SOVEREIGNS VERSUS BANKS: CREDIT, CRISES, AND CONSEQUENCES

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Abstract
Two separate narratives have emerged in the wake of the Global Financial Crisis. One interpretation speaks of private financial excess and the key role of the banking system in leveraging and deleveraging the economy. The other emphasizes the public sector balance sheet and worries about the risks of lax fiscal policy. However, the two may interact in important and understudied ways. This paper examines the co-evolution of public and private sector debt in advanced countries from 1870 to 2012. We find that in advanced economies financial crises are not preceded by public debt build-ups nor are they more likely when public debt is high. However, history shows that high levels of public debt tend to exacerbate the effects of private sector deleveraging after financial crises. The economic costs of financial crises rise substantially if large private sector credit booms are unwound at times when the public sector has little capacity to pursue macroeconomic and financial stabilization. (JEL: C14, C52, E51, F32, F42, N10, N20)

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1. Introduction

From Beijing to Madrid to Washington, the risks of excessive borrowing feature prominently in the public debate. A seemingly simple lesson that many people drew from the financial crisis is that high debts harbor risks. However, it is much less evident which debts one should worry about. A priori, many economists would probably point to the public sector where incentive failures of politicians and the common-pool problem might lead to reckless debt financing. Private households and companies, by contrast, are assumed to be acting in their enlightened self-interested, have some "skin in the game", and can be taken for "consenting adults".

Surveying such crises, or even just the latest examples, observers still debate whether it was private debts that ultimately bankrupted sovereigns or excessive public debt that undermined the banking sector. In some euro area countries, the public sector was overwhelmed by the costs of cleaning up the banking system and forced to seek bailouts (e.g., Ireland and Spain). The pattern in these cases aligns well with the link between financial crises and sovereign debt distress that has been documented in detail by Reinhart and Rogoff (2009a, 2010). In other countries, the main vulnerability was indeed concentrated on the public sector balance sheet itself (e.g., Greece). When the economic outlook worsened after the crisis, the sustainability of high public debts was called into question. Doubts about the solvency of the sovereign quickly spread to banks with substantial holdings of government debt (effects also seen in, e.g., Italy and Portugal), setting in motion a "diabolic loop" (Brunnermeier et al. 2011).

What the crisis made abundantly clear is that private and public debts cannot be looked at in isolation. Studying the interactions between the two from a long-run historical perspective is therefore the main purpose of this paper. While various studies have looked at private and public debt separately, a joint study of the evolution of public and private borrowing is missing. With our study, we aim to start to fill this gap. To do so, we rely on a novel long-run annual panel data set covering private bank credit and public debt and a wide swath of macroeconomic control variables for 17 advanced economies from 1870 to 2011. This is the near universe of advanced economies' experiences in the past 140 years. This long-run historical perspective allows us to work with a sufficiently large number of observations to achieve statistically meaningful results.

Based on this data set, we are able to present a number of new facts. Section 2 reveals that total economy debt levels have risen strongly over time, but the bulk of the increase has come from the private sector. Section 3 shows that private credit booms, not public borrowing or the level of public debt, tend to be the main precursors of financial instability in industrial countries. Section 4 documents salient features of the data—for example, that private borrowing is strongly procyclical whereas public debt is countercyclical to some degree.

In the remainder of the paper, we track how public debt and private credit booms affect the business cycle in normal times and after financial crises. In our main finding, we show that entering a financial crisis after a private sector credit boom is associated with considerably more painful recessions and slower recoveries, an effect that is even stronger with high levels of public debt.

A potential reason for this new finding is that high initial debt limits the range of macroeconomic and financial stabilization policies that the government can pursue. Deep-pocketed governments have greater scope for action without triggering solvency fears. Countries with greater fiscal capacity are less constrained in pursuing financial stabilization. In addition, countries with lower levels of public debt also have more room to provide fiscal stimulus to avert a detrimental simultaneous retrenchment of private and public spending. Our key finding echoes the argument laid out in Obstfeld (2013) about precautionary reasons to keep public debt levels moderate so that government can credibly promise to stabilize the financial sector in times of crisis.

Our results resonate with two active research areas in macroeconomics. One strand of work focuses on the role of private credit. Like Schularick and Taylor (2012), we find that financial crises are often credit booms gone bust. Crises, in turn, tend to have long-lasting economic effects. A number of recent studies have demonstrated that recoveries from financial crisis recessions tend to be considerably slower and more protracted than normal as private credit booms or overhangs hold back the economy.[1]

The second strand of recent research related to our work focuses on public debt. The surge of public debt in the wake of the crisis has not only led to doubts about the efficacy of deficit spending, but also triggered fears about the negative consequences of excessive levels of public debt. Reinhart and Rogoff (2010) and Reinhart, Reinhart, and Rogoff (2012) found that high public debt levels can be a drag on the economy.[2] Irons and Bivens (2010) question these findings, while Minea and Parent (2012) provide alternative estimates. In a related part of the literature, Corsetti et al. (2013) argue that if risk premia on public debt rise with higher levels of public debt, the multiplier effects of fiscal policy shrink. Ilzetzki, Mendoza, and Végh (2013) find a similar result for emerging economies.

Our key findings provide nuanced support for both strands of this literature. On the one hand, we reaffirm the central role played by private sector borrowing behavior for the build-up of financial fragility and slow recoveries from crises. In advanced economies, the idea that financial crises typically have their roots in fiscal profligacy, which in turn take a toll on the banking sector, is not supported by history as a general matter. Emerging economies might be different in this respect. On the other hand, our results also speak to the potential dangers of high public debt. Entering a financial crisis recession with an elevated level of public debt seems to exacerbate the effects of private sector deleveraging and is typically accompanied by a prolonged period of sub-par economic performance. That is, the long-run data suggest that without enough fiscal space, a country's capacity to perform macroeconomic and financial stabilization and to resume growth after a major crisis downturn may be seriously impaired.

1. See, for example, Cerra and Saxena (2008), Reinhart and Rogoff (2009a), Jordà, Schularick, and Taylor (2011, 2013), and Mian and Sufi (2010). For different views, see Howard, Martin, and Wilson (2011), as well as Bordo and Haubrich (2010).

2. Checherita-Westphal and Rother (2012) as well as Kumar and Woo (2010) provide supporting evidence of slower growth when public debts are high.

2. The Historical Evolution of Public Debt and Private Credit since 1870

The experience of the euro area periphery during the recent Global Financial Crisis exemplifies the connection that exists between private credit growth and financial crises on the one hand, and public debt and sovereign crises on the other. In 2007, Spain had a budget surplus of about 2% of GDP and its general government debt stood below 40% of GDP.[3] By 2012, Spain's government debt had doubled to reach about 90% of GDP. What began as a banking crisis driven by the collapse of the real estate bubble, quickly turned into a sovereign debt crisis. A similar, possibly even more dramatic, story could be told for Ireland. The lesson of these episodes seems to be that there was next to nothing in key indicators of public finances that indicated the imminent catastrophe. The build-up of financial risks mainly occurred on private balance sheets. In other words, public and private sector debt cannot be looked at in isolation. Yet the debate about mounting public debt levels in advanced economies has often focused on a narrower view of the historical experience, paying little attention to the development of private credit.

This section provides an overview of the co-evolution of private and public sector debt over the last 140 years. The data deployed in this paper are an update of the data set compiled in Schularick and Taylor (2012) with more recent observations, more countries (now including the experiences of Belgium, Finland, and Portugal), and more variables (including data on the fiscal positions and public debt of individual countries). It is important to note that the new data set builds on the research efforts of many economic historians in various countries and brings data from various sources together in one place. Without the generous support from colleagues around the world we would not have been able to compile this novel source for macrohistorical research. In particular, the sample includes observations from 1870 to 2011 at annual frequency for 17 advanced economies representing over 50% of world output (and close to 100% of advanced economy output) more or less consistently throughout the sample period (Maddison 2005).

Our data set builds on updated series for bank loans to the nonfinancial domestic private sector collected from historical sources such as banking supervisory statistics or national statistical yearbooks. The data cover bank lending in domestic currency by domestic banks. Data on the activities of foreign intermediaries and lending in foreign currency are unfortunately not available for the majority of countries.

In the subsequent analysis, we use this information about the asset side of banks' balance sheets as a proxy for the growth of aggregate private sector debt. There are no comprehensive cross-country historical data for the size of corporate bond markets or the lending activities of nonbank financial intermediaries. Some evidence exists to suggest that a substantial share of private debt was held privately in the 19th century. Although precise numbers are hard to come by, both in France and the United Kingdom, privately held mortgage debt accounted for up to 10% of GDP around

3. Source: OECD, Country Statistical Profile.

the year 1900; in the United States and Germany, an even higher share of farm and nonfarm mortgages was likely held outside financial institutions (Hoffman, Postel-Vinay, and Rosenthal 2000). In some countries, such as the United States, corporate bond markets were sizeable too and played an important role in providing finance for railroad construction and other overhead investment.

Using the comparative national balance sheets calculated by Goldsmith (1985), we can approximate the share of bank credit in total private sector liabilities over time. The data from Goldsmith sometimes rely on bold assumptions and are clearly not free of problems, but they allow us to check the broad trends. Goldsmith's data show that, in 1913, borrowing from banks accounted for about half of total private debt in many countries. Comparing our bank credit data to the total financial liabilities given by Goldsmith for the year 1913 yields ratios of around 50% for Belgium and the United States, and closer to 60% for Germany and the United Kingdom, depending on assumptions about the share of mortgages held outside the banking system. In 1930, bank credit equally accounted for 50%–60% of total private sector debt both in the United States and the United Kingdom, again based on the national balance sheet data of Goldsmith (1985). The comparison becomes easier after 1945 as flow of funds data in some cases provide alternative information on total private sector debt, which we can compare directly to our series for bank lending. In the United States, bank credit accounted for 53% of private sector debt in 1960 and close to 60% in 1970 and 55% in 1980, but has been falling since then to about 40% in 2000.

Summing up, despite the importance of other forms of financing, bank credit typically accounted for a large and often predominant form of private sector borrowing in industrial countries. The share of private sector debt not covered by our database is likely to have been larger in the years before World War I and in the past two decades of rapid growth of lending by nonbank intermediaries, but accounted for a substantial and often dominant share of private sector debt throughout the past 140 years. Last but not least, bank and nonbank debt growth rates tend to correlate closely in the years for which we have detailed data on both.

Our data set also extends existing historical public debt databases such as Reinhart and Rogoff (2009b), Abbas et al. (2011), and Mauro et al. (2013). Most importantly, we have been able to gather more data, mainly by exploiting additional sources such as statistical yearbooks. This allows us to close a number of important gaps in the series and to increase the number of observations by approximately 10% relative to the much used historical public debt database compiled by Abbas et al. (2011) at the International Monetary Fund. For our 17 countries, our long-run public debt data are also more comprehensive than the data sets compiled by Reinhart and Rogoff (2009b) and Mauro et al. (2013).

Although in absolute numbers the differences are relatively small (we have about 20–30 additional observations), these observations are often crucial to fill gaps and link information from different historical sources. Our datawork resulted in a number of important revisions. For instance, in the case of Switzerland and Denmark, debt levels in the aftermath of World War II were substantially higher than previously thought. In addition, we paid special attention to constructing consistent series over time by

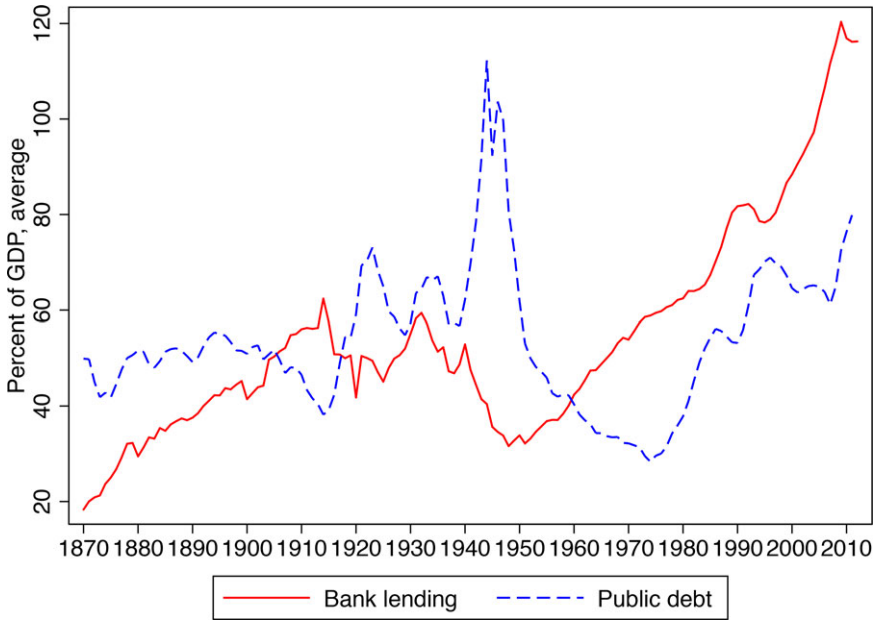

FIGURE 1. Public debt and private bank credit to the private nonfinancial sector, 1870–2011. The sample period is 1870–2011. Each year is the average across the 17 advanced countries in our sample. Total private credit is proxied by total bank loans to the nonfinancial sector, excluding interbank lending and foreign currency lending based on Schularick and Taylor (2012) and updates thereto. Public debt is the face value of total general government debt outstanding.

separating out central government debt from the debts of other state entities at the local level or debts of social security systems.

Figure 1 displays the private-credit-to-GDP and public-debt-to-GDP average ratio for the 17 countries in the sample, using as metrics our bank lending measure and general government debt. Several features deserve comment. On the public debt side, the dominant event in the 20th century is clearly World War II. The war raised the level of public debt to unprecedented levels, often breaching the 100% debt-to-GDP level (and in the case of Germany, Japan, and the United Kingdom shooting past 200%). In the reconstruction boom of the Bretton Woods era, public debt levels gradually declined over the 30 years following the end of the war, reaching a nadir of about 30%–40% debt-to-GDP level around the mid-1970s. Since the late 1970s, public debt levels steadily increased until the mid-1990s before improving somewhat in the decade before the crisis. The Global Financial Crisis put an end to this gradual improvement. Fiscal balances have worsened considerably and public debt has now shot up to levels last seen in World War II. In light of Japan's public debt trajectory, these trends would be accentuated if instead of the simple unweighted averages displayed here one would use GDP-weights. It is important to note that the public debt does not include contingent liabilities of the public sector arising from implicit guarantees for assets held by the financial sector.

However, these broad trends in public finance should be set against the startling trends in private credit discussed by Schularick and Taylor (2012). Leading up to World War II, bank credit to the nonfinancial sector maintained a fairly stable relationship with GDP. The median of bank lending to GDP was in the 40%–50% range for most of the pre–World War II period. Private credit collapsed in the Depression and during World War II when public debt expanded rapidly. Bank credit recovered its pre-war levels by the 1970s and surged to unprecedented levels in the following decades, well over 100% of GDP in our sample. (Bearing in mind our earlier discussion of bank versus total private credit, using Goldsmith's fragmentary data, the levels of total private credit are probably around twice these levels.) The implications of this financialization of Western economies are profound and have become an active area of investigation.

Visualizing the development of the two kinds of debts (private and public) in our sample, Figure 2 shows the size of the banking sector (proxied by total bank lending) and public debt for three different years separated by roughly 40-year intervals covering our sample. The top panel corresponds to 1928, the year before the Great Depression began in most countries. The middle panel corresponds to 1967, just before the rapid climb in private and public debt discussed earlier and visible in Figure 1. The bottom panel corresponds to 2007, the year before the start of the recent Global Financial Crisis. Here bank assets include loans to the nonfinancial sector, plus interbank lending and bank holdings of securities.

This exercise yields some interesting insights. First, the average level of public debt to GDP in 1928 was about 60%, virtually identical to the average level in 2007. Put differently, there has been very little change in public debt levels from the 1920s until to the start of the Global Financial Crisis. Second, the average level of bank lending to GDP in 2007 has doubled relative to the level seen in 1928, and seen again in 1967. At those earlier dates, few advanced countries had bank lending over 90% of GDP; by 2007, most of them did. Almost all of the increase in total (public and private) debt in the course of the 20th century was due to an expansion of bank lending. Averaging across all 17 advanced countries, the ratio of public debt to bank lending went from roughly 1:1 in 1928, to 1:1.5 in 1967, and to 1:2 in 2007. Third, while public debts have increased in most, albeit not all, Western economies in the late 20th century, public debt has only risen half as fast as bank lending since the 1970s.

Summing up, aggregate debt (the sum of public debt and private credit) has grown to historically unprecedented levels in Western economies over the last century and a half. The break with the past is particularly evident since the 1970s. However, the increase in economy-wide debt levels has been dominated by the behavior of the private sector (bank lending) and not by the public sector: it is private sector borrowing from banks, not public sector debt, that reached historically unprecedented levels in Western economies in the early 2000s on the eve of the recent crisis.

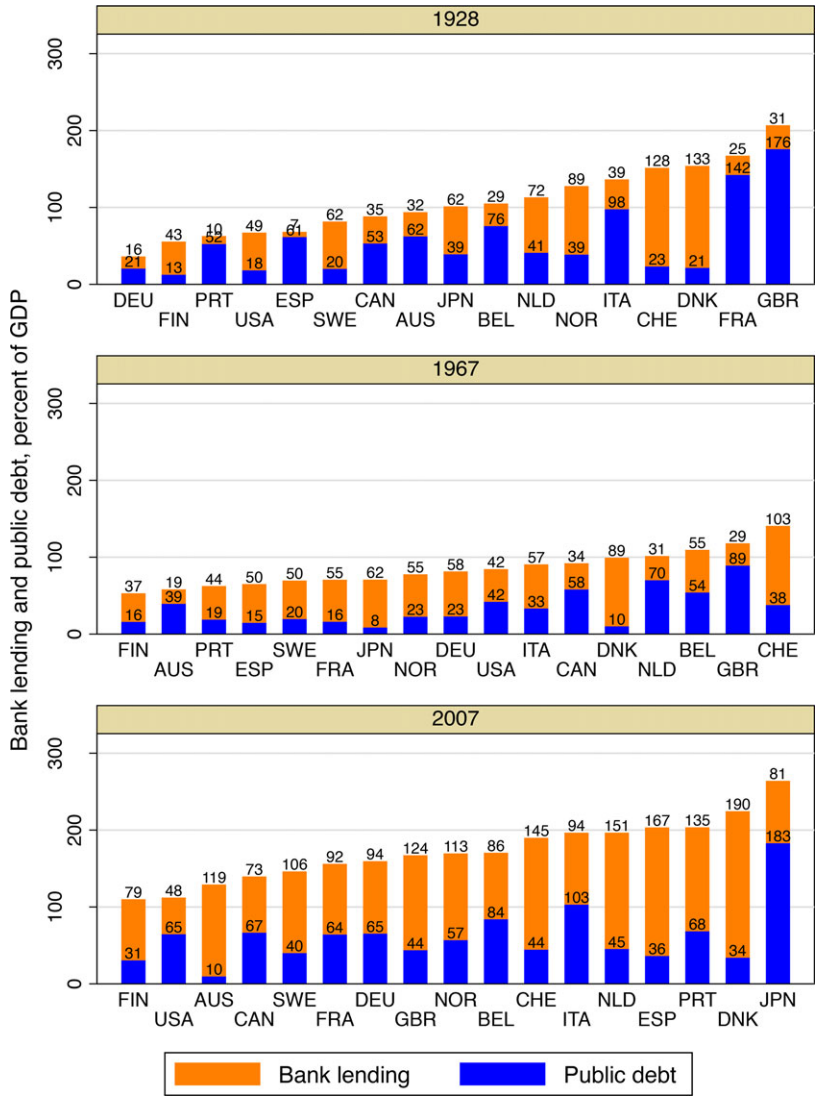

FIGURE 2. Relative sizes of private and public balance sheet sizes across countries and over time: Three snapshots of public debt and bank lending for 1928, 1967, and 2007. For each country, the bottom bar reflects the level of public debt to GDP. The top bar reflects the level of bank lending to GDP. Countries arranged by the size of the sum of public debt and bank lending to GDP at each date. For 1967, the Switzerland observation uses data for 1965, the closest available year.

3. Sources of Financial Instability: Sovereigns versus Banks

Is private or public borrowing the greater risk to financial stability? Historical evidence suggests that private sector credit booms often end in crises. The 2008 crisis clearly followed this historical pattern. In the United Kingdom, Denmark, and Spain, credit

to the private sector expanded by 70 percentage points to GDP in the five years preceding the global financial crisis; in Ireland, the credit-to-GDP ratio rose by even more at over 100 percentage points. In the United States, the increase was a still sizable 50 percentage points between 2002 and 2007. With the benefit of hindsight, the recent events evidently followed in the footsteps of previous lending booms. The Scandinavian and Japanese financial crises in the 1980s and 1990s also followed a period of rapid credit expansion. More than a decade ago, Eichengreen and Mitchener (2003) called the Great Depression a "credit boom gone wrong". In our long-run data set, three-quarters of all episodes in which the credit-to-GDP ratio rose by more than 30 percentage points (or more) over a five-year period ended in a systemic crisis.[4]

Clearly, not all financial crises fit this classification. Crises have also been caused by events such as the effect of weather on agricultural production and prices, changes in the terms of trade, or sudden stops in capital flows, which may interact with domestic credit in various ways. Especially in the 19th century, with the absence of a lender of last resort, such shocks could quickly lead to banking panics and financial crises. The US experience in particular was marked by railroad construction booms and busts, often in tune with the ebbs and flows of foreign capital inflows, and the vagaries of farm crop prices and production.

Yet also in the pre–World War I era, credit booms and periods of easy lending often preceded financial crises. For instance, the 1893 depression was foreshadowed by strong growth in nonfarm and farm mortgage lending. In the decade before the 1893 crisis, loans extended by American banks roughly doubled relative to GDP. Easy global credit fueled a multiyear construction boom in the 1880s, in places as far afield as Argentina and Australia, that ended when international capital inflows reversed in the wake of the Baring crisis of 1890–1891. In Germany, the Gruenderkrach in 1873 and the ensuing Gruenderkrise as well as the 1907 crisis also followed periods of sharp accelerations of credit growth relative to the previous decades (Tilly 2003). In the ten years preceding the 1907 financial crisis, the credit-to-GDP ratio rose by more than 20 percentage points relative to GDP in Germany, and by 30 percentage points in neighboring Denmark.

Yet excessive *public* borrowing has also been linked to the occurrence of banking crises. In the ongoing debate about the causes of the European crisis, some observers pointed to the irresponsible behavior of the sovereigns as the root cause. In this view, public over-borrowing led to solvency fears and sharp increases in risk premia (albeit rather too late). These solvency threats then spread to the banking sector as banks typically hold substantial amounts of government bonds with sharply declining values. Summarizing the argument of the public debt "hawks", Alesina (2012) argues that public over-borrowing can lead to banking crises: ". . . too much debt can bring fiscal crises, including government defaults. Markets, worried about solvency, will require high interest rates on government bonds, making it more costly for countries to service their debts. Defaults could cause banks holding government bonds to collapse, possibly

4. These simple correlations echo the finding of the crisis prediction literature that highlights the role of domestic credit (e.g., Gourinchas et al. 2001; Borio and Lowe 2002; Schularick and Taylor 2012).

leading to another financial meltdown." In the following we confront these views with the evidence from modern economic history.[5] What is the empirical evidence that, in advanced economies, banking crises have been either preceded by large deficits or become more likely at high levels of public debt?

To study the role of private and public sector debt in generating financial instability, this section builds on the classification framework developed in Jordà and Taylor (2011) and Schularick and Taylor (2012) using our expanded long-run 17-country data set. We start from a probabilistic model that specifies the log-odds ratio of a financial crisis event occurring in country i, in year t, as a linear function of lagged controls X, including changes in the private-credit-to GDP and public-debt-to-GDP ratios and their levels:

$$\log \frac{P[S_{it} = 1|X_{it}]}{P[S_{it} = 0|X_{it}]} = b_{0i} + b_1(L)X_{it} + e_{it}. \quad (1)$$

Here, L is the lag operator and the model allows for country fixed-effects.

Given the predicted odds from this model, denoted $\hat{p}$, we then evaluate whether a classifier or assignment rule, $I(\hat{p} > c)$, can do better than the null (a coin toss) in sorting the binary crisis event data given the threshold c. To proceed with formal inference, we use the techniques discussed by Jordà and Taylor (2011). We chart all combinations of true positives against true negatives in the unit box by varying the threshold c between $-\infty$ and $+\infty$, and create a Correct Classification Frontier (CCF). A classifier is informative if its CCF is above the null CFF of a coin toss, which lies on the diagonal. Formally, we can test if the area under the curve (AUC) exceeds 0.5 for the null to be rejected, and inference on families of AUCs turns out to be simple as their asymptotic distributions are normal.

In specifying the log-odds ratio in expression (1), we allow the controls to enter as five-year moving averages. This is a parsimonious way to summarize medium-term fluctuations and to facilitate the investigation of the interaction between public debt and private credit movements. We report estimates based on a variety of specifications detailed in what follows. The error term e_{it} is assumed to be well behaved, and wartime years are omitted from the estimation as in our previous work.

Dates of systemic financial crises are based on an update to the study by Jordà, Schularick, and Taylor (2013), which built on the timing of crisis events pioneered by Bordo et al. (2001) and Reinhart and Rogoff (2009b) for historical times. The Laeven and Valencia (2008, 2012) data set of systemic banking crises is the main source for post-1970 crisis events. Following the definition of Laeven and Valencia (2012), a financial crisis is characterized as a situation in which there are significant signs of financial distress and losses in wide parts of the financial system that lead to widespread insolvencies or significant policy interventions.[6] Since 1870, there have

5. Gourinchas and Obstfeld (2012) have studied the association between public debt and financial crises for a broader but shorter sample.

6. The important distinction here is between isolated bank failures, such as the collapse of the Herstatt Bank in Germany in 1974 or the demise of Baring Brothers in the United Kingdom in 1995, and system-wide distress as it occurred, for instance, in the crises of the 1890s and the 1930s, in the Japanese banking

TABLE 1. Financial crisis classification ability: private credit versus public debt.

Classifier logit model	(1)	(2)	(3)	(4)	(5)
Change in private credit/GDP	22.07***		21.65***	28.70**	
(five-year moving average)	(5.32)		(5.45)	(12.95)	
Change in public debt/GDP		−2.95	−2.99		−4.13
(five-year moving average)		(1.87)	(3.09)		(3.26)
Lagged level of private credit/GDP				−0.35	
				(0.62)	
Lagged level of public debt/GDP					−0.02
					(0.29)
Interaction term				−2.91	0.68
				(9.65)	(2.97)
Observations	1,942	2,000	1,836	1,936	1,980
Area under the curve (AUC)	0.69	0.61	0.69	0.69	0.61
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)

Notes: The table shows logit model classifiers where the dependent variable is the financial crisis event dummy, and the regressors are lags and/or levels of private credit/GDP and public debt/GDP, their interaction, and country fixed effects. Robust standard errors in parentheses. Country fixed effects in all models, not reported. The null model with fixed effects only has AUC = 0.533 (0.03).
Interaction term = (Lagged level of private credit/GDP) × (Lagged level of public debt/GDP).
*Significant at 10%; **significant at 5%; significant at 1%.

been no less than 94 systemic financial crises in the sample of 17 countries used here. A complete list of systemic financial crises for our data set can be found in Appendix A.

The key results are shown in Table 1 based on 17 advanced countries for the period 1870 to 2011. Starting with the simple model based on credit used in Schularick and Taylor (2012, Table 3), we run rival models with public debt added as an alternative, or in combination with the private credit measure. The question is, do any of these alternative variables add any information at all?

The answer seems to be no. In columns (1) and (2), the AUC of the private credit model for the full sample is 0.69 with a standard error of 0.03. The AUC of the public debt model is 0.61 with a standard error of 0.03, which is virtually identical to (and not significantly different from) the AUC of 0.53 for the null reference model with only country fixed effects. The joint model has an AUC that is virtually identical to the pure private sector credit model, indicating that little is gained by including public debt information in the long term. We also checked the robustness of these results by including additional controls for the level of credit and debt or an interaction between the two, but none of these specifications affected our key results and the additional controls were not statistically significant, as the table shows.

In addition, we ran a number of robustness checks (not shown here). We included GDP growth relative to trend as a control to see if crises are more likely in times of slow growth. We also split the sample to examine whether crisis dynamics differ between pre– and post–World War II. The results remained unaffected by the sample

crises in the 1990s, or during the Global Financial Crisis of 2008. It is clear that the lines are not always easy to draw, but the overall results appear robust to variations in the crisis definitions.

split—credit remains a statistically significant indicator for financial instability in both periods. In addition, growth trends turn out not to correlate closely with financial fragility before World War II. The link is somewhat tighter after World War II, but fails to be significant at standard thresholds.

Summing up, the idea that financial crises have their roots in fiscal problems finds little support over the long sweep of history. Some cases may of course exist—such as Greece today—but these cases have been the exception not the rule. In general, as for Ireland and Spain today, financial crises can be traced back to developments in the financial sector itself.

4. Private Credit and Public Debt over the Business Cycle, 1870–2011

One explanation for the results of the previous section could be differences in the cyclicality of private credit and private debt. How do private credit and public borrowing evolve over the business cycle? Are they procyclical or countercyclical? Have the dynamics of private credit and public debt changed in different eras and under different monetary regimes? And how does the behavior of private credit and public debt differ between normal cycles and those associated with financial crises? These are the questions we address in this section.

4.1. Methods

There are no official data on business cycle turning points going back 140 years and covering all the countries in our sample. We investigate the business cycle features of the data by generating two auxiliary dummy variables using the intuition in the Bry and Boschan (1971) algorithm. At a yearly frequency, this algorithm replicates the NBER's dating of US business cycle peaks and troughs almost perfectly.

The algorithm generates dates of peaks and troughs in economic activity for each country in our sample separately. Conveniently, this simple algorithm does not require any prior detrending of the data. Using real GDP per capita, a *peak* corresponds to a local maximum whereas a *trough* corresponds to a local minimum. Therefore, recessions refer to the period between a peak and the following trough, whereas expansions refer to the period between the trough and the subsequent peak. By definition, peaks and troughs perfectly alternate one another.

Using these peaks and troughs, we can compute three cyclical statistics of interest for any given variable: *amplitude*, *duration*, and *rate. Amplitude* denotes the average change between turning points, *duration* refers to the average interval of time elapsed between turning points, and *rate* is simply the ratio of *amplitude* over *duration* and provides a per year rate of change.

4.2. Five Stylized Facts

Using this dating method, we sketch the broad contours of output, debt, and credit in the modern business cycle. Remember that our 17-country sample represents the

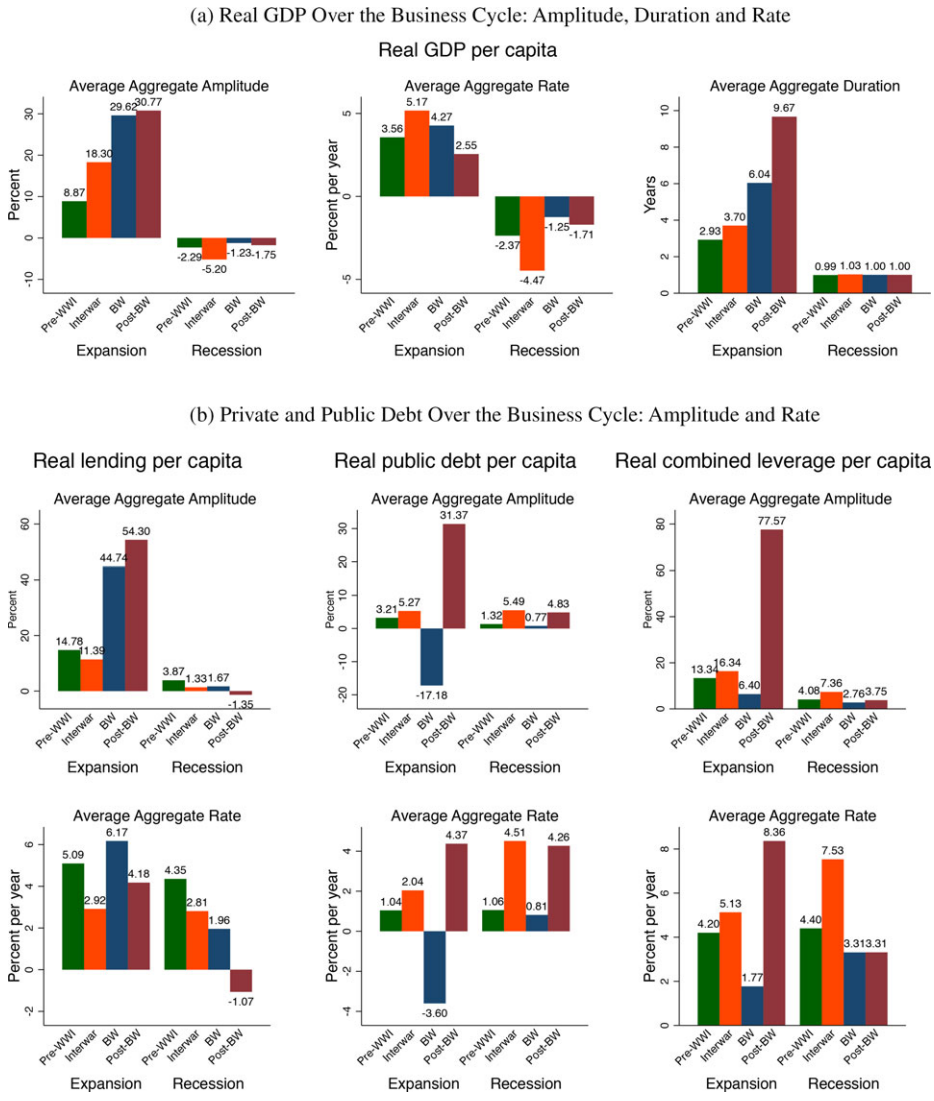

FIGURE 3. Real GDP, private credit, and public debt over the business cycle. Amplitude, duration, and rate are as defined in the text: duration is the length from start to end of the expansion/recession phase for real GDP per capita, in years; amplitude is change in any variable over the phase, in percent; rate is amplitude of any variable divided by the duration over the phase, in percent per year. BW denotes the Bretton Woods period.

near-universe of advanced economies for which long-run data exist. Five facts about the modern business cycle, encapsulated in Figure 3, stand out.

First, as panel (a) shows, the typical expansion has become longer lasting. Expansions lasted less than three years before World War I, almost four years between the two world wars, six years during the Bretton Woods era, and ten years since. As

expansions have become longer-lasting, output per capita amplitudes in expansions have gradually risen as well. It is striking that recessions have lasted one year on average in all periods, but were deeper during the interwar era.

Second, the annual rate of real GDP growth in the expansion (amplitude divided by duration) has gradually declined. It averaged 3.6% per annum before World War I, peaked at 5.2% per annum in the interwar period, declined to 4.3% per annum in the Bretton Woods era, and currently averages about 2.6% per annum. Put another way, business cycles last longer but annual growth rates have come down.

Third, private bank lending is distinctly procyclical. It grows faster in expansions than in recessions, and increasingly so. In a typical cycle of the post–Bretton Woods era, real private credit per capita increased by about 55%, about double the growth rate of per capita GDP (see Figure 3(b), column 1).

Fourth, public debt tends to grow faster in recessions than in expansions, indicating there is some counter cyclical stance to public borrowing. Moreover, the Bretton Woods period stands out as the only period where public debt was reduced in both expansions and recessions (Figure 3(b), column 2). In the immediate postwar decades, countries gradually reduced their World War II debt obligations aided by the reconstruction boom and tight financial system control.

Fifth, the combined sum of public debt and private credit (Figure 3(b), column 3) has grown at an unprecedented pace in the past four decades. It is evident from the chart that the 1970s mark a major break in the dynamics of aggregate debt. The combination of strong private credit growth and higher public borrowing put the annual growth of total liabilities at 8.4% per annum in expansions and 3.3% per annum in recessions, a remarkable development in the history of the last 140 years.

In sum, we find that business cycles have gradually become longer lasting and much more credit-intensive. Private borrowing tends to be strongly procyclical while public borrowing displays some countercyclical elements in advanced economies. In modern economic history, the Bretton Woods period stands out as the only period of sustained public debt reduction, both in expansions and recessions.

4.3. Booms, Busts, and Crises

Not all cycles are created equal. Some cycles end in financial crises and severe recessions; others do not. The natural next step is to ask how the cyclical behavior of credit differs between normal cycles and those that end in severe financial crises.

We therefore introduce a distinction between recessions that coincide with a major financial crisis—we call these *financial crisis recessions*—and those without major financial disruptions, which we call *normal recessions*. More precisely, we call a recession *financial* if a major financial crisis erupts within a two-year window around the peak (the start of the recession). This classification is summarized in Table B.1 of Appendix B and extends prior work in Jordà, Schularick, and Taylor (2013) with added data for Belgium, Finland, and Portugal and the post-2008 years, and some refinements to the definitions of financial crisis dates.

TABLE 2. Summary statistics for recessions, private credit, and public debt variables.

	All recessions		Financial recessions		Normal recessions	
(a) Full sample						
Financial recession indicator	0.23	(0.42)	1.00	0.00	0.00	0.00
Observations	269		63		206	
Normal recession indicator	0.77	(0.42)	0.00	0.00	1.00	0.00
Observations	269		63		206	
Change in private credit/GDP	0.71	(2.22)	1.76	(2.30)	0.40	(2.11)
Observations	204		47		157	
Change in public debt/GDP	−0.76	(6.06)	−0.13	(3.65)	−0.95	(6.62)
Observations	218		51		167	
Public debt level/GDP	0.51	(0.36)	0.50	(0.34)	0.51	(0.37)
Observations	247		58		189	
(b) Pre–World War II sample						
Financial recession indicator	0.28	(0.45)	1.00	0.00	0.00	0.00
Observations	186		52		134	
Normal recession indicator	0.72	(0.45)	0.00	0.00	1.00	0.00
Observations	186		52		134	
Change in private credit/GDP	0.57	(2.34)	1.41	(2.15)	0.25	(2.34)
Observations	128		36		92	
Change in public debt/GDP	−0.81	(6.75)	−0.28	(3.89)	−1.01	(7.54)
Observations	149		40		109	
Public debt level/GDP	0.52	(0.37)	0.51	(0.35)	0.52	(0.38)
Observations	167		47		120	
(c) Post–World War II sample						
Financial recession indicator	0.13	(0.34)	1.00	0.00	0.00	0.00
Observations	83		11		72	
Normal recession indicator	0.87	(0.34)	0.00	0.00	1.00	0.00
Observations	83		11		72	
Change in private credit/GDP	0.95	(2.00)	2.92	(2.50)	0.61	(1.71)
Observations	76		11		65	
Change in public debt/GDP	−0.65	(4.26)	0.40	(2.65)	−0.85	(4.49)
Observations	69		11		58	
Public debt level/GDP	0.48	(0.34)	0.48	(0.33)	0.48	(0.34)
Observations	80		11		69	

Notes: Financial crisis and normal recession indicators are binary 0–1. Changes in private credit and public debt are in percentage points change per year in the prior expansion. Public debt level is the ratio relative to GDP at the business cycle peak. The mean is shown. For nonbinary variables, the standard deviation is in parentheses.

Table 2 summarizes the universe of recessions and their classification using this approach. Panel (a) corresponds to the full sample, panel (b) to the pre–World War II sample, and panel (c) to the post–World War II sample. The full sample contains 269 recession episodes of which 63 (or 23%) are classified as financial crisis recessions and 189 are classified as normal recessions. The proportion varies with each subsample. In the pre–World War II era 28% of recessions were financial crisis recessions, whereas after World War II the proportion falls by about half to 13%.

The table also includes information on changes in *private credit, public debt ratios*, and *public debt levels* measured respectively as the percentage point change per annum in private credit and public debt over GDP, and as a fraction of GDP, each measured over the business cycle expansion. With respect to private credit, the key result arising from the table is that private credit grows twice as rapidly before financial crisis recessions than before normal recessions, regardless of the era. From a business cycle perspective, this clearly reinforces the earlier finding that financial crises tend to be preceded by a rapid accumulation of *private* liabilities.

The public-debt-to-GDP ratio, by contrast, tends to decline before normal and financial crisis recessions. In the pre–World War II sample, public debt declines at a rate of about 1% per annum before normal recessions and 0.3% per annum before financial crisis recessions. After World War II, the difference between normal and financial cycles is starker. Whereas debt declines by a similar amount in normal recessions, about 0.9% per annum, it *increases* at a rate of about 0.4% per annum before financial crisis recessions. However, this result is driven by the absence of financial crises under the Bretton Woods System and the parallel reduction in public debt in the postwar reconstruction boom. In fact, looking at debt levels as a fraction of GDP there are hardly any difference across eras or across the type of recession.

Summing up, we find that business cycles associated with financial crises tend to exhibit much more credit-intensive expansions. Across all countries and periods, public debt tends to decline in expansions that end in financial crises, but these declines are small. The lesson seems to be that, at least in advanced economies, the build-up of financial fragility typically occurs on private sector balance sheets, not through the government's budget.

5. Fiscal Capacity and the Costs of Financial Crises

The empirical observation that recoveries from financial crisis recessions seem to be special (see, e.g., Cerra and Saxena 2008; Reinhart and Rogoff 2009a; Claessens, Kose, and Terrones 2011) has prompted researchers to look deeper into the causes of slow recoveries. One key theme is that high and/or newly elevated levels of private indebtedness—a debt overhang—may hold back economic recovery after financial crises. In the crisis, agents in the economy suddenly realize that asset values were too high and leverage limits too lax. After this "Minsky moment", households (or companies) repair their balance sheets and adjust their debt levels. This deleveraging process in turn may weigh on aggregate demand and be responsible for the sluggish recovery (Koo 2008; Mian and Sufi 2010; Mian, Rao, and Sufi 2013).[7] Jordà,

7. Eggertsson and Krugman (2012) present a model with heterogeneous households: some households are patient creditors, others are impatient debtors. When credit conditions tighten in a crisis, indebted households have to cut back on consumption to adjust to the new borrowing constraint. The real interest rate needs to fall to induce higher spending by patient households, but the zero lower bound may prevent full adjustment in the short run. Hall (2011), Guerrieri and Lorenzoni (2011), as well as Philippon and

Schularick, and Taylor (2011, 2013) demonstrate in related empirical work that private debt overhang effects after credit booms are a regular feature of the business cycle.

Yet what has not been studied before is how private and public balance sheets jointly determine the cost of financial crises. Is the level of public debt systematically related to the economic fall-out from credit booms? Are financial crises worse when the fiscal space of the government is smaller? Does history provide evidence that there is a precautionary case for preserving fiscal space to cushion the fall-out from financial instability and reduce the economic costs of crises? The empirical approach that we follow to address these issues is multifaceted and proceeds in three steps.

After a short presentation of our key statistical methods (Section 5.1), we first revisit the historical evidence on the aftermath of private sector debt booms (Section 5.2). More precisely, we study if and how private credit booms influence the depth of recession and the speed of recovery. We find that *private credit* build-up during the expansion tends to make the subsequent recession deeper and longer lasting, confirming and extending the results in Jordà, Schularick, and Taylor (2011, 2013).

In the next step (Section 5.3), we take a closer look at the effects of high public debt on the recovery from normal and financial recessions. We show that the typical recession path of an economy is not affected by the level of public debt in normal times. In financial crisis recessions, the recovery path is consistently worse when public debt is one standard deviation higher than the mean. By year five, the recovery is about 2% weaker when initial public debt is high, but the effect is not statistically significant.

The two preceding approaches may provide some instructive evidence, but they do not yet address the crucial question we set out to study: how do private and public balance sheets interact in times of crisis? Is it the combination of private sector deleveraging after large credit booms *and* limited fiscal capacity of the government owing to high initial public debt that raises the cost of financial crises? We look at the aftermath of private credit booms at times of high public debt in the last part (Section 5.4) and come to the conclusion that it pays to be cautious (Obstfeld 2013).

High levels of public debt exacerbate the effects of private sector deleveraging. The combination of private sector credit booms with high levels of public sector debt leads to considerably deeper recessions and slower recoveries. Our results lend support to precautionary fiscal policy regimes to keep public sector debt low during normal times for a narrow, specific reason: to avoid the need for a parallel retrenchment of private and public sector borrowing in times of crisis, and in the associated and typically prolonged recession which follows.

5.1. Statistical Design

The statistical toolkit we use relies on the local projection (LP) approach introduced in Jordà (2005). Several reasons justify this choice.

Midrigan (2011), develop similar ideas. Another strand of the literature warns of the effects of the overhang from public borrowing. Reinhart, Reinhart, and Rogoff (2012) found evidence that public debt overhang episodes are associated with a substantial slowdown of GDP growth relative to low-debt years.

The sample of data available may appear abundant for most statistical analyses. However, we are interested in characterizing a number of dynamic multipliers from a multivariate perspective. Standard models are far too parametrically intensive for the available sample. Moreover, some of the multipliers that we calculate allow for asymmetries and nonlinearities in the form of modulation via the level of debt at the start of the recession. These features are difficult to model with assumptions about the underlying global data-generating process. In any case, this would impose numerical burdens that our sample cannot easily bear. Instead, direct local analysis of the multipliers of interest using the LP method is straightforward.

Let K denote the dimension of the vector of macroeconomic aggregates of interest, M denote the cross-section dimension of countries, and T denote the time dimension of the sample. For any variable $k = 1, \ldots, K$ we want to characterize the change of the variable from the start of the recession to some distant horizon $h = 1, \ldots, H$, or the change from time $t(p)$ to time $t(p) + h$ where $t(p)$ refers to the calendar time period t in which the pth peak in economic activity occurs (the start of the pth recession). We focus on the change from the start of the recession to some future period so that the results can be directly compared with results available in the literature for unconditional responses.

Let $y^k_{it(p)}$ denote a given macroeconomic aggregate observed for country $i = 1, \ldots, M$ at time $t(p)$. The h period ahead change is denoted $\Delta_h y^k_{it(p)+h}$. For simplicity, when $h = 1$ we simply use the first-difference notation Δ without the subscript, as is customary. Sometimes $\Delta_h y^k_{it(p)+h}$ will refer to the percentage point change, given by the h-step difference in 100 times the logarithm of the variable. An example is when y^k_{it} refers to 100 times the logarithm of real GDP per capita. Other times it may refer to the simple h-step difference, such as when y^k_{it} refers to an interest rate. These differences are easily understood from the context and we abstain from introducing further notation to indicate the distinction. The macroeconomic aggregates y^k_{it} are consolidated into the vector $Y_{it} = [\Delta y^1_{it} \ldots \Delta y^J_{it}\ y^{J+1}_{it} \ldots y^K_{it}]'$. The first J elements of this vector refer to variables expressed in first differences, such as 100 times the logarithm of real GDP per capita, and the remaining $K - J$ variables refer to variables in the levels, such as an interest rate.

Lastly, denote $x_{it(p)}$ the accumulated change of the variable x in the expansion that ended at time $t(p)$ for country i. Perturbations of this variable from its long-run mean (e.g., accelerations of borrowing) will define the experiments whose effects on other macroeconomic variables we wish to evaluate. The value of this variable remains fixed for any value of h over which $\Delta_h y^k_{it(p)+h}$ is considered.

Consequently, the path of the recession and the recovery, conditional on information up to time $t(p)$—and denoted $Y_{it(p)}, Y_{it(p)-1}, \ldots$—will vary depending on $x_{it(p)}$ and we will be interested in characterizing how these recovery paths change as $x_{it(p)}$ changes from a given baseline level that here we take as the long-run mean, $\bar{x}_i$, with respect to an experimental level $\bar{x}_i + \delta$.

That is, the average cumulated response for each variable in the K-dimensional vector of macroeconomic aggregates is defined as

$$CR\Big(\Delta_h y^k_{it(p)+h}, \delta\Big) = E\left(\Delta_h y^k_{it(p)+h} | x_{it(p)} = \bar{x}_i + \delta; Y_{it(p)}, Y_{it(p)-1}, \ldots\right) - E\left(\Delta_h y^k_{it(p)+h} | x_{it(p)} = \bar{x}_i; Y_{it(p)}, Y_{it(p)-1}, \ldots\right), \quad (2)$$

for $k = 1, \ldots, K$ and $h = 1, \ldots, H$. Under the assumption of linearity this cumulated response is simply the sum of the 1 to h impulse responses:

$$IR\left(\Delta y^k_{it(p)+h}, \delta\right) = E\left(\Delta y^k_{it(p)+h} | x_{it(p)} = \bar{x}_i + \delta; Y_{it(p)}, Y_{it(p)-1}, \ldots\right) - E\left(\Delta y^k_{it(p)+h} | x_{it(p)} = \bar{x}_i; Y_{it(p)}, Y_{it(p)-1}, \ldots\right), \quad (3)$$

for $k = 1, \ldots, K$ and $h = 1, \ldots, H$; that is,

$$CR\left(\Delta_h y^k_{it(p)+h}, \delta\right) = \sum_{\lambda=1}^{h} IR\left(\Delta y^k_{it(p)+\lambda}, \delta\right). \quad (4)$$

Expression (3) can be recognized as the definition of an impulse response in Jordà (2005). The reason to work with expression (2) rather than with expressions (3) and (4) is to provide a direct measure of the cumulated responses that do not rely on the probably implausible assumption of linearity. To proceed, we need a way to estimate expression (2).

In practice we estimate $CR(\Delta_h y^k_{it(p)+h}, \delta)$ by assuming that the expectation can be approximated by a local projection using the panel of countries $i = 1, 2, \ldots, 17$ and years $t = 1, \ldots, T$. In particular, this approximation can be obtained by estimating the following sequence of fixed-effects panel regressions:

$$\Delta_h y^k_{it(p)+h} = \theta^k_N d^N_{it(p)} + \theta^k_F d^F_{it(p)} + \beta^k_{h,N} d^N_{it(p)}\big(x_{it(p)} - \bar{x}_i\big) + \beta^k_{h,F} d^F_{it(p)}\big(x_{it(p)} - \bar{x}_i\big) + \sum_{l=0}^{L} \Gamma^k_{h,l} Y_{it(p)-l} + \alpha^k_i + u^k_{h,it(p)}, \quad (5)$$

for $k = 1, \ldots, K$ and $h = 1, \ldots, H$, where α^k_i are country fixed effects, u is the error term, θ^k_N is the common constant associated with normal recessions $d^N_{it(p)} = 1$ (0 otherwise), θ^k_F is the common constant associated with financial crisis recessions $d^F_{it(p)} = 1$ (0 otherwise); a history of l lags for the control variables $Y_{it(p)-l}$ with coefficient matrices $\Gamma^k_{h,l}$. When $x_{it(p)} = \bar{x}_i$, then θ^k_N and θ^k_F measure the average cumulated response in normal versus financial crisis recessions. Recall that these unconditional means differ in the sample, and allowing for this distinction is consistent with our earlier findings. When $x_{it(p)} = \bar{x}_i + \delta$, the marginal effect of the experiment

δ is given by the coefficients $\beta^k_{h,N}$ and $\beta^k_{h,F}$ depending on whether the recession is normal (N) or financial (F). Here we could have assumed that $\beta^k_{h,N} = \beta^k_{h,F}$ but we prefer to omit this restriction, and allow the data to speak out.

Our decision to use a panel estimator with fixed effects allows cross-country variation in the typical path and in the average response to δ. This is a convenient formulation that accounts for variation in the degree of financialization and other macroeconomic differences across countries, while still identifying the common component of the response.

If δ were exogenously determined, then expression (2) would provide the causal effect of an increase x on the outcome y at time h. Formally, we cannot claim this to be the case. However, we note that the amount of private credit or public debt is a given quantity at the start of the recession. There is no direct feedback mechanism except for a potential anticipation during the expansion on the severity of an impending recession.

The Y variables that we include as controls are: (1) the growth rate of real GDP per capita; (2) the growth rate of real loans per capita; (3) the consumer price index (CPI) inflation rate; (4) the growth rate of real investment per capita; (5) the growth rate of real public debt per capita; (6) short-term interest rates on government securities (usually three months or less in maturity); (7) long-term interest rates on government securities (usually five years or more in maturity); and (8) the current-account-to-GDP ratio. Note that our set of controls Y will include data on lending and public debt, which will tend to attenuate any effects that we measure through x. That is, we stack the odds against finding that credit or debt have any independent effects on the shape of the recession and recovery.

We remark that, in all that follows, we compute the treatment terms $(x_{it(p)} - \bar{x}_i)$ and controls $Y_{it(p)-l}$ as levels relative to their means in the financial and normal recession bins, respectively. The reason is that, by demeaning (or centering) the variables in this way, the intercept terms θ have the natural and desirable interpretation as the average conditional path when all controls are at their mean level in each bin.

Finally, also note that expression (5) does not allow for a different coefficient $\Gamma^k_{h,l}$ on the additional control variables for normal versus financial crisis recessions. The reason is that we are not interested in their coefficients. The role of these variables is to soak up information as explained in Jordà (2005). Although it would be ideal to have different coefficients depending on whether the recession is normal or financial, in practice the effect on the estimate of the coefficient of the response is very small and flexibility comes at a high cost of parsimony given our sample.

Starting with private credit, we use one times the standard deviation of private credit growth from its long-run average as our "experimental" x variable. That is, we track how credit booms in the expansion change the conditional forecasts of other macroeconomic variables in the subsequent recession and recovery.

Expression (5) serves as the platform from which we develop a more ambitious exploration of the effects of high public debt levels and the interaction between private and public debt overhangs. These extensions will require modifications to our main

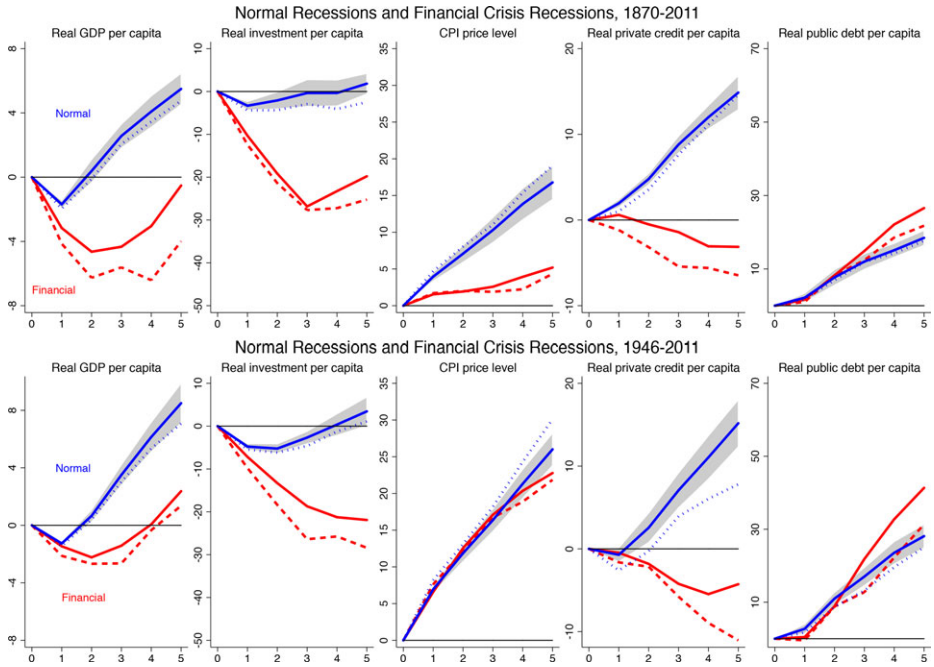

FIGURE 4. Conditional cumulative change from the start of the recession of selected macroeconomic aggregates as a function of the size of the preceding private credit boom and the type of recession. Samples: 1870–2011 and 1946–2011. Scales are matched by column but allowed to vary across variables. Each path shows local projections of the cumulative change relative to peak for years 1–5 of the recession/recovery period under different experiments. The top row refers to a private credit experiment. The solid line with shaded region refers to the average path in normal recessions. The shaded region is a 95% confidence interval. The dotted line refers to the path in a normal recession when private credit during the expansion grew at the mean plus one standard deviation. The solid line without shaded region refers to the average path in financial crisis recessions. The local projections are conditional on the full set of macroeconomic aggregates and their lags, with paths evaluated at the means. See text.

estimating equation in expression (5) that we discuss as each experiment is introduced in what follows.

5.2. Private Credit Booms

Consider first how lending booms alter the expected course of an economy through recession and recovery. We look at the effect of a one standard deviation perturbation from the long-run average across all countries in the annual change of private credit in the expansion. This experiment builds on the analysis in Jordà, Schularick, and Taylor (2013) but relies on a larger and longer sample.

Figure 4 reports the cumulated responses calculated using expressions (2) and (5) for output, investment, prices, bank lending, and public debt. Price is the CPI level; all other variables are real per capita. Table 3 reports the specific coefficient estimates

TABLE 3. Local projections showing response of real GDP per capita, for normal versus financial crisis recessions, allowing for the size of the preceding private credit boom. Sample: 1870–2011.

	Year 1	Year 2	Year 3	Year 4	Year 5
Normal recession (average effect)	−1.69***	0.38	2.56***	4.08***	5.49***
	(0.13)	(0.36)	(0.37)	(0.49)	(0.49)
Financial recession (average effect)	−3.17***	−4.64***	−4.33***	−3.05*	−0.52
	(0.55)	(1.13)	(1.21)	(1.45)	(1.27)
Private credit, Normal	−0.12	−0.22	−0.23	−0.29	−0.34
	(0.15)	(0.32)	(0.33)	(0.33)	(0.37)
Private credit, Financial	−0.39	−0.65	−0.52	−1.35	−1.40
	(0.33)	(0.75)	(0.52)	(0.98)	(0.81)
R^2	0.64	0.39	0.47	0.42	0.49
Normal = Financial (average effect), p	0.04	0.00	0.00	0.00	0.00
Normal = Financial (private credit), p	0.30	0.46	0.56	0.26	0.15
Observations	147	147	147	147	147

Notes: Each column shows local projections of the cumulative change in 100 times log real GDP per capita relative to peak for years 1–5 of the recession/recovery period. Private credit (followed by either Normal or Financial) refers to the marginal effect of private credit accumulation above the historical mean on the average path in Normal and Financial crisis recessions, respectively. Normal = Financial tests the null that coefficients for each type of recession are the same for the intercept terms in the row labeled average, and for the interaction terms in the row marked Private credit. In each case the p-value of the tests is provided. The local projections are conditional on the full set of macroeconomic aggregates and their lags, with coefficients not reported. See text. Robust standard errors (clustered by country) in parentheses.
*Significant at 10%; **significant at 5%; significant at 1%.

displayed for the responses of real GDP per capita in the full sample (top row and first column in the figure).

Consider the responses displayed in Figure 4. The top row refers to the full sample analysis whereas the bottom row refers to the post–World War II sample. In a normal recession, output declines in year one about 1%–2%, recovers its original pre-recession level by year two, and then continues to grow in years three to five. However, financial crisis recessions are considerably more painful. On average, they only reach bottom (−5%) around year two or three, and output does not quite recover its pre-recession level by year five.

Table 3 provides more detailed evidence for the full sample responses of real GDP per capita (top row, and first column in Figure 4). The table reports local projection coefficient estimates and robust standard errors (clustered by country) in parentheses. The first two rows capture the average response of output growth in normal and financial crisis recessions. Recall that in the full sample three out of four recessions are of the normal type, and one in four is a financial crisis recession. A formal test of the equality of the average responses in normal and financial crisis recessions is provided in the row labeled Normal = Financial (average effect). As the p-values show, there is unequivocal statistical evidence that the paths of the recession/recovery differ considerably depending on the type of recession. The two rows labeled Private credit report the marginal effect of private credit accumulation during the boom on the average path of output growth in the recession/recovery.

As a robustness check, we consider a subsample analysis based on post–World War II data, although this sample only contains eleven financial crisis recessions. We have already excluded the two World War periods from the analysis, but the interwar period was unusually turbulent and marked by the Great Depression. The bottom row of Figure 4 replicates the analysis in the top row using the shorter and more contemporary sample from 1946 to 2011. The results hold up qualitatively and quantitatively. Financial crisis recessions are more painful and take longer to recover from than normal recessions, although their severity has been somewhat tempered.

Overall, the responses confirm that financial crises are more painful and take longer to recover from than normal recessions, even after conditioning on macroeconomic aggregates and their lags. Moreover, a large accumulation of private sector debt during the preceding expansion—a private sector credit boom—tends to make recessions and recoveries worse.[8]

5.3. Public Debt

Does high public debt make normal and financial recessions worse and recoveries slower? To estimate these effects, we can modify expression (5) to measure how the level of debt to GDP modulates the average response in the recession conditional on controls.

Specifically, we now estimate a sequence of fixed-effects panel regressions:

$$\begin{aligned}\Delta_h y^k_{it(p)+h} = {} & \theta^k_N d^N_{it(p)} + \theta^k_F d^F_{it(p)} + \varphi^k_{h,N} d^N_{it(p)}\left(g_{it(p)} - \bar{g}_i\right) \\ & + \varphi^k_{h,F} d^F_{it(p)}\left(g_{it(p)} - \bar{g}_i\right) + \sum_{l=0}^{L} \Gamma^k_{h,l} Y_{it(p)-l} + \alpha^k_i + u^k_{h,it(p)}\end{aligned} \tag{6}$$

for $k = 1, \ldots, K$ and $h = 1, \ldots, H$, where $g_{it(p)}$ denotes the level of debt to GDP for country i at the start to the recession at time $t(p)$.

Using expression (6) we then consider three experiments: the three experiments refer to situations in which debt is about 15%, 50%, and 85% of GDP, which we call low, medium, and high levels of debt relative to GDP (in these experiments, and in what follows, perturbations in public debt are relative to the country mean). We continue to allow the mean to be country-specific to allow for variation in addition to the fixed effect.

The results of these experiments are reported in Figure 5 for normal and financial crisis recessions, using the full sample. Figure 5 displays the trajectory of output,

8. We ran similar experiments for the accumulation of public debt in the expansion, as opposed to the level which we study in the next section, but did not find strong effects.

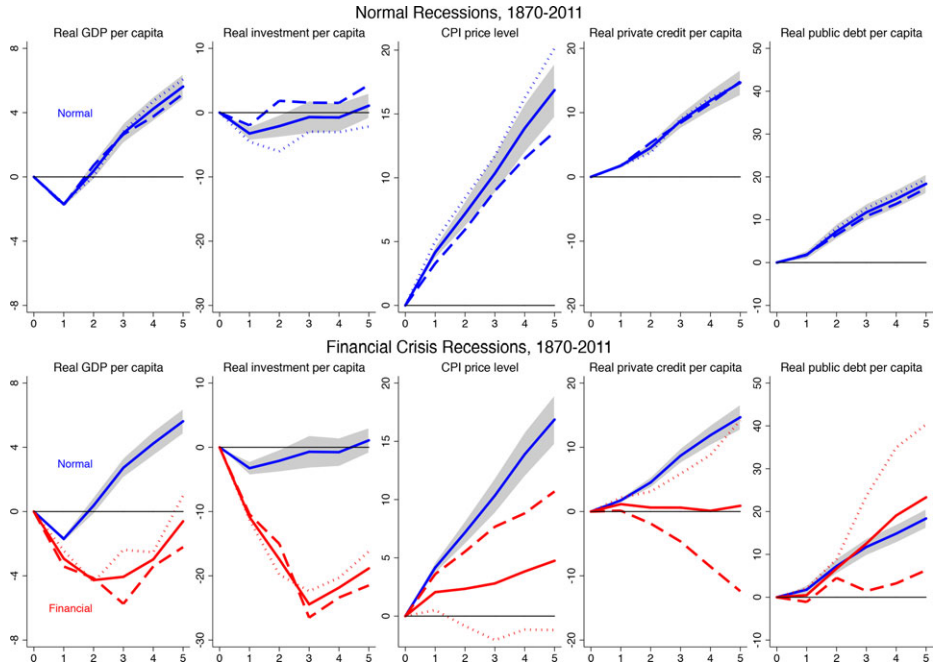

FIGURE 5. Conditional cumulative change from the start of the recession of selected macroeconomic aggregates as a function of the public debt level at the start of the recession and the type of recession. Sample: 1870–2011. Scales are matched by column but allowed to vary across variables. Each path shows local projections of the cumulative change relative to peak for years 1–5 of the recession/recovery period under different experiments. The top row refers to normal recessions. The solid line with 95% confidence region refers to public debt at the historical mean, and hence replicates the average response reported in Figure 4. The dotted line corresponds to public debt one standard deviation below mean, and the dashed line to public debt one standard deviation above the mean. The bottom row refers to financial crisis recessions. The solid line with 95% confidence region replicates the trajectory displayed in the first row. As with the normal recessions, the dotted line corresponds to public debt one standard deviation below mean, the solid line to public debt at the mean, and the dashed line to public debt one standard deviation above the mean. These results are conditional on the full set of macroeconomic aggregates and their lags, with paths evaluated at the means. See text.

investment, inflation, bank lending, and public debt in a normal recession and in a financial crisis recession.

The top row displays typical trajectories in a normal recession. The solid, dotted, and dashed lines denote the trajectory when the debt level at the start of the recession is at its long-run average (along with a 95% confidence region), is one standard deviation below mean, and is one standard deviation above mean, respectively. The bottom row maintains the solid line as the trajectory in a normal recession, with the debt level at the start of the recession at its long-run average (with a 95% confidence region), and then adds three additional trajectories, all corresponding to a financial crisis under the three different assumptions on the level of debt. As before, the dotted line corresponds to debt at one standard deviation below the mean, the solid line (without confidence

TABLE 4. Local projections showing response of real GDP per capita, for normal versus financial crisis recessions, allowing for the public debt level at the start of the recession. Sample: 1870–2011.

	Year 1	Year 2	Year 3	Year 4	Year 5
Normal recession (average effect)	−1.70***	0.37	2.73***	4.24***	5.62***
	(0.09)	(0.27)	(0.31)	(0.39)	(0.40)
Financial recession (average effect)	−2.93***	−4.27***	−4.06***	−2.98**	−0.61
	(0.49)	(0.91)	(0.96)	(1.07)	(0.89)
Public debt, Normal	−0.14	0.88	−0.21	−1.23	−1.16
	(0.56)	(0.89)	(1.44)	(2.53)	(3.07)
Public debt, Financial	−1.30	0.33	−4.42	−1.16	−4.23
	(3.00)	(4.39)	(6.82)	(7.70)	(7.02)
R^2	0.62	0.34	0.44	0.39	0.45
Normal = Financial (average effect), p	0.05	0.00	0.00	0.00	0.00
Normal = Financial (public debt), p	0.69	0.90	0.57	0.99	0.73
Observations	161	161	161	161	161

Notes: Each column shows local projections of the cumulative change in 100 times log real GDP per capita relative to peak for years 1–5 of the recession/recovery period. Results correspond to local projections of cumulative change in 100 times log real GDP per capita relative to peak for years 1–5 of the recession/recovery. *Public debt* (followed by either *Normal* or *Financial*) refers to the marginal effect of the public debt level above the historical mean on the average path in *Normal* and *Financial* crisis recessions, respectively. *Normal = Financial* tests the null that coefficients for each type of recession are the same for the intercept terms in the row labeled *average*, and for the interaction terms in the row marked *Public debt*. In each case the p-value of the tests is provided. The local projections are conditional on the full set of macroeconomic aggregates and their lags, with coefficients not reported. See text. Robust standard errors (clustered by country) in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1%.

region) refers to debt at the long-run average, and the long-dashed line corresponds to debt at one standard deviation above the long-run average.

Consider the trajectories for output first. The level of public debt at the start of the recession does not meaningfully alter the path of the economy in normal times. The trajectories of output when debt is low, at its long-run mean, or high are virtually the same. Things are different for financial crisis recessions. The output path is somewhat lower. The effects add up to a statistically insignificant 2% by year five. With higher debt levels at the start of the recession, bank lending in particular appears to contract more, hinting at more protracted private sector deleveraging when fiscal capacity is constrained.

Table 4 provides a detailed look at the coefficient estimates behind the responses reported for real GDP per capita in Figure 5. Specifically, the first two rows correspond to the average response of real GDP per capita in Normal and Financial crisis recessions, and are relatively similar in magnitude to the first two rows in Table 3. The next two rows, labeled Public Debt and either Normal or Financial, contain the marginal effect of public debt on the severity of the recession, and are estimated with a great deal of imprecision.

As an example, if public debt is running 35 percentage points of GDP (or one standard deviation) below its long-run country-mean at the recession peak, then the predicted path of the recession (the dotted line in the first row and first column of

Figure 5) can be calculated for each year as the sum of the coefficient from the first row in Table 4 minus 0.35 times the coefficient in the third row.

Table 4 contains two formal tests. The line Normal = Financial (average) reports the p-values of the per year test of equality that the average trajectory in recessions is the same whether the recession is normal or a financial crisis recession. As in Table 3, this null is easily rejected. Below it, the line Normal = Financial (public) provides the p-values of the test that the marginal effect of the level of public debt at the start of the recession has the same effect whether in normal or financial crisis recessions. These coefficients are imprecisely estimated in the given sample and the null cannot be rejected.

At this stage, we have found some limited evidence that high levels of public debt can affect the path of economies coming out of recessions. Our granular conditional estimations suggest that the negative effects of high public debt are visible in some macroeconomic variables. Lending seems to be particularly strongly affected and, to a lesser degree, investment and growth. In the next section, we turn to the interaction of private credit booms and high public debt. We will see that the effects are magnified when large private credit booms meet constrained government balance sheets.

5.4. Credit Booms and High Public Debt

What if the private sector levers up at a time of high public debt? Are the after-effects of private sector credit booms compounded when the public sector is constrained by already high levels of public debt? The goal of this section is to study the aftermath of financial crises that were preceded by large private sector credit booms and occurred at time of high public debt which limits the fiscal capacity of the government to pursue macroeconomic and financial stabilization. We will see that the interaction matters a lot. Particularly in financial crisis recessions the drag from a private credit boom is made worse by high levels of public debt.

Looking at private and public debt jointly can be easily accomplished within the statistical design presented in expressions (2), (5), and (6). Specifically, consider extending this last expression as:

$$\begin{aligned}\Delta_h y^k_{it(p)+h} = {} & \theta^k_N d^N_{it(p)} + \theta^k_F d^F_{it(p)} + \beta^k_{h,N} d^N_{it(p)}\big(x_{it(p)} - \bar{x}_i\big) \\ & + \beta^k_{h,F} d^F_{it(p)}\big(x_{it(p)} - \bar{x}_i\big) + \varphi^k_{h,N} d^N_{it(p)}\big(g_{it(p)} - \bar{g}_i\big) \\ & + \varphi^k_{h,F} d^F_{it(p)}\big(g_{it(p)} - \bar{g}_i\big) + \delta^k_{h,N} d^N_{it(p)}\big(g_{it(p)} - \bar{g}_i\big)\big(x_{it(p)} - \bar{x}_i\big) \\ & + \delta^k_{h,F} d^F_{it(p)}\big(g_{it(p)} - \bar{g}_i\big)\big(x_{it(p)} - \bar{x}_i\big) \\ & + \sum_{l=0}^{L} \Gamma^k_{h,l} Y_{it(p)-l} + \alpha^k_i + u^k_{h,it(p)} \end{aligned} \tag{7}$$

for $k = 1, \ldots, K$ and $h = 1, \ldots, H$. The coefficients $\beta^k_{h,N}$ and $\beta^k_{h,F}$ capture the effect of accumulation of private sector liabilities during the expansion. The coefficients have

a similar interpretation to the coefficients in expression (5). Next, the coefficients $\varphi^k_{h,N}$ and $\varphi^k_{h,F}$ capture the effect of the level of debt at the start of the recession, as discussed in the previous section. Notice that the debt level g enters as deviations from country-specific means to allow for cross-country variation. Finally, the coefficients $\delta^k_{h,N}$ and $\delta^k_{h,F}$ correspond to the interaction of the public debt level with the private credit overhang term. Their purpose is to allow for a modulated effect on x. That is, these coefficients allow us to consider whether the effects of a private credit binge during the expansion aggravate a financial crisis recession even more when public debt levels are high to begin with.

Figure 6 displays as concise a summary of the numerous experiments as is possible. The figure is organized in two rows. The top row corresponds to experiments with normal recessions and the bottom row to experiments with financial crisis recessions. Both rows display experiments in which bank lending grew at the average level plus one standard deviation in the previous expansion, but the effect of the private credit overhang is modulated by the level of public debt to GDP at the start of the recession. The various dashed lines indicate how the path of the economy differs with public debt one standard deviation below the country mean (about 15% of GDP on average; dotted line), at the long-run country mean (about 50% of GDP on average; short-dashed line), or one standard deviation above the country mean (about 85% of GDP on average; long-dashed line). In all figures, the average path of normal recessions is displayed as a solid line along with a 95% confidence region.

Let us start with the top row that shows the effects in normal recessions. Broadly speaking, these five charts convey a similar message to the one discovered in the previous section. When the experiment focuses on public debt levels above the historical average, there are no measurable effects on growth and investment in normal recessions. However, the real story appears in the second row, namely in financial crisis recessions. High initial levels of public debt to GDP appear to constitute a considerable drag on the post-crisis recovery, driving up the cost of the financial crisis. Put differently, when a large private sector credit boom is unwound at a time when the public sector has little capacity to pursue macroeconomic and financial stabilization, output stays severely depressed for many years and is far off the previous peak even in year five.

The behavior of investment reinforces this message of a potentially dangerous cocktail of private and public sector debt: after private sector credit booms, high levels of public debt are associated with substantial shortfalls in investment coinciding with prolonged declines in bank lending.

Table 5 provides a granular look at the response of real GDP per capita. The first two rows (labeled Normal recession and Financial recession) contain the coefficients summarizing the average path of each type of recession and correspond rather closely to the coefficients reported in Tables 3 and 4. The row labeled Normal = Financial (average) again reports the p-value of the test of the null hypothesis that the average paths for each type of recession are statistically indistinguishable. That hypothesis is soundly rejected as it was earlier.

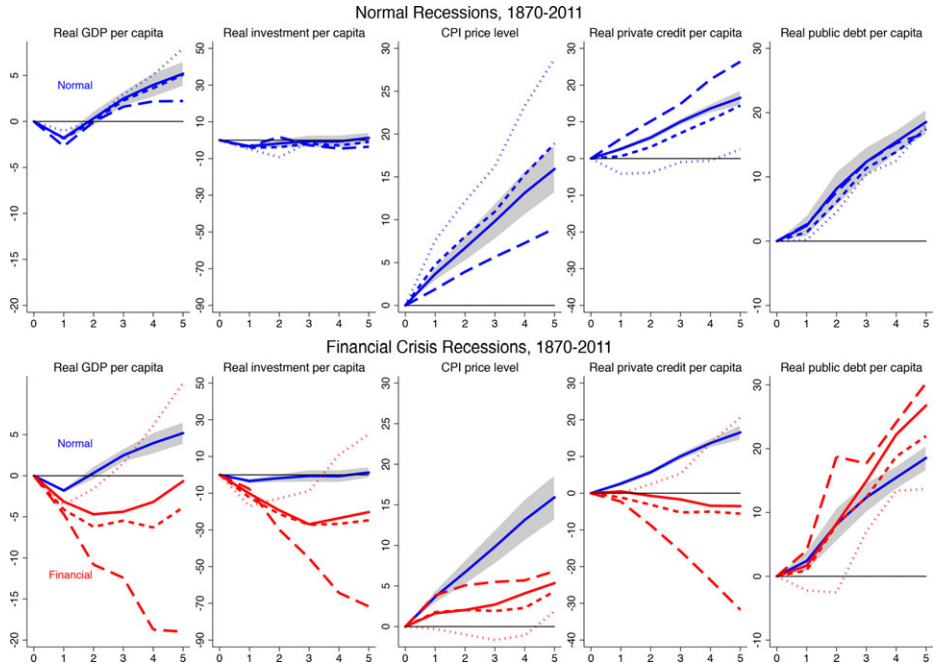

FIGURE 6. Conditional cumulative change from the start of the recession of selected macroeconomic aggregates as a function of the interaction of the size of the preceding private credit boom and the public debt level at the start of the recession and the type of recession. Sample: 1870–2011. Scales are matched by column but allowed to vary across variables. Each path shows local projections of the cumulative change relative to peak for years 1–5 of the recession/recovery period under different experiments. The top row refers to normal recessions, and the bottom row refers to financial crisis recessions. The solid lines depict the average response in each type of recession with all variables at their mean, and in the normal case with a 95% confidence region. The various nonsolid lines indicate how the path of the economy differs with two simultaneous perturbations: when private credit grows at the average level plus one standard deviation in the previous expansion; and, in addition, when public debt is set one standard deviation below mean, at the mean, or at one standard deviation above the mean. Each of these public debt levels is represented with a dotted line when debt is below mean, a short-dashed line when debt is at the mean, and a long-dashed line when debt is above the mean. These results are conditional on the full set of macroeconomic aggregates and their lags, with paths evaluated at the means. See text.

The next two rows of coefficients, labeled Public debt, are comparable to the similarly labeled coefficients in Table 4. Compared to that table, here the negative effects in financial crisis recessions are larger, more accurately estimated, and quite different to the coefficients in a normal recession. A formal test of equality of the coefficients across type of recession is provided in the row labeled Normal = Financial (debt). The null is rejected for year 4 at the 90% confidence level and for years 2, 3, and 5, at the 95% confidence level.

The tabulation of estimated coefficients concludes with two rows of interaction terms labeled Public debt × private credit. A few of the coefficients are statistically different from zero. However, economically speaking the coefficient estimates suggest

TABLE 5. Local projections showing response of real GDP per capita, for normal versus financial crisis recessions, allowing for the size of the preceding private credit boom and the public debt level at the start of the recession. Sample: 1870–2011.

	Year 1	Year 2	Year 3	Year 4	Year 5
Normal recession (average effect)	−1.80***	0.33	2.49***	3.97***	5.19***
	(0.14)	(0.41)	(0.41)	(0.67)	(0.69)
Financial recession (average effect)	−3.15***	−4.69***	−4.38***	−3.19**	−0.67
	(0.56)	(1.17)	(1.21)	(1.47)	(1.20)
Private credit, Normal	−0.03	−0.12	−0.09	−0.16	−0.05
	(0.13)	(0.29)	(0.30)	(0.41)	(0.43)
Private credit, Financial	−0.39	−0.61	−0.43	−1.25	−1.28*
	(0.34)	(0.69)	(0.50)	(0.78)	(0.67)
Public debt, Normal	−0.66	0.34	−0.94	−2.12	−3.18
	(0.76)	(0.88)	(1.17)	(2.62)	(3.83)
Public debt, Financial	−2.74	−4.96**	−13.85***	−11.80**	−14.92***
	(2.95)	(2.09)	(4.16)	(4.60)	(3.99)
Public debt × private credit, Normal	−0.65***	−0.27	−0.34	−0.67	−1.81
	(0.21)	(0.65)	(1.17)	(1.45)	(1.87)
Public debt × private credit, Financial	0.52	−2.92	−1.85	−8.50*	−10.13**
	(1.18)	(2.24)	(2.49)	(4.52)	(3.93)
R^2	0.65	0.41	0.51	0.46	0.54
Normal = Financial (average effect), p	0.06	0.01	0.00	0.00	0.00
Normal = Financial (credit), p	0.25	0.44	0.55	0.25	0.09
Normal = Financial (debt), p	0.47	0.02	0.01	0.09	0.06
Normal = Financial (interactions), p	0.28	0.17	0.41	0.06	0.01
Normal, debt effect = 0, p	0.02	0.75	0.72	0.70	0.56
Financial, debt effect = 0, p	0.32	0.03	0.01	0.01	0.00
Observations	147	147	147	147	147

Notes: Each column shows local projections of the cumulative change in 100 times log real GDP per capita relative to peak for years 1–5 of the recession/recovery period. Private credit refers to marginal effect of a credit boom on the path in Normal and Financial crisis recessions. Public debt refers to marginal effect of public debt on the path in Normal and Financial crisis recessions. Interaction credit × debt refers to the marginal effect of the interaction between a credit boom and public debt in Normal and Financial crisis recessions. Normal = Financial tests the null that the coefficients for the average, credit, debt and interaction cases are the same, reporting the p-value of the tests in each case. The lines labeled debt effect = 0 report the p-values of the tests of the null that the coefficients of the marginal effect of public debt and the interaction coefficient are jointly zero in Normal or Financial recessions. The local projections are conditional on the full set of macroeconomic aggregates and their lags (coefficients not reported). See text. Robust standard errors (clustered by country) in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1%.

that this interaction term captures an important friction for the recovery. A simultaneous deviation of private credit and public debt one standard deviation above the mean can result in about 5% less cumulative growth in real GDP per capita by year five (an average of one percentage point per annum) through this mechanism alone. A test of the null hypothesis that the effect is the same regardless of the type of recession is reported in the row labeled Normal = Financial (interaction). The null is rejected in years four and five, with p-values of 0.06 and 0.01.

The table includes two final formal hypotheses tests. These are designed to evaluate the null that the effect of debt and the effect of the interaction term are simultaneously insignificant. The rows reporting the p-values of the test in normal and financial crisis recessions are labeled debt effect. We find some evidence against the null, as in the case of normal recessions the p-value in year one is 0.02; but the rejection is strong in financial crisis recessions where the p-values for years two to five are 0.03, 0.01, 0.01, and 0.00 respectively. The sample sizes are rather limited. However, although sometimes imprecisely estimated, the economic effects here are much too large to be dismissed.

In sum, our findings argue in support of keeping public debt low for precautionary reasons. In particular, high public debt is associated with prolonged spells of weak growth in financial crisis recessions, especially those with high leverage. We speculate that lack of fiscal space undercuts governments' ability to use fiscal resources to recapitalize banks and/or offset demand drag from private sector balance-sheet repair.

6. Conclusion

This paper provides a first look at over 100 years of the inter-relationships of private credit and sovereign debt. We end with five main conclusions.

First, while public debt has grown in most countries in recent decades, the extraordinary growth of private sector debt (bank loans) is chiefly responsible for the strong increase of total liabilities in Western economies. About two-thirds of the increase in total economy debt originated in the private sector. Shadow bank liabilities, important in some cases such as the United States and United Kingdom, amplify this conclusion. Sovereign and bank debts have generally been inversely correlated over the long run, but have increased jointly since the 1970s. In modern times, the Bretton Woods period stands out as the only period of sustained public debt reduction, both in expansions and recessions.

Second, in advanced economies, financial stability risks originate primarily in the private sector rather than in the public sector. To understand the driving forces of financial crises, we have to study private borrowing and its problems. In the very long run, if we compare the impact of changes or run-ups in private credit (bank loans) and sovereign debt as a predictor of financial crisis and its associated distress, private credit is the more significant predictor; sovereign debt adds little predictive information. This fits with the events of 2008 well: with the exception of fiscal malfeasance in Greece, most other advanced countries did not have obvious public debt problems ex ante. Of course, ex post, the fierce financial crisis recession would wreak havoc on public finances via crashing revenues and rising cyclical expenditures.

Third, with a broader and longer sample we confirm that private debt overhangs are a regular feature of the modern business cycle. We find that once a country does enter a recession, whether it is an ordinary type or a financial-crisis type of recession, if it carries the legacy of a large private credit boom, then the post-recession output path of the economy is typically adversely affected with slower growth.

Fourth, our new data also allow us to see the distinct contribution of public debt to the costs of financial crises. We find evidence that high levels of public debt matter for the path of economies out of recessions, lending some support to the results of Reinhart, Reinhart, and Rogoff (2012). The negative effects of high public debt on the performance of the economy arise specifically after financial crises, and in particular when private borrowing has also been elevated. High levels of public debt make little difference in normal times, but entering a financial crisis recession with a high level of public debt exacerbates the effects of private sector deleveraging and typically leads to a prolonged period of sub-par economic performance, driving up the output costs of crises.

Fifth, from a macroeconomic policy standpoint these findings could inform ongoing efforts to devise better guides to monetary, fiscal, and financial policies going forward, at a time when policy makers are searching for new approaches in the aftermath of the Great Recession. On the private credit side, many countries and international bodies are considering or implementing rules or guides for macro prudential policies that incorporate private credit indicators. On the fiscal side, sovereign stresses in advanced countries have also brought to the fore questions of fiscal space and what limits on average or over the cycle may be usefully employed, whether, for example, in the form of fiscal rules or in better planning the timing of austerity. Our results give some historical underpinnings to these efforts: when private or public debts are elevated the dangers posed by crises and deep recession appear to be amplified.

Three key facts emerge from our analysis of around 150 recessions and recoveries since 1870. First, in a normal recession and recovery, real GDP per capita falls by 1.5% and takes only two years to regain its previous peak, but in a financial crisis recession, the drop is typically 5% and it takes over five years to regain the previous peak. Second, the output drop is even worse and recovery even slower when the crisis is preceded by a credit boom. Third, the path of recovery is worse still when a credit-fueled crisis coincides with elevated public debt levels. The current experience in the advanced economies provides a useful out-of-sample comparison, and meshes closely with these historical patterns.

Appendix A: Dates of Systemic Financial Crises, 1870–2011

The crisis prediction classification models in the paper employ data on all systemic financial crises from 1870 to 2011. Dates of systemic financial crises are based on Jordà, Schularick, and Taylor (2011) and Schularick and Taylor (2012), sources therein, and updates. See text.

AUS: 1893, 1989.
BEL: 1870, 1885, 1925, 1931, 1939, 2008.
CAN: 1873, 1907, 1923.
CHE: 1870, 1910, 1931, 1991, 2008.

DEU: 1873, 1891, 1901, 1907, 1931, 2008.
DNK: 1877, 1885, 1908, 1921, 1987, 2008.
ESP: 1883, 1890, 1913, 1920, 1924, 1931, 1978, 2008.
FIN: 1878, 1900, 1921, 1931, 1991.
FRA: 1882, 1889, 1930, 2008.
GBR: 1873, 1890, 1974, 1984, 1991, 2007.
ITA: 1873, 1887, 1893, 1907, 1921, 1930, 1935, 1990, 2008.
JPN: 1882, 1900, 1904, 1907, 1913, 1927, 1997.
NLD: 1893, 1907, 1921, 1939, 2008.
NOR: 1899, 1922, 1931, 1988.
PRT: 1890, 1920, 1923, 1931, 2008.
SWE: 1878, 1907, 1922, 1931, 1991, 2008.
USA: 1873, 1884, 1893, 1907, 1929, 1984, 2007.

Appendix B: Dates of Normal and Financial Crisis Recessions, 1870–2006

The local projections empirical analysis in the paper employs business cycle peaks from 1870 to 2006, excluding windows around the two world wars, with projections out to five years ahead, with the annual panel sample data, with the last year's projections from 2006 ending in 2011. As a result, peaks from the 2007–2011 period are not used in the sample, meaning that the empirical work does not include the Global Financial Crisis as an in-sample event. The peak dates that are used are as shown in the table below, where "N" denotes a normal business cycle peak, and "F" denotes a peak associated with a systemic financial crisis (a crisis within ± 2 years of the peak). The dating method follows Jordà, Schularick, and Taylor (2011) and uses the Bry and Boschan (1971) algorithm. See text.

TABLE B.1. Dates of normal and financial crisis recession peaks.

AUS	N	1875	1878	1881	1883	1885	1887	1889	1896	1898	1900	1904
		1910	1913	1926	1938	1943	1951	1956	1961	1973	1976	1981
	F	1891	1894	1989								
BEL	N	1872	1874	1887	1890	1900	1913	1916	1942	1951	1957	1974
		1980	1992									
	F	1870	1883	1926	1930	1937						
CAN	N	1871	1877	1882	1884	1888	1891	1894	1903	1913	1917	1928
		1944	1947	1953	1956	1981	1989					
	F	1874	1907									
CHE	N	1875	1880	1886	1890	1893	1899	1902	1906	1912	1916	1920
		1933	1939	1947	1951	1957	1974	1981	1994	2001		
	F	1871	1929	1990								

(*Continued*)

TABLE B.1. Continued.

DEU	N	1879	1898	1905	1913	1922	1943	1966	1974	1980	1992	2001
	F	1875	1890	1908	1928							
DNK	N	1870	1880	1887	1911	1914	1916	1923	1939	1944	1950	1962
		1973	1979	1992								
	F	1872	1876	1883	1920	1931	1987					
ESP	N	1873	1877	1892	1894	1901	1909	1911	1916	1927	1932	1935
		1940	1944	1947	1952	1958	1974	1980	1992			
	F	1883	1889	1913	1925	1929	1978					
FIN	N	1870	1883	1890	1898	1907	1913	1916	1938	1941	1943	1952
		1957	1975									
	F	1876	1900	1929	1989							
FRA	N	1872	1874	1892	1894	1896	1900	1905	1907	1909	1912	1916
		1920	1926	1933	1937	1939	1942	1974	1992			
	F	1882	1929									
GBR	N	1871	1875	1877	1883	1896	1899	1902	1907	1918	1925	1929
		1938	1943	1951	1957	1979						
	F	1873	1889	1973	1990							
ITA	N	1870	1883	1897	1918	1923	1925	1932	1939	1974	2002	2004
	F	1874	1887	1891	1929	1992						
JPN	N	1875	1877	1880	1887	1890	1892	1895	1898	1903	1919	1921
		1929	1933	1940	1973	2001						
	F	1882	1901	1907	1913	1925	1997					
NLD	N	1870	1873	1877	1889	1894	1899	1902	1913	1929	1957	1974
		1980	2001									
	F	1892	1906	1937	1939							
NOR	N	1876	1881	1885	1893	1902	1916	1923	1939	1941	1957	1981
	F	1897	1920	1930	1987							
PRT	N	1870	1873	1877	1888	1893	1900	1904	1907	1912	1914	1916
		1925	1927	1934	1937	1939	1941	1944	1947	1951	1973	1982
		1992	2002	2004								
	F	1890	1923	1929								
SWE	N	1873	1876	1881	1883	1885	1888	1890	1899	1901	1904	1913
		1916	1924	1939	1976	1980						
	F	1879	1907	1920	1930	1990						
USA	N	1875	1887	1889	1895	1901	1909	1913	1916	1918	1926	1937
		1944	1948	1953	1957	1969	1973	1979	1981	1990	2000	
	F	1873	1882	1892	1906	1929						

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