

Sovereigns versus Banks: Credit, Crises, and Consequences*

Abstract

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1 Introduction

From Beijing to Madrid to Washington, the risks of excessive borrowing feature prominently in the public debate. It's not hard to see why. A seemingly simple lesson that the many people drew from the financial crisis is that high debts harbor risks. When circumstances suddenly change, as they sometimes do, levels of indebtedness that seemed perfectly fine before may turn out to be highly problematic after a shock. Arguably, this lesson underpins changes in behavior such as attempts at deleveraging by foreclosed homeowners in Florida as well as for governments in Southern Europe. 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 problems 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."

Yet, as usual, in the real world, things are messy and not so unambiguous. The crisis in the Eurozone provides a neat illustration. Some observers, often with great conviction, see the crisis through the lens of public finance. The key source of the problem, according to this view, is the inherent inability of past governments in the periphery, and possibly soon even some in parts of the core, to live within their means. Stricter fiscal rules will prevent another crisis down the road. Others observers, by contrast, argue that it is private borrowing that we have to worry about most. In this reading, the crisis in Europe, excepting some egregiously misleading accounting in Greece, is essentially the result of credit booms and housing bubbles that emanated from the private sector and were fueled by private cross-border lending flows. When the bubble eventually burst, the public sector was forced to pick up the pieces and prevent the economy from going into a tailspin, whilst its fiscal space was eaten up by crisis-induced revenue collapses. In other words, public debt is merely an epiphenomenon and distracts from the real source of vulnerability.

Whether private debts ultimately bankrupted sovereigns or excessive public debt undermined the banking sector is a question that is not easily answered. In some countries, the public sector was overwhelmed by the costs of cleaning up the banking system and forced to seek bail-outs (Ireland and Spain). The pattern in these cases aligns well with the link between financial crises and sovereign debt crisis that has been documented in

detail by Carmen Reinhart and Kenneth Rogoff (2009; 2011). In other countries, the main source of vulnerability was indeed concentrated on the public sector balance sheet itself. 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 (such as in 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 main purpose of this paper. While various studies look at private and public debt separately, a joint study of the evolution of public and private borrowing is missing. We aim to fill this gap. We use an updated long-run panel dataset at annual frequency covering private and public debt and a long list of macroeconomic control data for 17 advanced economies from 1870 to 2010. Thanks to our large dataset, we are able to study the near universe of advanced economies’ experience the past 140 years. Such a long-run historical perspective allows us to work with a sufficiently large number of observations and arrive at statistically meaningful results.

We first present a number of new stylized facts. Most importantly, we show that total economy debt levels have risen strongly over time, but the bulk of the increase has come from the private sector. We also look at the role of public and private debts as precursors of financial instability. Here, the message is equally explicit. Private credit booms, not public debt booms, are the main predictor of financial crises. Debts of the private sector constitute the main risk for financial stability, at least in our sample of advanced economies. In the last part of the paper, we use local projections methods to develop conditional forecasts which track how public and private debt levels can influence business cycle dynamics. We find that high levels of public debt do not matter much in normal recessions, but play an important role in financial crisis recessions. Entering a financial crisis with high levels of public debt is associated with considerably more painful recessions, presumably because they limit the fiscal space of the government. Yet the overall conclusion is again that private, not public borrowing has the strongest effects.

Macroeconomists as a profession have embarked on a journey to rediscover the importance of debt. It is a re-discovery, because eminent economists in the past have been

interested in debt dynamics. Fisher's analysis of debt-deflation in the Great Depression and Minsky's model of financial instability are two examples. Yet their admonitions were not taken too seriously. High rates of private credit growth raised few eyebrows before the crisis. Now, after the crisis, it seems all too obvious that the unprecedented expansion of private sector balance sheets (liabilities principally in the form household indebtedness, and counterpart assets in the bank and shadow-bank systems) was sowing the seeds of financial fragility. A notable shift has also taken place in the realm of public debt, albeit in the opposite direction. Before the crisis, public borrowing was typically viewed with suspicion—debts were seen as a danger to solvency and inflation credibility in the longer run, and fiscal action as a blunt or even powerless instrument in the short run. Active policy in these realms was, by and large, considered a thing of the past with a questionable reputation, a leftover from the bygone ages of Keynesian stabilization policy. Today the debate about the merits and limits of public borrowing is back on the table and wide open.

So far, the rediscovery of debt in macroeconomics has proceeded along two different axes. The emphasis of the first line of research is on private sector credit booms and their effects. Financial crises are typically preceded by a rapid build-up of private debt, particularly bank lending, relative to output. In other words, financial crises are credit booms gone bust (Schularick and Taylor 2012). Crises in turn tend to have long-lasting economic effects. A number of recent studies demonstrated that recoveries from financial crises tend to be considerably slower and more protracted than normal (see for example Cerra and Saxena 2008; Reinhart and Rogoff 2009; Jorda, Schularick, Taylor 2011ab).¹

The empirical observation that recoveries from financial crises are special has prompted researchers to look deeper into the causes of slow recoveries. One key theme is that high levels of private indebtedness—a “debt overhang”—may hold back economic recovery after financial crises. In the crisis, agents in the economy, or a key subset of agents, 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, Rao, Sufi 2011; Mian and

¹ Some authors continue to express doubts that recoveries from financial crises are qualitatively different from standard recessions. See Howard, Martin, and Wilson (2011) as well as Bordo (2012).

Sufi 2012). Krugman and Eggertsson (2012) present such 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. Interest needs to fall to induce higher spending by patient households to compensate for the loss in aggregate demand, but the zero lower bound may prevent full adjustment. Hall (2011), Guerrieri and Lorenzoni (2011) as well as Philippon and Midrigan (2011) develop similar ideas. Using long-run historical data since 1870, Jordà, Schularick and Taylor (2011b) demonstrate in related empirical work that debt overhang effects tend to be a regular feature of the business and are particularly pronounced after financial crises.

The second avenue of recent research has focused 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 et al. (2012) argued that a threshold of 90 percent of GDP exists, beyond which public debt levels may become a drag on the economy. Checherita and Rother (2010) as well as Kumar and Woo (2010) have found supporting evidence of slower growth when public debts are high. Irons and Bivens (2010) question these findings, while Minea and Parent (2012) argue that the threshold if it exists is considerably higher, at around 115 percent of GDP. In a related strand of the literature, Corsetti et al. (2012) argue that if risk premia on public debt rise with higher levels of public debt, the multiplier effects of fiscal policy shrink.

The main goal of this paper is to combine the literature on private and public overhangs and study their economic effects jointly. These are difficult empirical questions that are not easily disentangled. We intend to approach these questions in the following way. In the first section we present some long-run historical facts. In the next section, we test if public or private debt accumulation poses greater risks to financial stability. In the following sections we look at the cyclical properties of debt and present a rich dynamic estimation of the effects of public and private borrowing on key macroeconomic variables.

2 A Brief History of Public Debt and Private Credit

In 2007, Spain had a budget surplus of about 2 percent of GDP and its general government debt stood at about 40 percent of GDP.² Projections for 2012 suggest the deficit will be around 7 percent of GDP, an “improvement” over the 11 percent Figure reached two years earlier. Meanwhile, government debt will have doubled to about 80 percent of GDP in 2012. What began as a banking crisis driven by the collapse of the real estate bubble, quickly turned into a sovereign debt crisis. Creditors understood that the government would have to shoulder the vast majority of private losses, or risk disintegration of Spanish financial markets, evaporation of private credit and contagion to the rest of the Euro zone.

The experience of the Euro Area periphery during the recent Global Financial Crisis exemplifies the connection that exists between credit and financial crises on one hand, and public debt and sovereign crises on the other. The debate about fiscal austerity in the face of mounting public debt has so far focused on a narrower view of the historical experience. This debate has examined the different paths toward fiscal consolidation, but paying little attention to the role of private credit. And in any case, few have considered how the level of public debt is constraining the response to the crisis this time around. This section provides an overview of the main trends of the last 140 years before we examine the relevant issues in more detail.

The data for this paper updates the data 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 of countries. In particular, the sample includes observations from 1870 to 2011 at annual frequency for 17 advanced economies³ representing over 50% of world output more or less consistently throughout the sample (see Maddison, 2005). More details are provided in the appendix.

Figure 1 displays the public-debt-to-GDP ratio and private-credit-to-GDP ratio for 17 countries in the sample. Several features deserve comment. The dominant event in the sample is clearly World War II, which affected virtually every country in the sample and raised the level of public debt to unprecedented levels, often breaching the 100 percent

² Source: OECD, Country Statistical Profile.

³ These are: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the U.K. and the U.S.

debt to GDP level (and in the case of Germany, Japan and the U.K. shooting past 200 percent). Coinciding with the Bretton Woods era of fixed exchange rates and capital controls, public debt levels gradually declined over the thirty years following the end of the war, reaching a nadir of about 30-40 percent debt to GDP around the mid-1970s. World War I exhibited many of the same features but at a much smaller scale (with the obvious exceptions of Germany, France and the U.K.). The gradual consolidation of fiscal balances after the war ended would be interrupted by the Great Recession, and then rapidly reversed. The last 40 years of the sample coincide with a gradual worsening of public finances as the blanket of the welfare state has been gradually stretched by changing demographics. Since the Global Financial Crisis erupted, fiscal balances have worsened considerably, reaching levels last seen in World War II.

[Figure 1 about here]

These broad trends in public finance should be set against the startling trends in private credit markets uncovered by Schularick and Taylor (2012). Leading up to World War II, in what Schularick and Taylor (2012) describe as the "age of money," banks loans shared a stable relationship with broad money, and slowly leveled off as a fraction of GDP. Both loans and money then collapsed relative to GDP during the financial turmoil and banking crises of the 1930s. After 1945, the system began to return to its former shape. Yet, gradually at first, the link between money and private credit would begin to unravel. By the time of the collapse of the Bretton Woods system, that process would accelerate dramatically and reaffirm the advent of the "age of credit." Since the 1970s, credit-to-GDP ratios have broken the link to money and surged to unprecedented levels. The implications of this transformation are profound and constitute an active area of investigation. Since the Global Financial Crisis struck, that process of financialization has experienced a small reversal. Whether the reversal continues or the secular trend simply takes a break only time will tell, since the usual deleveraging that follows financial crises has yet to run its course.

As a way to visualize the amount of total debt (private and public) across the countries in our sample, Figure 2 presents stacked bar graphs of bank asset levels 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.

[Figure 2 about here]

The average level of public debt to GDP in 1928 was about 60 percent, virtually identical to the average level in 2007. However, whereas public debt levels had been mostly declining from the end of World War I until the Great Depression, debt levels just about doubled from 1967 to 2007. The average level of bank assets in 1928 is virtually identical to the level in 1967, but these are considerably lower (by nearly a factor of 3) to the levels seen in 2008. Thus, the ratio of public debt to bank assets went from $3/4$ in 1928, to $1/2$ in 1967, and to $1/3$ in 2008. These broad trends indicate that it is difficult to find evident markers of impending financial doom by focusing on one indicator or the other in isolation.

The picture remains murky even when the focus is on the cross section of countries visible in Figure 2. Take 2008 as an example. Of the 16 countries displayed, Spain had the lowest combined level of liabilities at 139 percent of GDP and yet it finds itself in the midst of a sovereign debt crisis. The U.S. had the second lowest level of liabilities in that panel at 165 percent yet it became the epicenter for the Global Financial Crisis. However, Pozsar, Adrian, Ashcraft and Boesky (2010) report that by 2008 the shadow banking system had surpassed the traditional banking system in the U.S. That adjustment would quickly move the U.S. to the top third of the distribution with a profile that would more closely resemble that of the U.K. or Germany.

3 Sources of Financial Instability: Banks vs. Sovereigns

Is private or public borrowing the greater risk to financial stability? In the following, we build on a basic forecasting framework and dataset from Schularick and Taylor (2012) to answer the question whether public or private borrowing help predict a financial crisis. We use long long-run annual data for 17 countries. 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 macroeconomic fundamentals, including changes in the

private and public debt to GDP ratio, in year t ,

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

where L is the lag operator.

We summarize the information about lagged trends in macroeconomic variables using a 5-year moving average term which allows us to introduce interaction terms between public and private credit trends in the course of the analysis. We also subject this specification to several perturbations that take the form of including additional control variables in the vector X as described above. The error term e_{it} is assumed to be well behaved.

The analysis proceeds as follows. In a first step, we estimate a crisis prediction model using lagged (5-year moving average) changes in the private credit to GDP ratio as the sole predictor of financial instability. This essentially replicates the credit-based crisis prediction model proposed in Schularick and Taylor (2012). Our preferred specification is a panel logit regression with country fixed effects. In a second step, we run the same model using lagged changes (5-year moving average) in public debt to GDP. We then compare the predictive ability of both approaches using a measure of classification ability. See the appendix for details on data sources.

Over the course of history, credit growth turns out to contain valuable predictive information about the likelihood of a financial crisis event (Schularick and Taylor 2012). To see this in the historical data we used a simple classification test, standard in clinical and other applications in hard sciences. We stay agnostic about the policymakers utility function, but given current information x , we just ask whether our classifier (a model signal $f(x)$ and a fixed threshold c) can generate something better than the null (a coin toss) in sorting the binary crisis event data.

To proceed with inference we use the techniques discussed by Jord'a and Taylor (2011). We chart true positives against true negatives in the unit box, for all thresholds c , and create a Correct Classification Frontier (CCF). A classifier is informative if its CCF is above the null CCF of a coin toss which lies on the diagonal, i.e. generates more truth. Formally, the area under the curve (AUC) should exceed 0.5 for the null to be rejected, and inference on families of AUCs turns out to be simple (they are asymptoti-

cally normal). In what follows we adopt a null of country-fixed-effects, which captures the unconditional likelihood of a crisis in one country versus another.

The key results are shown in Table 1 and Figure 3, based on 14 (*) advanced countries for the period 1870 to 2008 (*). We take our existing and quite successful forecast model based on credit, and run it against rival models with public credit added as an alternative, or in combination with the private credit measure (the null being fixed-effects only). The question is, do any of these alternative variable sets add any information at all, either relative to the null or relative to the credit-based model, when they are added in the classifier, as judged by a positive and statistically significant increase in the area under the CCF? And the answer in both cases is very clearly no.

Table 1: Financial Crisis Predictive Ability: Private v Public Debt

LHS: d = Crisis dummy. RHS: X = Lagged private credit/GDP and public debt/GDP.

	(1)	(2)	(3)	(4)	(5)	
Change in private credit/GDP (5 year m.a.)	33.28*** (7.971)		30.72*** (8.005)	28.04** (11.86)		
Change in public debt/GDP (5 year m.a.)		-3.009 (1.989)	-1.234 (2.853)		-2.932 (3.702)	
Lagged level of private credit/GDP				0.275 (0.668)		
Lagged level of public debt/GDP					-0.0138 (0.331)	Notes:
Interaction term				2.541 (11.99)	-0.970 (3.591)	
Observations	1,603	1,726	1,523	1,535	1,672	
AUC	0.718	0.613	0.710	0.706	0.616	
s.e.	0.0328	0.0318	0.0339	0.0331	0.0321	

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The AUC of the private credit model for the full sample is 0.72 with a standard error of 0.033. The AUC of the public debt model is 0.61 with a standard error 0.032. The difference between the two is large and statistically significant. Moreover, the joint model has an AUC that is virtually identical to the pure private sector credit model indicating that not much is gained by including the public debt information in the long-run. We also checked for the robustness of these results by including additional controls for the levels of credit and debt or an interaction between the two, but none of these specification changes impacted our key results and the additional controls were not statistically significant, as the table shows.

This might as well be a one horse race. When estimated on a common sample, as in the CCFs in Figure 3, the public debt variable clearly has no benefit as a predictor compared to the country-fixed-effects null (AUC of 0.602 versus 0.594). Once private credit is added, public debt still has little marginal effects (AUC of 0.710 versus 0.708). Thus, the idea that financial crises have their roots in fiscal problems is not supported over the long sweep of history. Some cases may of course exist like Greece today but these have been the exception not the rule. In general like Ireland and Spain today financial crises can be traced back to developments in the financial sector itself, namely excess credit.

[Figure 3 about here]

Over 140 years there has been no systematic correlation of financial crises with either prior current account deficits or prior growth in public debt levels. Private credit has always been the only useful and reliable predictive factor. Do these results change over time? When we look at subsamples, we are interested in testing whether private or public credit are better predictors for financial crises in the two subperiods. The large differences in predictive ability between private and public borrowing that we identified in the long-run sample remain visible. The AUC for the private sector credit model is 0.70 for the pre-WW II period, and about 0.78 post WWII. The public debt model AUC is around 0.61 both pre and post WWII. Thus our key conclusion appears robust.

4 The Cyclical Properties of Private Credit and Public Debt

This section takes a closer look at the behavior of private and public debt over the business cycle. There are no official data on business cycle turning points going back 140 years and covering all the countries in our sample. However, a close read of the broad guidelines used by the National Bureau of Economic Research (NBER) to date turning points provides a good road map. The basic intuition is simple. Using a smoothed version of the log of real GDP, determine turning points using local maxima and minima ensuring that recessions last at least two quarters, complete cycles last at least 15 months and that recessions and expansions alternate. Since our data are observed annually, the minimum length requirements are automatically met and there is no need to smooth

the data given its frequency. Therefore, determining the peaks and troughs of economic activity consists in simply keeping track of periods in which output went from growing to declining and vice versa. The following section explains the dating algorithm more formally and presents summary statistics of cyclical properties.

4.1 Methods

We investigate a large vector of macroeconomic data observed across countries and time. The notation $y_{i,t}^k$ refers to an observation with $k = 1, \dots, K$ indexing the macroeconomic variable; $i = 1, \dots, M$ indexing the country; and $t = 1, \dots, T$ indexing the year. The $1 \times K$ vector $Y_{i,t}$ collects observations of all the K variables we consider for country i at time t .

In order to investigate the business cycle features of the data, we find it convenient to generate 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 peaks and troughs almost perfectly. We construct the variable $d_{i,t}^P = 1$ when $y_{i,t-1}^{GDP} \leq y_{i,t}^{GDP} \geq y_{i,t+1}^{GDP}$ and zero otherwise. Alternatively, we construct the variable $d_{i,t}^B = 1$ when $y_{i,t-1}^{GDP} \geq y_{i,t}^{GDP} \leq y_{i,t+1}^{GDP}$ and zero otherwise. Here the variable $y_{i,t}^{GDP}$ denotes the logarithm of real GDP per capita so that $d_{i,t}^P = 1$ in local *peaks* of economic activity, and $d_{i,t}^B = 1$ in local *troughs* instead (with the superscript B denoting "bottom" to avoid confusion with T , which denotes the available time periods in the sample and not *trough*). The period between a *trough* and the subsequent *peak* denotes an expansion whereas the period between a *peak* and the subsequent *trough* denotes a recession. This simple algorithm does not require any prior detrending of the data.

By construction, peaks are inevitably followed by troughs and vice versa (we rule out that two troughs could occur in succession, for example). If the data were to start precisely at one of these turning points and end at the other, the number of cycles would be $C_i = \sum_{t=1}^T d_{i,t}^P = \sum_{t=1}^T d_{i,t}^B$ with C standing for cycles. In practice there may be a small discrepancy between the two sums owing to the beginning and end points of the sample, but we prefer to keep things simple in the exposition that follows. We will use the notation $t(p)$ to denote the time period associated with the $p \in \{1, \dots, P\}$ peak, which marks the start of the recession going forward, and the end of the expansion going backwards. Similarly, one can define $t(b)$ for $b \in \{1, \dots, B\}$. Here P and B are the numbers of peaks and troughs, respectively, and are defined implicitly.

These auxiliary time indices are convenient to compute three cyclical statistics of interest: *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 *rate* so as to provide a per year rate of change. Therefore, for a given variable $k \in \{1, \dots, K\}$, we can define:

$$A_E(y^k) = 100 \times \frac{1}{M} \sum_{i=1}^M \left(\frac{1}{C} \sum_{b,p=1}^C y_{i,t(p)}^k - y_{i,t(b-1)}^k \right)$$

$$A_R(y^k) = 100 \times \frac{1}{M} \sum_{i=1}^M \left(\frac{1}{C} \sum_{b,p=1}^C y_{i,t(b)}^k - y_{i,t(p-1)}^k \right),$$

as the average amplitude in expansions $A_E(y^k)$, and the average amplitude in recessions $A_R(y^k)$. This could be a valid approach if the variable $y_{i,t(j)}^k$ is expressed in logs so that the difference is approximately a percentage change (e.g., log output), or as a share so that the difference is approximately a percentage point change (e.g., investment share of GDP). If the variable $y_{i,t(j)}^k$ is not in logs, it is straightforward to normalize the simple difference by $y_{i,t(j-1)}^k$ to obtain a percentage change, with $j = b, p$. The average duration of expansions and recessions is simply:

$$D_E(y^k) = \frac{1}{M} \sum_{i=1}^M \left(\frac{1}{C} \sum_{b,p=1}^C t(p) - t(b-1) \right)$$

$$D_R(y^k) = \frac{1}{M} \sum_{i=1}^M \left(\frac{1}{C} \sum_{b,p=1}^C t(b) - t(p-1) \right).$$

Finally, the average annual rates can be calculated as

$$\rho_E(y^k) = \frac{1}{M} \sum_{i=1}^M \left(\frac{1}{C} \sum_{b,p=1}^C \frac{y_{i,t(p)}^k - y_{i,t(b-1)}^k}{t(p) - t(b-1)} \right)$$

$$\rho_R(y^k) = \frac{1}{M} \sum_{i=1}^M \left(\frac{1}{C} \sum_{b,p=1}^C \frac{y_{i,t(b)}^k - y_{i,t(p-1)}^k}{t(b) - t(p-1)} \right).$$

The next section computes these statistics for our sample.

4.2 Private Credit, Public Debt: Amplitude and Rate over Time

Jordà, Schularick and Taylor (2011) break down the history of the last 140 years into four periods: (1) the pre-World War I period; (2) the inter-war period; (3) the Bretton Woods period; and (4) the post-Bretton Woods period. The broad contours of the modern business cycle underlying the main calculations can be summarized as follows. The typical expansion has gradually become longer lasting. Expansions lasted about 3 years before World War I, almost 4 years between wars, 6 years after World War II and until the fall of Bretton Woods, and 10 years since. Meanwhile, it is striking to see that recessions last one year on average, regardless of the era. Because expansions have become longer lasting, amplitudes have also risen gradually as well. However, the annual rate of growth (amplitude divided by duration) has gradually declined. It averaged 3.5 percent per annum (p.p.a.) before World War I, peaked at 5.2 p.p.a. in the interwar period, declined to 4.3 p.p.a. in the Bretton Woods era, and currently averages about 2.7 p.p.a.

Figure 4 reports amplitude and annual rates of growth for real bank lending per capita, real public debt per capita and the sum of the two. Two broad features stand out for the real private loans to GDP ratio. The first is that the average annual rate of growth of private credit in expansions roughly coincided with the rate of per capita GDP growth in the three eras preceding the fall of Bretton Woods. After the fall of Bretton Woods the rate of private credit (excluding shadow banking) would be double the rate of growth of per capita GDP. This reinforces the broad outlines presented in Figure 2 in regard to the increasing importance of credit in the last 40 years. The second feature worth mentioning is that credit continues to grow even during recessions. Credit grew half as fast in recessions prior to World War I and in the Bretton Woods era. Interestingly, it grew faster in the interwar period, in part due to the massive and protracted declines in economic activity even with the credit crunch caused by the Great Recession. More recently and in part due to the financial retrenchment of recent years, the growth of credit during recessions in the post-Bretton Woods era has been about zero.

[Figure 4 about here]

The behavior of public debt is somewhat different and has to be set against the geopolitical and historical backgrounds discussed in Figure 1. Debt grew slowly early on until World War I, at a rate of about 1 p.p.a., specially relative to private credit, which

grew at 4 times that rate. The interwar period was very volatile. Early in the period, most countries were reducing the run-up of debt due to World War I. Once the Great Recession struck, that process would stall and go into reverse with the military build up leading to World War II. As a result, public debt grew at about 2 p.p.a., a bit faster than private credit. The Bretton Woods era saw countries gradually reducing their World War II debt obligations. In terms of duration and speed, it is hard to overestimate the significance of these secular trends. The rate of debt reduction ticked at 3.3 p.p.a. at a time when the growth of private credit neared 6 p.p.a. Since the fall of Bretton Woods the rates at which private and public liabilities have increased are about the same at approximately 4.5 p.p.a.

Taken together, the combined annual rates of credit expansion due to private and public liabilities experienced a gradual decline: From about 5 p.p.a at the start of the sample, to half that by the end of the Bretton Woods era. Since then, the combined effects of "the era of credit" and the expansion of the welfare state put the annual growth of the economy's liabilities at about 9 p.p.a, a rather remarkable development in the history of the last 140 years.

5 Private and Public Liabilities During the Boom

The rest of our paper investigates the determinants of the recovery after a financial crisis and the role of credit and public debt. We shall see that *excess credit* build-up during the expansion tends to make the recession deeper and longer lasting. Moreover, although the level of public debt to GDP does not seem to predict when the next financial crisis will hit (see e.g. Jordà, Schularick and Taylor, 2011), it does seem to modulate how the economy behaves after the crisis strikes. These features have to be set against the potential benefits of these build-ups during the expansion, a matter we discuss below.

What do we mean by *excess credit*? In what follows, we define *excess* variables, one for private credit, the other for public debt. We will also investigate the combined effect in some of the experiments, but soon drop it for brevity. Each excess credit variable measures respectively, the rate of change per year in the aggregate bank loans to GDP ratio in the expansion; and the rate of change in the ratio of public debt to GDP in the expansion, both in percentage points per annum (p.p.a.).

Table 2: Characteristics of Real GDP per Capita in Booms, Classified According to Different Measures of Excess Credit

Excess credit variable definition			<i>Amplitude</i>		<i>Duration</i>		<i>Rate</i>		
			<i>Low excess</i>	<i>High excess</i>	<i>Low excess</i>	<i>High excess</i>	<i>Low excess</i>	<i>High excess</i>	
<i>Private Credit</i>	Full Sample	Mean	15.3	21.8	4.2	5.6	3.9	3.6	
		s.d.	16.7	34.1	4.1	6.4	2.1	2.3	
		Obs.	115	137	115	137	115	137	
	Pre WWII	Mean	11.4	10.6	2.9	2.9	4.3	3.7	
		s.d.	10.8	12.3	2.3	2.3	2.3	2.5	
		Obs.	78	91	78	91	78	91	
	Post WWII	Mean	23.6	44.1	7.0	10.8	3.0	3.5	
		s.d.	22.9	49.5	5.4	8.5	1.3	2.0	
		Obs.	37	46	37	46	37	46	
<i>Public Debt</i>	Full Sample	Mean	15.8	20.4	4.2	5.3	4.2	3.5	
		s.d.	15.1	32.3	3.8	6.2	2.5	2.1	
		Obs.	86	166	86	166	86	166	
	Pre WWII	Mean	12.5	10.1	2.9	2.9	4.6	3.6	
		s.d.	13.2	10.6	2.3	2.3	2.8	2.1	
		Obs.	61	108	61	108	61	108	
	Post WWII	Mean	24.0	39.6	7.4	9.8	3.3	3.3	
		s.d.	16.7	47.2	4.9	8.3	1.1	2.0	
		Obs.	25	58	25	58	25	58	
	<i>Combined</i>	Full Sample	Mean	17.3	19.6	4.3	5.3	4.3	3.4
			s.d.	17.2	31.9	3.8	6.2	2.4	2.1
			Obs.	87	165	87	165	87	165
Pre WWII		Mean	13.0	9.8	2.9	2.9	4.8	3.5	
		s.d.	11.8	11.5	2.2	2.4	2.6	2.2	
		Obs.	58	111	58	111	58	111	
Post WWII		Mean	25.9	39.8	7.0	10.2	3.4	3.2	
		s.d.	22.7	47.5	4.8	8.4	1.3	1.9	
		Obs.	29	54	29	54	29	54	

Notes: Low and High refer to samples with excess credit variable below or above its full sample mean.

Table 2 provides a summary of the average *amplitude*, *duration* and *rate* (as defined earlier), broken down by whether each measure of excess credit was above or below its historical mean—a straightforward way to subdivide the sample. The analysis excludes both World Wars and reports the results for the full sample, and subsamples split by World War II.

The behavior of credit before and after World War II documented in Schularick and Taylor (2012) motivates the sample split. Although the split is perhaps less natural for public debt, we kept it the same so as to facilitate comparability.

The first block of entries in Table 2 divides the sample into Low and High excess

credit based to the behavior of excess private bank loans, the second block to the behavior of public debt and the third block using the combined sum of private loans and public debt. The first block of entries replicates the same calculation reported in Jordà, Schularick and Taylor (2012). As in that table, the expansion of credit after World War II results in longer lasting expansions (by about 4 years) at which output per capita grows at a faster rate (3 versus 3.5 p.p.a) and resulting in an almost doubling of the accumulated gains in output per capita (24 versus 44 percent). These are considerable gains. (*)

The results for public debt are similarly positive but not quite by the same magnitudes. Expansions in the post World War II era last about 2.5 years longer during which time more output gains are accumulated although in this case, the rate of annual growth remains the same. In combination, these advantages are somewhat more muted. Expansions last about 3 years longer but the annual rate of growth is slower, at 3.2 p.p.a, when debt grows above average. When debt grows below average, the rate of annual growth is *faster* at 3.4 p.p.a. (*)

The gains in the post World War II era contrast with the gains in the earlier era. During that time, public debt appears to have no effect on the duration of the expansion and the rates of growth clearly suffer. The pre World War II era is one where accumulated growth is lower when credit, public debt, or the combination is high than when it is low. However, it is difficult to disentangle the overall effect of the Great Recession in this period.

6 Sowing the Seeds of the Storm

It is well understood that financial crises generate deep and long lasting recessions. Cerra and Saxena (2008) provide an exhaustive analysis on what happens to output after certain events using post-1970 data on a large sample of 190 countries that includes developed, as well as many emerging economies. Their analysis however, focuses mostly on political and financial factors that tend to be more relevant for emerging rather than developed economies. Claessens, Kose and Terrones (2011) use a similar sample to narrow the focus on financial crises and their determinants, whereas Jordà, Schularick and Taylor (2011) examine similar questions for the smaller set of developed economies,

but extending the sample back 140 years. When it comes to analyzing the determinants of the depth of the recession and speed of recovery, Jordà, Schularick and Taylor (2012) provide the more relevant results. They provide conclusive evidence suggesting that the more credit builds up in the expansion, the deeper the recession and the slower the recovery, regardless of whether the recession is a financial crisis or not.

Using our dataset, it is natural to ask whether some of the same themes in Jordà, Schularick and Taylor (2012) are relevant when focus is on public debt. Does the accumulation of public debt have the same effects as the accumulation of private credit on the shape of the subsequent recession? What is the interaction between public debt and private credit? In financial crises, specially in a banking crisis that requires the government to absorb large private losses to promote stability in financial markets, does the fiscal position of the country as it enters the crisis determine its path out of it? These are the questions that we explore in the next few sections. Absent from this analysis is the question of what is the appropriate response of the fiscal authority to recessions and financial crises. Exploring these issue would be the topic of a different paper which might build on the lessons from this paper.

6.1 Recession Dynamics: An Unconditional Analysis

The dependent variable of interest is the cumulative change (reported in percentage points) of the log real GDP per capita (y) relative to its level when the recession strikes. That is, the reference year 0 is taken as the peak year using the Bry and Boschan (1971) algorithm described earlier. The data on GDP are from Barro and Ursúa (2008). In addition we classify recessions into *normal* and *financial crises*. This classification is summarized in the appendix and essentially extends prior work in Jordà, Schularick and Taylor (2012) with the data for Belgium, Finland and Portugal. We are interested in characterizing the recession paths of different recessions/recoveries broken down by the amount of private lending and public debt built-up during the preceding expansion. The data for these two variables are an extension of the data collected by Schularick and Taylor (2012) and Reinhart and Rogoff (2009). Table 3 summarizes the universe of recessions and their classification using this approach.

Table 3: Summary Statistics

<i>Panel A: Full sample</i>						
	(1)		(2)		(3)	
	All		Financial		Normal	
	mean	(s.d.)	mean	(s.d.)	mean	(s.d.)
Financial recession indicator	0.29		1		0	
Observations	255		73		182	
Normal recession indicator	0.71		0		1	
Observations	255		73		182	
Excess private credit	0.56	(1.96)	0.85	(2.25)	0.44	(1.82)
Observations	189		54		135	
Excess public debt	-0.84	(6.13)	-0.48	(3.61)	-0.99	(6.91)
Observations	212		62		150	
<i>Panel B: Pre-World War II sample</i>						
	(1)		(2)		(3)	
	All		Financial		Normal	
	mean	(s.d.)	mean	(s.d.)	mean	(s.d.)
Financial recession indicator	0.33	0.47	1.00		0.00	
Observations	178		59		119	
Normal recession indicator	0.67	0.47	0.00		1.00	
Observations	178		59		119	
Excess private credit	0.33	2.01	0.49	1.96	0.25	2.04
Observations	124		40		84	
Excess public debt	-0.84	6.84	-0.69	3.87	-0.92	7.92
Observations	145		48		97	
<i>Panel C: Post-World War II sample</i>						
	(1)		(2)		(3)	
	All		Financial		Normal	
	mean	(s.d.)	mean	(s.d.)	mean	(s.d.)
Financial recession indicator	0.18		1		0	
Observations	77		14		63	
Normal recession indicator	0.82		0		1	
Observations	77		14		63	
Excess private credit	0.99	(1.78)	1.85	(2.76)	0.76	(1.35)
Observations	65		14		51	
Excess public debt	-0.84	(4.23)	0.24	(2.48)	-1.13	(4.56)
Observations	67		14		53	

The table is broken down into three panels. 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 255 recession episodes of which 73 are classified as financial crises and 182 are classified as normal recessions. However, that proportion varies with each subsample. In the pre-World War II sample 1 in 3 recessions was a financial crisis whereas after World War II, the proportion decreases to about 1 in 5. The table includes information on the *excess variables*, that is, the accumulation of credit and the accumulation of public debt in preceding expansions.

With respect to private credit, it is clear that credit grows twice as rapidly before financial crises than in normal recessions, regardless of the era. Clearly after World War II, the rate accelerated substantially as we learned from Table 2 and as we can see in Table 3. Public debt tends to decline in expansions, but the ratios are surprisingly similar to the ratios just discussed for private credit. In the pre-World War II sample, debt declines at a rate of about 0.9 p.p.a. before normal recessions but only 0.7 p.p.a. before financial crises. After World War II, the difference becomes very stark. Whereas debt declines by a similar amount in normal recessions, about 1.1 p.p.a, it *increases* at a rate of about 0.25 p.p.a. before financial crises.

Figure 5 plots the path of the average recession and subsequent recovery, broken down using different criteria. The solid thick line labeled *normal* is a simple average of the path of output once the recession starts. Recessions tend to last one year (which we knew from Figure 4 earlier). By year 2 output is back to its pre-recession level and by year 5 it has gained about five percentage points from its previous peak.

Figure 5 displays four paths the economy follows in a financial recession depending on whether the amount of private credit and public debt accumulated in the previous expansion is respectively $\{low, low\}$, $\{low, high\}$, $\{high, low\}$ or $\{high, high\}$. Dashed lines indicate financial recessions with below average accumulation of public debt in the expansion. Dotted lines indicate above average accumulation instead. In each case, the thinner lines correspond to below average private lending in the expansion and thicker lines above average lending. The figure communicates two clear messages. The first message is that the recovery paths differ little as a function of public debt accumulated in the expansion. If anything, higher accumulation of debt in an expansion when credit accumulation is below average appears to enhance the recovery slightly. The second

message is that there is a stark difference in the depth of the recession depending on the level of excess credit in the expansion, regardless of how much public debt has been accumulated. In the below average scenario, the recession craters at about one year and although the recovery path is slightly lower than in a normal recession, by year five the accumulated growth is about 1 percentage point lower than in the normal case. In contrast, a financial crisis where excess credit is above average generates a recession whose trough take place a year later than normal. By year five, the economy has not yet recovered the level of output it had in the previous peak. This is a significant difference in the statistical as well as economic senses.

[Figure 5 about here]

7 Statistical Design

We have uncovered a number of interesting facts using simple descriptive statistics. Some of these findings reaffirm extant results in the literature. Financial crises result in deeper recessions and slower recoveries as Cerra and Saxena (2008), Reinhart and Rogoff (2009, 2010), Jordà, Schularick and Taylor (2012) and many others have documented. Moreover, while we find that the more excess private lending builds-up in the expansion, the deeper and longer the recession—a result first reported in Jordà, Schularick and Taylor (2012)—the same cannot be said for the accumulation of government debt. The build-up of these liabilities has negative effects during the recession but positive effects on the expansion. The experience since World War II suggests that expansions last longer and growth happens at a slightly higher rate when private credit grows above average. The results are more mixed for an above average increase in the government's fiscal position.

In the next few sections attention turns to more subtle issues. So far the analysis has been *unconditional* by which we mean that we have made not attempt to adjust for controls. Could some of the effects of private credit on the severity of the recession be explained by omitted variables? Beyond economic activity, what can be said about the response of other macroeconomic aggregates in financial crises? How do these responses vary with the build-up of liabilities during the expansion? And how does the level of public debt constrain the response of the fiscal authority during a financial crisis,

irrespective of how much the fiscal position varied over the expansion? Addressing these questions and others requires that we ratchet the level of statistical sophistication to the next level.

The statistical toolkit we will use relies on the *local projection* (LP) approach introduced in Jordà (2005). Several reasons justify the choice. 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 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 through 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. And in any case, impose numerical burdens that our sample cannot easily bear. Instead, direct local analysis of the multipliers of interest using the LP method is straightforward.

We present the main regressions by building on the notation introduced earlier. Recall that K denotes the dimension of the vector of macroeconomic aggregates of interest, M denotes the cross-section dimension of countries, and T denotes the time dimension of the sample. For any variable $k = 1, \dots, K$ we want to characterize the change of the variable from the start of the recession to some distant horizon $h = 1, \dots, H$, or the change from time $t(p)$ to time $t(p) + h$ where recall that p refers to *peak*. Hence $t(p)$ denotes the time period that corresponds to the p^{th} peak or recession. We focus on the change from the start of the recession to some distant period so that the results can be directly compared with the results presented in earlier sections and results available in the literature for unconditional responses.

Using the earlier notation $y_{it(p)+h}^k$ to refer to a particular macroeconomic aggregate observed for country $i = 1, \dots, M$ at time $t(p) + h$, the h period ahead change is denoted $\Delta_h y_{it(p)+h}^k$. Sometimes $\Delta_h y_{it(p)+h}^k$ will refer to the percentage point change, given by the h -difference in 100 times the logarithm of the variable. An example is when y_{it}^k refers to 100 times the logarithm of real GDP per capita. Other times it may refer to the simple time difference, such as when y_{it}^k 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_{it}^k are consolidated into the vector $Y_{it} = [\Delta y_{it}^1 \dots \Delta y_{it}^J \ y_{it}^{J+1} \dots y_{it}^K]'$. 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 define the experiments whose effects on other macroeconomic variables we wish to evaluate. In other words and depending on the experiment, x will refer to the accumulated change in bank lending to GDP ratio; or the public debt to GDP ratio. The value of this variable remains fixed for any value of h over which $\Delta_h y_{it(p)+h}^k$ is considered.

Consequently, the path of the recession and the recovery, conditional on information up to time $t(p)$ —and denoted $Y_{it(p)}, Y_{it(p)-1}, \dots$ —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 $\bar{x}_i + \delta_i$. The reason that δ_i is indexed by i is because we examine a one standard deviation effect, which varies from one country to another. That is, the average cumulated response for each variable in the K -dimensional vector of macroeconomic aggregates is defined as:

$$CR \left(\Delta_h y_{it(p)+h}^k, \delta_i \right) = E_{it(p)} \left(\Delta_h y_{it(p)+h}^k | x_{it(p)} = \bar{x}_i + \delta_i; Y_{it(p)}, Y_{it(p)-1}, \dots \right) - E_{it(p)} \left(\Delta_h y_{it(p)+h}^k | x_{it(p)} = \bar{x}_i; Y_{it(p)}, Y_{it(p)-1}, \dots \right), \quad k = 1, \dots, K; h = 1, \dots, H \quad (2)$$

Under linearity, this cumulated response is simply the sum of the 1 to h impulse responses:

$$IR \left(\Delta_h y_{it(p)+h}^k, \delta_i \right) = E_{it(p)} \left(\Delta y_{it(p)+h}^k | x_{it(p)} = \bar{x}_i + \delta_i; Y_{it(p)}, Y_{it(p)-1}, \dots \right) - E_{it(p)} \left(\Delta y_{it(p)+h}^k | x_{it(p)} = \bar{x}_i; Y_{it(p)}, Y_{it(p)-1}, \dots \right), \quad k = 1, \dots, K; h = 1, \dots, H \quad (3)$$

that is

$$CR \left(\Delta_h y_{it(p)+h}^k, \delta_i \right) = \sum_{j=1}^h IR \left(\Delta y_{it(p)+h}^k, \delta_i \right). \quad (4)$$

Expression (3) will 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

assumption of linearity.

In practice we estimate $CR \left(\Delta_h y_{it(p)+h}^k, \delta_i \right)$ by assuming that the expectation can be approximated by a local projection. In particular, this approximation can be obtained using the following fixed effects panel expression:

$$\begin{aligned} \Delta_h y_{it(p)+h}^k &= \alpha_i^k + \theta_N^k d_{it(p)}^N + \theta_F^k d_{it(p)}^F + \beta_{h,N}^k d_{it(p)}^N \left(x_{it(p)} - \bar{x}_i \right) + \beta_{h,F}^k d_{it(p)}^F \left(x_{it(p)} - \bar{x}_i \right) \\ &+ \sum_{l=0}^L \Gamma_{h,l}^k Y_{it(p)-l} + u_{h,it(p)}^k; \quad k = 1, \dots, K; h = 1, \dots, H \end{aligned} \quad (5)$$

where α_i^k are country fixed effects, θ_N^k is the common constant associated with *normal* recessions $d_{it(p)}^N = 1$ (0 otherwise); θ_F^k is the common constant associated with financial recessions $d_{it(p)}^F = 1$ (0 otherwise); a history of l lags for the control variables $Y_{it(p)-l}$ with coefficient matrices $\Gamma_{h,l}^k$. When $x_{it(p)} = \bar{x}_i$ then θ_N^k and θ_F^k measure the average cumulated response in normal versus financial recessions. As we determined earlier, these unconditional means appear to differ in the sample and allowing for this distinction is consistent with our earlier findings. When $x_{it(p)} = \bar{x}_i + \delta_i$, the marginal effect of the experiment δ_i is given by the coefficients $\beta_{h,N}^k$ and $\beta_{h,F}^k$ depending on whether the recession is *normal* (N) or *financial* (F). Here we could have assumed that $\beta_{h,N}^k = \beta_{h,F}^k$ but we prefer to allow the data to speak for themselves.

Using a panel with fixed effects allows cross-country variation in the typical path computed and in the average response to δ_i . This is convenient formulation accounts for variation across countries in their degree of financialization and other macroeconomic differences while still being able to identify the common component of the response.

If δ_i 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 accumulated during the expansion is a given quantity at the start of the recession. Naturally, there is no direct feedback mechanism except for any possible anticipation during the expansion on the severity of an impending recession. In addition, we use an extensive set of controls and their lags to soak up variation in economic outcomes that can be explained by conditions experienced during the expansion and that quite possibly relate to the level of credit and debt accumulated therein. Finally, we 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.

8 Recession Dynamics: A Conditional Approach

Using the methods described in the previous section, our first order of business is to re-examine many of the results discussed with the unconditional approach and broaden our analysis to a longer list of macroeconomic outcomes. The variables that we will 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 3 months or less in maturity); (7) long-term interest rates on government securities (usually 5 year or more in maturity); and (8) the current account to GDP ratio. We reiterate that including the growth rates of real loans per capita and debt per capita stack the odds against finding that credit or public debt build-ups during the boom explain the recession and the recovery. These variables will be the controls included in the vector Y defined earlier. Next we use the accumulated change during the expansion in either private credit or public debt as our x variable. Specifically, we consider a two standard deviation perturbation to the long-run average in each case as the relevant experiment.

Figure 6 reports the cumulated responses calculated using expressions (2) and (5) for output, investment, inflation, lending and debt. We can calculate responses for the remaining variables in our control set but these are not reported to save space. The top row of charts in the Figure reports the responses to a private credit experiment whereas the bottom reports the responses to a public debt experiment. The experiments using excess private credit contain many of the same themes in Jordà, Schularick and Taylor (2012). Financial crises are more painful and take longer to recover from than normal recessions, even after conditioning on macroeconomic aggregates and their lags. Moreover, excess credit build-up during the expansion, measured as a two standard deviation from long-run mean experiment, makes recessions and recoveries worse regardless of type. In a normal recession output declines in year one, by year two it has recovered its original

pre-recession level and then continues to grow in years three to five. Excess credit slows down this process but not substantially.

[Figure 6 about here]

On the other hand, financial recessions are considerably more painful. On average, they reach bottom around year two or three and output does not quite recover its pre-recession level by year five. Excess credit makes matters considerably worse. The recession can be about two to three percentage points worse at its trough and the recovery is even slower. The effects are even more dramatic when considering investment, with drops in the order of 30 to 40 percentage points. Regarding inflation, whereas prices continue to grow during normal recessions, they remain stable in financial crises. Similarly, lending activity continues during a normal recession, it stands still in the average financial crisis and it contracts in a financial crisis with higher than average excess credit. Not surprisingly, public debt grows during any type of recession, although the differences across types and experiments are a little more mixed.

The second row of charts in Figure 6 corresponds to the experiment with public debt. These charts contain some points of commonality with the top row of charts, which correspond to the private credit experiment. Recall that in Figure 5, the unconditional analysis suggested that the shape of the recession does not vary much as a function of the amount of public debt built-up in the expansion. To a large extent and after adding controls, the same can be said when looking at the response of output in a financial crisis in Figure 6. In a normal recession, the response to a higher than average accumulation of public debt resembles closely the response seen for the private credit experiment. Part of the reason is made evident in the response to investment and to lending. Taken together, the charts seem to suggest that there is some form of crowding out when public debt grows above average in the expansion and that results in lower output, lower investment and lower lending.

As a robustness check, we consider a subsample analysis based on post-World War II data. Although we have excluded the two World War periods from the analysis, the interwar period was unusually turbulent and marked by the Great Depression. Figure 7 replicates the analysis in Figure 6 using the shorter and more contemporary sample. Broadly speaking, the results hold up surprisingly well, not just qualitatively but also

quantitatively. Accumulation of above average private credit or public debt tends to make the recession worse, regardless of type. In this second subsample the differences between experiments are considerably smaller. The conclusion appears to be that above average increases in liabilities during the expansion, whether private or public, will tend to make the subsequent recession deeper and the recovery slower. These patterns affect both normal recessions and financial crises.

[Figure 7 about here]

It is worth summarizing our preliminary conclusions so far. A simple unconditional analysis consisting of averaging the behavior of output in recessions confirmed the well-known fact that financial crises are more painful than normal recessions. Without conditioning on any other control, there was clear evidence that above average credit formation in the expansion results in a more painful recession. The evidence did not suggest that the same was true for above average accumulation of public debt. Using the full sample of data and allowing for an extensive set of controls and their lags, we were able to confirm many of these initial findings for output. At the same time, the analysis allowed us to examine the behavior of other macroeconomic aggregates during these events to form a more complete picture. The analysis done with post-World War II data confirmed many of the initial results, qualitatively as well as quantitatively. However, in the more contemporary sample, the data support the view that the accumulation of public debt during the expansion has a similar effect than the excess build-up of credit. This feature was less apparent with the rudimentary unconditional analysis.

Based on these findings, it is natural to wonder whether these effects depend on the initial level of public debt to GDP. In financial crises, the government is often forced to assume large losses from the private sector (Ireland in the Global Financial Crisis provides a stark reminder). Irrespective of how quickly debt accumulated during the recession, presumably the country that finds itself with the higher level of debt to GDP at the start of the recession will have less room to absorb these losses. The next section investigates this issue in more detail.

9 Financial Crises and the Level of Debt

Using historical data for developed economies starting in the early 1800s, Reinhart and Rogoff (2012) find that when the ratio of public debt to GDP exceeds 90% over five years, growth slows down by about 1 percentage point per year. In the previous section we examined how the accumulation of debt during the expansion affects the trajectory of the recession, a different question. In this section we take on the main premise in Reinhart and Rogoff (2012) and ask if the *level* of debt relative to GDP has any effect on the features of the recession. The natural starting point is to investigate these level effects for normal and financial recessions without focusing on how much credit or debt was accumulated in the expansion. The reason is that in financial recessions the government typically assimilates losses from the private banking sector that inflate its debt levels quickly. To the extent that those levels are high to begin with, a subsequent collapse of financial confidence (such as the one recently experienced in the periphery countries of the Euro zone) could prevent quicker repair of domestic financial markets and hence lengthen the recovery. In normal recessions, automatic stabilizers typically worsen the fiscal position of countries but do not result in the quick and sizeable run ups experienced during financial crises.

Before examining the role of credit and debt accumulation in the expansion, 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:

$$\begin{aligned} \Delta_h y_{it(p)+h}^k &= \alpha_i^k + \theta_N^k d_{it(p)}^N + \theta_F^k d_{it(p)}^F + \phi_{h,N}^k d_{it(p)}^N (g_{it(p)} - \bar{g}_i) + \phi_{h,F}^k d_{it(p)}^F (g_{it(p)} - \bar{g}_i) + \\ &+ \sum_{l=0}^L \Gamma_{h,l}^k Y_{it(p)-l} + u_{h,it(p)}^k; \quad k = 1, \dots, K; h = 1, \dots, H \end{aligned} \quad (6)$$

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 debt level is at zero, the debt level is at the mean, or the debt level is at twice the mean. Over the sample, the average debt level is 51 percent of GDP. Thus twice the mean indicates a situation where debt is running slightly above 100 percent of GDP. Notice that like before, we allow the mean to be country-specific to allow for variation in addition to

the fixed effect. The result of these experiments is reported in figures 8 (for financial recessions) and 9 (for normal recessions), using the full sample.

Figure 8 displays the trajectory of output, investment, inflation, bank lending and public debt in a normal recession and in a financial crisis. The top row displays typical trajectories in a normal recession. The solid line is the trajectory when the debt level at the start of the recession is at its long-run average (along with a 95% confidence region); the dotted line when debt is at zero; and the dashed line when debt is at twice the per country average or about 100 percent of GDP for most countries. 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 (along with a 95% confidence region) and then contains three additional trajectories, all corresponding to a financial crisis under different assumptions on the level of debt. Specifically, the dotted line corresponds to debt at zero; the short-dashed line refers to debt at the long-run average (about 51 percent of GDP); and the long-dashed line corresponds to debt at twice its long-run average.

[Figure 8 about here]

Consider the trajectories for output first. Within the confines of our limited sample and our methods, one can detect that the level of debt at the start of the recession has a nonlinear effect. In normal times, the trajectory of output when debt is at zero or at its long-run mean is virtually the same. When debt is above 100 percent, the recovery begins to slow down considerably starting in year two. Similarly, in a financial crisis, the higher the debt level at the start of the recession, the worse the recession and the slower the recovery. In fact, when debt is at zero, the recession is deeper but the recovery is faster. By year five the level of GDP is the same as the level achieved in a normal recession with an average level of debt. At average levels of debt, recovery from a financial crisis is achieved in year 4. But at high levels of debt, the recovery continued to sputter even at year five.

The behavior of bank lending tends to mirror output reasonably well. Higher levels of debt slow down lending and in the case of a financial crisis, it can even cause lending to shrink considerably. This would be consistent with a scenario in which the government is unable to assume losses from the banking sector and the recovery of financial markets is delayed. The behavior of public debt appears to lend support to this

view. Consider what happens in a financial crisis at high levels of debt. Debt grows over the first two years during which time lending activity seems to keep up with the typical trajectory. After two years however, there is a quick reversal and debt begins to contract. The austerity required to achieve this has a visible effect on lending activity, which contracts almost one for one with the contraction of debt. The behavior of prices is broadly consistent with what one would expect. Higher levels at the beginning of the recession make the recovery slower and hence the trajectory of prices tends to be more deflationary. Lastly, the behavior of investment is consistent with the behavior of output, lending and debt in a financial crisis but is harder to explain during a normal recession.

These results are based on a rudimentary first pass at the data. The only consideration is whether debt levels are high at the beginning of the recession. Previous sections show that how many liabilities are accumulated during the expansion have an important effect on the path of the recovery. The next section connects the level effects just discussed with the cumulative effects presented earlier.

10 Debt Overhangs versus Debt Accumulation

The goal of this section is to connect the main themes in Jordà, Schularick and Taylor (2012) regarding the effects of credit in financial recessions; the effects of debt overhangs discussed in Reinhart, Reinhart and Rogoff (2012); and the new results reported here on the effects of public debt run-ups. This can be easily accomplished within the statistical design presented in expressions (2), (5) and (6). Specifically, consider extending this last expression as follows:

$$\begin{aligned}
\Delta_h y_{it(p)+h}^k &= \alpha_i^k + \theta_N^k d_{it(p)}^N + \theta_F^k d_{it(p)}^F + \beta_{h,N}^k d_{it(p)}^N (x_{it(p)} - \bar{x}_i) + \beta_{h,F}^k d_{it(p)}^F (x_{it(p)} - \bar{x}_i) + \\
&\quad \phi_{h,N}^k d_{it(p)}^N (g_{it(p)} - \bar{g}_i) + \phi_{h,F}^k d_{it(p)}^F (g_{it(p)} - \bar{g}_i) + \\
\delta_{h,N}^k d_{it(p)}^N (g_{it(p)} - \bar{g}_i) (x_{it(p)} - \bar{x}_i) &+ \delta_{h,F}^k d_{it(p)}^F (g_{it(p)} - \bar{g}_i) (x_{it(p)} - \bar{x}_i) + \\
\sum_{l=0}^L \Gamma_{h,l}^k Y_{it(p)-l} + u_{h,it(p)}^k & \quad k = 1, \dots, K; h = 1, \dots, H.
\end{aligned} \tag{7}$$

This is a complicated expression with numerous interaction effects that requires some explanation. The coefficients $\beta_{h,N}^k$ and $\beta_{h,F}^k$ capture the experiment based on the effect of accumulation of liabilities during the expansion. These can be in the form of bank lending or public debt. The coefficients have a similar interpretation to the coefficients in expression (5). Next, the coefficients $\phi_{h,N}^k$ and $\phi_{h,F}^k$ capture the effect of the level of debt at the start of the recession discussed in the previous section. Notice that the debt levels g enter in deviation from country specific means to allow for cross-variation. Finally, the coefficients $\delta_{h,N}^k$ and $\delta_{h,F}^k$ correspond to the interaction of the debt level with the excess liability term. Their purpose is to allow for the type of modulated effect on x that is apparent in Figure 8. That is, these coefficients allow us to consider whether the effects of a credit binge during the expansion aggravate a financial crisis even more when debt levels are high to begin with.

Figure 9 displays as concise a summary of numerous experiments as is possible. The figure is organized in four rows. Columns are organized by macroeconomic aggregate, that is, each column displays the trajectories of output, investment, prices, lending and debt. The top two rows correspond to experiments with normal recessions and the bottom two rows to experiments with financial crises. Within each block of two rows—normal versus financial—the top row displays experiments in which private credit grows at the average level plus one standard deviation and the effect is modulated depending on whether the level of debt to GDP at the start of the recession is at zero, at the long-run average (about 51 percent of GDP), or at twice the long-run average (slightly above 100 percent of GDP). Each of these debt levels is represented with a dotted line when debt is at zero, a short-dashed line when debt is at the mean, and a long-dashed line when debt is at twice the mean. The bottom row within the group examines what happens when the experiment refers to the accumulation of public debt in the expansion instead. Finally, in all figures the average path of normal recessions is displayed along with a 95 percent confidence region.

[Figure 9 about here]

Consider the first column of experiments first so as to set the tone for the remainder of the discussion. These correspond to the trajectories of output for the different experiments just described. Recall that in all cases the discontinuous lines reflect an

accumulation of liabilities that is at the mean plus one standard deviation. This is the reason that the trajectories associated with the level of debt being at the mean do not coincide with the solid lines. Broadly speaking, these four charts convey a very similar message to the one discovered in the previous section. The level of debt appears to have a nonlinear effect. At low levels, here at a hypothetical zero level and at a mean of about 50 percent of GDP on average, the trajectories are very similar. However, when the experiment focuses on debt levels at twice the historical average, the economy tends to suffer from deeper and more prolonged recessions. In almost every case, the negative effects of having accumulated extra liabilities during the expansion (whether through bank lending or through accumulation of public debt), are mostly undone by entering the recession with low levels of debt to GDP.

One explanation can perhaps be found in the last column of Figure 9, which displays the trajectories of public debt in the recession. When debt levels are at their lowest, debt tends to accumulate the most rapidly, which likely serves as a cushion against the recession. When debt levels are at their highest, debt during the first and sometimes second year grows at a similar rate, but then a severe bout of austerity takes place in which the reduction of debt is rapid and quite sizeable. This effect is very similar across recession type and independently of the type of liability accumulated in the expansion.

There are important differences that emerge in the behavior of other macroeconomic aggregates depending on the type of experiment. Turning to the behavior of investment, the second column, there are considerable differences between normal recessions and financial crises. The top two rows correspond to a normal recession and differences between the two are minor. Whether private credit or public debt is accumulated rapidly during the expansion, the trajectories are very similar. The striking feature in both cases is that when debt levels are high, investment appears to recover *more* quickly. We think that the reason behind this apparently puzzling result has to do with the trajectory of debt. The higher the debt level at the start of the recession, the quicker the fiscal consolidation. Think of it as a reverse *crowding out*. When debt levels are low, there is more fiscal space to stimulate the economy and investment suffers (even though the trajectory of output improves). Some of the same effects are visible in a financial crisis but they are much more muted. There is a much more apparent tension between restoring financial markets to health and the economy in general, and the recovery of

investment.

The crowding out conjecture during normal recessions appears to be supported by the contrast between the behavior of lending in normal recessions with the excess credit experiment relative to the excess debt experiment. In the excess credit experiment, the behavior of lending in the recession depends very little on the debt to GDP level at the start of the recession. This is not the case when the experiment refers to excess debt. Lending recovers more slowly a low levels of debt with the stronger stimulus visible in the trajectory of public debt. Austerity initially helps, but eventually hurts the economy and it slows down the recovery of lending. These broad outlines are even starker in a financial recession. High levels of debt to GDP at the start complicate the recovery enormously. Add to the fiscal retrenchment and the contractionary effects on output, a retrenchment in lending.

The behavior of prices is largely consistent across experiments. High levels of debt to GDP tend to be associated with a more depressed trajectory for output and deflation. Fiscal stimulus when debt levels are low tend to be associated with higher inflation except in a financial crisis, where the effects are more mixed.

11 Conclusion

[To be written.]

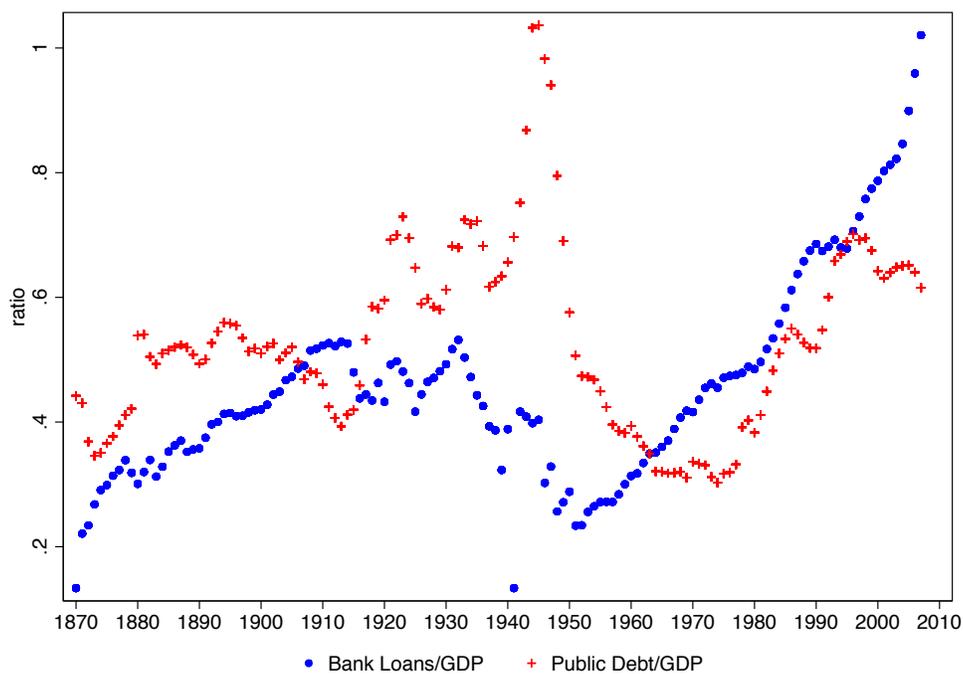
Data Appendix

[To be written.]

References

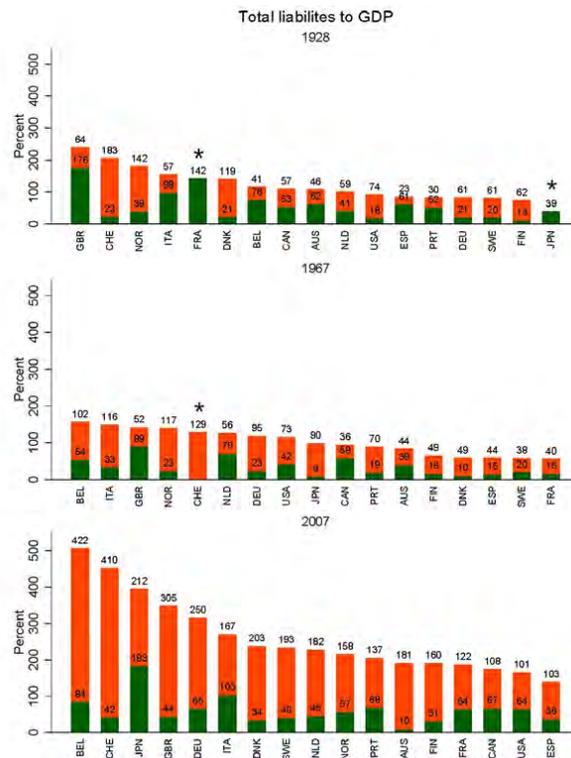
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Figure 1. Public debt and private bank credit as a percentage of GDP. Sample: 1870-2011



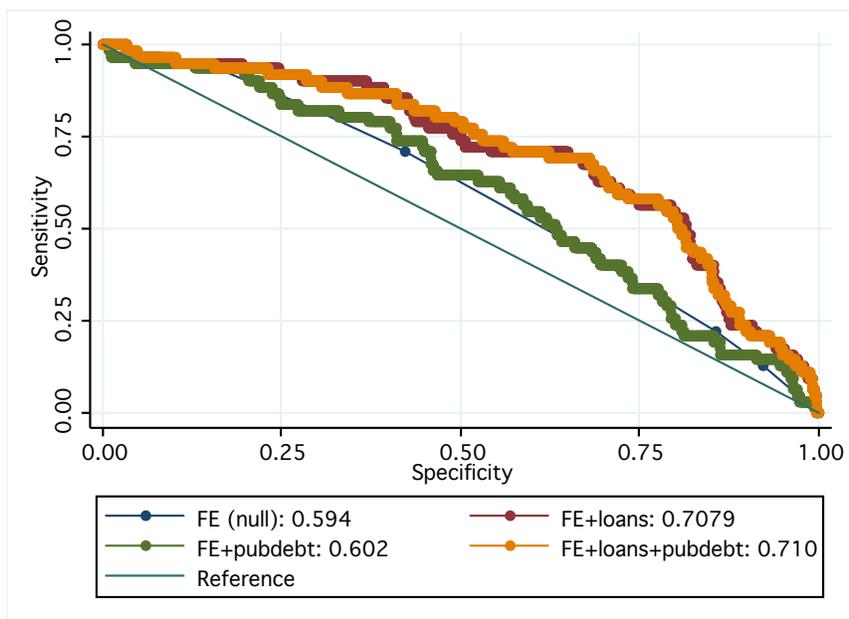
Source: The sample period is 1870–2008. Bank loans are loans by banks in aggregate to the nonfinancial sector, excluding interbank lending and foreign currency lending based on Schularick and Taylor (2012). Public debt is total sovereign debt outstanding based on Reinhart and Rogoff (2009). See Jordà, Schularick, and Taylor (forthcoming).

Figure 2. Private and public liabilities across countries: Three snapshots



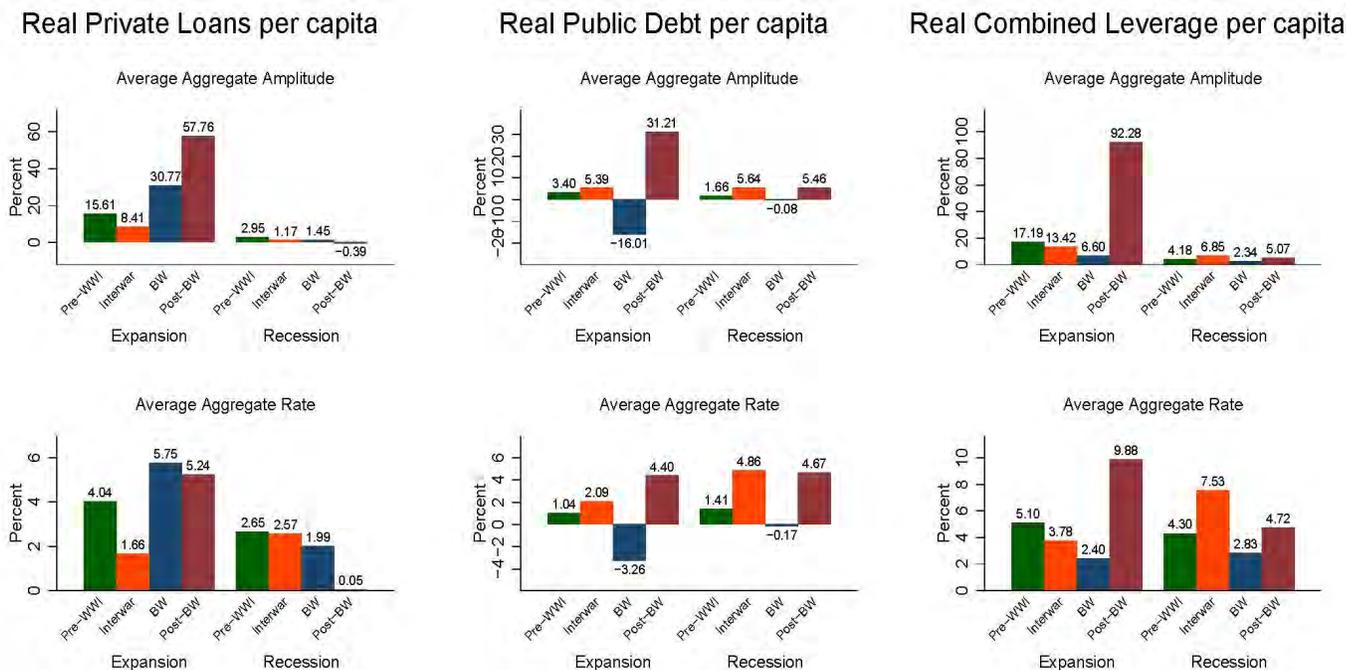
Notes: for each country, the bottom bar reflects the level of public debt to GDP. The top bar reflects the level of bank assets to GDP. Data on banking assets for France and Japan in 1928 are missing. Countries arranged by the size of the total liabilities to GDP.

Figure 3. Predictive Ability of Public Debt and Private Credit Growth for Financial Crises, Correct Classification Frontiers



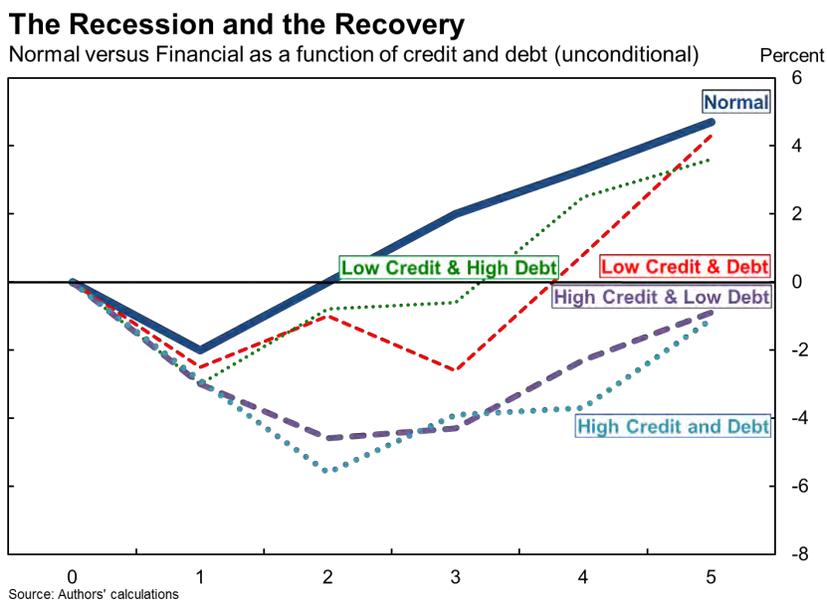
Notes and source: See Schularick and Taylor (2012). In this chart, for all models, the predictions from the prewar and postwar country-fixed-effects logit models of Schularick and Taylor (2012) are combined to give a crisis prediction for the full sample 1870–2008 and 14 advanced countries. War years are omitted. Schularick and Taylor (2012) show that the models using credit and broad money differ significantly between the two eras, with the predictive value of credit outstripping that of broad money after WW2. The “Null” is the model with country-fixed-effects only and no other regressors. The “Credit” model uses 5-year lagged moving average of the change in loans to GDP ratio. “Pub. debt” uses a 5-year lagged moving average of change in the public debt to GDP ratio. Relative either to the “Null” or the “Credit” model, the addition of “Pub. Debt” does not significantly improve the classifier. The chart shows the Correct Classification Frontiers and inference is based on a c^2 test of the area under the curve, AUC, which would be 0.5 under the “Reference” null of no information.

Figure 4. The cyclical properties of private credit and public debt. Sample: 1870 -2011



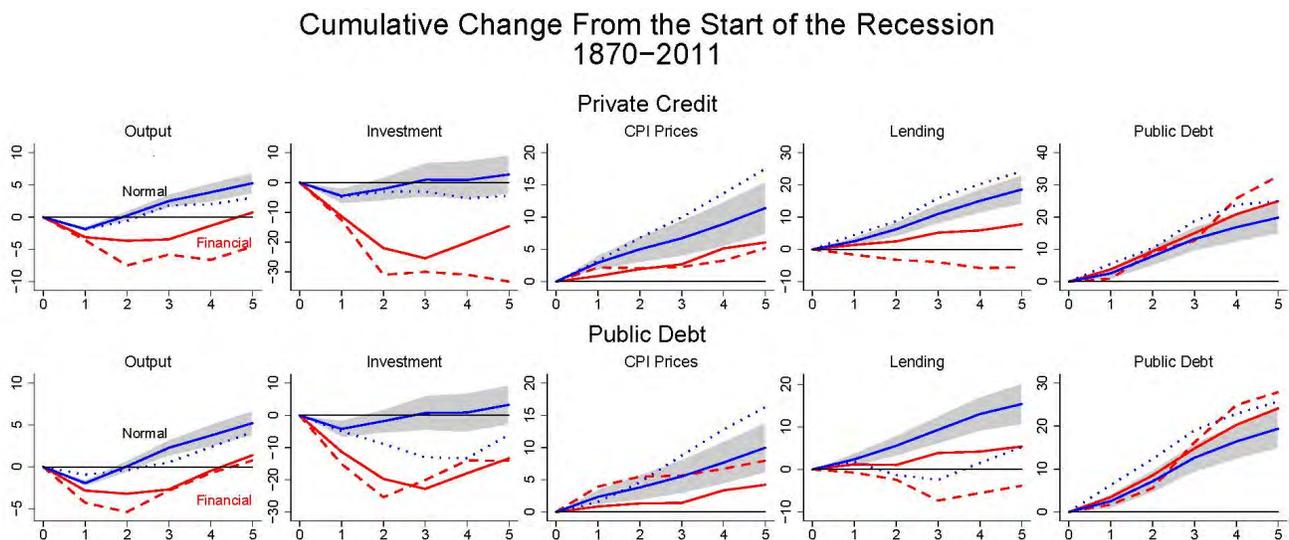
Notes: *Amplitude* refers to the accumulated change between turning points in percent of GDP; *Rate* refers to the amplitude divided by the *duration* of the appropriate stage of the cycle. The duration is calculated off the business cycle for GDP in years. The ratio of amplitude over duration results in a per year rate of change in percent relative to GDP. Pre-WWI refers to the sample 1870-1914, WWI refers to the sample 1919-1939, BW refers to the sample 1948-1971, and post-BW refers to the sample 1972-2011.

Figure 5. The unconditional dynamics of a recession as a function of credit and debt accumulated in the expansion.



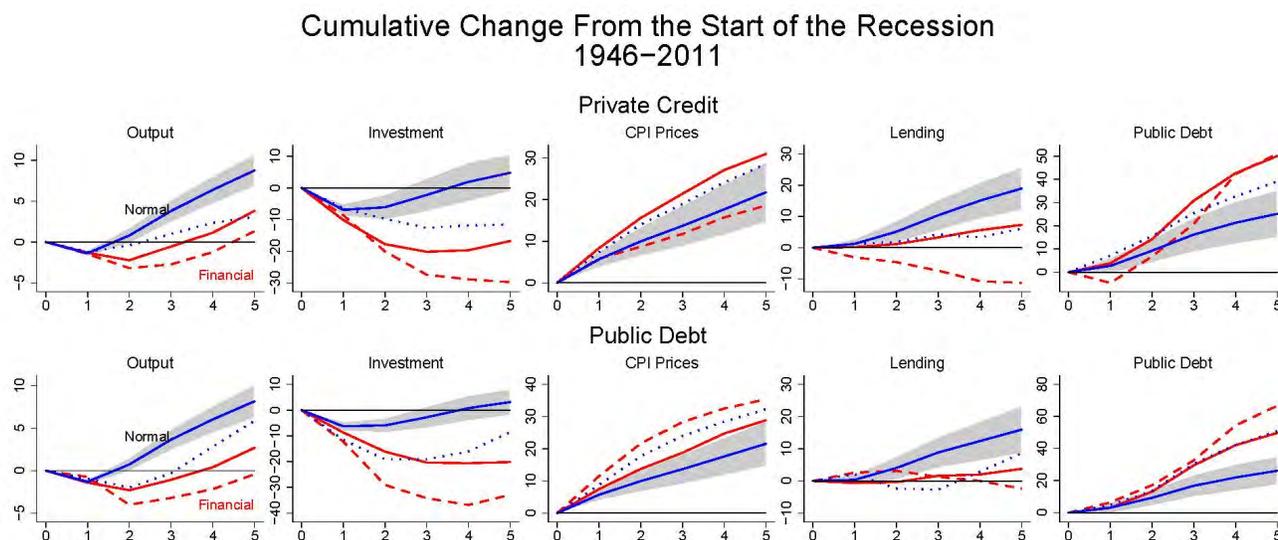
Notes: recessions normalized to zero. The average path of GDP reports as a percentage change with respect to the zero benchmark. Thick line refers to the average path of GDP in normal recessions. Dotted lines refer to the average path of GDP in financial crises when public debt accumulated in the expansion is above its long-run average. Dashed lines refer to the average path of GDP in financial crises when public debt accumulated in the expansion is below its long-run average. Within each of these two types of scenarios, the thicker versions refer to financial recessions that on top had private lending grow above average during the expansion. The thinner versions refer to below average growth of private lending instead.

Figure 6. Conditional cumulative paths of selected macroeconomic aggregates in the recession as a function of liabilities accumulated in the expansion and the type of recession. Sample: 1870-2011.



Notes: Top row refers to an *excess credit* experiment; bottom row refers to an *excess debt* experiment. For all variables, the cumulative change in the variable since the start of the recession is displayed. 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 liabilities accumulated during the expansion grew at the mean plus two standard deviations. The solid line without shaded region refers to the average path in financial crises. The dashed line refers to the path in financial crises when liabilities accumulated during the expansion grew at the mean plus two standard deviations. *Output* measured as real GDP per capita; *Investment* in real terms and per capita; *CPI Prices* measure the change in the index; *Lending* measured as real bank lending in per capita terms; and *Public Debt* measured in real terms and per capita (?). These results are conditional on macroeconomic aggregates and their lags as explained in the text.

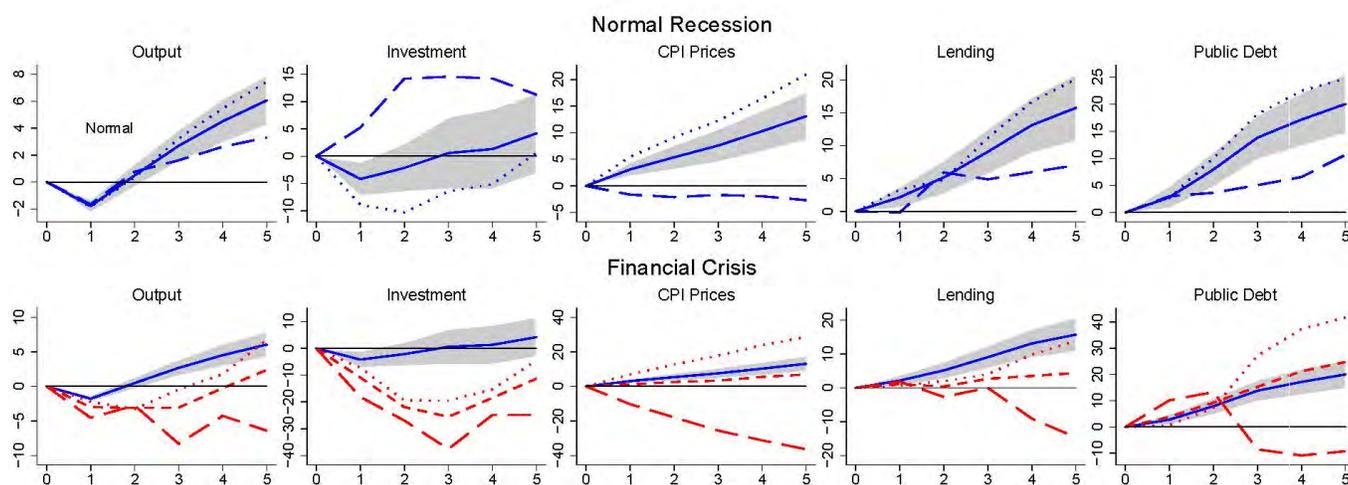
Figure 7. Conditional cumulative paths of selected macroeconomic aggregates in the recession as a function of liabilities accumulated in the expansion and the type of recession. Sample: 1945-2011.



Notes: Top row refers to an *excess credit* experiment; bottom row refers to an *excess debt* experiment. For all variables, the cumulative change in the variable since the start of the recession is displayed. 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 liabilities accumulated during the expansion grew at the mean plus two standard deviations. The solid line without shaded region refers to the average path in financial crises. The dashed line refers to the path in financial crises when liabilities accumulated during the expansion grew at the mean plus two standard deviations. *Output* measured as real GDP per capita; *Investment* in real terms and per capita; *CPI Prices* measure the change in the index; *Lending* measured as real bank lending in per capita terms; and *Public Debt* measured in real terms and per capita (?). These results are conditional on macroeconomic aggregates and their lags as explained in the text.

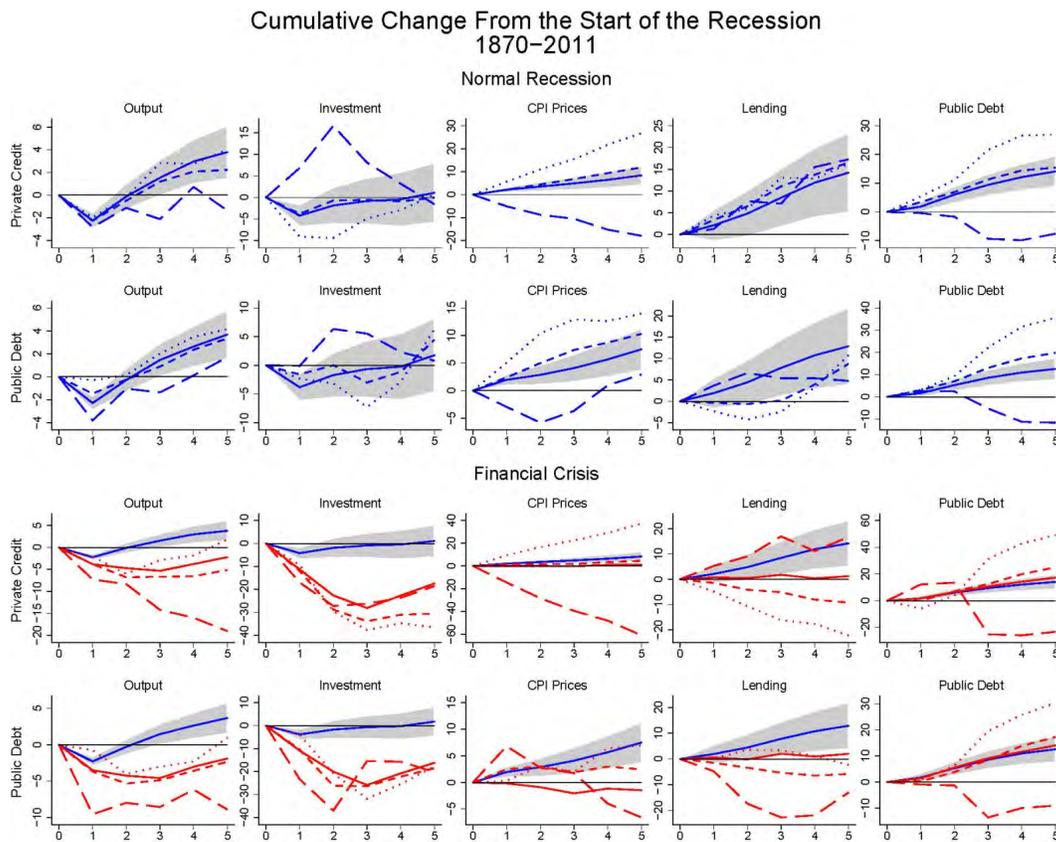
Figure 8. The effect of the debt level on the path of the recession. Sample: 1870-2011

Cumulative Change From the Start of the Recession 1870-2011



Notes: top row refers to normal recessions. Solid line with 95% confidence region refers to debt at the historical mean and hence replicates the average response reported in earlier figures. The dotted line corresponds to debt at zero and dashed line to debt at twice the mean. The bottom row refers to financial crises. The solid line with confidence region replicates the trajectory displayed in the first row. Dotted line corresponds to debt at 0, dashed is debt at historical mean, and long dash with debt at twice the historical mean.

Figure 9. Interaction between the level of debt at the start of the recession and the accumulation of liabilities in the expansion.



Notes: see text for details.