

Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008[†]

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In the brief history of macroeconomics, the subject of money and banking has witnessed wide fluctuations in both its internal consensus and external influence. The crisis of 2008–2009 has reignited a new interest in understanding money and credit fluctuations in the macroeconomy and the crucial roles they could play in the amplification, propagation, and generation of shocks both in normal times and, even more so, in times of financial distress. This may reopen a number of fundamental fault lines in modern macroeconomic thinking—between theories that treat the financial system as irrelevant, or, at least, not central to the understanding of economic outcomes, and those that reserve a central role for financial intermediation. Economic history has an important role to play in this debate. The failures revealed by the present crisis demand that we humbly return to macroeconomic and financial history in the hope that better empirical evidence may provide safer guidance than introspection alone.

Still, for other, more pragmatic reasons, a return to the past is inevitable, because “rare events” thrust comparative economic history to the fore. If regular business cycles are roughly once-per-decade events, then we already have very few observations in the postwar data for any given country. More disruptive events like depressions and financial crises are rarer still, at least in developed economies. When sample sizes are this small, providing a detailed quantitative rendition, or even just a sketch of the basic stylized facts, requires that we work on a larger canvas, expanding our dataset across both time and space. Hence, scholars have reached back to make careful comparisons not just with past decades, but past centuries, using formal statistical analysis to examine the nature of financial crises and other rare events with new panel datasets, as in recent work by Reinhart and Rogoff (2009), Barro (2009), and Almunia et al. (2010). In the same spirit, the purpose of this paper is to step back and ask such questions about money, credit, and the macroeconomy in the

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[†]To view additional materials, visit the article page at <http://dx.doi.org/10.1257/aer.102.2.1029>.

long run. As a key part of this effort, we present a new long-run historical dataset for 14 developed countries over almost 140 years that will provide not just the empirical backbone for our research agenda but also serve as a valuable resource for future investigations by other scholars interested in this subject.

Economic thinking about the role of money and credit in the macroeconomy has changed substantially over time (Freixas and Rochet 1997, chapter 6). The experience of the late nineteenth and early twentieth centuries, including the disruptions of the 1930s, formed the foundation of the “money view,” which is indelibly associated with the seminal contributions of Friedman and Schwartz (1963).¹ In the late twentieth century the “irrelevance view” gained influence, associated with the ideas of Modigliani and Miller (1958) among others, where real economic decisions became independent of financial structure altogether. Starting in the 1980s, the “credit view” gradually attracted attention and adherents. In this view, starting with the works of Mishkin (1978), Bernanke (1983), and Gertler (1988), and drawing on ideas dating back to Fisher (1933) and Gurley and Shaw (1955), the mechanisms and quantities of bank credit matter, above and beyond the level of bank money.² Still, one strand of criticism notes that in most financial-accelerator models, credit is largely passive—a propagator of shocks, not an independent source of shocks (Borio 2008; Hume and Sentance 2009).³ By contrast, in other classes of models, multiple equilibria or feedback effects are possible (Bernanke and Gertler 1995; Kiyotaki and Moore 1997); work by Geanakoplos (2009) on leverage cycles meshes with this view.⁴

Given these disparate views, we ask: what are the facts? To our knowledge, the dynamics of money, credit, and output have not been studied across a broad sample of countries over the long run. There are, however, a few recent studies that are comparable to ours in spirit, in that they lift the veil of finance to reexamine the link between financial structure and real activity in the past or present. Adrian and Shin (2008, 2009), Mendoza and Terrones (2008), as well as Hume and Sentance (2009), have analyzed the structural changes in the financial system in recent years and the consequences for financial stability and monetary policy. Previously, Rousseau and Wachtel (1998) investigated the link between economic performance and financial intermediation between 1870 and 1929 for five industrial countries, while

¹In this account, the central bank can and must exert proper indirect control of aggregate bank liabilities, but beyond that, the actual functions of the banks, and their role in credit creation via bank loans, are of no great importance.

²The entire bank balance sheet, the asset side, leverage, and composition, may have macroeconomic implications. One consequence may be an amplification of the monetary transmission mechanism, that is, a financial accelerator effect (Bernanke and Blinder 1992). Another issue might be financial fragility induced by collateral constraints (Bernanke, Gertler, and Gilchrist 1999; hereafter, BGG). This important turn in the literature in the 1980s was guided by more inductive empirical work, where warnings about the role of credit included Eckstein and Sinai (1986) and Kaufman (1986).

³This limitation was well understood: for example, Bernanke and Gertler (1995, p. 28) stated that “[t]he credit channel is an enhancement mechanism, not a truly independent or parallel channel.” A step forward is to introduce disturbances to credit constraints in a BGG-style model (Nolan and Thoenissen 2009; Jermann and Quadrini 2009), though we still need to know precisely what drives the processes or beliefs that create such disturbances.

⁴More radical departures are possible in an older tradition; in the work of scholars such as Minsky (1977), the financial system itself is prone to generate economic instability through endogenous credit bubbles with waves of euphoria and anxiety. And indeed, economic historians such as Kindleberger (1978) have generally been sympathetic to such ideas pointing to recurrent episodes of credit-driven instability throughout financial history.

Eichengreen and Mitchener (2003), among others, have studied the credit boom preceding the Great Depression.⁵

I. Money, Credit, and Crises in the Long Run

As quantitative historians, we want to know whether the structures and dynamics of money, credit, and the macroeconomy have shifted in the long run—and how, and with what effects. The contribution of this paper is to make a start on the broader, systematic, cross-country quantitative history of money and credit, by focusing on three main questions: (i) which key stylized facts can we derive from the long-run trends in money and credit aggregates?; (ii) how have the monetary policy responses to financial crises changed over time?; and (iii) what role do credit and money play as a cause of financial crises? Our empirical analysis proceeds as follows.

We first document and discuss our newly assembled dataset on money and credit, aligned with various macroeconomic indicators, covering 14 developed countries from 1870 to 2008. We establish a number of important stylized facts about what we shall refer to as the “two eras of finance capitalism.” The first era runs from 1870 to 1939. In this era, money and credit were volatile but over the long run they maintained a roughly stable relationship to each other, and to the size of the economy measured by GDP. The only exception was the Great Depression period: in the 1930s money and credit aggregates collapsed. In this first era, the one studied by Friedman and Schwartz, the “money view” of the world looks entirely plausible.

The second financial era, starting in 1945, looks very different, however. First, money and credit began a long postwar recovery, trending up rapidly and then surpassing their pre-1940 levels compared to GDP by about 1970. That trend continued to the present and, in addition, credit itself then started to decouple from broad money and grew rapidly, via a combination of increased leverage and augmented funding via the nonmonetary liabilities of banks. With the banking sector progressively more leveraged in the second financial era, particularly in the last decade or so, the divergence between credit supply and money supply offers *prima facie* support for the credit view as against a pure money view; we have entered an age of unprecedented financial risk and leverage, a new global stylized fact that is not fully appreciated.

In a second empirical investigation we look at money, credit, and the consequences of crises. We use an event-analysis approach to study the coevolution of money and credit aggregates and real economic activity in the five-year window following a financial crisis. We also pursue this analysis in two periods, 1870–1939 and 1945–2008. This approach is motivated by our identification of two distinct eras of finance, as above; it also reflects the very different monetary and regulatory framework after World War II (WW2); namely, the shift away from gold to fiat money, the greater role of activist macroeconomic policies, the greater emphasis on bank supervision and deposit insurance, and the expanded role of the Lender of Last Resort. Our results show dramatically different crisis dynamics in the two eras,

⁵ A great number of postwar studies have focussed on the role of financial structure in comparative development and long-run economic growth, a question that is related but distinct from our analysis (Goldsmith 1969; Shaw 1973; McKinnon 1973; Jung 1986; King and Levine 1993).

or “now” versus “then.” In postwar crises, central banks have strongly supported money base growth, and crises have not been accompanied by a collapse of broad money, although credit does still contract. On the real side, a striking result is that the economic impact of financial crises is no more muted in the postwar era than in the prewar era. Given the much larger financial systems we have today (the first stylized fact above), however, the real effects of the postwar regime could take the form of preventing potentially *even larger* real output losses that could be realized in today’s more heavily financialized economies without such policies. With regard to prices, inflation has tended to rise after crises in the post-WW2 era, with economies avoiding the strong Fisherian debt-deflation mechanism that tended to operate in pre-WW2 crises, and this could be another factor preventing larger output losses. The bottom line is that the lessons of the Great Depression, once learned, were put into practice. After 1945, financial crises were fought with more aggressive monetary policy responses, banking systems imploded neither so frequently nor as dramatically, and deflation was avoided—although crises still had real costs. In tandem with our previous findings, however, it is natural to ask to what extent the implicit and explicit insurance of financial systems by governments encouraged the massive expansion of leverage that emerged after the war.

In a final empirical exercise, we ask what we can learn about the fragility of financial systems using our credit data. Specifically, we test one element of the credit view argument—associated with Minsky, Kindleberger, and others—that financial crises can be seen as “credit booms gone wrong.” This approach also echoes Joseph Schumpeter’s diagnosis that “reckless lending” and financial speculation are closely linked to credit creation as the “monetary complement of innovation” over the business cycle (Schumpeter 1939). We follow the early-warning approach and construct a typical macroeconomic lagged information set at any date T for all countries in our sample. Lagged credit growth turns out to be highly significant as a predictor of financial crises, but the addition of other variables adds very little explanatory power. Introducing interaction terms, we also find some support for the notion that financial stability risks increase with the size of the financial sector and that boom-and-bust episodes in stock markets become more problematic in more financialized economies.

These new results from long-run data inform current controversies over macroeconomic policy in developed countries. Specifically, the pre-2008 consensus argued that monetary policy should follow a “rule” based only on output gaps and inflation, but a few dissenters thought that credit deserved to be watched carefully and incorporated into a broader central bank policy framework. The influence of the credit view has certainly advanced after the 2008–09 crash, just as respect has waned for the glib assertion that central banks could ignore potential bubbles and easily clean up after they burst.

II. The Data

To study the long-run dynamics of money, credit, and output we assembled a new annual dataset covering 14 countries over the years 1870–2008. The countries covered are the United States, Canada, Australia, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. At the core of our dataset are yearly data for aggregate bank loans and

total balance sheet size of the banking sector. We complemented these credit series with narrow (M0 or M1) and broad (typically M2 or M3) monetary aggregates as well as data on nominal and real output, inflation, and investment. To investigate the potential inter-relationship between crises, credit, and asset prices, we have also collected long-run stock market indices from a number of (partly new) sources as discussed in a later section below.

The two core definitions we work with are as follows. Total lending, or *bank loans*, is defined as the end-of-year amount of outstanding domestic currency lending by domestic banks to domestic households and nonfinancial corporations (excluding lending within the financial system). Banks are defined broadly as monetary financial institutions and include savings banks, postal banks, credit unions, mortgage associations, and building societies whenever the data are available. We excluded brokerage houses, finance companies, insurance firms, and other financial institutions. Total *bank assets* is then defined as the year-end sum of all balance sheet assets of banks with national residency (excluding foreign currency assets).

It is important to point out that the definitions of credit, money, and banking institutions vary profoundly across countries, which makes cross-country comparisons difficult. In addition, in some cases, such as the Netherlands or Spain, historical data cover only commercial banks, not savings banks or credit cooperatives. In this paper, we therefore focus predominantly on the time-series dimension of the data and for the most part avoid outright comparisons in levels (e.g., we employ country fixed effects). The definitions of money and credit aggregates, however, have also changed within countries over time in response to institutional or financial innovation. Building a consistent and comparable dataset was therefore no easy task and we often had to combine data from various sources to arrive at reasonably consistent long-run time series.⁶ Further details on our dataset can be found in the online Appendix, but Table 1 summarizes the key variables at our disposal.

Several features of the data are already apparent in Table 1. In the upper panel, the major ratios of assets and loans to money and GDP both climbed after the war, but the averages disguise some important trends. The trend breaks are more apparent as we study the growth rates in the lower panel, where it is clear that annual growth rates of broad money (3.65 percent), loans (4.16 percent), and assets (4.33 percent) were fairly similar in the pre-WW2 period; in contrast, after WW2 average broad money growth (8.57 percent) was much smaller than loan growth (10.94 percent) and asset growth (10.48 percent). The loan-money ratios grew at just 0.17 percent per year before WW2 but 2.22 percent per year after, a 20-fold increase in the growth rate of this key leverage measure. Similarly, asset-money growth rates jumped from 0.43 percent to 1.82 percent per year, a quadrupling. Thus, even at the level of simple summary statistics

⁶Our key sources were official statistical publications such as the US Federal Reserve's *All Bank Statistics* or the Bundesbank's *Geld- und Kreditwesenstatistik*. We also draw on the work of individual economic historians such as David Sheppard's statistics for the British financial system or Malcolm Urquhart's work on Canadian financial statistics. And we are indebted to our many colleagues who provided advice and assistance to us in all these tasks. We wish to acknowledge the support we received from Joost Jonker and Corry van Renselaar (Netherlands); Gianni Toniolo and Claire Giordano (Italy); Kevin O'Rourke (Denmark); Eric Monnet and Pierre-Cyrille Hautcoeur (France); Carl-Ludwig Holtfrerich (Germany); Rodney Edvinsson (Sweden); Youssef Cassis (Switzerland); Pablo Martin Aceña (Spain); Ryland Thomas (Britain). In addition, we would like to thank Michael Bordo and Solomos Solomou for sharing monetary and real data from their data collections with us. Kris Mitchener directed us to the sources for Japan; Magdalena Korb and Nikolai Baumeister helped with translation.

TABLE 1—ANNUAL SUMMARY STATISTICS BY PERIOD

| | Pre-World War II | | | Post-World War II | | |
|----------------------------|------------------|---------|--------|-------------------|--------|--------|
| | <i>N</i> | Mean | SD | <i>N</i> | Mean | SD |
| Loans/money | 665 | 0.4217 | 0.3582 | 831 | 0.5470 | 0.4239 |
| Assets/money | 617 | 0.7132 | 0.4453 | 828 | 1.0135 | 0.6688 |
| Broad money/GDP | 742 | 0.5343 | 0.2070 | 834 | 0.6458 | 0.2405 |
| Loans/money | 642 | 0.7581 | 0.4382 | 833 | 0.8380 | 0.4942 |
| Assets/money | 586 | 1.2790 | 0.5642 | 831 | 1.5758 | 0.7525 |
| $\Delta \log$ Real GDP | 868 | 0.0148 | 0.0448 | 854 | 0.0270 | 0.0253 |
| $\Delta \log$ CPI | 826 | -0.0002 | 0.0568 | 852 | 0.0452 | 0.0396 |
| $\Delta \log$ Narrow money | 787 | 0.0278 | 0.0789 | 825 | 0.0780 | 0.0717 |
| $\Delta \log$ Money | 741 | 0.0365 | 0.0569 | 833 | 0.0857 | 0.0552 |
| $\Delta \log$ Loans | 652 | 0.0416 | 0.0898 | 833 | 0.1094 | 0.0749 |
| $\Delta \log$ Assets | 607 | 0.0433 | 0.0691 | 825 | 0.1048 | 0.0678 |
| $\Delta \log$ Loans/money | 626 | 0.0017 | 0.0729 | 825 | 0.0222 | 0.0643 |
| $\Delta \log$ Assets/money | 573 | 0.0043 | 0.0452 | 820 | 0.0182 | 0.0595 |

Notes: Money denotes broad money. Loans denote total bank loans. Assets denote total bank assets. The sample runs from 1870 to 2008. War and aftermath periods are excluded (1914–1919 and 1939–1947), as is the post-WWI German crisis (1920–1925). The 14 countries in the sample are the United States, Canada, Australia, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

we can grasp that the behavior of money and credit aggregates changed markedly in the middle of the twentieth century. A more detailed analysis of these and other data, however, brings the differences between the two eras into sharper relief.

III. Money and Credit in Two Eras of Finance Capitalism

In a first step, we analyze the new dataset with an eye toward deriving a number of stylized facts about credit and monetary aggregates from the gold standard era until today.

The first important fact that emerges from the data is the presence of two distinct “eras of finance capitalism” as shown in Figures 1 and 2. Figure 1 displays the trend in credit and money aggregates relative to GDP, while Figure 2 displays the long-run trends in the credit-to-money ratios, where in each case we show the average trend for the 14 countries in our dataset. To construct these average global trends, both here and in some other figures that follow, we show the mean of the predicted time effects from fixed country-and-year effects regressions for the dependent variable of interest. That is, for any variable x_{it} we estimate the fixed effects regression $x_{it} = a_i + b_t + e_{it}$ and then plot the estimated year effects b_t to show the average global level of x in year t .

From these figures we see that the first financial era lasted from 1870 to WW2. In this era, money and credit were volatile but over the long run they maintained a roughly stable relationship to each other and relative to the size of the economy as measured by GDP. Money and credit grew just a little faster than GDP in the first few decades of the classical gold standard era from 1870 to about 1890, but then remained more or less stable relative to GDP until the credit boom of the 1920s and the Great Depression. In the 1930s, both money and credit aggregates collapsed. Figure 2 shows that the relationship between the loan or asset measures and broad money remained almost perfectly stable throughout the first era up to WW2, save

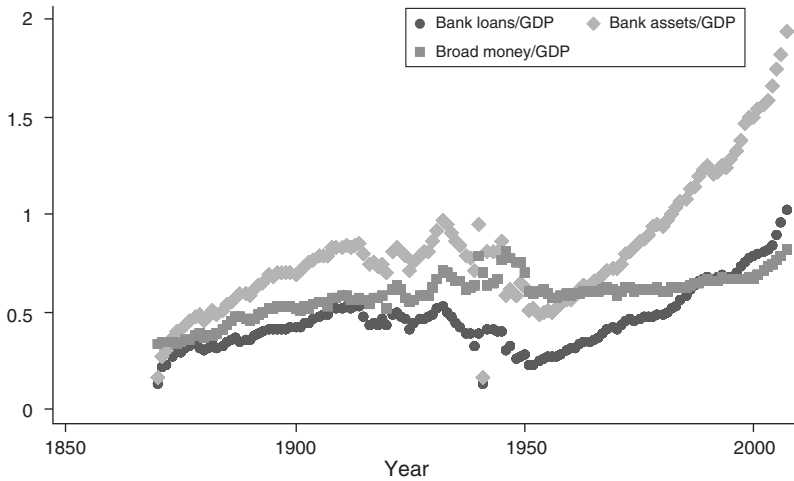


FIGURE 1. AGGREGATES RELATIVE TO GDP (*Year Effects*)

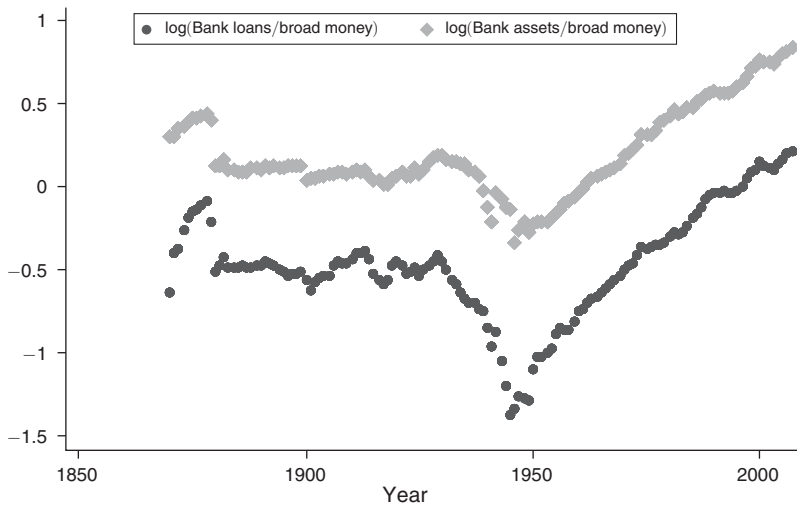


FIGURE 2. AGGREGATES RELATIVE TO BROAD MONEY (*Year Effects*)

for the 1930s global credit crunch. In that epoch, money growth and credit growth were essentially two sides of the same coin. The same was not true in the second era after WW2, when loans and assets both embarked on a long, strong secular uptrend relative to broad money, and here both graphs reveal profound structural shifts in the relationship between credit, money, and output.

Thus, during the first era of finance capitalism, up to 1939, the era studied by canonical monetarists like Friedman and Schwartz, the “money view” of the world looks entirely reasonable. Banks’ liabilities were first and foremost monetary, and exhibited a fairly stable relationship to total credit. In that environment, by steering aggregate liabilities of the banking sector, the central bank could hope to exert a smooth and steady influence over aggregate lending.

The relationships changed dramatically in the post-1945 period. First, credit began a long recovery after the dual shocks to the financial sector from the Great Depression and the war. Loans and bank assets took off on a very rapid upward trend in the Bretton Woods era, as seen in Figure 1, and they managed to surpass their pre-1940 ratios, compared to GDP, by about 1970. Second, credit not only grew strongly relative to GDP, but also relative to broad money after WW2, via a combination of higher leverage and (after the 1970s) through the use of new sources of funding, mainly debt securities, creating more and more nonmonetary bank liabilities.⁷ Again, the pre-WW2 ratios of credit and assets to money were surpassed circa 1970, as seen in Figure 2. Loan-money and asset-money ratios, shown here in logs, continued ever higher, attaining levels +0.750 log points higher than their prewar average by around 2000 (i.e., about $\times 2$ in levels).

We also note that this increase in the credit-to-money ratio does not apply only to a few individual countries, e.g., the usual Anglo-Saxon suspects, but has been a common phenomenon in many countries. Figure 3 shows the log loan-money and log asset-money ratios for all countries at decadal dates. Country experiences varied somewhat before WW2, but in a way consistent with accepted historical narratives. For example, the countries of the late nineteenth century periphery in our sample—Italy and Spain—saw rapid financial catch-up relative to the core in the 1870–1939 period, and this explains their rapid leverage growth in the pre-WW2 period, when most other countries exhibit a flat trend. But after WW2, for all countries in the sample, the experience is strikingly similar—a trend increase in both ratios from the 1950s to the present. These new insights expose a *global* story of decades of slowly encroaching risk on bank balance sheets, not one confined to a few profligate nations.

To sum up, the ratio of credit to money remained broadly stable between 1870 and 1930. The Great Depression then saw a marked deleveraging of the banking system. In the postwar period, banks first grew their loan books relative to available deposits, before sustaining high credit growth through increasing reliance on nonmonetary liabilities. The dynamics are basically comparable between the European countries in the sample and the United States, but the pace of the balance sheet growth has been even higher in Europe than in the United States, as, in the latter, nonbank financial intermediaries like broker dealers have played a large role and exhibited even stronger balance sheet expansion than the commercial banks (Adrian and Shin 2008).

What does this structural change mean for the questions about money, credit, and output raised before? First, in the latest phase, in which banks fund loan growth through nonmonetary liabilities, the traditional monetarist view could potentially become more problematic. While central banks might still be able to steer aggregate credit through the monetary aggregates, it is also possible that the link between money and credit becomes looser than in a situation where banks' liabilities are predominantly or even exclusively monetary. This is exactly what many of the world's central banks found out in the 1980s, as Friedman and Kuttner (1992) have documented.

Second, if we look at the ratio of bank credit to nonmonetary liabilities on banks' balance sheets, it is easy to see how funding structures have changed in a historically

⁷It is even likely that our numbers underestimate the process of credit creation in the past decades as a growing portion of lending, at least in some countries, was securitized and is no longer carried on banks' balance sheets.

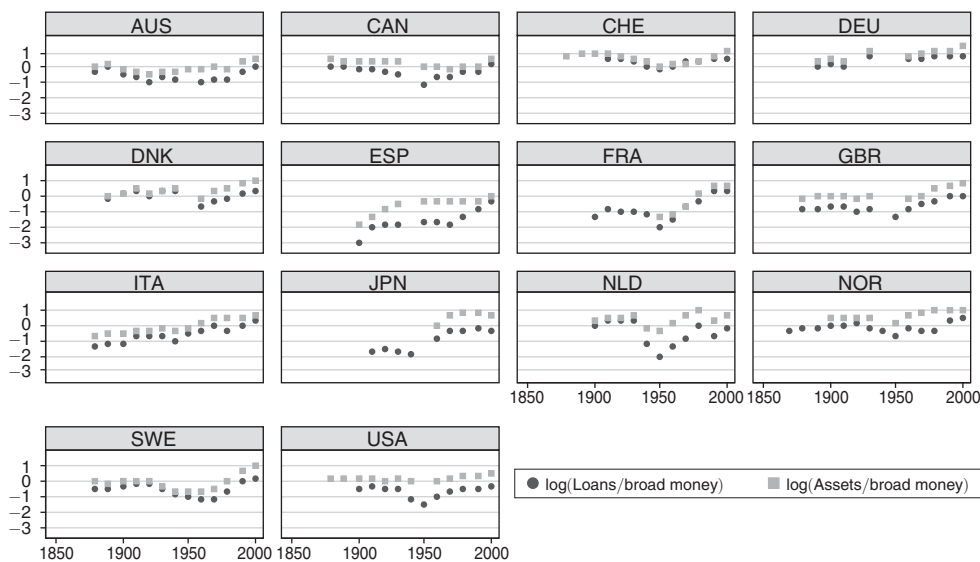


FIGURE 3. AGGREGATES RELATIVE TO BROAD MONEY (By Country)

unprecedented way. Banks' access to nonmonetary sources of finance has become an important factor for aggregate credit provision. Thus, what happens in financial markets—borrowing conditions, liquidity, market confidence—starts to matter more than ever for credit creation and financial stability, possibly amplifying the cyclicity of financing in a major way (Adrian and Shin 2008). While these links still need to be explored in greater detail, the consequences for macroeconomic stability could be powerful, since the conventional transmission mechanisms can now be buffeted by large financial shocks. Last but not least, the increasing dependence of the banking system on access to funding from financial markets could also mean that central banks are forced to underwrite the entire funding market in times of distress in order to avoid the collapse of the banking system, as witnessed in 2008–09. This “mission creep” follows from the fact that banking stability can no longer rest on the foundations of deposit insurance alone, with the Lender of Last Resort now having to confront wholesale (i.e., nondeposit) bank runs.

This hitherto-unknown historical backdrop buttresses arguments that without stronger forms of capital and/or liquidity requirements, banking systems will be prone to skate on the thinnest of ice (Kashyap et al. 2008; Farhi and Tirole 2009). Indeed, these developments correlate with the frequency of financial crises. The frequency of crises in the 1945–71 period was virtually zero, when liquidity hoards were ample and leverage was low; but since 1971, as these hoards evaporated and banks levered up, crises became more frequent, occurring with a four percent annual probability.⁸

⁸Data on the frequency of financial crises are taken from Bordo et al. (2001, Figure 1, banking crises).

IV. Money, Credit, and Output after Financial Crises: An Event Analysis

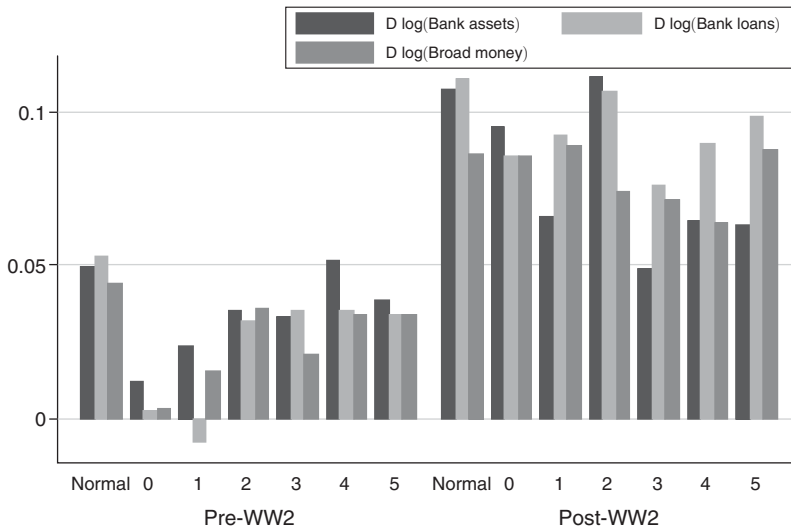
In this section we look at financial crises in more depth. We are able to demonstrate the existence of dramatically different crisis dynamics in the two eras of finance capitalism, or now versus then. We exploit our long-run dataset with an eye toward improving our understanding of the behavior of money and credit aggregates as well as the responses of the real economy and prices in financial crisis windows before and after WW2. We were concerned that our results might be strongly influenced by the Great Depression, so we also reran our analysis excluding data for the 1930s Depression window, but we obtained similar results as documented below. We find substantially different dynamics in the pre- and post-WW2 periods that we think reflect different monetary and regulatory frameworks: the shift away from gold to fiat money, the greater role of activist macroeconomic policies, and greater emphasis on bank supervision and deposit insurance.

For our event-analysis we adopt an annual coding of financial crisis episodes based on documentary descriptions in Bordo et al. (2001) and Reinhart and Rogoff (2009), two widely used historical datasets that we compared and merged for a consistent definition of event windows (a table showing the crisis events can be found in the online Appendix). In line with the previous studies, we define financial crises as events during which a country's banking sector experiences bank runs, sharp increases in default rates accompanied by large losses of capital that result in public intervention, bankruptcy, or forced merger of financial institutions. We have corroborated the crisis histories from Bordo et al. (2001) and Reinhart and Rogoff (2009) with alternative codings found in the databases compiled by Laeven and Valencia (2008), as well the evidence described in Cecchetti, Kohler, and Upper (2009). In a last step, we have sent the crisis dates to colleagues who are country specialists and asked them to confirm the dates that we have listed. A table showing the crisis events by country-year can be found in the online Appendix. In total, we identify 79 major banking crises in the 14 countries we study. We are hopeful that the crisis dates will prove useful in future research.⁹

Figure 4 opens the discussion with a look at the behavior of money and credit in the aftermath of financial crises. We see that there are clear differences between the two eras of finance capitalism. Before WW2, credit and money growth dipped significantly below normal levels after crisis events and did not recover to precrisis growth rates until fully five years after the crisis. In contrast, after WW2 a dip in the growth rate of the monetary and credit aggregates is hardly discernible in the aftermath of a crisis.¹⁰ We infer that in the later period, central banks have supported

⁹We wish to thank, without implicating, Daniel Waldenstroem (Stockholm), Pierre-Cyrille Hautcoeur and Angelo Riva (Paris), Jan Klovland (Oslo), Carl-Ludwig Holtfrerich (Berlin), Reinhard Spree (Munich), Margrit Grabas (Saarbrücken), Charles Tilly (Munster), Mari Oonuki (Tokyo), Tobias Straumann (Zurich), Joost Jonker (Utrecht), Michael Bordo (Rutgers), Pablo Martín-Aceña (Alcala). We asked these scholars whether they agreed that systemic banking crises took place in the given years and if any events were missing. In a few cases the question was not whether a significant crisis had occurred, but whether it should be called systemic. In such cases, we used some discretion to ensure comparability between countries. We generally coded crises if a significant part of the banking system was affected as measured by the number or the size of affected institutions.

¹⁰It is sometimes claimed that negative credit growth would be a signal of a credit crisis (e.g., Chari, Christiano, and Kehoe 2008). In our data, before WW2 crises were associated with slightly negative average loan growth in the year after the crisis began. This result is driven, however, by the Great Depression. In general it is the second derivative of loan growth that changes sign during a crisis, not the first. See Biggs, Mayer, and Pick (2009) for an explanation and related evidence.

FIGURE 4. AGGREGATES (*Postcrisis Periods Relative to Normal*)

growth of the monetary base, prevented collapse of broad money, and thus kept bank lending at comparatively high levels. Only total bank assets now behave in a meaningfully different way after financial crises, as we will discuss in further detail below.

Turning to real economic effects, shown in Figure 5, it becomes clear that the impact of financial crises was more muted in the postwar era in absolute numbers, but of comparable magnitude relative to trend. As mentioned before, this result holds up even when the Great Depression is excluded from the prewar event analysis. Measured by output declines, financial crises remain severe in the post-1945 period. The maximum decline in real investment activity was somewhat more pronounced before WW2, albeit with a sharp bounce back after four to five years.

Turning to Figure 6, we see that it is with regard to price developments that a major difference between the two eras appears, which is again not driven by the Great Depression. Financial crises in the prewar era were associated with pronounced deflation (for three years), and a stagnation of narrow and broad money growth. Financial crises in the postwar era were, if anything, accompanied by some upwards pressure on inflation relative to normal, potentially due to the much more active monetary policy response, as shown by the expansion of narrow money. Our data suggest that through more activist policies the strong Fisherian debt-deflation mechanism that typically operated in prewar crises was avoided in the postwar period. The internal reallocation of real debt burdens was therefore likely to have been dramatically different in the two periods.

The bottom line of our event analysis is the following. Policymakers learned lessons from the Great Depression. After this watershed, financial crises were fought with a more aggressive monetary policy response and quick support for the financial sector. Also, institutional responses to the Great Depression, such as deposit insurance, are likely to have contributed to greater stability of the monetary aggregates in postwar crises. As a consequence, irregular deleveraging of the financial sector was avoided and aggregate asset and loan growth remained relatively high.

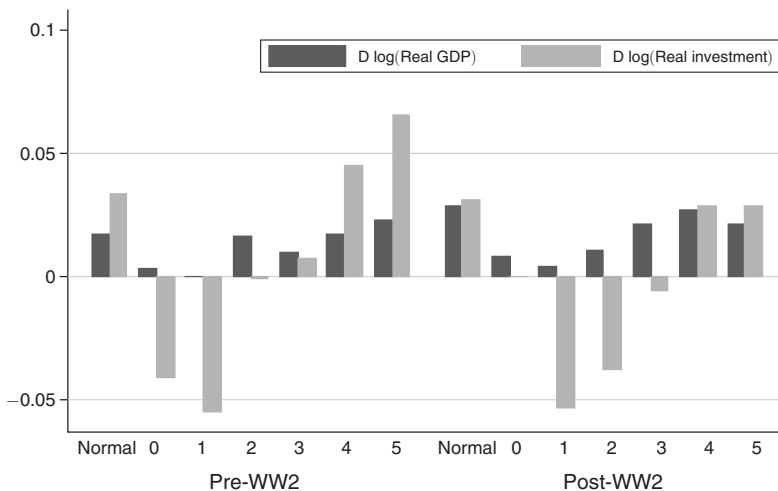


FIGURE 5. REAL VARIABLES (Postcrisis Periods Relative to Normal)

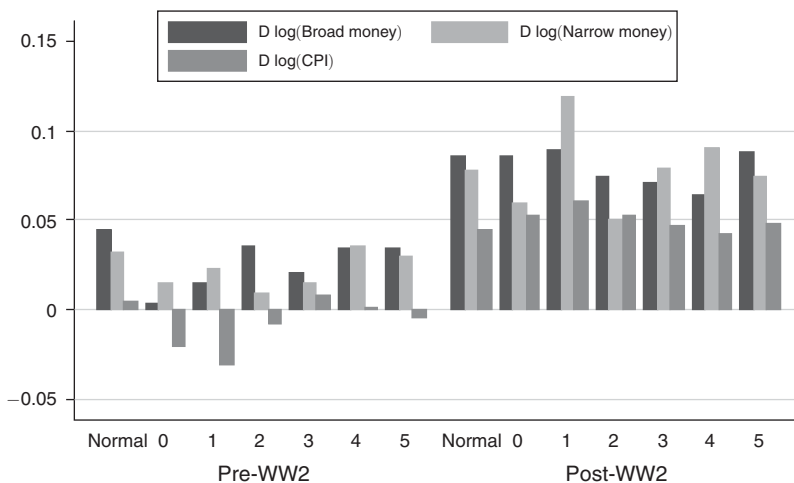


FIGURE 6. MONEY AND INFLATION (Postcrisis Periods Relative to Normal)

Table 2 summarizes the key lessons of our event study by showing the cumulative level effects (relative to trend growth in noncrisis years five years after the event) of financial crises in the two eras of finance capitalism. What stand out clearly are positive inflation, higher narrow-money growth, and a smaller deleveraging (on the loan side) that have taken place in crisis episodes in the second half of the twentieth century (compare columns 1 and 3). Recalling the important proviso that all deviations are measured relative to the noncrisis trend, we see that before WW2, 5 years after a crisis year the level of broad money was 14 percent below trend, and bank loans 25 percent below trend. In the postwar period, however, narrow money growth did not slow down relative to trend, and the declines were a mere 8 percent (not statistically significant) for broad money and 14 percent for bank loans.

TABLE 2—CUMULATIVE EFFECTS AFTER FINANCIAL CRISES

| Cumulative log level effect, after years 0–5 of crisis, versus noncrisis trend, for: | Pre-World War II | Pre-World War II, excluding 1930s | Post-World War II |
|--|----------------------|-----------------------------------|----------------------|
| Log broad money | −0.139*** (0.027) | −0.103*** (0.029) | −0.077* (0.040) |
| Log narrow money | −0.083** (0.037) | −0.098*** (0.036) | 0.009 (0.053) |
| Log bank loans | −0.248*** (0.044) | −0.220*** (0.047) | −0.144*** (0.055) |
| Log bank assets | −0.156*** (0.035) | −0.144*** (0.038) | −0.258*** (0.050) |
| Log real GDP | −0.041** (0.020) | −0.018 (0.020) | −0.079*** (0.018) |
| Log real investment | −0.190** (0.091) | −0.115 (0.089) | −0.257*** (0.049) |
| Log price level | −0.089*** (0.025) | −0.055*** (0.026) | 0.007 (0.029) |

Note: Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Of course, a key institutional difference between the pre- and postwar environments is the introduction of deposit insurance in many countries in response to the banking panics during the Great Depression. The effects are visible in our long-run data, which show the greater stability of narrow and broad monetary aggregates in financial crises in the postwar era. By contrast, total bank assets, which rely on uninsured sources of funding to a greater extent, have actually become *more* volatile in the postwar era. Turning next to the effect on the securities side of banks' balance sheets, the signs of a changing response to crises are even stronger, with bank assets falling 26 percent below trend in the postwar period, versus 16 percent prewar. This confirms the modern findings by Adrian and Shin (2008), who show that the behavior of nonloan items on the balance sheets of financial institutions is particularly procyclical.

Turning to real effects, it is interesting to observe that despite the much more aggressive policy response, the cumulative real effects have been even somewhat stronger in the postwar period. In the aftermath of postwar financial crises, output dropped a cumulative 7.9 percent relative to trend, and real investment by more than 25 percent. The prewar output decline effect, however, is largely an artifact of the massive financial implosions of the 1930s. Excluding the 1930s (see column 2), the cumulative real output and investment declines after crises were substantially smaller and not statistically significant. The finding of limited losses prior to the 1930s would be consistent with the idea that in the earlier decades of our sample the financial sectors played a less central role in the economy and financial crises were hence less costly. It is also consistent with the view that economies suffered less from nominal rigidity, especially before 1913, as compared to the 1930s, and hence were better able to adjust to nominal shocks like crisis-induced debt deflation (Chernyshoff, Jacks, and Taylor 2009).

The finding that the real effects of financial crises have not been less pronounced despite stronger policy responses and institutional safeguards such as deposit insurance is surprising. It meshes, however, with research on historical business cycles that has shown that recessions after WW2 have become less frequent, but not less severe (Romer 1999), a result that is most clearly true when the Great Depression is treated as a special case. These findings are mirrored in our data. Moreover, since we focus on postcrisis dynamics, our data do not yet reflect the real effects of the Great Recession of 2008–2009 because events are still unfolding and this datapoint is not in our sample. But given the severity of the recent recession, this would certainly strengthen our overall result that the real effects of financial crises have not become less severe.

But this result begs a new question: why are output losses so large today despite more activist policies and the presence of deposit insurance? Some other forces might be at work here. Governments have made more efforts since the 1930s to prevent negative feedback loops in the economy and have sought to cushion the real and nominal impact of financial crises through policy activism. But at the same time, the financial sector has grown and increased leverage, expanding the size of the threat even as the policy defenses have been strengthened. As a result, the shocks hitting the financial sector might now have a potentially larger impact on the real economy, absent the policy response. Still, a complete diagnosis has to recognize the potential reverse causality, too: it is an open question to what extent implicit government insurance and the prospect of rescue operations have in turn contributed to the spectacular growth of finance and leverage within the system, creating more of the very hazards they were intended to solve.

V. Credit Booms and Financial Crises

In the previous sections we have documented the rise of credit and discussed how activist monetary policy responses to crises could have been a factor behind the uninterrupted growth of leverage in the postwar financial system. We now look at the sources of recurrent financial instability in modern economies. More specifically, we want to know whether the financial system itself creates economic instability through endogenous lending booms. In other words, are financial crises “credit booms gone wrong?”

By looking at the role of the credit system as a potential source of financial instability—and not merely as an amplifier of shocks, as the financial accelerator theory has it—we implicitly also ask a different question about the importance of credit in the conduct of monetary policy. The precrisis New Keynesian consensus held that money and credit have essentially no constructive role to play in monetary policy. Hence, central bankers were to set interest rates in response to inflation and the output gap, with no meaningful additional information coming from credit or monetary aggregates. Yet even before the crisis of 2008–2009, this view did not go unchallenged. A number of dissenters argued that money and credit aggregates provided valuable information for policymakers aiming for financial and economic stability.¹¹

¹¹ Some argued that excessive credit created “imbalances” and a risk of financial instability (e.g., Borio and Lowe 2002, 2003; Borio and White 2003; White 2006; Goodhart 2007). Recent theories show how a credit signal

On this point, one could also detect echoes of other recent research pointing to a tentative relationship between credit booms and financial fragility in studies of emerging market crises.¹²

The idea that financial crises are credit booms gone wrong is not new. The story underlies the oft-cited works of Minsky (1977) and Kindleberger (1978), and it has been put forward as a factor in the current cycle (Hume and Sentance 2009; Reinhart and Rogoff 2009), as well as in the Great Depression (Eichengreen and Mitchener 2003). Yet statistical evidence is still relatively scant. A number of previous studies has established that systemic financial crises tend to be preceded by rapid expansions of credit (McKinnon and Pill 1997; Kaminsky and Reinhart 1999; Gourinchas, Valdes, and Landerretche 2001). This explanation appears as a somewhat robust element in descriptions of *emerging-market* crises; but evidence that the same problem afflicts advanced countries has not yet attained a consensus position, partly due to the small sample sizes provided by recent history, an inconclusive situation that we can hope to rectify.

Our contribution to this literature is twofold. First, our sample consist of long-run data for 14 developed economies, in contrast to the focus of much of the recent literature on the experience of developing countries, where financial crises are often linked to currency instability or sovereign debt problems. A pure developed-country sample is also arguably less affected by the institutional weaknesses and credibility questions that emerging markets tend to face. Second, our focus is clearly on the long run. Our cross-country dataset spans 140 years of economic history. Moving beyond explorations of selected events and the experience of the past 30 or 40 years, our interest is in whether there is systematic evidence for credit growth-induced financial instability in history. If we can find such a link, then the argument for the credit boom-and-bust story will be strengthened. In this respect, our work follows in the footsteps of recent long-run comparative work by Reinhart and Rogoff (2009) and others. A key innovation here, however, is that our new dataset enables us to work with detailed financial and other macroeconomic data on an annual basis, including data (e.g., bank loans and assets) that have never been collected or explored in previous research. As a consequence, we can study the determinants and temporal dynamics of financial crises in considerably greater detail than before. In this respect, our work is more closely related to the analyses of lending booms focusing on recent decades (e.g., Gourinchas, Valdes, and Landerretche 2001).

To test for this link, we propose to use a basic forecasting framework to ask a simple question: does a country's recent history of credit growth help predict a financial crisis, and is this robust to different specifications, samples, and control variables? Formally, we use our long-run annual data for 12 countries, and estimate a probabilistic model of a financial crisis event in country i , in year t , as a function of a lagged information at year t , in one of two forms,

might dampen suboptimal business-cycle volatility (Christiano, Motto, and Rostagno 2007).

¹²On the whole, the early-warning literature on banking crises focuses mainly on (i) emerging markets and (ii) factors other than lending booms (for a survey see Eichengreen and Arteta 2002, Table 3.1). Exceptions, which use data from recent decades only, include Demirgüç-Kunt and Detragiache (1998); Kaminsky and Reinhart (1999); Gourinchas, Valdes, and Landerretche (2001). Particularly relevant works are those by Borio and Lowe (2002, 2003), who like us focus on cumulative effects and place a high weight on the lagged credit growth signal.

$$\text{OLS Linear Probability: } p_{it} = b_{0i} + b_1(L)D \log CREDIT_{it} + b_2(L)\mathbf{X}_{it} + e_{it},$$

$$\text{Logit: } \text{logit}(p_{it}) = b_{0i} + b_1(L)D \log CREDIT_{it} + b_2(L)\mathbf{X}_{it} + e_{it},$$

where $\text{logit}(p) = \ln(p/(1 - p))$ is the log of the odds ratio and L is the lag operator. The $CREDIT$ variable will usually be defined as our total bank loans variable deflated by the CPI. The lag polynomial $b_1(L)$, which contains only lag orders greater than or equal to one, will be the main object of study and the goal will be to investigate whether the lags of credit growth are informative. The lag polynomial $b_2(L)$ will, if present, allow us to control for other possible causal factors in the form of additional variables in the vector \mathbf{X} . The error term e_{it} is assumed to be well behaved.

We first present some simple variants of these models in Table 3. These results take the form of an estimate of the above equations with no additional controls, so that the term \mathbf{X} is omitted. In this long and narrow panel there are 1,272 observations over 14 countries, with an average of about 91 observations per country. The dependent variable is a dummy equal to one when there is a financial crisis according to our definitions, and otherwise zero. Our crisis definitions are the same as detailed above.

To keep the lag structure reasonable, we consider up to five annual lags of any regressor.¹³ Model specification 1 presents an OLS Linear Probability model with simple pooled data. Model specification 2 adds country fixed effects to the OLS model, but these are not statistically significant ($p = 0.75$). Keeping country effects, model specification 3 then adds year effects to OLS, and these are highly statistically significant. What does this say? It implies that there is a common global time component driving financial crises—and, if you happen to know this effect *ex ante*, you can use it to dramatically enhance your ability to predict crises. This is not too surprising given the consensus view that financial crises have tended to happen in waves and often afflict multiple countries, but is also not of very much practical import for out-of-sample forecasting, since such time effects are not known *ex ante*. Thus, from now on, given our focus on prediction, we study only models without time effects.

In all of the OLS models the sum of the lag coefficients is about 0.40, which is easy to interpret. Average real loan growth over five years in this sample has a standard deviation of about 0.07, so a one standard deviation change in real loan growth increases the probability of a crisis by about 0.0280, or 2.8 percentage points. Since the sample frequency of crises is just under four percent, this shows a high sensitivity of crises to plausible shocks within the empirical range of observed loan growth disturbances.

Still, there are well-known problems with the Linear Probability model, notably the fact that the domain of its fitted values is not constrained to the unit interval relevant for a probability outcome. Thus, in columns 4 and 5 we switch to a logit

¹³ Formal lag selection procedures (AIC, BIC, and likelihood ratio tests) suggest we could in most cases use just two lags of $CREDIT$; however, higher order lags are sometimes significant, as can be seen in Table 2, and credit booms are typically considered phenomena that last for many years, so we maintain five lags as our initial specification.

TABLE 3—FINANCIAL CRISIS PREDICTION—OLS AND LOGIT ESTIMATES

| Estimation method | OLS | OLS | OLS | Logit | Logit |
|---|----------------------|----------------------|----------------------|---------------------|---------------------|
| Fixed effects | None | Country | Country + year | None | Country |
| Specification | (1) | (2) | (3) | (4) | Baseline |
| | (1) | (2) | (3) | (4) | (5) |
| L. $\Delta \log$ (loans/P) | -0.0281 (0.0812) | -0.0273 (0.0815) | -0.0489 (0.0801) | -0.257 (2.077) | -0.398 (2.110) |
| L2. $\Delta \log$ (loans/P) | 0.301*** (0.0869) | 0.302*** (0.0872) | 0.320*** (0.0833) | 6.956*** (2.308) | 7.138*** (2.631) |
| L3. $\Delta \log$ (loans/P) | 0.0486 (0.0850) | 0.0478 (0.0853) | 0.00134 (0.0819) | 1.079 (2.826) | 0.888 (2.948) |
| L4. $\Delta \log$ (loans/P) | 0.00494 (0.0811) | 0.00213 (0.0814) | 0.0346 (0.0782) | 0.290 (1.282) | 0.203 (1.378) |
| L5. $\Delta \log$ (loans/P) | 0.0979 (0.0746) | 0.0928 (0.0752) | 0.136* (0.0729) | 2.035 (1.607) | 1.867 (1.640) |
| Observations | 1,272 | 1,272 | 1,272 | 1,272 | 1,272 |
| Groups | 14 | 14 | 14 | 14 | 14 |
| Sum of lag coefficients | 0.425*** | 0.417*** | 0.443*** | 10.10*** | 9.697*** |
| Standard error | 0.123 | 0.126 | 0.136 | 2.590 | 2.920 |
| Test for all lags = 0 [†] | 4.061*** | 3.871*** | 4.328*** | 24.95*** | 17.23*** |
| p-value | 0.00116 | 0.00174 | 0.000661 | 0.000143 | 0.00408 |
| Test for country effects = 0 [†] | — | 0.71 | 0.84 | — | 7.67 |
| p-value | — | 0.754 | 0.617 | — | 0.864 |
| Test for year effects = 0 [†] | — | — | 4.15*** | — | — |
| p-value | — | — | 0.0001 | — | — |
| R ² †† | 0.016 | 0.023 | 0.290 | 0.0434 | 0.0659 |
| Pseudolikelihood | — | — | — | -210.8 | -205.8 |
| Overall test statistics [†] | 4.061*** | 1.638* | 4.184*** | 24.95*** | 36.21*** |
| p-value | 0.0012 | 0.0445 | 0.00001 | 0.000143 | 0.00663 |
| AUROC | 0.673*** | 0.720*** | 0.952*** | 0.673*** | 0.717*** |
| Standard error | 0.0357 | 0.0341 | 0.00865 | 0.0360 | 0.0349 |

Notes: [†]Reported statistic is F for OLS, χ^2 for logit. ^{††}Reported statistic is Pseudo R^2 for logit. Standard errors in parentheses. Logit standard errors are robust.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

model. Model specification 4 displays pooled logit, and specification 5 adds country fixed effects by including dummies in the regression, though again these are not statistically significant. Unfortunately, we cannot implement a logit model with year effects. In our setting, the problem is small N and large T , the opposite of typical microeconomic applications. This means that the incidental parameters problem afflicts the T dimension, and we have consistency in N . Conditional fixed effects can only be estimated using years in the panel where there is actual variation in the outcome variable. In our case, this collapses the number of observations from 1,272 to just 140, so that model parameters could not be precisely estimated. We accordingly adopt column 5, the Logit model with country effects but without time-effects, as our preferred *baseline* specification henceforth.

Our key finding is that all forms of the model show that a credit boom over the previous five years is indicative of a heightened risk of a financial crisis. The diagnostic tests reported show that the five lags are jointly statistically significant at the 1 percent level; the regression χ^2 is also significant. The difference between the first and second lag coefficients is also suggestive; the former is negative and the latter

large and positive, confirming that when the *second* derivative of credit changes sign we can see that trouble is likely to follow (Biggs, Mayer, and Pick 2009). The sum of the lag coefficients is about ten, and also statistically significant. To interpret this we need to convert to marginal effects, where in column 5, at the means of all variables, the sum of the marginal effects over all lags is 0.301, similar to, albeit a little smaller than, the 0.40 estimate given by the OLS Linear Probability model noted above.

Finally, we note that in all its forms the model has predictive power, as judged by a standard tool used to evaluate binary classification ability, the Receiver Operating Characteristic (ROC) curve. This is shown in Figure 7 for our preferred baseline model. The curve plots the true positive rate $TP(c)$ against the false positive rate $FP(c)$, for all thresholds c on the real line, where the binary classifier is $I(\hat{p} - c > 0)$, $I(\cdot)$ is the indicator function, and \hat{p} is the linear prediction of the model which forms a continuous signal. When the threshold c gets large and negative, the classifier is very aggressive in making crisis calls, almost all signals are above the threshold, and TP and FP converge to one; conversely, when c gets large and positive, the classifier is very conservative in making crisis calls, almost all signals are below the threshold, and TP and FP converge to zero. In between, an informative classifier should deliver $TP > FP$ so the ROC curve should be above the 45-degree line of the null, uninformative (or “coin toss”) classifier.

At this point, we would prefer not to take a stand on where the policymaker would place the cutoff value of the threshold. The utility computation depends on costs of different outcomes and the frequency of crises. For example, the cutoff should be more aggressive if the cost of an undiagnosed crisis is high, but less so if the cost of a false alarm is higher. If crises are rare, the threshold bar should also be raised to deflect too-frequent false alarms (see Pepe 2003). Fortunately, a test of predictive ability exists that is independent of the policymaker’s cutoff. This is the area under the ROC curve (AUROC). It is essentially a test of whether the distribution of the model’s signals are significantly different under crisis and non-crisis states, thus allowing them to use a basis for meaningfully classifying these outcomes. The AUROC provides a simple test against the null value of 0.5 with an asymptotic normal distribution, and for our baseline model $AUROC = 0.717$ with a standard error of just 0.0349. The model can therefore be judged to have predictive power versus a coin toss, although it is far from a perfect classifier, which would have $AUROC = 1$.¹⁴

All the above forecasts suffer from in-sample look-ahead bias, even though they use lagged data. To put our model to a sterner test, we limited the forecast sample to the post-1983 period only (350 country-year observations) and compared in-sample and out-of-sample forecasts (the former based on full sample predictions, with look-ahead bias; the latter based on rolling regressions, using lagged data only). The in-sample forecast produced an even higher $AUROC = 0.763$ (s.e. = 0.0635), but the out-of-sample also proved informative, with an $AUROC = 0.646$ (s.e. = 0.0695), with the latter having statistical significance at better than the 5 percent level. We think any predictive power is impressive at this stage given the general

¹⁴ Is 0.7 a “high” AUROC? For comparison, in the medical field where ROCs are widely used for binary classification, an informal survey of newly published prostate cancer diagnostic tests finds AUROCs of about 0.75.

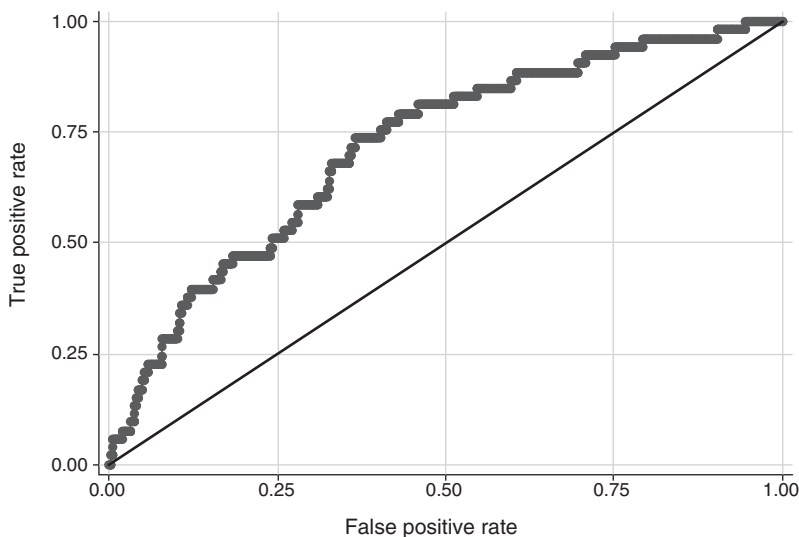


FIGURE 7. RECEIVER OPERATING CHARACTERISTIC CURVE (*Baseline Model*)

Note: Area under ROC curve = 0.717.

skepticism evinced by the “early warning” literature, and our out-of-sample results add some reassurance.

We now ask some questions about the value added of our results and their robustness. The first claim we make is that the use of credit aggregates, rather than monetary aggregates, is of crucial importance. This would have broad implications, first for economic history, since monetary aggregates have been widely collected and may be easily put to use. But it also has policy implications. Indeed, after the crisis of 2008–09 the argument has often been heard that greater attention to such aggregates, in contrast to a narrow focus on the Taylor rule indicators of output and inflation, might have averted the crisis. But when we look at the long-run data systematically, monetary aggregates are *not* that useful as predictive tools in forecasting crises, in contrast to the correct measure, total credit. We find the success of the credit measure appealing, and not just because it vindicates the drudgery of our laborious data collection efforts: we think credit is a superior predictor, because it better captures important, time-varying features of bank balance sheets such as leverage and nonmonetary liabilities. The basis for these claims is the collection of results reported in Tables 4 and 5.

In Table 4 we start with the baseline model, reproduced in specification 6. Throughout this table we continue to estimate the model over the entire sample, using a logit model with country fixed effects. Having settled on this model, we now also report, for completeness, the marginal effects on the predicted probability evaluated at the means for the lags of credit. We then take several perturbations of the baseline that take the form of replacing the five lags of credit with alternative measures of money and credit.

Specification 7 replaces real loans with real broad money, still deflated by CPI. The fit is still statistically significant, although slightly weaker judging from lower

TABLE 4—BASELINE MODEL AND ALTERNATIVE MEASURES OF MONEY AND CREDIT

| Specification (Logit country effects) | Baseline (6) | Replace loans with broad money (7) | Replace loans with narrow money (8) | Replace real loans with loans/GDP (9) | Replace real loans with loans/broad money (10) |
|---|---|---|---|--|--|
| L. $\Delta \log$ (loans/P) | -0.398 -2.11 | -1.051 -2.771 | -2.504 -1.806 | 2.091 -2.235 | 0.601 -2.383 |
| L2. $\Delta \log$ (loans/P) | 7.138*** -2.631 | 5.773*** -2.181 | 2.303 -1.781 | 7.627*** -2.135 | 5.842*** -2.327 |
| L3. $\Delta \log$ (loans/P) | 0.888 -2.948 | 3.515 -2.329 | 1.768 -1.664 | 3.569 -2.386 | 2.092 -2.048 |
| L4. $\Delta \log$ (loans/P) | 0.203 -1.378 | -1.535 -2.287 | -2.880* -1.51 | 2.333* -1.405 | 1.613 -1.766 |
| L5. $\Delta \log$ (loans/P) | 1.867 -1.64 | 3.077 -2.256 | 1.373 -1.63 | 3.164** -1.583 | 0.497 -2.37 |
| Marginal effects at each lag evaluated at the means | -0.0124 0.222 0.0276 0.00629 0.0580 | -0.0350 0.192 0.117 -0.0511 0.102 | -0.0888 0.0817 0.0627 -0.102 0.0487 | 0.0598 0.218 0.102 0.0668 0.0905 | 0.0196 0.190 0.0681 0.0525 0.0162 |
| Sum | 0.301 | 0.326 | 0.00211 | 0.538 | 0.346 |
| Observations | 1,272 | 1,348 | 1,381 | 1,245 | 1,224 |
| Groups | 14 | 14 | 14 | 14 | 14 |
| Sum of lag coefficients | 9.697*** | 9.779*** | 0.0596 | 18.78*** | 10.65*** |
| Standard error | 2.920 | 3.400 | 3.240 | 3.651 | 4.053 |
| Test for all lags = 0, χ^2 | 17.23*** | 17.77*** | 6.557 | 29.85*** | 10.62* |
| p-value | 0.00408 | 0.00324 | 0.256 | 0.000016 | 0.0594 |
| Test for country effects = 0, χ^2 | 7.674 | 8.755 | 8.834 | 8.012 | 9.140 |
| p-value | 0.864 | 0.791 | 0.785 | 0.843 | 0.762 |
| Pseudo R^2 | 0.0659 | 0.0487 | 0.0381 | 0.0923 | 0.0497 |
| Pseudolikelihood | -205.8 | -224.6 | -237.4 | -198.9 | -201.5 |
| Overall test statistic, χ^2 | 36.21*** | 36.81*** | 17.37 | 47.77*** | 19.82 |
| p-value | 0.00663 | 0.00555 | 0.498 | 0.000163 | 0.343 |
| Predictive ability, AUROC | 0.717*** | 0.681*** | 0.631*** | 0.743*** | 0.680*** |
| Standard error | 0.0349 | 0.0294 | 0.0339 | 0.0337 | 0.0378 |

Note: Robust standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

R^2 , and predictive power—the AUROC is also marginally lower. The basic message at this point, however, is that broad money could potentially proxy for credit. Both the liability and the asset side of banks' balance sheets seem to do a good job of predicting financial trouble ahead over the whole sample—though we shall qualify this result in a moment. Specification 8 replaces loans with narrow money and the model falls apart, which is not unexpected; given the instability in the money multiplier, the disconnect between base money and credit conditions is too great to expect this model to succeed. Specifications 9 and 10 replace real loans with the loans-to-GDP ratio and the loans-to-broad-money ratio, respectively. Both of these variants of the model also meet with some success, and specification 9 outperforms slightly in terms of measures of fit and predictive ability as measured by AUROC.

TABLE 5—BASELINE MODEL WITH PRE-WW2 AND POST-WW2 SAMPLES

| Specification (Logit country effects) | Baseline pre-WW2 sample using loans (11) | Baseline post-WW2 sample using loans (12) | Pre-WW2 sample replace loans with broad money (13) | Post-WW2 sample replace loans with broad money (14) |
|---|--|---|--|---|
| L. Δ log (loans/P) | 2.249 (2.362) | -0.316 (3.005) | -0.227 (3.014) | 2.705 (4.438) |
| L2. Δ log (loans/P) | 7.697** (3.221) | 8.307*** (2.497) | 7.393** (3.004) | 4.719** (2.375) |
| L3. Δ log (loans/P) | 2.890 (3.056) | 2.946 (2.687) | 4.077 (2.915) | 4.060* (2.170) |
| L4. Δ log (loans/P) | 2.486 (1.587) | 0.755 (2.623) | -0.249 (1.982) | -0.838 (5.359) |
| L5. Δ log (loans/P) | 4.260** (1.735) | -1.749 (3.204) | 4.844* (2.647) | 0.808 (4.016) |
| Observations | 510 | 706 | 585 | 708 |
| Groups | 13 | 14 | 13 | 14 |
| Marginal effects at each lag evaluated at the means | 0.0873 0.299 0.112 | -0.00642 0.169 0.0598 | -0.0102 0.332 0.183 | 0.0617 0.108 0.0926 |
| | 0.0965 0.165 | 0.0153 -0.0355 | -0.0112 0.218 | -0.0191 0.0184 |
| Sum | 0.760 | 0.202 | 0.711 | 0.261 |
| Sum of lag coefficients | 19.58*** | 9.943 | 15.84*** | 11.45* |
| Standard error | 4.921 | 6.056 | 5.119 | 6.022 |
| Test for all lags = 0, χ^2 | 19.20*** | 12.44** | 13.53** | 12.13** |
| <i>p</i> -value | 0.00176 | 0.0292 | 0.0189 | 0.0330 |
| Test for country effects = 0, χ^2 | 6.369 | 5.348 | 11.74 | 5.917 |
| <i>p</i> -value | 0.932 | 0.945 | 0.549 | 0.920 |
| Pseudo R^2 | 0.130 | 0.0771 | 0.0855 | 0.0476 |
| Pseudolikelihood | -106.4 | -83.97 | -126.2 | -86.71 |
| Overall test statistic, χ^2 | 40.21*** | 36.44*** | 35.95*** | 19.89 |
| <i>p</i> -value | 0.00195 | 0.00401 | 0.00716 | 0.280 |
| AUROC | 0.763*** | 0.718*** | 0.728*** | 0.659*** |
| Standard error | 0.0391 | 0.0691 | 0.0361 | 0.0600 |

Notes: Robust standard errors in parentheses. In the prewar sample NLD is dropped from the logit regression because there are no crises in the sample (with five lags of credit or money in nonwar years), so $N = 13$ for these cases.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

So far the main results might tempt us to conjecture, first, that various scalings of credit volume could have similar power to predict financial crises; and, second, that broad money could also proxy for credit adequately well. The former idea may be true, but Table 5 quickly dispels the latter. The robustness checks here take the form of splitting the sample into pre-WW2 and post-WW2 samples, where we are guided to conduct this test by the summary findings above showing very different trends in the behavior of money and credit in these two epochs.

Specifications 11 and 12 show that using our credit measure, real loans, the baseline model performs quite well in terms both of fit and predictive power, both before and after WW2. Column 12 is particularly interesting, since the significant and alternating signs of the first and second lag coefficients in the postwar period highlight the sign of the second derivative (not the first) in raising the risk of a crisis. In

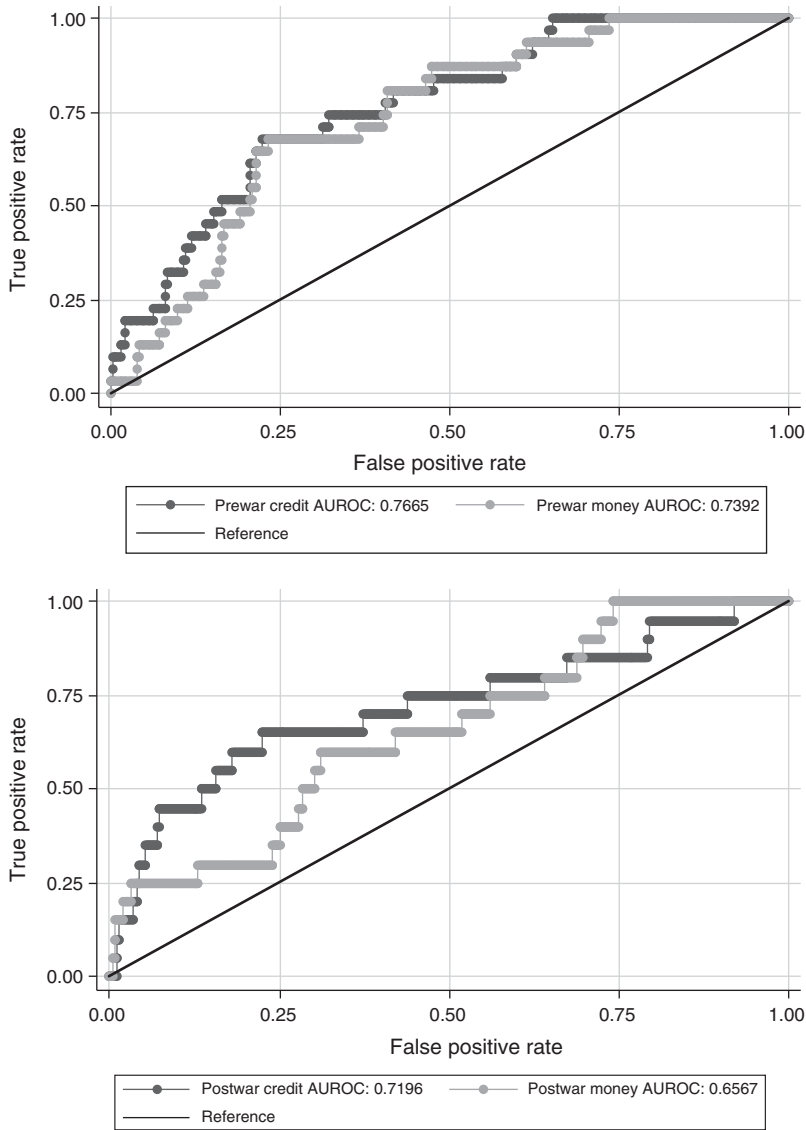


FIGURE 8. ROC COMPARISONS OF MONEY AND CREDIT AS PREDICTORS: PREWAR VERSUS POSTWAR

contrast, specifications 13 and 14 expose some unsatisfactory performance when broad money is used. Before WW2 the weaknesses are not evident, as we find the lag coefficients (on broad money) still significant, and similar predictive power. But after WW2 the model based on broad money is a failure: the fit is much poorer, and from a predictive standpoint the model has a much lower AUROC.

To explore the predictive ability differences more closely, we examined the ROC curves for specifications 11–14 as shown in Figure 8, this time computed on common samples within each period (thus, the statistics differ slightly from those in Table 5). We used AUROC comparison tests along with Kolmogorov-Smirnov tests (of the difference in the signal distributions under each outcome) to see whether

one model or the other was to be preferred in each period for its binary classification ability. Before WW2 (for $N = 486$ common observations), a test of equality in AUROCs between the credit and money models passed easily ($p = 0.37$); the ROC curves are very close to each other and almost overlapping; and both models attain a maximum height above the diagonal that is significantly different from zero. After WW2 (for $N = 700$ common observations), the money model ROC curve is below the credit model ROC curve at almost all points, except at a few points close to the (0,0) and (1,1) points, where operation is unlikely to be optimal for the policymaker; the two AUROCs are different, with a p -value of 0.237. We also find that of the four ROCs in Figure 8, only the post-WW2 money model fails the Kolmogorov-Smirnov test, so its maximal height above the diagonal (TP minus FP) is not statistically different from zero at conventional levels, which is also highly discouraging.

How do we interpret these results? The findings mesh well with our overall understanding of the dramatic changes in money and credit dynamics after the Great Depression. In the summary data for the pre-WW2 sample, we saw how broad money and credit moved hand in hand, so that a Friedman “money view” of the financial system, focusing on the liability side of banks’ balance sheets, was an adequate simplification. After WW2 this was no longer the case, and credit was delinked from broad money aggregates, which would beg the question as to which was the more important aggregate in driving macroeconomic outcomes. At least with respect to crises, the results of our analysis are clear: credit matters, not money.

These findings have potentially important policy implications, especially for central banks that still embrace the oft-forgotten idea of using quantitative indicators as a “pillar” of monetary policymaking. If this pillar is there to support price stability goals, then indeed a monetary aggregate may be the right tool for the job; but if financial stability is a goal, then our results suggest that a better pillar might make use of credit aggregates instead, and their superior power in predicting incipient crises.

VI. Robustness Tests

To underscore the value of our model based on the “credit view” and to guard against omitted variable bias, in Table 6 we subject our baseline specification to several perturbations that take the form of including additional control variables X , as described above. Specification 15 adds 5 lags of real GDP growth. Specification 16 adds 5 lags of the inflation rate, since inflation has been found to contribute to crises in some studies (e.g., Demirgüç-Kunt and Detragiache 1998). Neither set of controls can raise the fit and predictive performance of the model substantially. The inclusion of these terms has little effect on the coefficients on the lags of credit growth, their quantitative or statistical significance, and their substantive contribution to the model’s predictive ability. Specifications 17 and 18 add 5 lags of the nominal short-term interest rate or its real counterpart, since some studies find that high interest rates—e.g., to defend a peg—can help trigger crises (e.g., Kaminsky and Reinhart 1999). While some of the lags are significant at the five percent level, they do not alter the baseline story and the credit effects remain strong.

In specification 19 we add five lags of the change in the investment-to-GDP ratio, to explore the possibility that the nature of the credit boom might affect the probability that it ends in a crisis. For example, according to arguments heard from time to

TABLE 6—ROBUSTNESS CHECKS

| Specification (Logit country effects) | Baseline plus 5 lags of real GDP growth (15) | Baseline plus 5 lags of inflation (16) | Baseline plus 5 lags of nominal short- term int. rate (17) | Baseline plus 5 lags of real short- term int. rate (18) | Baseline plus 5 lags of change in I/Y (19) |
|--|---|--|---|--|---|
| L. Δ log (loans/P) | 1.544 (2.081) | -0.771 (2.362) | 0.113 (2.072) | -1.458 (2.442) | -0.152 (2.250) |
| L2. Δ log (loans/P) | 8.571*** (2.403) | 10.22*** (2.690) | 8.491*** (2.982) | 10.99*** (2.689) | 7.131** (2.845) |
| L3. Δ log (loans/P) | 3.114 (2.347) | -1.590 (2.856) | 1.054 (3.443) | -1.258 (3.239) | 0.546 (3.213) |
| L4. Δ log (loans/P) | 2.555* (1.441) | 1.503 (1.461) | 0.241 (1.697) | 2.686 (1.673) | 1.124 (1.366) |
| L5. Δ log (loans/P) | 3.539** (1.555) | 1.128 (1.842) | 1.996 (2.058) | 0.821 (1.820) | 3.004 (1.943) |
| Observations | 1,272 | 1,272 | 969 | 961 | 1,218 |
| Groups | 14 | 14 | 14 | 14 | 14 |
| Sum of lag coefficients | 19.32*** | 10.49*** | 11.89*** | 11.78*** | 11.65*** |
| Standard error | 4.329 | 3.121 | 3.275 | 3.385 | 3.404 |
| Test for all lags = 0, χ^2 | 28.99*** | 24.45*** | 19.45*** | 26.54 | 16.59 |
| p-value | 0.00002 | 0.000178 | 0.00159 | 0.00007 | 0.00536 |
| Test lags of added vbl. = 0, χ^2 | 34.43 | 19.55 | 3.888 | 14.98 | 4.895 |
| p-value | 0.000002 | 0.00152 | 0.566 | 0.0105 | 0.429 |
| Test for country effects = 0, χ^2 | 10.41 | 8.031 | 7.727 | 5.888 | 8.538 |
| p-value | 0.660 | 0.842 | 0.806 | 0.922 | 0.807 |
| Pseudo R^2 | 0.123 | 0.104 | 0.0765 | 0.110 | 0.0870 |
| Pseudolikelihood | -193.3 | -197.4 | -181.8 | -174.9 | -196.2 |
| Overall test statistic, χ^2 | 61.47*** | 52.23*** | 36.40** | 47.46*** | 52.38*** |
| p-value | 0.00023 | 0.000466 | 0.0275 | 0.00128 | 0.000445 |
| AUROC | 0.751*** | 0.770*** | 0.725*** | 0.750*** | 0.737*** |
| Standard error | 0.0432 | 0.0422 | 0.0448 | 0.0454 | 0.0419 |

Notes: Robust standard errors in parentheses. Marginal effects not reported.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

time, if credit is funding “productive investments” then the chances that something can go wrong are reduced—as compared to credit booms that fuel consumption binges or feed speculative excess by households, firms, and/or banks.¹⁵ Our results caution against this rosy view. Over the long run, in our developed country sample, most of the lags of investment are not statistically significant at the conventional level, and the only one that is actually significant has a “wrong” positive sign, suggesting that crises are slightly more likely when they have been funding investment booms as opposed to other activity.¹⁶ As an additional check, we also tested the interaction of the five-year moving average of credit growth with real investment growth. The interaction term was found to be statistically insignificant. Interacting

¹⁵The argument has often been applied to foreign capital flows manifest in current account deficits. The argument that capital flowing into investment booms does not matter has been variously stated as the “Lawson doctrine,” “Pitchford critique,” or “consenting adults view.” See Edwards (2002) for a survey of this area.

¹⁶The sum of the lags on investment is positive, so crises are marginally more likely in an investment boom, controlling for credit growth.

the two variables also had virtually no impact on the fit or the predictive power of the model.¹⁷ In brief, when it comes to investment finance versus consumption finance, we could not find any conclusive evidence that the nature of the credit boom made any difference. If this is the case, then the suspicion arises that when banks originate lending, they may be almost equally incapable of assessing repayment capacity in all cases, with investment loans having no special virtues.

Summing up the results from Table 6, we conjecture that, although some of the auxiliary control variables may matter in some contexts—perhaps in other samples that include emerging markets—for the developed economies these other factors are not the main signal of financial instability problems. Rather, the key indicator of a problem is an excessive credit boom. Indeed, the sum of the lag loan coefficients (or their marginal effects) is even higher in Table 6 columns 15–19 than in the baseline specification (6), so credit effects are amplified here, rather than being diminished by the added controls; and the pseudo- R^2 values range between 0.0765 and 0.123, compared to the 0.0659 value in the baseline case, showing that the greater fraction of the model's fit is always due to the credit terms.

In the final part of our robustness analysis, we ask whether the inclusion of asset prices and controls for the level of financial development affect our results regarding the role of credit growth in generating financial instability. Asset price boom and bust cycles have a long history that is well documented (Kindleberger 1978). Also, the financial crisis of 2008–2009 was closely linked to the boom and bust of housing prices in the United States and elsewhere, raising the possibility that asset prices play a central role in the emergence of systemic financial crises. Yet one can also think of other asset price booms (the run-up in the prices of technology stocks before 2001 comes to mind) that have not triggered large-scale financial instability.

From a monetary policy point of view, recurring asset price booms have led to considerable debate about their role in setting monetary policy. Until recently, the consensus has been that asset price developments should only influence the formulation of monetary policy to the degree that they affect the central banks' inflation forecast (Bernanke and Gertler 2001). In light of recent events, however, a more granular assessment of asset bubbles has been suggested (Mishkin 2008). The key distinction here is that asset price bubbles that are not accompanied by increased leverage against higher asset values might not pose particular stability risks for the financial system. If booming asset prices relax collateral constraints, however, which in turn feed more lending and higher prices, financial stability risks could be elevated. As the positive feedback loop between asset values and lending reverses, the balance sheets of financial intermediaries and households can come under severe strain.

As a first step to disentangle these issues empirically, we include stock price data into our regressions and test if they increase the predictive power of the model. In the context of our long-run cross-country sample, stock market indices are the only available indicator for asset market developments. Data availability and comparability problems make the use of house price data impossible. If the inclusion of stock

¹⁷The results are not reported due to space constraints but are available from the authors on request.

prices into our regression yields strong predictive signals, this would be evidence that stock price booms per se pose financial stability risks. Later on, we will also use interaction terms to test whether the financial risks emanating from stock price booms depend on credit levels or the pace of credit creation. To create the database of long-run stock prices in the 14 countries in our sample we started with standard sources (e.g., Global Financial Data), and then, thanks to the help of a number of colleagues, we were able to extend our dataset and include extended time series of historical equity-market indices for France, Italy, the Netherlands, and Sweden that have become available in recent years.¹⁸

The results are shown in Table 7. In specification 20 we add 5 lags of changes in nominal stock prices to our baseline, and in regression 21 we add changes in real (CPI-deflated) stock prices. The overall results of these additive models are mixed. The lags of nominal stock prices are insignificant, but reach significance at the five percent level in the case of real prices. The predictive ability of the model as measured by the AUROC rises slightly from 0.717 to 0.731. The pseudo- R^2 remains in 0.09 range, demonstrating that the greatest fraction of the fit of the model still comes from the credit terms which remain highly significant in all specifications. While asset prices contain some additional information about the likelihood of future crises, their overall contribution is relatively small. From a policy perspective, the key variable to watch is credit.

Before we turn to possible interaction effects, we address a related set of issues in specifications 22 and 23 in Table 7. We ask whether there is evidence that crises are more likely in larger financial systems (as proxied by the credit to GDP ratio) as compared to times when the level of financial intermediation is lower. As we employ country fixed effects throughout, we are effectively asking whether the crisis probability is greater in times when the credit to GDP ratio is high relative to the country average. One could hypothesize that such a positive relationship might stem from the fact that more complex financial systems and more highly leveraged economies have a greater propensity for disruptions in the face of shocks. But also a political economy explanation is possible. Excessive risk taking and moral hazard problems could become more endemic if the financial sector grows relative to the size of the economy.

Looking at these issues from a purely empirical point of view, some evidence emerges that crisis probabilities grow with financial depth. In specification 22 we include the credit-to-GDP ratio. This leads to an immediate increase of the AUROC by about two points relative to the baseline. The level of credit to GDP is also significant if both stock prices and credit levels are included in specification 23. Also, the pseudo- R^2 of the regression increases by some margin indicating a slightly better fit. While the importance and significance of the credit growth remains unaffected, our long-run sample data suggest that the risk of financial crises grows with a higher credit-to-GDP level. This analysis therefore provides some quantitative evidence to

¹⁸While the coverage is generally good for the twentieth century, nineteenth-century price data are harder to come by. We are indebted to Pierre-Cyrille Hautcoeur (France), Peter Koudijs (Netherlands), Angelo Riva (Italy), and Daniel Waldenström (Sweden) for sharing their data with us. Jan Tore Klovland, Kevin O'Rourke, and Hans-Joachim Voth directed us to other sources.

TABLE 7—CREDIT, ASSET PRICES, AND FINANCIAL DEVELOPMENT

| Specification (Logit country effects) | Baseline plus 5 lags of nominal stock price change (20) | Baseline plus 5 lags of real stock price change (21) | Baseline plus Loans over GDP (22) | Baseline plus 5 lags of real stock prices plus loans/GDP (23) |
|--|--|---|--|--|
| L. Δ log (loans/P) | -2.491 (2.324) | -2.540 (2.312) | -0.755 (2.293) | -3.392 (2.470) |
| L2. Δ log (loans/P) | 7.316** (2.910) | 7.165** (2.915) | 7.599*** (2.871) | 7.848** (3.215) |
| L3. Δ log (loans/P) | 3.405 (2.899) | 3.185 (2.864) | 0.720 (3.307) | 3.297 (3.171) |
| L4. Δ log (loans/P) | -1.352 (1.521) | -1.684 (1.539) | 0.0933 (1.497) | -1.747 (1.669) |
| L5. Δ log (loans/P) | 1.678 (1.835) | 1.771 (1.784) | 2.326 (1.784) | 2.460 (1.994) |
| L1. Δ log (stock prices) | -1.046** (0.464) | -0.865** (0.434) | | -0.768* (0.455) |
| L2. Δ log (stock prices) | 0.535 (0.644) | 0.563 (0.673) | | 0.550 (0.666) |
| L3. Δ log (stock prices) | 0.272 (0.651) | 0.715 (0.692) | | 0.691 (0.690) |
| L4. Δ log (stock prices) | 0.954 (0.822) | 1.098 (0.811) | | 1.024 (0.814) |
| L5. Δ log (stock prices) | 0.0844 (0.631) | 0.467 (0.703) | | 0.438 (0.627) |
| Loans/GDP (log) | | | 1.100* (0.624) | 1.601** (0.703) |
| Observations | 1,061 | 1,062 | 1,271 | 1,061 |
| Groups | 14 | 14 | 14 | 14 |
| Sum of lag coefficients | 8.557** | 7.898** | 9.984*** | 8.466** |
| Standard error | 3.468 | 3.443 | 2.918 | 3.460 |
| Test for all lags = 0, χ^2 | 22.04*** | 20.65*** | 17.45*** | 21.19*** |
| <i>p</i> -value | 0.000515 | 0.000944 | 0.00371 | 0.000747 |
| Test lags of added vbl. = 0, χ^2 | 8.664 | 13.28** | | 11.89** |
| <i>p</i> -value | 0.123 | 0.0209 | | 0.0363 |
| Test for country effects = 0, χ^2 | 5.499 | 5.433 | 11.43 | 10.33 |
| <i>p</i> -value | 0.939 | 0.942 | 0.575 | 0.587 |
| Pseudo R^2 | 0.0882 | 0.0901 | 0.0749 | 0.108 |
| Pseudolikelihood | -169.8 | -169.5 | -203.8 | -166.2 |
| Overall test statistic, χ^2 | 39.65** | 46.84*** | 41.48*** | 47.20*** |
| <i>p</i> -value | 0.0119 | 0.00154 | 0.00208 | 0.00212 |
| AUROC | 0.727*** | 0.731*** | 0.731*** | 0.764*** |
| Standard error | 0.0399 | 0.0383 | 0.0379 | 0.0358 |

Notes: Robust standard errors in parentheses. Marginal effects not reported.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

back up the claim that larger, more complex financial systems may be inherently more risky; e.g., as argued in the prescient paper by Rajan (2005).

What about interaction effects? Are asset price booms more dangerous when they occur at high credit-to-GDP levels or when they coincide with elevated rates of credit growth in the economy? Do these interactions force us to modify our core

TABLE 8—CREDIT, ASSET PRICES, AND FINANCIAL DEVELOPMENT—INTERACTIONS

| Specification (Logit country effects) 5-year moving average of: | Baseline (24) | Baseline plus (25) | Baseline plus (26) | Baseline plus (27) | Baseline plus (28) | Baseline plus (29) |
|---|---------------------|--------------------|---------------------|---------------------|---------------------|---------------------|
| $\Delta \log(\text{loans}/P)$ | 5.340*** (2.069) | 5.012** (2.288) | 7.526*** (2.464) | 6.752*** (2.012) | 6.632*** (2.243) | 7.370*** (2.368) |
| $\Delta \log(\text{stocks}/P)$ | | 0.524 (1.391) | 2.704 (2.103) | | | 0.236 (1.464) |
| $\Delta \log(\text{loans}/P) \times \Delta \log(\text{stocks}/P)$ | | | -22.77 (14.19) | | | |
| Loans/GDP (log) | | | | 1.432*** (0.530) | 1.515** (0.751) | 1.704*** (0.615) |
| $\Delta \log(\text{loans}/P) \times \text{loans}/\text{GDP}(\log)$ | | | | | -1.243 (8.516) | |
| $\Delta \log(\text{stocks}/P) \times \text{loans}/\text{GDP}(\log)$ | | | | | | 4.661 (3.401) |
| Observations | 1,278 | 1,278 | 1,278 | 1,437 | 1,437 | 1,278 |
| Groups | 14 | 14 | 14 | 14 | 14 | 14 |
| Test for country effects = 0, χ^2 | 7.447 | 7.528 | 7.980 | 15.58 | 14.58 | 16.21 |
| <i>p</i> -value | 0.878 | 0.873 | 0.845 | 0.272 | 0.334 | 0.238 |
| Pseudo- R^2 | 0.0348 | 0.0351 | 0.0407 | 0.0456 | 0.0457 | 0.0652 |
| Pseudolikelihood | -203.7 | -203.7 | -202.5 | -246.8 | -246.8 | -197.3 |
| Overall test statistic, χ^2 | 17.58 | 18.47 | 22.95 | 35.78*** | 35.71*** | 30.92** |
| <i>p</i> -value | 0.227 | 0.239 | 0.115 | 0.00190 | 0.00317 | 0.0205 |
| AUROC | 0.663*** | 0.662*** | 0.669*** | 0.689*** | 0.689*** | 0.714*** |
| Standard error | 0.0392 | 0.0385 | 0.0369 | 0.0368 | 0.0367 | 0.0371 |

Notes: Robust standard errors in parentheses. Marginal effects not reported.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

finding about the role of accelerations in credit creation as the prime suspect in causing financial instability? In order to keep the number of interaction terms manageable, we now use five-year moving averages (the window excludes the current observation) and their interactions to explain the occurrence of a financial crisis. We start in Table 8, in specification 24, with a simple replication of our baseline model, relating the likelihood of a financial crisis to the rate of real credit growth in the five preceding years. This five-year moving average model matches our previous findings. Credit growth clearly helps predict financial crises. While the predictive ability of the model is (unsurprisingly) a little lower than in the fully specified model with five lags, the AUROC reaches a still respectable 0.663 (still significantly different from 0.5). In specification 26, we test for the impact of asset price booms conditional on credit growth. Including real stock prices plus the interaction of stock prices and credit growth does not meaningfully improve the predictive ability. The AUROC rises slightly to 0.669 and the fit does not rise meaningfully either. The interaction of credit growth and asset prices yields a statistically insignificant negative coefficient estimate on the interaction term. We are working with five-year moving averages, so this result could be partly due to the lags involved. When credit growth is strong and stock prices are rising during the boom phase, the risk of a crisis is low. Once the interaction term turns negative—i.e., when stock prices start falling or credit growth reverses—the odds increase. This accords with the view of Mishkin (2008) and

others that it is the unwinding of *leverage-driven* asset bubbles that puts financial stability most at risk, posing a serious challenge for central banks.

In specification 28 we add credit-to-GDP and the interaction of credit growth and credit-to-GDP ratios. Predictive ability rises, but the interaction term is clearly insignificant. The impact of credit growth on financial crisis risks is not conditional on the size of the financial sector. Yet we find again that financial stability risks seem to increase independently with larger financial systems. This is shown in a higher predictive ability of the model, which stems from adding information about the size of the financial sector, not from interaction effects with credit growth (27). When we run the identical model without the interaction term we find that fit, predictive ability, and the coefficients on credit growth and levels are virtually unchanged. In light of 140 years of data, larger financial sectors (relative to long-run country means) appear to make for more crisis-prone economies. Further research is clearly needed to explore the causal relationships.

Yet while the effect of credit booms does not seem to be conditional on high credit-to-GDP ratios, there are reasons to think that stock price booms and busts are more dangerous if they occur in highly financialized economies. In specification 29, we therefore introduce an interaction term of stock price changes and credit-to-GDP levels, in addition to controls for credit growth, stock price trends, and the size of the financial system. In other words, we are asking whether asset booms are more problematic in highly developed financial systems. The answer from 140 years of historical data is affirmative. Both predictive ability and fit improve considerably, while the coefficient on the stock price increase falls strongly. Conditional on low credit-to-GDP levels, stock price booms are inconsequential. But the risks grow with the size of the financial sector. It is also worth adding that across these regressions credit growth remains highly significant, confirming our key result that accelerations of credit growth are a key variable to watch from a policy perspective.

To conclude, a predictive analysis of our large long-term, cross-country dataset lends support to the idea that, for the most part, financial crises throughout modern history can be viewed as credit booms gone wrong. From our regressions, past growth of credit emerges as the single best predictor of future financial instability, a result that is robust to the inclusion of various other nominal and real variables. Moreover, credit growth seems a better indicator than its nearest rival measure, broad money growth, especially in the postwar period. In light of the structural changes of the financial system that we documented above, this comes as no surprise. As credit growth has increasingly decoupled from money growth, credit and money aggregates are no longer two sides of the same coin. This brings us back to the crucial questions raised at the beginning of this section: should central banks pay attention to credit aggregates or confine themselves to following inflation targeting rules? Historical evidence suggests that credit has a constructive role to play in central bank policy. Valuable information about macroeconomic and financial stability would be missed if policymakers chose to ignore the behavior of credit aggregates, although how this information is included in the overall policy and regulatory regime, and via which instruments, is an open and much debated question.

Yet two other potentially important insights emerged from our long-run perspective on the determinants of financial crises. First, with regard to the effects of

asset price booms and busts, our empirical analysis demonstrated that stock market booms become more problematic with larger financial sectors. At early stages of financial development, run-ups in equity markets are much less dangerous. Second, in light of 140 years of financial crises, the evidence suggests that larger financial sectors are more crisis-prone. While the underlying causes remain in the dark—possibly fragility effects of growing complexity, increased moral hazard in more financialized economies, or lax regulation as a result of both a larger financial system and frequent financial crises—this empirical finding deserves further dedicated research.

Our results also strengthen the idea that credit could matter, above and beyond its role as a propagator of shocks hitting the economy. The credit system may not be merely an amplifier of economic shocks, as in the financial accelerator model. At the very least, the importance of past credit growth as a predictor of financial crises and the robustness of the results to the inclusion of other key macro variables raises the possibility that the financial sector is quite capable of creating its very own shocks. While different identification strategies are clearly needed, our historical data lend some support to the ideas of scholars such as Minsky (1977) and Kindleberger (1978), who have argued that the financial system itself is prone to generate economic instability through endogenous credit booms.

VII. Conclusions

Our ancestors lived in an Age of Money, where credit was closely tied to money, and formal analysis could use the latter as a proxy for the former. Today, we live in a different world, an Age of Credit, where financial innovation and regulatory ease broke that link, setting in motion an unprecedented expansion of the role of credit in the macroeconomy. Without a historical perspective, these profound changes are difficult to appreciate, and one task of this paper has been to document this evolution and its ramifications.

We saw how the stable relationship between money and credit broke down after the Great Depression and WW2, as a new secular trend took hold that carried on until today's crisis. We conjecture that these changes conditioned, and were conditioned by, the broader environment of macroeconomic and financial policies: after the 1930s, the ascent of fiat money plus Lenders of Last Resort—and a slow shift back toward financial *laissez faire*—encouraged the expansion of credit to occur. The policy backstop also, to some degree, insulated the real economy from a scaling up of the damaging effects that prior crises had wrought in days when the financial system played a less pivotal role. Implicit government insurance and the prospect of rescue operations, however, might also have contributed to the spectacular growth of finance and leverage within the system, creating more of the very hazards they were intended to solve. The important structural changes that have taken place in the financial system over the past decades have led to a greater role of credit in the macroeconomy. It is a mishap of history that just at the time when credit mattered more than ever before, the reigning doctrine had sentenced it to playing no constructive role in monetary policy.

In terms of lessons for policymakers and researchers, history demonstrates that they ignore credit at their peril. Credit aggregates contain valuable information about

the likelihood of future financial crises. It is not, of course, a perfect predictor, and there may be fundamental reasons why, in some periods, especially in eras of financial development and innovation, credit expands to support real economic gains. At the same time, the record shows that recurrent episodes of financial instability have more often than not been the result of credit booms gone wrong, most likely due to failures in the operation and/or regulation of the financial system. For economists, adherence to the money view, not to mention the irrelevance view, has been called into question by the crisis. For policymakers, a complacent attitude toward the growth in the scale and riskiness of the credit system now looks like a misguided choice that ignored history.¹⁹ Financial historians have long warned that more attention should be paid to recurrent episodes of financial sector instability in modern economies. We are hopeful that some of the firmer evidence we have assembled here will inform new avenues of research into the role of credit in the macroeconomy.

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¹⁹Notable examples being the critical reaction and laissez-faire response to precrisis warnings sounded at the Jackson Hole conferences by Borio and White (2003), and Rajan (2005). Policymakers are now taking a harder look, however, at how to regulate credit and the procyclicality of the financial system (e.g., Turner 2009).

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