>	<b>Average Before-After Difference in Credit Growth</b>
No CRS improvement	-1.23%
CRS improvement	0.24%

<b>Based on 42 cases</b>	<b>Average Before-After Difference in Credit Growth</b>
No CRS improvement	-8.13%
CRS improvement	-6.27%