MONEY, CREDIT, AND FINANCIAL CRISES BY INTERNATIONAL MONETARY REGIME: AN EXTENSION OF SCHULARICK & TAYLOR

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ABSTRACT

Schularick and Taylor (ST) (2012) address a debate in the literature over whether broad money aggregates versus credit aggregates explain financial crises. Analyzing econometrically an impressive data set of financial crises and monetary and credit indicators spanning 14 countries between 1870 and 2008, their results provide support for lagged credit growth as the better predictor of financial crises relative to broad money. This paper provides two modest extensions: First, while the original analysis split the data across two major eras, pre- and post-WWII, ST's data set encompasses the four major international monetary regimes in modern history—the gold standard (1870-1913), the interwar period (1920-1938), the Bretton Woods system (1948-1971), and post-Bretton Woods (or neoliberal) era (1972-2008)—for which I break down the time series to test if their results hold across each regime using their same methodology. Second, while ST use bank loans as their private sector credit indicator, credit aggregates in the neoliberal period encompass a greater proportion of tradable securities assets for which we have new data compiled by the IMF's Global Debt Database (GDD). The GDD also provides disaggregated private sector time series for businesses and households. I test whether these indicators improve the predictive capacity of the original authors' baseline model. In the first case, I find their results hold, credit aggregates still perform better. In the second, the updated credit aggregates which include debt securities as well as loans improve the baseline model prediction. I also find that household debt-to-GDP growth increases the likelihood of a crisis relative to the business sector.

1 INTRODUCTION

In "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008," Schularick and Taylor (2012) take inspiration from Hyman Minsky and Charles Kindleberger to ask "what can we learn about the fragility of the financial systems" from data (p. 1032). Two dominant views have defined the mainstream macroeconomic literature to explain financial crises, the "money view" and the "credit view." The money view is associated with the contributions of Friedman and Schwartz (1963), which looks at the liabilities side of the banking system balance sheet and argues that crises, such as the Great Depression, can be explained by the collapse of broad money—mainly due to central bank ineptitude. The credit view, on the other hand, looks at the asset side of banks' balance sheets. The credit view gained prominence and adherents in the 1980s with the work of Bernanke (1983) and others, building off prior ideas of Fisher (1978), and argues that "the mechanism and quantities of bank credit matter, above and beyond the level of bank money" (p. 1030). Schularick and Taylor contribute to this debate by undertaking a quantitative historical approach to examining whether monetary or credit aggregates are better at predicting crises.

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To that end, Schularick and Taylor (from here on referred to as ST) put together an impressive dataset consisting of 14 countries over years 1870 to 2008, making for a total of 1,272 observations. The countries consist of the United States, the United Kingdom, Canada, Australia, Denmark, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, and Switzerland. Their dependent variable is a dummy variable of crisis. The dataset does contain a number of variables such as bank assets, narrow money (M0, M1), GDP, price level (CPI), investment, and population. But the main variables of interest are broad money (M2, M3) and total bank loans at the country level.

ST divide their data years broadly into two major eras, pre- and post-World War II. Their motivation for this demarcation is on the basis of Figure 1 and Figure 2 which I have reproduced based on their original paper and code provided.[1] Figure 1 is a scatter plot of three aggregates, normalized by GDP, of all 14 countries in the sample: broad money, bank loans, and bank assets. The vertical red lines delineate the beginnings of new eras. The middle vertical line is placed at 1945 representing roughly the start of post-war era after WWII (though for many countries, including the US, the war did not completely end until 1947). What is clear from Figure 1, after 1950, we see a significant increase in bank credit and asset aggregates. ST point to this stylized fact as evidence of a decoupling of credit from broad money aggregates. To further their case, they also plot the log ratio of bank loans to broad money, as well as the log ratio of total bank assets to broad money, which I have replicated in Figure 2 from their original paper. Notice the ratios are fairly steady until roughly 1950. Bank loans and assets being in the denominator, clearly grow faster than broad money, indicating a decoupling between the two aggregates. This can be attributed to financial innovation, which arguably accelerates after 1970 and the financial deregulatory wave that followed.

Given these stylized facts, they set out to determine which banking aggregates provide better predictive power, with the expectation that credit aggregates, total bank loans, will be a better predictor of financial crises in the post-war period. Using a logit model, ST regress separately broad money growth and total bank loans on a dependent crisis dummy variable observed by country and year. Their results indeed indicate lagged credit growth is the best predictor of financial crises relative to broad money, but even more so in the post-war era as per their hypothesis.

But as we can see from Figure 1, there is more going on with these credit and monetary aggregates in the period before 1945. ST have impressively been able to collect data going back to 1870, which is basically the official start of the international Gold Standard (Eichengreen 2019 [1998], pp. 13-16). That means the data set manages to captures four major eras of international monetary regimes. The two additional vertical lines in Figure 1 delineate roughly these four eras. Excluding the World War I and II years, the eras break down as follows: The Gold Standard (1870-1913), the Interwar period (1920-1938), the Bretton Woods system (1948-1971), and post-Bretton Woods (or Neoliberal) era (1972-2008). Having such a long historical dataset provides an opportunity to investigate how these credit and money aggregates behaved under these international regimes.

[1] Dataset and STATA code are provided by the authors at http://dx.doi.org/10.1257/aer.102.2.1029

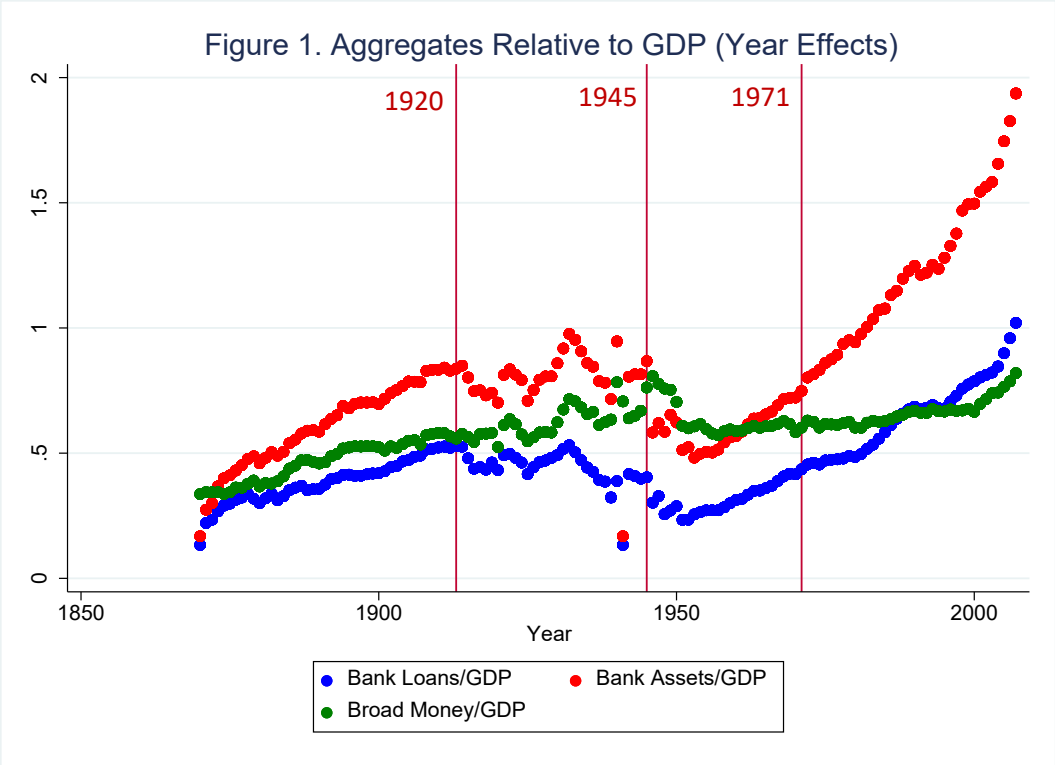
Figure 1. Aggregates Relative to GDP (Year Effects)
1920
1945
1971
0
.5
1
1.5
2
1850
1900
1950
2000
Year
Bank Loans/GDP
Bank Assets/GDP
Broad Money/GDP

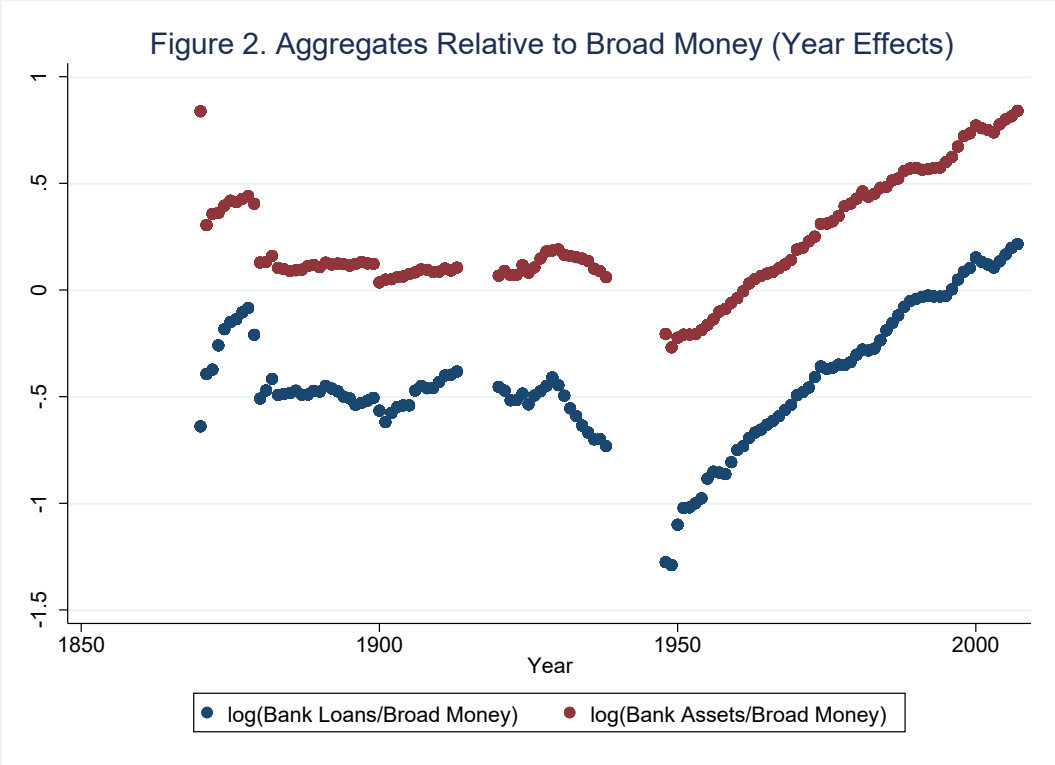
Figure 2. Aggregates Relative to Broad Money (Year Effects)
-1.5
-1
-.5
0
.5
1
1850
1900
1950
2000
Year
log(Bank Loans/Broad Money)
log(Bank Assets/Broad Money)

The purpose of this paper then, is to provide two modest extensions. The first is to conduct the same analysis as ST for each of these periods. This includes the logit regression to determine which aggregates perform better at predicting crises. The second extension looks more closely at the so-called neoliberal (post-Bretton Woods) era using updated statistics of aggregate private sector debt from the IMF Global Debt Database. ST's credit aggregate captures only total bank loans. But commercial bank credit has been decreasing as a share of total non-financial private sector credit since the early 1970s (see Figure 3).[2] Using updated measures of credit (or debt), we can investigate whether they perform better as a predictor of financial crises than just looking at commercial bank loans—as commercial banks are no longer the only financial institutions able to intermediate credit.

The remainder of the paper is structured as follows. Section 2 will review summary statistics broken down by international regime and attempts to provide brief historical context. This section will also replicate ST's event study based on the new periodization proposed. Section 3 will elaborate on the methodology and model used by ST and replicate some of their results. This section will also include the extension by international monetary regime, as well as results for the specification using updated statistics of total private sector debt, including household debt, and non-financial corporate debt. Section 4 will conclude with reflections on this exercise and suggested further extensions using ST's methodology.

Figure 3: US Bank Credit to Total Private Sector Credit (1973-2019)

Source: Board of Governors of the Federal Reserve System

[2] My thanks to Robert Pollin for pointing this out to me in an earlier presentation of this paper. There appears, however, to have been some recovery since 2009 as private credit to households dropped off significantly after the financial crisis. Looking at the data into 2019, however, the ratio has somewhat recovered. Figure 3 data was obtained from the FRED database, provided by the Federal Reserve of St. Louis, using codes TOTBKCR and BOGZ1FL384104015Q (Board of Governors of the Federal Reserve System 2021).

2 SUMMARY STATISTICS AND CUMULATIVE EFFECTS OF FINANCIAL CRISES

To begin, Table 1-A reproduces summary statistics from Table 1 of ST (p. 1034). What stands out from the top panel is the average ratios of loans and assets to GDP both increased from one era to the next—both being measures of debt. Loans and assets to broad money measures (M2, M3) also increased. But these are averages and do not tell us much. Looking at the lower panel, we see the average change in log variables. The annual growth rates of broad money and loans are higher. Loans to broad money and assets to broad money also increased between to the two eras. We also see much higher loan to money and asset to money ratio growth in the post-war era. Notably, real GDP growth is higher in the post-war era (2.7 percent), but we must also factor in the 1930s' Great Depression in the prior period. Given how deep and long the depression was, it should come as no surprise growth would be lower (about 1.5 percent). However, as we will see from Table 1-B, even factoring out the Interwar period, growth is still only about 1.4 percent.

Table 1-B below splits the pre-WWII years into the gold standard (GS) era and the interwar period. Comparing the GS to the Interwar period in the upper panel, loans to GDP is higher in the latter period despite factoring in the 1930s, but loans to money are higher during the former. In the lower panel, we see average loan growth (6.16 percent) outpaced asset growth (5.50 percent) during the GS. We see the opposite trend during the interwar period, though it may be worth disaggregating the 1920s and 1930s, again, to account for the Great Depression. Relative to the ST periodization, in Table 1-A, we see that loans to money growth was greater at about 1.11 percent (relative to 0.17 percent). Loans on average grow faster than broad money.

TABLE 1-A. ANNUAL SUMMARY STATISTICS BY ST PERIODIZATION

	Pre-World War II			Post-World War II		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Loans/GDP	665	0.4217	0.3582	831	0.5470	0.4239
Assets/GDP	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
Δ log Real GDP	868	0.0148	0.0448	854	0.0270	0.0253
Δ log CPI	826	-0.0002	0.0568	852	0.0452	0.0396
Δ log Narrow money	787	0.0278	0.0789	825	0.0780	0.0717
Δ log Money	741	0.0365	0.0569	833	0.0857	0.0552
Δ log Loans	652	0.0416	0.0898	833	0.1094	0.0749
Δ log Assets	607	0.0433	0.0691	825	0.1048	0.0678
Δ log Loans/money	626	0.0017	0.0729	825	0.0222	0.0643
Δ log Assets/money	573	0.0043	0.0452	820	0.0182	0.0595

Note: Money denotes broad money. Loans denote total bank loans. Assets denote total bank assets. This sample runs from 1870-2008. War periods are excluded (1914-1919 and 1939-1947), as well as the post-WW1 German crisis (1920-1925).

TABLE 1-B. ANNUAL SUMMARY STATISTICS BY NEW PERIODIZATION, PRE-WWII

	Gold Standard (1870-1913)			Interwar Period (1920-1938)		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Loans/GDP	407	0.3891	0.3162	258	0.4732	0.4114
Assets/GDP	397	0.6596	0.4340	220	0.8097	0.4501
Broad money/GDP	484	0.4870	0.1756	258	0.6229	0.2314
Loans/money	384	0.7783	0.3878	258	0.7281	0.5033
Assets/money	366	1.2786	0.5389	220	1.2797	0.6052
Δ log Real GDP	602	0.0143	0.0388	266	0.0160	0.0561
Δ log CPI	567	0.0036	0.0429	259	-0.0087	0.0787
Δ log Narrow money	530	0.0306	0.0694	257	0.0218	0.0954
Δ log Money	485	0.0446	0.0494	256	0.0214	0.0663
Δ log Loans	394	0.0616	0.0747	258	0.0110	0.1016
Δ log Assets	386	0.0550	0.0557	221	0.0230	0.0842
Δ log Loans/money	370	0.0111	0.0604	256	-0.0118	0.0861
Δ log Assets/money	354	0.0050	0.0371	219	0.0031	0.0559

Note: Money denotes broad money. Loans denote total bank loans. Assets denote total bank assets. This sample runs from 1870 to 1938. WWI period is excluded (1914-1919).

The GS as a system required central banks to have an "overriding commitment" to the maintenance of convertibility to the gold peg (Eichengreen 2019 [1998], p. 32). That meant maintaining control of the broad money supply as much as base money. However, banking innovations such as fractional reserve banking, which allowed banks to hold only a fraction of their assets against liabilities in the form of reserves (e.g. cash, specie, and liquid securities).[3] This development effectively coupled changes in the business cycle with changes in credit, creating the possibility of bank runs which were a frequent occurrence, but also for financial panics via contagion effects (ibid, p. 32). However, these contagion effects were not just limited to one country, they could spread to others in Kindlebergian fashion via pure psychology alone—among other transmission mechanism (Kindleberger and Aliber 2005 [1978], p. 108). This was also no less the case in the interwar period which had roughly half as many financial crises scattered across countries in our data panel from ST.

Building on those banking innovations after the WWI, the interwar period was an incoherent monetary system as some countries, such as Great Britain and the United States, attempting to reestablish the GS system, while others conducted various forms of managed floating. According to Eichengreen (2019 [1998]), the 1920s also ushered in an era of international flows of speculative financial capital, leading to extremes in balance of payments in various European countries and even the US. There was also the fact that the volatility of exchange rates and the competitive devaluations of the 1930s had severely hampered trade. The failure to

[3] What is often missed in discussions of the development in fractional reserve baking is the specific innovations in the payment system. As communication technology improved, banks could form networks of bilateral and multilateral accounts with each other to facilitate net payment settlement. This capacity increased significantly with the rise of net clearing houses such as the New York Clearing House—still in operation today.

coordinate exchange rates during the interwar period arguably exacerbated the political tensions that led to WWII.

Table 1-C splits the post-war period into the era of Bretton Woods (1945-1971) and post-Bretton Woods (1972-2008). The reasons for demarcation at 1971 is because this is when President Nixon suspended convertibility to gold.[4] It is also when we see the beginning of deregulatory financial policies with the Employee Retirement Income Security Act (or ERISA) of 1974.[5] From the table we see that that loans and assets to GDP ratios are in line and, in fact, lower than ratios of the pre-WWII era. Post-Bretton Woods, these ratios double. Looking at the annual log changes from the lower panel, we see real GDP growth is greater in the Bretton Woods era than the post era (3.81 relative to 1.97). From the upper panel, Loans to money ratio average is 57.2 percent during Bretton Woods. That average increases to an average of 100 percent in the neoliberal era across countries. From the lower panel, we see broad money is growing faster than narrow money (M0), but growing at relatively the same pace post-BW. Interestingly, loans are also growing faster on average during Bretton Woods than in the post era (12.05 relative to 10.27), while assets are growing at about the same pace during and post Bretton Woods (10.93 relative to 10.21). The growth in the loans to money ratio is also after in the Bretton Woods period relative to the neoliberal period.

One might suspect the growth of credit during Bretton Woods could be destabilizing, though perhaps less so within a highly regulated financial system. Rapid credit expansions appear to be more rapid on average across countries even relative to the neoliberal era of deregulated finance. Looking at these simple averages, one should be cautious to infer too much. Nevertheless, speculative finance and capital flows during Bretton Woods were far more limited by governments.

> Interest rates were capped. The assets of banks could invest in were restricted. Governments regulated financial markets to channel credit toward strategic sectors. The need to obtain import licenses complicated efforts to channel capital transactions through the current account. [Capital] Controls held back the flood… [acting as] part of the series of levees and locks with which the raging rapids [of capital flows] were tamed. (Eichengreen 2019 [1998], p. 87)

[4] This date in generally used as the US was the lynchpin of the system. After convertibility was suspended, capital flows grew frantic, quickly engender other to suspend their own pegs. Under the Smithsonian Agreement, G-7 countries attempted to revive the Bretton Woods System, requiring the US dollar to devalue modestly while European countries would revalue their own currencies. Although the US would peg back to gold, briefly, it was not compelled to reinstate convertibility (Eichengreen 2019 [1998], p. 124). The official end of Bretton Woods was formally ratified with the Jamaica Accords of 1976.

[5] The wave of deregulation continued with interest rates. In 1978, Supreme Court ruled "banks [can] export the usury laws of their home state nationwide"; In 1980, Depository Institutions Deregulation and Monetary Control Act phases out interest rate ceilings on deposit accounts; In 1982, Garn-St. German Depository Institution Act "deregulates thrifts almost entirely"; Then in 1999, we got the Gramm-Leach-Bliley Act, supported by Greenspan, President Clinton's Treasury Secretary Robert Rubin, as well as Lawrence Summers, his successor, repealed what was left of Glass Steagall allowing commercial lending and providing for a and new financial market innovation such as money market mutual funds as saving investment instruments (Sherman 2009, pp. 1-2). This led Alan Greenspan to later exclaim "[t]he relationship [between the money supply and economic growth] has completely broken down" in front of the Senate Banking Committee in 1993 (Greenhouse 1993).

TABLE 1-C. ANNUAL SUMMARY STATISTICS BY NEW PERIODIZATION, POST-WAR ERA

	Bretton Woods (1945-1971)			Post-BW (1972-2008)		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Loans/GDP	313	0.3362	0.2934	518	0.6743	0.4397
Assets/GDP	310	0.6053	0.2990	518	1.2578	0.7087
Broad money/GDP	316	0.6093	0.2307	518	0.6680	0.2438
Loans/money	315	0.5720	0.4369	518	0.9998	0.4559
Assets/money	313	1.0772	0.5252	518	1.8772	0.7079
Δ log Real GDP	336	0.0381	0.0297	518	0.0197	0.0188
Δ log CPI	334	0.0396	0.0366	518	0.0488	0.0410
Δ log Narrow money	307	0.0723	0.0593	518	0.0813	0.0780
Δ log Money	315	0.0872	0.0529	518	0.0848	0.0566
Δ log Loans	315	0.1205	0.0793	518	0.1027	0.0713
Δ log Assets	307	0.1093	0.0661	518	0.1021	0.0688
Δ log Loans/money	307	0.0293	0.0642	518	0.0179	0.0640
Δ log Assets/money	302	0.0197	0.0537	518	0.0173	0.0627

Note: Money denotes broad money. Loans denote total bank loans. Assets denote total bank assets. This sample runs from 1945-2008. Post-war era split by breakdown of the Bretton Woods institutions and the start of financial deregulatory policies beginning with ERISA (1974).

The financial repression of the Bretton Woods era made for a prosperous period, and remarkably devoid of financial crises. Table 2 breaks down the occurrence of financial crises by country using our new periodization based on international monetary regime. The first thing that stands out is the column of zeroes during the Bretton Woods system. Of the countries in this sample at least, none of them experienced a financial crisis during this period.

The GS period, on the other hand, had many. What is not evident from this table is that many had them in the same year—evidence of the contagion effects noted by Kindleberger. In 1873, for example, five countries experienced financial crises in the same year including Great Britain, Canada, Italy, Germany, and the United States. Denmark had one the year after. In 1907, nine countries would be enveloped in a crisis, included were the countries above plus France, the Netherlands, Switzerland, and Japan. The Great Depression beginning in 1931 would envelop six countries (at least in this dataset). But many countries would experience a financial crisis of one kind or another during this short 18 year span. Only Australia and Great Britain (no doubt still devastated by the WWI) would manage to avoid one.

For the neoliberal era (post-BW), however, ST's dataset obviously understates the number of crises, particularly since emerging market and developing countries are left out. Every year of the neoliberal era at least one country—that is within the sample—experiences a financial crisis. The largest group in the sample being eight countries during the Global Financial Crisis of 2007-2008, with the only exceptions being Australia and Canada—Canada interestingly being the only country to have noticeably avoided a crisis since the end of Bretton Woods.

TABLE 2. FINANCIAL CRISES BY COUNTRY AND PERIOD

Country	Gold Standard (1870-1913)	Interwar Period (1920-1938)	Bretton Woods (1948-1971)	Post-BW (1972-2008)	Total
Australia	1	0	0	1	2
Canada	2	1	0	0	3
Denmark	4	2	0	1	7
France	3	1	0	1	5
Germany	4	1	0	1	6
Great Britain	2	0	0	4	6
Italy	4	3	0	2	9
Japan	5	1	0	1	7
Norway	1	2	0	1	4
Spain	3	3	0	2	8
Sweden	2	2	0	2	6
Switzerland	2	1	0	1	4
The Netherlands	2	1	0	1	4
United States	4	1	0	2	7
Total	39	19	0	20	78

Table 3-A below replicates Table 2 from ST (p. 1041), but Table 3-B does so with my proposed period breakdowns. These results are based on the point estimate of the cumulative effects 5 years on from a financial crisis relative to normal, or non-crisis, years. The Bretton Woods era is omitted as there were no financial crises during this period. What stands out is that we see greater decreases in real GDP growth in the post-Bretton Woods era relative to the Gold Standard and interwar period. We still see higher levels of deflation under post-Bretton Woods relative to the Gold Standard, but clearly not the interwar period as it included the Great Depression.

Comparing the results of the two tables, separating the GS era from the interwar period makes the former a little rosier. While we still see significant collapses in broad money, bank credit, and real investment, it is not quite too the same degree once the Great Depression is factored out. Still the GS system does not fare much better than the neoliberal era post-Bretton Woods. Collapses in broad money and credit, five years on after a crisis, are significant. Bank asset collapses are nearly on par with losses in the interwar period, and declining real investment is still about 20.4 percent post crisis on average. These results also likely understate the case given the data stops in 2008—as we know, many more crises would result in Europe and Asia in 2009-10, plus the subsequent European sovereign debt crisis of Greece and other periphery countries within the Eurozone.

These results motivate well the desire to predict future financial crises as best we can. To that end, we turn to the next section to review ST's empirical methodology and provide an extension to determine if we can improve that predictive capacity of their specification.

TABLE 3-A. CUMULATIVE EFFECTS AFTER FINANCIAL CRISES, ST PERIODIZATION

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

TABLE 3-B. CUMULATIVE EFFECTS AFTER FINANCIAL CRISES, NEW PERIODIZATION

Cumulative log level effect, after years 0-5 of crisis, versus noncrisis trend, for:	Gold Standard	Interwar period	Post-Bretton Woods
Log broad money	-0.061**	-0.330***	-0.123***
	(0.029)	(0.054)	(0.044)
Log narrow money	-0.079**	-0.129	-0.035
	(0.040)	(0.084)	(0.063)
Log bank loans	-0.149***	-0.411***	-0.178***
	(0.049)	(0.082)	(0.054)
Log bank assets	-0.096**	-0.305***	-0.308***
	(0.038)	(0.073)	(0.052)
Log real GDP	-0.036*	-0.039	-0.049***
	(0.021)	(0.049)	(0.015)
Log real investment	-0.164*	-0.324	-0.204***
	(0.094)	(0.240)	(0.048)
Log price level	-0.025	-0.295***	-0.038
	(0.023)	(0.066)	(0.032)

Note: There are no financial crises during the Bretton Woods era; therefore, it has been omitted. Standard errors in parentheses. ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

3 METHODOLOGY AND EXTENSION

ST conduct their regression analysis using a logit model. Their baseline specification takes the following form:

$$\text{Logit}\ (P_{nt}) = \beta_{0n} + \beta_1\ (L)\ \Delta \log CREDIT_{nt} + \beta_2\ (L)\ X_{nt} + \Upsilon_n + \epsilon_{nt}$$

where logit(P) = ln(P/(1-P) is the log of the odds ratio of a crisis in country *n*, and year *t*. L is a lag indicator, Δ indicates differentiation (change), and *CREDIT* is defined as total real bank loans. The *CREDIT* variable is alternated with a broad money variable, also deflated by CPI. Υ captures country level fixed effects that account for variation between countries. And ϵ is the error term. Lastly, X is a vector of control variables that are incorporated with ST's robustness checks. For the purposes of this paper, we dispense with the robustness checks and focus on just the money and credit aggregates with country level fixed effects.

ST's base line results for the entire sample are reported in the first column of Table 4. As they note in their paper, the "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" (p. 1045). From the lagged coefficients of the baseline model, the sign between the first and second coefficient alternates from negative to positive. The second coefficient is also large and significant. The sum of the lag coefficients is also large and significant. To interpret the results, however, we need to convert the coefficient to its marginal effects.

For the baseline model, the sum of the marginal effects is 0.301, indicating one standard deviation of average real credit growth over five years, about 0.07, increases the odds of a crisis by 0.021, or 2.1 percent.

To evaluate the model's predictive power, we look to the Receiver Operating Characteristic (ROC) curve. Figure 4 below replicates Figure 7 from ST (p. 1047) which plots the true positive rate against the false positive rate, where the 45-degree line represents the null, or "uninformative" classifier (p. 1046). Plots along the 45-degree line indicate the model is no better than a "coin toss," or 50-50 chance, in terms of predictive ability. Thus, an "informative" classifier produces a plot curve above the 45-degree line. The area under the curve informs us of the predictive power of the model. This statistic is noted as AUROC (for Area Under Receiver Operating Curve) in Table 4. This is the statistic we wish to maximize to produce the most predictive model. The baseline model, column (1), has an AUROC of 0.717, and is statistically significant at the 1 percent level.

Table 4 also reports results using alternative measures of money and credit aggregates in the logit specification. ST perform this same exercise in Table 4 (p. 1048), but use broad money, narrow money, loans to GDP, and loans to broad money. From their results I have replicated the models with the two main variables of interest, real loans (baseline) and broad money—presented in column (1) and (2), respectively. I also replicate a third as it had the highest predictive power as measured by the AUROC of 0.743 (statistically significant at the 1 percent level), loans to GDP—column (3). This is the model to beat.

The first extension of ST's methodology for this paper is presented in column (4), (5), and (6). For these models, I use updated credit, or debt, aggregates from the IMF global debt database (GDD) compiled from years 1950 to date by Mbaye, Moreno-Badia, and Chae (2018). Specifically, I use a private sector debt aggregate consisting of the total stock of loans and debt securities issued to

households and nonfinancial corporations as a share of GDP.[6] Models (5) and (6) disaggregate the private sector into households from nonfinancial corporations to see if there is any improvement in predictive ability of crisis.

TABLE 4. ST BASELINE MODEL WITH NEW ALTERNATIVE MEASURES OF MONEY AND CREDIT

Specification (Logit country effects)	Baseline using real loans (1)	Replace loans with broad money (2)	Replace loans/P with loans/GDP (3)	Replace log loans/P with total private debt/GDP (4)	Replace log loans/P with household debt/GDP (5)	Replace log loans/P with non-financial corp. debt/GDP (6)
L. Δ log (loans/P)	-0.398	-1.051	2.091	8.642	-8.587	18.215**
	(2.110)	(2.771)	(2.235)	(6.683)	(27.491)	(8.177)
L.2. Δ log (loans/P)	7.138***	5.773***	7.627***	2.541	5.554	6.968
	(2.631)	(2.181)	(2.135)	(9.479)	(26.442)	(11.758)
L.3. Δ log (loans/P)	0.888	3.515	3.569	15.016**	39.109**	16.317*
	(2.948)	(2.329)	(2.386)	(7.534)	(16.339)	(9.842)
L.4. Δ log (loans/P)	0.203	-1.535	2.333*	-12.405*	-22.861	-14.804
	(1.378)	(2.287)	(1.405)	(6.537)	(17.154)	(10.285)
L.5. Δ log (loans/P)	1.867	3.077	3.164**	11.343	46.557***	9.804
	(1.640)	(2.256)	(1.583)	(9.146)	(15.016)	(9.637)
Sum of lag coefficients	9.697***	9.779***	18.780***	25.136***	59.770**	36.500**
	(2.920)	(3.400)	(3.651)	(9.163)	(30.144)	(14.454)
Marginal effects at each lag (at the means)	-0.0124	-0.0350	0.0598	0.1628	-0.2087	0.4710
	0.2220	0.1920	0.2180	0.0479	0.1349	0.1801
	0.0276	0.1170	0.1020	0.2828	0.9502	0.4219
	0.0063	-0.0511	0.0668	-0.2337	-0.5555	-0.3828
	0.0580	0.1020	0.0905	0.2137	1.1312	0.2535
Sum of marginal effects	0.3010	0.3260	0.5380	0.4735	1.4521	0.9437
Pseudo R-squared	0.066	0.049	0.092	0.138	0.180	0.147
AUROC	0.717***	0.681***	0.743***	0.781***	0.762***	0.772***
	(0.035)	(0.029)	(0.034)	(0.049)	(0.077)	(0.062)
Observations	1272	1348	1245	594	388	377

Note: Data used in models 4, 5, and 6 deal only with years between 1950 and 2008. Robust standard errors in parentheses. ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

[6] GDD also offers an alternative aggregate for total private sector debt which includes all credit instruments. This measure might have been superior to the one used, all loans plus debt securities, but the series does not begin until 1995 for our 14 countries with the exception of data for the United States. Therefore, using it would have the significantly drawback of reducing the number of observations we would have to test the model.

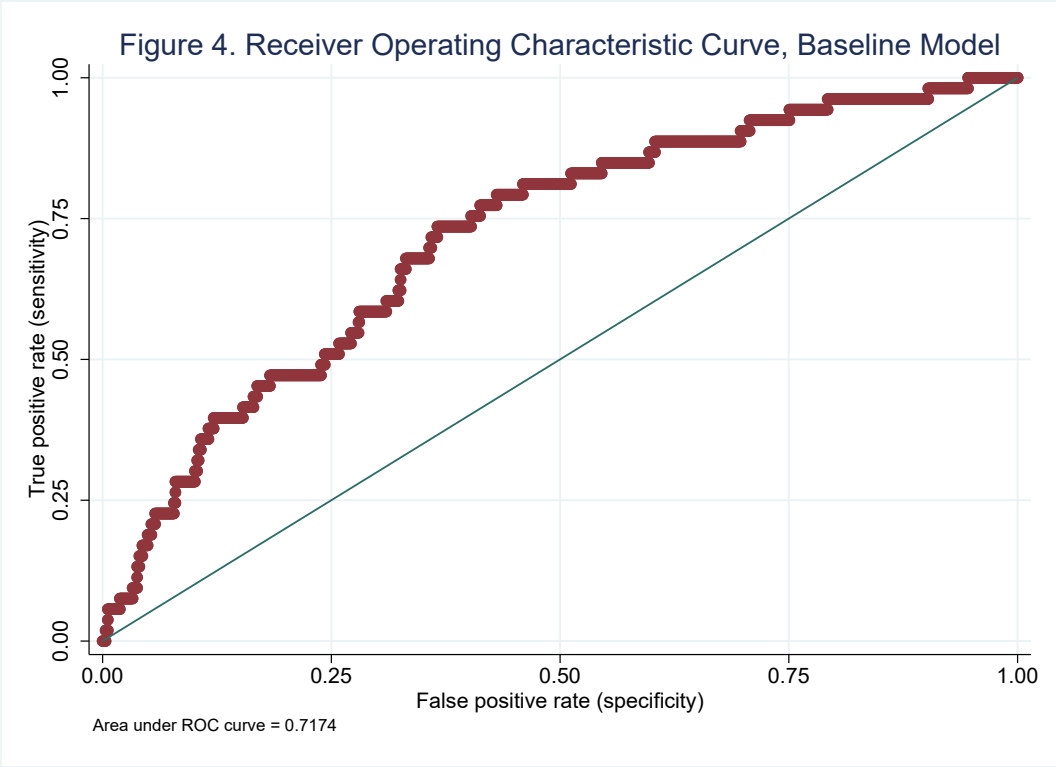

Table 5. Baseline Model with New Periodization

	Gold Standard		Interwar Period		Post-Bretton Woods	
Specification (Logit country effects)	Using loans	Using money	Using loans	Using money	Using loans	Using money
L. Δ log (loans/P)	2.498	-0.960	4.661	3.452	0.980	4.533
	(3.433)	(3.956)	(6.538)	(6.543)	(3.299)	(3.569)
L.2. Δ log (loans/P)	5.771	6.469*	21.430***	16.491**	9.697***	5.915**
	(4.110)	(3.460)	(8.172)	(6.399)	(2.915)	(2.345)
L.3. Δ log (loans/P)	3.774	5.009	7.557	9.770*	4.256	5.545***
	(4.757)	(3.890)	(5.726)	(5.317)	(2.714)	(2.136)
L.4. Δ log (loans/P)	4.299*	1.676	5.736	-2.769	1.695	1.240
	(2.232)	(2.880)	(3.851)	(5.459)	(3.234)	(5.002)
L.5. Δ log (loans/P)	6.318**	1.537	7.663**	19.052***	0.387	2.367
	(2.468)	(2.699)	(5.535)	(6.857)	(3.912)	(3.334)
Observations	322	399	130	130	481	481
Sum of lag coefficients	22.661**	13.731	47.046**	45.995***	17.016***	19.601***
	(9.460)	(8.762)	(16.644)	(12.868)	(5.761)	(6.586)
AUROC	0.766***	0.720***	0.857***	0.833***	0.755***	0.718***
	(0.042)	(0.048)	(0.039)	(0.044)	(0.063)	(0.053)

Note: Loans refers to total bank loans, while money refers to broad money. Robust standard errors in parentheses. The Bretton Woods period (1948-1971) is omitted as there were no crises in that period. ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

One note to make before moving on to the results of the alternative measures is that these debt aggregates have not been converted into logs. ST differentiate the log (which converts to a percentage change) of their ratio of bank loans-to-GDP. However, this makes for a convoluted interpretation—the percent change of a percentage change of a ratio—and is unnecessary. With that in mind, the coefficients in models (4) through (6) should be interpreted as simply the change in the debt-to-GDP ratio. In column (4), for example, the sum of marginal coefficients is 0.473. If the private debt-to-GDP ratio increases by one standard deviation, approximately 0.05 in this sample, over five years, the likelihood of a crisis increases by 0.0237, or 2.37 percent. Note, household debt-to-GDP as sum of marginal coefficients of 1.452, indicating the same increase over five years would increase the likelihood of a crisis by 0.0726, or 7.26 percent.

By introducing these updated aggregates, we see from models (4) through (6) we are able to increase the predictive power of the model relative to ST's model (3) as measured by the AUROC statistic. Using total private debt produces the highest AUROC statistic of 0.781, and is statistically significant at the 1 percent level. Breaking it down by sector, household and nonfinancial corporations, also appears to yield better predictive capacity relative to bank loans alone—with an AUROC of 0.762 and 0.772, respectively.

Finally, to conclude the exercise, we apply the ST baseline model based on our new periodization by international monetary regime. The results are reported in Table 5 below. Recall the Bretton Woods period is left out as there are no crises during that period. Notice that for all three periods, total real bank loans perform better with predicting crises than broad money—validating the credit view—though not to the same degree difference ST find using their own periodization. [7]

4 CONCLUSION

Schularick and Taylor (2012) provide an original contribution to the literature on financial crises. One might argue their empirically-based historical approach filled a certain lacuna left by heterodox economists after the significant contributions of Minsky and Kindleberger—this is not to say that either theorists were unable to empirically validate their approaches, but not in the same systematic fashion. There results also vindicate the credit view over the money view—which as a kind of robustness test in itself, still held up with the new periodization by monetary regime. The dataset ST constructed also provided an opportunity to dig deeper into the behavior of monetary and credit aggregates between 1870 and 2008, encompassing four unique periods of international monetary systems. By conducting an event study (Tables 3-B), we see with each successive regime, the cumulative effects after a financial crisis result in recessions becoming longer and deeper. Diving further into the data on financial crises, Bretton Woods further stands out as a unique period in history of international cooperation, active state guidance of financial resources, resulting in an unprecedented era void of financial panics despite its limitations and contradictions as a monetary system. Finally, the introduction of new aggregate debt indicators for the private sector, particularly when disaggregated into the households and nonfinancial businesses, appear to improve the logit model prediction as measured by the AUROC statistic. Based on the results presented in Table 4, the sum of marginal effects indicates increases in the household sector debt ratio significantly increases the potential for a crisis relative to the nonfinancial corporate debt ratio.

[7] ST find pre-WWII, the AUROC for the baseline model using loans is 0.763, while money is 0.728. Post-WWII, they find a slightly greater difference of 0.718 for bank loans and 0.659 for money.

ST appear to provide a sound methodology for predicting financial crises. The extension exercise to incorporate updated and more inclusive measures of private debt appear to improve the predictability of the model. Though further extensions are warranted, particularly ensuring they hold up to further robustness tests. A further extension using this methodology using credit growth thresholds rather than the unspecified changes in credit seems apt. While some economists have investigated the impact of private debt ratios on growth (e.g., Cecchetti et al. 2011, Lombardi et al. 2017), this author is only aware of two others who have suggested the change in debt to be as significant when above certain thresholds (Vague 2014, 2019; Keen 2017). Keen (2017), for example, in a recent book on the financial crises remarked that credit growth in the US

> had averaged less than 6 per cent of GDP between 1945 and 1970, [but] averaged 14 per cent of GDP between 2006 and 2008. Private debt had grown enormously in America over the post-war period—from just 37 per cent of GDP in 1945 to 165 per cent of GDP by 2008. A slowdown in the rate of growth of debt was inevitable, and this alone was enough to cause total demand in the economy to fall (ibid, p. 24).

This would suggest that not only the level ratio of debt to GDP is important, but certain threshold rates at which it is growing relative to GDP also matters, and would make an important contribution to literature.

REFERENCES

Bernanke, B. S. (1983). "Nonmonetary Effects of the Financial Crisis in Propagation of the Great Depression." *American Economic Review,* 73(3): 257–76.

Board of Governors of the Federal Reserve System (US) (2021), Bank Credit, All Commercial Banks [TOTBKCR], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/TOTBKCR, March 4, 2021.

Board of Governors of the Federal Reserve System (US) (2021), Domestic Nonfinancial Sectors; Debt Securities and Loans, Excluding Government Sectors; Liability, Level [BOGZ1FL384104015Q], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/BOGZ1FL384104015Q, March 4, 2021.

Cecchetti, S. G., M. S. Mohanty & F. Zampolli (2011), "The real effects of debt," BIS Working Papers No. 352, Bank of International Settlements.

Eichengreen, B. (2019 [1998]), *Globalizing Capital: A History of the International Monetary System*, Princeton, NJ: Princeton University Press.

Fisher, I. (1933), "The Debt-Deflation Theory of Great Depressions," *Econometrica*,1(4): 337–57.

Friedman, M. & A. J. Schwartz (1963), *A Monetary History of the United States: 1867–1960*, Washington, DC: National Bureau of Economic Research.

Greenhouse, S. (July 23, 1993), "Fed Abandons Policy Tied to Money Supply," The New York Times, Archives. Retrieved from https://www.nytimes.com/1993/07/23/business/fed-abandons-policy-tied-to-money-supply.html

Keen, S. (2017), *Can we avoid another financial crisis?* Malden, MA: Polity Press

Kindleberger, C. P. & R. Z. Albers (2005 [1978]), *Manias, Panics and Crashes: A History of Financial Crises* (5th ed.), New York, NY: Palgrave Macmillan.

Lombardi, M., M. Mohanty & I. Shim (2017), "The Real Effects of Household Debt in the Short and Long Run," BIS Working Paper No. 607, Bank of International Settlements.

Mbaye, S., M. Moreno-Badia & K. Chae (2018), "Global Debt Database: Methodology and Sources," IMF Working Paper, International Monetary Fund, Washington, DC. [Data] Retrieved from https://www.imf.org/external/datamapper/datasets/GDD

Schularick, M. & A. Taylor (2012), "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008," *American Economic Review*, 102(2): 1029-1061.

Sherman, M. (2009), "A Short History of Financial Deregulation in the United States," Center for Economic and Policy Research. Retrieved from http://cepr.net/documents/publications/dereg-timeline-2009-07.pdf

Vague, R. (2014), *The Next Economic Disaster: Why It's Coming and How to Avoid it*, Philadelphia, PA: University of Pennsylvania Press.

Vague, R. (2019), *A Brief History of Doom: Two Hundred Years of Financial Crises*, Philadelphia, PA: University of Pennsylvania Press.