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ABSTRACT

This paper studies the role of leverage in the business cycle. Based on a study of nearly 200 recession episodes in 14 advanced countries between 1870 and 2008, we document a new stylized fact of the modern business cycle: more credit-intensive booms tend to be followed by deeper recessions and slower recoveries. We find a close relationship between the rate of credit growth relative to GDP in the expansion phase and the severity of the subsequent recession. We use local projection methods to study how leverage impacts the behavior of key macroeconomic variables such as investment, lending, interest rates, and inflation. The effects of leverage are particularly pronounced in recessions that coincide with financial crises, but are also distinctly present in normal cycles. The stylized facts we uncover lend support to the idea that financial factors play an important role in the modern business cycle.

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1 Introduction

All major landmark events in modern macroeconomic history have been associated with a financial crisis. Students of such disasters often identified leverage, that is excess credit, as the "Achilles heel of capitalism," as James Tobin put it in his review of Hyman Minsky's book *Stabilizing an Unstable Economy* (Tobin 1989). It was a historical mishap that just when the largest credit boom in history engulfed Western economies, consideration of the influence of financial factors on the real economy had dwindled to the point where it no longer played a central role in macroeconomic thinking. Standard models were therefore ill-equipped to identify the sources of growing financial fragility, so the warning signs of increased leverage in the run-up to the crisis of 2008 were largely ignored. Researchers and policymakers alike have been left searching for clearer insights, and building on our earlier work this paper tries to speak to both audiences.

On the research side, we will argue that credit and leverage have an important role to play in shaping the business cycle, in particular the intensity of recessions as well as the likelihood of financial crisis. This contribution rests on new data and empirical work within an expanding area of macroeconomic history. Just as Reinhart and Rogoff (2009ab) have cataloged in panel data the history of public-sector debt and its links to crises and economic performance, we draw on a new panel database of private bank credit creation to examine how private bank lending may contribute to economic instability. Our findings suggest that the prior evolution of credit does shape the business cycle, and this is the first step towards a formal assessment of the important macroeconomic question of whether credit is merely an epiphenomenon. If this is so, then models that omit banks and finance may be sufficient; but if credit plays an independent role in driving the path of the economy in addition to real factors, more sophisticated macro-finance models will be needed henceforth.

On the policy side, a primary challenge going forward is to redesign the monetary and financial regimes, a process involving central banks and financial authorities in many countries. The old view that a single-minded focus on credible inflation targeting alone would be necessary and sufficient deliver macroeconomic stability has been discredited. If more tools are needed, the question is how macro-finance interactions need to be integrated into a broader macroprudential policymaking framework that can mitigate systemic crises and the heavy costs associated with them. In addition, while there is an awareness that public debt instability may need more careful scrutiny (e.g., Greece), in the recent crisis the problems of many other countries largely stemmed from private credit fiascoes, often connected to housing (e.g., Ireland, Spain, U.S.).

In 2008, when prevailing research and policy thinking seemed to offer little guidance, the authorities found themselves in a difficult position, and central banks turned to economic history for guidance. According to a former Governor of the Federal Reserve, Milton Friedman's and Anna Schwartz' seminal work on the Great Depression became "the single most important piece of economic research that provided guidance to Federal Reserve Board members during the crisis" (Kroszner 2010, p. 1). But crises also offer opportunities. It is now well understood that the interactions between the financial system and the real economy were a weak spot of modern macroeconomics. Since the crisis, the role of leverage in the business cycle has come back to the forefront of macroeconomic research.

In this paper, we exploit a long-run dataset covering 14 advanced economies since 1870. We document a new and, in our view, important stylized fact about the modern business cycle: the credit-intensity of the expansion phase is closely associated with the severity of the recession phase. In other words, we show that a stronger increase in financial leverage, measured by the rate of growth of bank credit over GDP in the boom, tends to lead to a deeper subsequent downturn. Or, as the title of the paper suggests—credit bites back. This relationship between leverage and the severity of the recession is particularly strong when the recession coincides with a systemic financial crisis, but can also be detected in "normal" business cycles. We also show that the effects tend to be stronger in economies with larger financial sectors.

Our paper is part of a broad new agenda in empirical macroeconomics driven by the urge to better understand the role of financial factors in macroeconomic outcomes. Economic historians and empirical economists have started to systemically re-examine the evidence on the causes and consequences of financial fragility in advanced economies (Reinhart and Rogoff 2009a, 2009b; Mendoza and Terrones 2008; Hume and Sentance 2009; Reinhart and Reinhart 2010). Bordo and Haubrich (2010) have studied the role of financial factors in the U.S. business cycle since 1875. Claessens, Kose, and Terrones (2011) have documented important aspects of the interaction between real and financial factors in international business cycles post-1960. In this paper, we work with detailed long-run financial data for 14 countries at annual frequency that have been made available only recently (Schularick and Taylor, forthcoming). This allows us to study the role of financial factors in the modern business cycle in a long-run cross-country setting.

Our paper also connects with previous research that established stylized facts for the modern business cycle (Romer 1986; Sheffrin 1988; Backus and Kehoe 1992; Basu and Taylor 1999). In line with this research, our main aim is to "let the data speak." We document historical facts about the links between leverage and the business cycle without forcing them into a tight theoretical structure. That being said, *prima facie* our results lend some plausibility to the idea that financial factors play an important role in the modern business cycle, as exemplified in the work of Irving Fisher (1933) and Hyman Minsky (1986), works which have recently attracted renewed attention (e.g., Eggertsson and Krugman 2010). Our key finding of a relationship between the debt build-up in the expansion and the severity of the downturn can potentially be rationalized in a Fisher-Minsky framework. Higher leverage raises the vulnerability of economies to shocks. With more nominal debts outstanding, a procyclical behavior of prices can lead to greater debt-deflation pressures. Higher leverage can also lead to more pronounced confidence shocks and expectational swings, as conjectured by Minsky. Financial accelerator effects described by Bernanke and Gertler (1990) are also likely to be stronger when balance sheets are larger and thus more vulnerable to weakening. Moreover, many of these effects are likely to be more pronounced when leverage "explodes" in a systemic financial crisis. Not only may additional monetary effects may arise from banking failures and asset price declines, but the confidence shocks could also be bigger and expectational shifts more "coordinated."

Disentangling these potential propagation mechanisms is beyond the scope of this paper. The focus will be on the empirical regularities. In the first part of the paper, we present descriptive statistics for 140 years of business cycle history. Our first task is to date business cycle upswings and downswings consistently across countries, for which we use the Bry-Boschan (1971) algorithm. We then look at the behavior of real and financial aggregates across these business cycle episodes. We show that the duration of expansions has increased over time and the amplitude of recessions has declined. However, the rate of growth during upswings has fallen and credit-intensity has increased. In the second part, we ask whether the credit-intensity of the upswing is systemically related to the severity of the subsequent downturn. We construct a measure of the credit intensity of the boom—the "excess" growth of credit over GDP—and correlate this with the peak-to-trough output decline in the recession. We document, to our knowledge for the first time, that a close relationship exists between the build-up of leverage during the expansion and the severity of the subsequent recession. We also test whether this relation has changed over time (from Gold

Standard times to today) and whether the effects are larger in more"financialized" economies.

In the third part of the paper, we use local projection methods pioneered in Jordà (2005) to track the effects of excess leverage on the path of nine key macroeconomic variables for up to six years after the beginning of the recession. Among others, we study the marginal effects that higher leverage has on the behavior of variables such as investment, consumption, money, and bank lending. We also calculate the cumulative marginal losses that economies incur over this time horizon due to excess leverage in the previous expansion. We find large differences in the behavior of output, investment, and lending. The effects are considerably stronger in recession episodes that coincide with financial crises, but remain clearly visible in garden-variety recessions. We also test the robustness of our results by looking at the postwar sample separately. We then turn to an illustrative quantitative exercise based on our estimated models. In light of our results, the increase in leverage that the U.S. economy has seen in the expansion years since the 2001 recession means that any forecast for economic growth should be trimmed by about 75 basis points, and forecasts of inflation also by up to 100 basis points.

In the last part of the paper we look at the overall macroeconomic costs of financial crises. Cerra and Saxena (2008) find that financial crises lead to output losses in the range of 7.5% of GDP over ten years. Reinhart and Rogoff (2009ab) calculate that the historical average of peak-to-trough output declines following crises are about 9%, and many other papers concur. Using our long-run data, we can by and large confirm these estimates. Yet we can advance the analysis further and take a more granular approach than previous studies in two respects. First, we show how the behavior of individual macroeconomic indicators differs between normal recessions and recessions that are associated with a financial crisis. In addition to larger output costs, we find particularly strong differences with regard to price trends, lending, and investment. Second, we show how our key variable of interest, excess leverage, makes matters worse in all cases, in normal as well as financial recessions. In other words, we move beyond the average unconditional effects of crises typically discussed in the literature and demonstrate that the economic costs of financial crises can vary considerably depending on the leverage incurred during the previous expansion phase.

A question that arises naturally is what, if anything, can be said about the factors accounting for the severity of post-crisis recessions. Students of the Great Depression are familiar with these questions. The "untreated" banking crises in the early 1930s led to a steep drop in the money supply, analyzed in depth by Friedman and Schwartz (1963).[1] During the Great Recession after 2008, central banks were free from Gold Standard constraints, provided liquidity to the banking system, and successfully avoided outright deflation. The fall in GDP and rise in unemployment was also considerably smaller in most countries than in the 1930s. However, in some cases the success of central banks remained surprisingly incomplete. For instance, in proportional terms, the British economy seems on track for a comparable cumulative loss in output in the Great Recession than in the Great Depression—despite highly activist and unconventional monetary policies, a strong real devaluation, and persistently high inflation rates.

This raises the possibility that financial crises impact the macroeconomy not only through monetary channels. A key empirical finding of our study is that financial crisis recessions tend to go hand in hand with a sharp slowdown in credit growth and investment, which are amplified if the leverage build-up during the preceding expansion was large. One potential explanation is that after financial crises banks are curtailing credit and not lending to businesses despite promising investment opportunities. Kroszner, Laeven, and Klingebiel (2007) find evidence that such industries suffer more in financial crises. Abiad, Dell'Ariccia, and Li (2011) argue that impaired financial intermediation can lead to slow "creditless recoveries" by punishing industries that are more dependent on external finance. Yet weak demand for credit could also be a culprit. After a crisis, households and companies seek to reduce leverage, so that spending and investment are primarily constrained by balance-sheet repair, not by the availability of credit. For instance, Mian and Sufi (2011) study economic developments in individual U.S. counties during the Great Recession. They find that higher income leverage going into the crisis is associated with much weaker spending growth after crisis. Policy makers can ease the pain of the deleveraging process, but there is no quick fix for an extended process of balance-sheet repair. Such views clearly mesh with the influential work of Koo (2009) on balance-sheet recessions.

With the data at hand, we can not address these questions directly. But some of our results can help inform future research and policy-making. We find that short-term interest rates fall sharply in financial crisis recessions. To the extent that interest rates of short-term central bank rates and treasury bills paint a reliable picture of credit conditions in the wider economy, this

[1] A deflationary dynamic took hold that gave rise to Irving Fisher's (1933) debt-deflation theory of the Great Depression. The link between deflation, surging real interest rates, and rising debt burdens is generally accepted as an important reason for the depth and persistence of the Depression (Bernanke and James 1991). There is also evidence that countries that avoided the deflationary pressures of Gold Standard adherence fared better in the Depression (Eichengreen and Sachs 1985; Bernanke and Carey 1996; Obstfeld and Taylor 2004).

would support a credit demand-centered explanation. If demand for credit remained strong but lending constraints in the financial sector prevented a higher rate of credit creation, one could expect an increase, not a decrease in interest rates. Still, a major caveat could be that our data do not account for widening spreads over benchmark rates or other forms of credit rationing.

However, our results speak more directly to the question whether policy-makers risk unleashing inflationary pressures by keeping interest rates low. Looking back at business cycles in the past 140 years, we show that policy-makers have little to worry about. In the aftermath of credit-fueled expansions that end in a systemic financial crisis, downward pressures on inflation are pronounced and long-lasting. If policy-makers are aware this typical after-effect of leverage busts, they can set policy without worrying about a phantom inflationary menace.

2 The Business Cycle in Historical Context

2.1 The Data

The dataset used in this paper covers 14 advanced economies over the years 1870–2008 at annual frequency. The countries included are the United States, Canada, Australia, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. The share of global GDP accounted for by these countries was around 50% in the year 2000 (Maddison 2005). For each country, we have assembled national accounts data on nominal GDP, real GDP and consumption per capita, investment and the current account, as well as financial data on outstanding private bank loans (domestic bank credit), a measure of broad money (typically M2), and short- and long-term interest rates on government securities (usually 3-months at the short end and 5 years at the long end). For most indicators, we relied on data from Schularick and Taylor (forthcoming), as well as the extensions in Jordà, Schularick and Taylor (2011). The latter is also the source for the chronology and definition of financial crises which we use to differentiate between normal recessions and recessions that coincided with financial crises ("financial crisis recessions"). The classification of such episodes of systemic financial instability for the 1870 to 1960 period matches the definitions of a banking crisis used in the database compiled by Laeven and Valencia (2008) for the post-1960 period.

2.2 The Chronology of Turning Points in Economic Activity

Most countries do not have agencies that determine turning points in economic activity and even those that do have not kept records that reach back to the nineteenth century. Jordà, Schularick and Taylor (2011) as well as Claessens, Kose, and Terrones (2011) experimented with the Bry and Boschan (1971) algorithm—the closest algorithmic interpretation of the NBER's definition of recession.[2] The Bry and Boschan (1971) algorithm for yearly frequency data is simple to explain. Using *real GDP per capita* data in levels, a variable that generally trends upward over time, the algorithm looks for local minima. Each minimum is labeled as a trough and the preceding local maximum as a peak. Then recessions are the period from peak-to-trough and expansions from trough-to-peak. In Jordà, Schularick, and Taylor (2011) we drew a comparison of the dates obtained with this algorithm for the U.S. against those provided by the NBER. Each method produced remarkably similar dates, which is perhaps not altogether surprising since the data used are only at a yearly frequency. In addition, we sorted recessions into two types, those associated with systemic financial crises and those which were not, as described above. The resulting chronology of business cycle peaks is shown in Table 1, where "N" denotes a normal business cycle peak, "F" denotes a business cycle peak associated with a systemic financial crisis. There are 292 peaks identified in this table over the years 1870 to 2008 in the 14 country sample. However, in later empirical analysis the usable sample size will be curtailed somewhat, in part because we shall exclude the two world wars, in part because of the available span of data available for relevant covariates.

2.3 Four Eras of Financial Development and the Business Cycle

In order to better understand the role of leverage and its effects on the depth and recovery patterns from recessions, we first examine the cyclical properties of the economies in our sample. We differentiate between four eras of financial development, following the documentation of long-run trends in financial development in Schularick and Taylor (forthcoming). The period before World War II was characterized by a relatively stable ratio of loans to GDP, with leverage and economic growth moving by and large in sync. Within that early period, it is worth separating out the interwar period since in the aftermath of World War I, countries on both sides of the

[2] See www.nber.org/cycle/.

Table 1: Business Cycle Peaks

"N" denotes a normal business cycle peak
"F" denotes a business cycle peak associated with a systemic financial crisis

AUS	N	1875	1878	1881	1883	1885	1887	1889	1893	1896	1898	1900	1904
		1910	1913	1926	1938	1943	1951	1956	1961	1973	1976	1981	
	F	1891	1989										
CAN	N	1877	1882	1884	1888	1903	1913	1917	1928	1944	1947	1953	1956
		1981	1989	2007									
	F	1871	1874	1891	1894	1907							
CHE	N	1875	1880	1886	1890	1893	1899	1902	1906	1912	1916	1920	1933
		1939	1947	1951	1957	1974	1981	1990	1994	2001			
	F	1871	1929										
DEU	N	1879	1898	1913	1922	1943	1966	1974	1980	1992	2001		
	F	1875	1890	1905	1908	1928							
DNK	N	1870	1880	1887	1911	1914	1916	1923	1939	1944	1950	1973	1979
		1992	2001										
	F	1872	1876	1883	1920	1931	1987						
ESP	N	1873	1877	1892	1894	1901	1911	1916	1927	1932	1935	1940	1944
		1947	1952	1958	1974	1980	1992						
	F	1883	1889	1913	1925	1929	1978	2007					
FRA	N	1874	1892	1894	1896	1900	1909	1912	1916	1920	1926	1933	1937
		1939	1942	1974	1992								
	F	1872	1882	1905	1907	1929	2007						
GBR	N	1871	1875	1877	1883	1896	1899	1902	1918	1925	1938	1943	1951
		1957	1979										
	F	1873	1889	1907	1929	1973	1990	2007					
ITA	N	1870	1883	1897	1918	1923	1925	1932	1939	1974	1992	2002	2004
	F	1874	1887	1891	1929	2007							
JPN	N	1875	1877	1887	1890	1892	1895	1903	1919	1921	1929	1933	1940
		1973	1997	2001	2007								
	F	1880	1882	1898	1901	1907	1913	1925					
NLD	N	1870	1873	1877	1889	1892	1894	1899	1902	1913	1929	1957	1974
		1980	2001										
	F	1906	1937	1939									
NOR	N	1876	1881	1885	1893	1902	1916	1923	1939	1941	1957	1981	
	F	1897	1920	1930	1987								
SWE	N	1873	1881	1883	1885	1888	1890	1899	1901	1904	1913	1916	1924
		1939	1976	1980									
	F	1876	1879	1907	1920	1930	1990	2007					
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	2007						

Notes: AUS stands for Australia, CAN for Canada, CHE for Switzerland, DEU for Germany, DNK for Denmark, ESP for Spain, FRA for France, GBR for the U.K., ITA for Italy, JPN for Japan, NLD for The Netherlands, NOR for Norway, SWE for Sweden, USA for the United States. The dating method follows Jordà, Schularick and Taylor (2011) and uses the Bry and Boschan (1971) algorithm. See text.

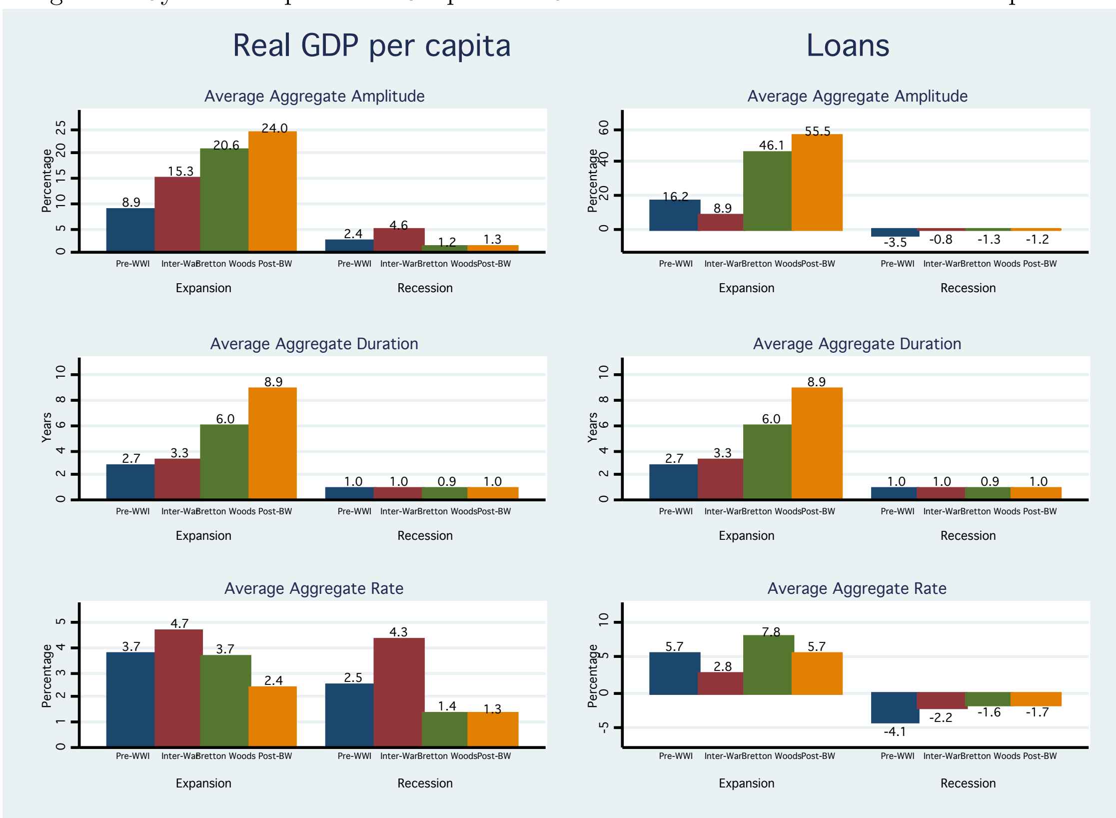
conflict temporarily suspended convertibility to gold. Despite the synchronicity of lending and economic activity before World War II, both the gold standard and the interwar era saw frequent financial crises, culminating in the Great Depression. Major institutional innovations occurred during the time, often in reaction to financial crises. In the U.S., this period saw the birth of the Federal Reserve System in 1913, and the introduction of the Glass-Steagall Act in 1933, which established the Federal Insurance Deposit Corporation (designed to provide a minimum level of deposit insurance and hence reduce the risk of bank runs) and introduced the critical separation of commercial and investment banking. This separation that endured for over 60 years until the repeal of the Act in 1999.

The regulatory architecture of the Depression era, together with the new international monetary order agreed at the 1944 Bretton Woods conference, created an institutional framework that provided financial stability for about three decades. The Bretton Woods era, marked by international capital controls and tight domestic financial regulation, was an oasis of calm. None of the countries in our sample experienced a financial crisis in the three immediate post-WW2 decades. After the end of the Bretton Woods system, leverage exploded and crises returned. In 1975, the ratio of financial assets to GDP was 150% in the U.S. By 2008 it had reached 350% (Economic Report of the President 2010). In the U.K., the financial sector's balance sheet reached a nadir of 34% of GDP in 1964. By 2007 this ratio had climbed to 500% in the UK (Turner 2010); for the 14 countries in our sample, the ratio of bank loans to GDP almost doubled since the 1970s (Schularick and Taylor forthcoming). Perhaps not surprisingly, financial crises returned, culminating in the 2008 global financial crisis.

We begin by summarizing the salient properties of the economic cycle for the countries in our sample over these four eras of financial development. For this purpose we calculate three cyclical features applied to GDP and to lending activity as measured by our *loans* variable: (1) the negative of the peak-to-trough percent change and the trough-to-peak percent change, which we denominate as the *amplitude* of the recession/expansion cycle; (2) the *duration* of recession/expansion episodes in years; (3) and the ratio of amplitude over duration which delivers a per-period rate of change and which we denominate *rate*. Figure 1 summarizes these calculations in graphical form.

This analysis of real GDP per capita data in column 1 of the figure reveals several interesting features. The average expansion has become longer lasting, going from a duration of 2.7 years before World War I to about 9 years in the post-Bretton Woods period (row 2, column 1). Because

Figure 1: Cyclical Properties of Output and Credit in Four Eras of Financial Developement



Notes: See text.

of the longer duration, the cumulative gain in real GDP per capita almost tripled from 9% to 24% (row 1, column 1). However, the rate at which the economy grew in expansions has slowed considerably, from a maximum of almost 5% before World War-II to 2.4% in more recent times (row 3, column 1). In contrast, recessions last about the same in all four periods but output losses have been more modest in recent times (before the Great Recession, since our dataset ends in 2008). Whereas the cumulative real GDP per capita loss in the interwar period peaked at 4.6%, that loss is now less than half at 1.3% (row 1, column 1). This is also evident if one looks at real GDP per capita growth rates (row 3, column 1).

Looking now at loan activity in column 2 of the figure, there are some interesting differences and similarities. Because we are using business cycle turning points to reference what happens to loans, the duration chart (column 2, row 2) is the same as in column 1. The leverage story starts to take form if one looks at the relative amplitude in loans versus real GDP per capita. Whereas in pre-WWI the amplitude of loans is about 16%, it dropped to an all time low in the interwar period of 9% (a period which includes the Great Depression but also the temporary abandonment of the Gold Standard), but by the most recent period the cumulated loan activity of 56% in expansions more than doubles cumulated real GDP per capita gains of 24% (from row 1, column 1). Another way to see this is by comparing the rates displayed in the charts of the bottom row of the figure. Prior to World War II, real GDP per capita grew at a yearly rate of between 3.7% to 4.7% (before and after World War I) during expansions, and loans at a rate of 5.7% and 2.8% respectively; that is, the rate of real GDP per capita growth in the interwar period nearly doubles the rate of loan growth. In the post–Bretton Woods era, a yearly rate of loan growth of 5.7% more than doubles the yearly rate of real GDP per capita growth, which stands at just 2.4%, a dramatic reversal.

Interestingly, the negative numbers in column 2, rows 1 and 3 of the figure indicate that, on average, credit continues to grow even in recessions. Yet as we consider what happens during expansions, we should note that the rate of loan growth has stabilized to some degree in recent times, going from 7.8% per year in the Bretton Woods era to 5.7% in the post-Bretton Woods era (see row 3, column 2). However, it is important to remember that, for some countries, the explosion of the shadow banking system in more recent times may obscure the true level of leverage in the economy. For example, Pozsar et al. (2010) calculate that for the U.S., the size of the shadow banking system surpassed the traditional banking system sometime in 2008.

2.4 Credit Intensity of the Boom

The role of leverage on the severity of the recession and on the shape of the recovery is the primary object of interest in what is to come. But the analysis would be incomplete if we did not at least summarize the salient features of expansions when credit intensity varies. Key to our subsequent analysis is a measure of excess leverage during the expansion phase preceding a recession and to that end we will construct a variable that measures the excess cumulated aggregate bank loan to GDP growth in the expansion normalized by the duration of the expansion to generate a percent, per-year rate of change. Table 2 provides a summary of the average amplitude, duration and rate of expansions broken down by whether excess leverage during those expansions was above or below its historical mean—the simplest way to divide the sample. Summary statistics are provided for the full sample (excluding both World Wars) and also over two subsamples split by World War II. The split is motivated by the considerable differences in the behavior of credit highlighted by

Table 2: Expansions and Leverage

	Amplitude		Duration		Rate	
	Low Leverage	High Leverage	Low Leverage	High Leverage	Low Leverage	High Leverage
Full Sample						
Mean	16%	19%	4.0	5.5	4.3%	3.4%
Standard Deviation	(23)	(28)	(5.5)	(5.6)	(2.5)	(1.9)
Observations	87	159	87	159	87	159
Pre-World War II						
Mean	12%	10%	2.6	3.1	5.0%	3.5%
Standard Deviation	(12)	(8)	(2.0)	(2.8)	(2.6)	(2.0)
Observations	59	110	59	110	59	110
Post-World War II						
Mean	28%	38%	8.9	9.7	2.7%	3.4%
Standard Deviation	(35)	(45)	(8.0)	(7.3)	(1.4)	(1.7)
Observations	36	41	36	41	36	41

Notes: Amplitude is peak to trough change in real real GDP per capita. Duration is peak to trough time in years. Rate is peak to trough growth rate of real real GDP per capita. High leverage denotes credit/GDP above its full sample mean at the peak. Low leverage denotes credit/GDP above its full sample mean at the peak.

Schularick and Taylor (forthcoming) before and after this juncture and described above.

In some ways, Table 2 echoes some of the themes from the previous section. From the perspective of the full sample analysis, the basic conclusion would seem to be that leverage serves to extend the expansion phase by about 1.5 years so that the accumulated growth is about 4% higher, even though on a per-period basis, low leverage expansions display faster rates of real GDP per capita growth. However, there are marked differences between the pre- and post-World War II samples. As we noted earlier, expansions last quite a bit longer in the latter period, in Table 2 the ratio is about 1-to-3. Not surprisingly, the accumulated growth in the expansion is also about three times larger in post-World War II even though the overall rate of growth is slower. But the more important difference comes in terms of the relative rates of growth with low and high leverage. Even though leverage is on average much higher in post-World War II, excess leverage appears to translate into periods of faster economic growth whichever way it is measured: cumulated growth from trough to peak between low and high leverage expansions is almost 10% larger (28% versus 38%); expansions last almost an extra year in periods of high leverage (8.9 versus 9.7 years); and this results in faster per year growth rates (2.7% versus 3.4%).

Naturally, the sample size is rather too short to validate the differences through a formal statistical lens, but at a minimum the data suggest that the explosion of leverage after World War II did have a measurable impact on growth in expansion phases. But it is quite another matter whether these gains were enough to compensate for what was to happen during recessions and to answer that question in detail, we now focus on that side of the equation.

3 The Credit Intensity of the Boom and the Severity of the Recession

With our business cycle dating strategy implemented as described, we can now begin the formal empirical analysis of the main hypothesis in the paper. We will make use of a data universe consisting of up to 187 business cycles in 14 advanced countries over 140 years (we exclude cycles during each world war, and have to exclude those for which loan data are not available). We use these data to address our key question: is the intensity of credit creation, or leveraging in the preceding expansion phase systematically related to the severity of the subsequent recession phase?

We will follow various empirical strategies to attack this question, beginning in this section with the simplest regression approach. Each one of our observations will consist of data relating to one of the business cycle peaks in country i and time t, and the full set of such observations will be the set of events $\{i_1t_1, i_2t_2, \ldots, i_Rt_R\}$, with $R = 187$. For each peak date, the key pre-determined independent variable will the excess growth rate of aggregate bank loans relative to GDP in the prior expansion phase, which we will speak of as a measure of the credit intensity of the boom or a way of thinking about how fast the economy was increasing its leverage according to the loan/GDP ratio metric. We can also look at the level of the loan/GDP ratio, to see if the absolute level of leverage matters as well.

The dependent variables we first examine will be some of the key characteristics of the subsequent recession phase that follows the peak: the growth rate of real GDP per capita (Y), the growth rate of real consumption per capita (C), the duration of the recession (in years), and the peak-to-trough amplitude of the recession (in units of log Y). As noted above, the data on Y and C are from Barro and Ursúa (2008) and the duration and amplitude measures are derived from the Bry-Boschan (1971) algorithm, as discussed above.

Table 3 presents our first set of results, which confirm that the hypothesis may have merit. The four columns correspond to each of the recession characteristics treated as the dependent

Table 3: Recession characteristics versus excess loan growth in prior expansion

	(1) Growth rate of Y	(2) Growth rate of C	(3) Duration	(4) Peak-Trough Amplitude
Excess loan/GDP growth rate	-0.0063***	-0.0050*	-0.0089	-0.0140***
	(0.0019)	(0.0030)	(0.0628)	(0.0048)
Observations	187	167	187	187

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Independent variables are for the prior expansion and are standardized. Country fixed effects not shown. Y is real GDP per capita. C is real consumption per capita.

variables, which are regressed in turn on the main independent variable, the excess loan/GDP growth rate, or credit intensity, in the prior expansion phase, which in all of the regressions in this section is treated a standardized variable, with zero mean and unit variance.

Column 1 shows that higher credit intensity in the prior boom phase is associated with slower growth of real GDP per capita in the subsequent recession phase, and the relationship is statistically significant at the 1% level. The coefficient of -0.0063 indicates that a 1 standard deviation increase in credit intensity lowers recession period growth of real GDP per capita by 0.63 percentage point per year, a quantitatively significant amount when accumulated over several years.

There are two main things to say about this first finding. First, it is the main result that we will explore in greater detail and verify for robustness throughout the paper. Second, as we shall see, it will be important to see that this is a result that is driven not just by recessions associated with financial crises, which are in turn driven by credit intensity, a chain of association that has been noted before (Reinhart and Rogoff 2009ab; Schularick and Taylor, forthcoming). In other words, we will show that excess credit is a problem in all business cycles not just those that end with a financial crisis.

Column 2 shows that higher credit intensity in the prior boom phase is associated with slower growth of real consumption in the subsequent recession phase, although compared to column 1 the coefficient is less precisely estimated. This may reflect the fact that we have fewer observations in this case and also that the historical consumption series, as well as being full of more holes, are also likely subject to greater measurement error than the GDP series.

Column 3 shows that higher credit intensity in the prior boom phase is not statistically associated with the duration of the subsequent recession. Given the result in Column 1 it would seem then that in general, the impact of credit intensity must work through the depth of the recession

Table 4: Recession characteristics versus excess loan growth and loan/GDP level in prior expansion

	(1) Growth rate of Y	(2) Growth rate of C	(3) Duration	(4) Peak-Trough Amplitude
Excess loan/GDP growth rate	-0.0069***	-0.0121***	0.0091	-0.0113**
	(0.0022)	(0.0032)	(0.0739)	(0.0053)
Loan/GDP level	0.0020	0.0135***	-0.0095	0.0028
	(0.0030)	(0.0047)	(0.0995)	(0.0071)
Excess × Loan/GDP level	-0.0048*	-0.0194***	-0.0254	-0.0054
	(0.0026)	(0.0038)	(0.0884)	(0.0063)
Observations	186	166	186	186

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Independent variables are for the prior expansion and are standardized. Country fixed effects not shown. Y is real GDP per capita. C is real consumption per capita.

not its length, and this is confirmed in Column 4, where higher credit intensity is associated with greater peak to trough amplitude in the recession. The coefficient of -0.014 indicates that a 1 standard deviation increase in credit intensity in the boom phase is associated with an extra 1.4 percentage points in lost real GDP per capita in the recession phase.

3.1 Additional Controls

These first results report only the simple bivariate relationship between our credit intensity measure of excess loans/GDP growth and the recession characteristics. In Table 4 we explore whether the level of the loans/GDP variable also has an impact, to see if more highly financialized economies tend to be more sensitive to the boom-bust linkage we are exploring. To that end we include the level of loans/GDP variable at the peak and its interaction with the excess growth rate variable.

The results are not so different for duration and amplitude in columns 3 and 4. But in both columns 1 and 2 (the effects on real GDP and consumption per capita) there is some suggestion that the interaction effect matters, but it is of marginal significance in the case of real GDP per capita. The stronger effect seems to be on real consumption per capita in column 2, where both adding both the level and interaction terms makes all three terms in the regression highly statistically significant, with the sign on the interaction term as expected: the effect of credit intensity in the boom is amplified when the level of loans/GDP is higher. Again, the right-hand side variables are standardized so for the case of consumption, a 1 s.d. increase in credit intensity when loans/GDP are at their mean value of zero lowers recession growth by 1.21 percentage points per annum; but when loans/GDP are 1 s.d. above there mean, the effect is much larger

(1.21+1.94) and equals 3.15 percentage points per annum.

In Column 1 for the case of real GDP per capita the corresponding effects are smaller: a 1 s.d. increase in credit intensity when loans/GDP are at their mean value of zero lowers recession growth by 0.69 percentage points per annum; but when loans/GDP are 1 s.d. above there mean, the effect is much larger (0.69+0.48) and equals 1.17 percentage points per annum.

The basic lesson of these result is that when booms are characterized by fast growing credit, the recession is even worse when credit levels are also very high. Moreover, although a strong drag is felt on real GDP per capita, the effect is even larger on real consumption per capita.

3.2 Subsample Splits

To conclude our initial empirical tests based on the regression approach, we explore the robustness of our results in Table 5 by examining how the results might vary by subsample splits. Column 1 replicates the baseline results from Table 1, for comparison, but now arranged in a column. Panel (a) looks at the effect of credit intensity in the boom on recession phase real GDP per capita growth; panel (b) looks at real consumption per capita growth; panel (c) looks at duration; and panel (d) looks at peak-trough amplitude.

In each column we now repeat each regression on the different subsamples. Columns 2 and 3 split the sample one way, and look at recessions associated with financial crises (51 observations) and normal non-crisis recessions (136 observations) to see if the effects are driven by the crisis phenomenon, or are stronger in such times. The basic finding here is that the impact on real GDP and consumption per capita in the recession is estimated to be larger judged by the point estimates, as compared to column 1, but the estimates are imprecise for consumption, again most likely for the reasons noted earlier. The real GDP per capita growth drag increases from −0.58 percentage points to −1.03, for a 1 s.d. change in credit intensity in the boom. The real consumption per capita drag increases from −0.39 percentage points to −1.23, for a 1 s.d. change in credit intensity in the boom. However, the results for the real GDP per capita variable serve as a caution that the dangers of excessive leverage are not confined simply to booms that end in crises; even normal non-crisis business cycles can have amplified recession phases when preceded by a credit intensive boom. The results in panels (c) and (d) are also of interest. It would appear that normal non-crisis recessions are shorter and sharper, but crisis recessions are somewhat longer.

Columns 4 and 5 split the sample another way, looking at cases where the level of leverage is

Table 5: Recession characteristics versus excess loan growth in prior expansion, subsamples

	(1) All	(2) Financial Crisis	(3) No Financial Crisis	(4) Hi Leverage	(5) Low Leverage
(a) Growth rate of Y					
Excess loan/GDP growth rate	-0.0063***	-0.0103*	-0.0058***	-0.0168***	-0.0022
	(0.0019)	(0.0051)	(0.0019)	(0.0049)	(0.0019)
Observations	187	51	136	63	124
(b) Growth rate of C					
Excess loan/GDP growth rate	-0.0050*	-0.0123	-0.0039	-0.0321***	0.0025
	(0.0030)	(0.0081)	(0.0029)	(0.0093)	(0.0026)
Observations	167	44	123	47	120
(c) Duration					
Excess loan/GDP growth rate	-0.0089	0.2450**	-0.1240*	-0.0242	0.0025
	(0.0628)	(0.1180)	(0.0719)	(0.1170)	(0.0026)
Observations	187	51	136	63	120
(d) Peak-Trough Amplitude					
Excess loan/GDP growth rate	-0.0140***	-0.0048	-0.0195***	-0.0265***	-0.0071
	(0.0048)	(0.0099)	(0.0055)	(0.0087)	(0.0058)
Observations	187	51	136	63	124

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Independent variables are for the prior expansion and are standardized. Country fixed effects not shown. Y is real GDP per capita. C is real consumption per capita.

measured by the loan/GDP ratio. High leverage in column 4 includes cases where the loan/GDP is above its sample average at the peak; low leverage in column 5 includes the other cases where the loan/GDP is below its sample average at the peak. The results are as expected, and most of the impacts are worse in the recession phase when leverage is high. The real GDP per capita growth drag increases from -0.22 percentage points (and insignificant) to -1.68 when we go from low to high. The real consumption per capita growth drag increases from $+0.25$ percentage points (and insignificant) to -3.21 when we go from low to high. Duration is insignificant in both cases, but the estimated peak to trough real GDP per capita loss almost quadruples from 0.71 percentage points (and insignificant) to 2.65 percentage points (and highly significant).

To sum up, these preliminary exercises suggest that according to the long run record in advanced economies based on nearly 200 recession episodes over a century and a half, we can say that what happens to credit during the boom phase of an expansion generally matters a great deal as regards the nature of the subsequent recession. When the boom is associated with high rates of growth of loans in excess of GDP, the recession is generally more severe. This effect is even stronger when the level of the loans/GDP variable is high, that is, if the economy is highly financialized.

These results serve to motivate the analysis which follows. In the rest of the paper we utilize more sophisticated techniques to provide stronger assurance as to both the statistical and quantitative significance of these impacts, using dynamic modeling techniques and linear projection methods to get a more granular view as to how the recession phase plays out according to precise but empirically plausible shifts in leverage during the prior boom.

4 The Dynamics of Leverage, Recession, and Recovery

The results of the previous section suggest that an economy's leverage history may play an important role in determining how the recession and subsequent recovery phase evolve. To provide a deeper analysis this section investigates the role of leverage on the time-paths of macroeconomic variables using modern methods of dynamic analysis. We should be clear that our intent is not to seek a causal explanation for recessions—an important matter that deserves its own separate paper. Rather, we ask whether there are differences in the manner the economy evolves after a normal versus financial recession, and what role leverage may play in making matters worse in each case. The answers turn out to have important research and policy implications.

The statistical toolkit that we favor is the local projection approach introduced in Jordà (2005). Local projections are based on the premise that dynamic multipliers (of which impulse responses are an example but not the only one) are properties of the data that can be calculated directly rather than indirectly through a reference model such as a VAR. In the simplest case, think of calculating a sample mean or deriving an estimate of the mean with the parameter estimates of a regression. There are several advantages if one takes this direct route, the most obvious being that specification of a model is not required and therefore one is not subject to misspecification problems. In situations where asymmetries, nonlinearities, richer data structures (such as time-series, cross-section panels of data) or other deviations from the norm are a concern (such as in our application), the simplicity of the local projection approach offers a considerable advantage over the indirect route since parametric and numerical requirements needed to accommodate these richer structures in VARs are often prohibitive in finite samples.

Conceptually, local projections are a natural extension of the concept of an *average treatment effect* to the dynamic context., that is, the notion that we calculate the average response of a variable, conditional on covariates when we vary the treatment variable from the "off" (or "control") to the "on" (or "treatment") positions. In practice that interpretation relies greatly on whether variations in the treatment conditional on covariates can be considered exogenous—or, in the context of our application, whether the variation in the amount of excess leverage in the prior expansion can be considered exogenous in the subsequent recession. Moreover, one would also need to determine the triggers of a garden-variety recession versus a financial crisis recession to do the proper adjustments. These are certainly interesting questions that we intend to pursue in future research. But in the meantime, conditional on experiencing a recession of a particular type (taken here as a given), we can examine what is the effect of leverage at the margin, which is a useful and informative characterization of the salient features of the historical sample.

4.1 Statistical Design Using Local Projections

A natural summary of the dynamic behavior of economies in recession is to normalize the data at the start of the recession, and then examine the average path of the variables of interest from that point forward. This is the approach that is often followed in the event-study literature and a classic example is the Romer and Romer (1989) examination of the effects of exogenous shocks to monetary policy. There are several extensions of and departures from this approach that we think are worth pursuing and that guide how we analyze the data below.

The basic event-study approach treats every occurrence identically. We feel this does not provide sufficient texture since the data suggest that the manner in which countries endure recessions and experience recoveries varies widely across time and countries, and may depend on certain economic conditions. For this reason consider the measure of excess leverage that we have entertained so far: that is, let us use the data for the expansion preceding the recession of interest to construct the ratio of the trough-to-peak ratio of loan to GDP growth divided by the duration of the expansion. This generates a variable that is the approximate per-year rate of excess cumulation of lending to output growth. Excess leverage measured in this manner is about 1.5% per year but in our sample we find it can fluctuate from a minimum of -22% per year (meaning a rather dramatic period of deleveraging) to a maximum of 27% per year. In the U.S. the mean is about the same but the range of variation is more modest, in the $\pm 10\%$ range.

A second point of departure with respect to event-study analysis is that we are interested in examining the dynamic behavior of several variables in a system and from this point of view, it is important to account for how these variables have related to each other historically. Since our data are in panel form, traditional model-based times series methods (VARs) are too parametrically intensive for our investigation. Moreover, because we are investigating a rather new phenomenon, for which we want to provide results that can be used as a reference point by other researchers, we want to use methods that are flexible and impose the least constraints on the data. For these reasons, we use a variation of the *local projection* approach introduced in Jordà (2005, 2009).

Specifically, let $y_{k,t}$ denote the $n \times 1$ vector of observations for variable k in the system of $k = 1, ..., K$ variables for n countries at time $t = 1, ..., T$. The K variables are collected into the vector Y_t for notational convenience. Let x_t denote the $n \times 1$ vector of excess leverage values for each of the n countries. We will be interested in calculating the *dynamic multiplier* which we define as follows:

$$\begin{aligned} R(y_{k,t(r)}, h, \delta) &= E_{t(r)}(y_{k,t(r)+h} | x_{t(r)} = \overline{x} + \delta; Y_{t(r)}, Y_{t(r)-1}, ...) \\ &- E_{t(r)}(y_{k,t(r)+h} | x_{t(r)} = \overline{x} \quad ; Y_{t(r)}, Y_{t(r)-1}, ...), \end{aligned} \tag{1}$$

where $R(y_{k,t(r)}, h, \delta)$ denotes the response of variable $y_{k,t(r)}$, h periods in the future when excess leverage deviates from its mean value $\overline{x}$ by an amount δ, and the expectations are *conditional* on the history of the variables in the system up to time $t(r)$. The notation $t(r)$ denotes the calendar time period t associated with the r^{th} recession in the sample, where $r = 1, ..., R$. The reason for making this distinction is that the variable excess leverage, represented here by $x_{t(r)}$, is calculated as the amount of excess leverage accumulated during the expansion preceding the r^{th} recession.

Before turning to the specifics, it is worth remarking on several features. Although expression (1) may remind some readers of the calculation of an average treatment effect (in a dynamic setting) with treatment δ, we must notice that for that interpretation to be valid one would need δ to be exogenously determined. This poses an interesting question, but one that is beyond the scope of this paper, and which we wish to pursue later in the context of a richer model of the economy, where we can trace the determinants of excess leverage and why it is accumulated during some expansions but not others. This is a goal for our future research, where in the context of a modeling environment one can more clearly investigate the role of policy. Our aim here is more modest and it is simply to document what the average effect is across recessions and examine whether normal and financial recessions react differently.

Notice that expression (1) is conditional on the past histories of the other variables in the system. This is an important feature when we set out to measure the true average effect of excess leverage: we want to be sure to condition on all other available information so as not to pollute our measurement with omitted information. In fact, the set-up in expression (1) is well defined to be interpreted as a *conditional forecast* and hence the response associated with δ can be seen as an excess leverage adjustment factor for the forecast of the k^{th} variable at time $t(r)$. This interpretation is of considerable policy relevance: as we will see shortly, one of the more intriguing results we report below suggests that in financial crises, excess leverage tends to further depress lending and investment activity over longer periods of time. But the fact that these effects occur in a deflationary environment has potentially important implications for the relevant policy trade-offs. It would appear that more than one central banker is presently laboring under a misapprehension about the nature of these trade-offs.

In practice, estimating expression (1) would require the correct model of the conditional mean, which calls for nonparametric methods. Such methods have data requirements that are not met by our panel and for this reason we will interpret the operator $E_{t(r)}$ to mean the linear projection operator. When the data are linear, this operator coincides with the conditional mean operator, but in general this need not be the case. Under these assumptions, estimation of expression (1) on the data can be accomplished using a panel fixed effects estimator. Fixed effects are a convenient way to allow cross-country variation in the average response to leverage (as one might expect, say, when there is variation in the institutional framework in which financial markets and policies operate in each country), while at the same time allowing us to identify the common component of the response.

One may be concerned that panel fixed effects estimation with lagged endogenous variables could be problematic for reasons well known at least since Nickell (1986) and explored in more detail in Arellano and Bond (1991) and Alvarez and Arellano (2003). But there are two conditions that need to be met for the incidental-parameters bias to be a problem: (1) a short time series; and (2) a high degree of autocorrelation. Both conditions are not at work in our application since we have relatively long time series (about 140 year-observations) and the variables $y_{k,t}$ refer in most cases to growth rates, which tend to have serial correlation parameters well below 1. In the trade-off between bias and variance, logic dictates that we stick to the usual fixed-effects estimator.

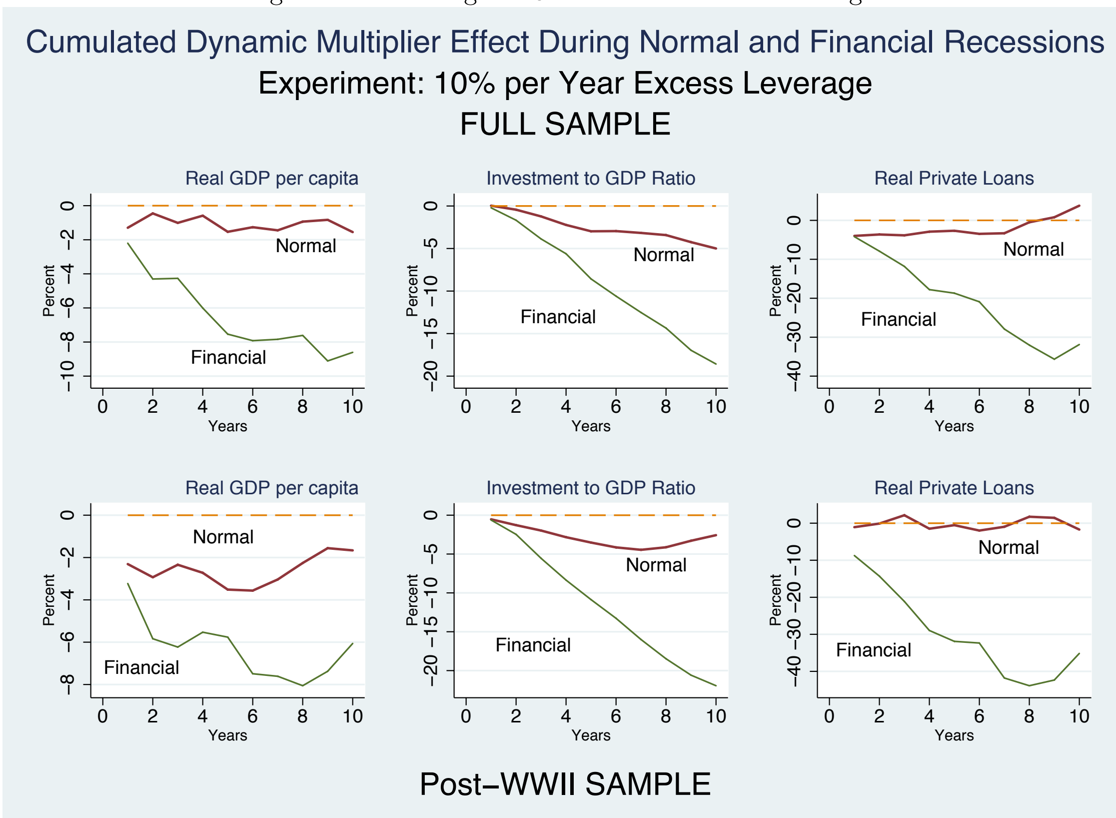
4.2 Cumulative Marginal Effects of Leverage

This section investigates how leverage affects the recession and subsequent recovery by distinguishing whether the recession is financial in nature (i.e., associated with a financial crisis) or not. This is a significant point of departure from the literature and one we feel worth emphasizing. Using the methods just described, we use a nine variable system that contains the following variables: (1) the growth rate of real GDP per capita; (2) the growth rate of real consumption per capita; (3) the growth rate of real private loans; (4) the growth rate of real money balances (measured by M2 in most cases); (5) the consumer price index (CPI) inflation rate; (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); (8) the investment to GDP ratio; and (9) the current account to GDP ratio.

We begin by offering a simple summary of the *cumulated marginal effects* of excess leverage—that is, e.g., how much deeper is the loss of output in a financial recession as a function of leverage, accumulated over time– to set the stage before we turn to the specifics of the year-to-year dynamics. Figure 2 reports two sets of results, one based on the full sample (excluding periods of war) and displayed in the top row, the other based on post–World War II data and displayed in the bottom row. In each row, the thought experiment is the same and consists in summarizing the marginal cumulated effect of excess leverage on three key variables, output, investment and lending, in normal versus financial recessions.

These marginal cumulated effects are calculated by comparing the paths of economies at the onset of the recession when "per year excess leverage" defined as the excess loan growth rate in the prior recession goes from 0% to 10% in a per-year rate. Because this variable is on average positive (about 1.5% per year on the full sample, i.e., for all expansions, with a standard deviation of about 6.5%) and 10% lies at the high end of the range of what we observe (slightly above the mean plus one standard deviation), one must exercise caution before extrapolating any interpretation. Rather, the main reason for looking at a number like 10% is to make it easy for the reader to scale as appropriate and understand any particular episode. For example, in a country that experiences excess leverage in the order of 2% above mean, the marginal accumulated effect can be directly read from our graph by scaling with a factor of 1/5. Regardless, the main message is contained in the relative scale of the cumulated losses between normal and financial recessions and on that

Figure 2: The Marginal Cumulated Effect of Leverage



Notes: See text.

score the main message is simple: whereas in a normal recession excess leverage of 10% results in a loss of about 1% even after 10 years, losses can accumulate to about 9% at the end of the decade following a financial crisis recession.

These large differences in output are even more stark when considering what happens to investment: after 10 years, the accumulated loss is around 5% during normal recessions, but it is nearly four times larger during a financial crisis. One explanation for the disparities that we are finding in this preliminary exercise is perhaps to be found in lending. Lending declines during normal recessions, but rather mildly and eight years out, the accumulated losses are turned into gains. In contrast, lending activity freezes during financial crises and real loans decline at alarming rates which cumulate to about a 35% decline before starting recover, nine years after the start of the recession.

In order to put these figures into a more practical context, consider that the United States at the beginning of the 2008 global financial crisis arguably had excess leverage from mean of about 3% to 3.5% (possibly more if one were to account more accurately for the leverage in the shadow banking system). Then the nearly 35% drop in loans noted in the experiment we were discussing earlier would scale down to something closer to a negative 10% cumulated marginal shock, a number that is well within the plausible range in current economic policy discussions.

The natural question arises: Are these stark differences an artifact of the dramatic events during the Great Depression? The answer seems to be no. We repeated the experiments for these three variables using post-World War II data and obtained virtually identical figures, displayed in the bottom row of Figure 2. The results show clearly that the cumulative real GDP per capita losses due to excess leverage are particularly large in financial crisis recessions. But they are substantial in normal recessions, and even larger than in the full sample, as can be seen in the charts.

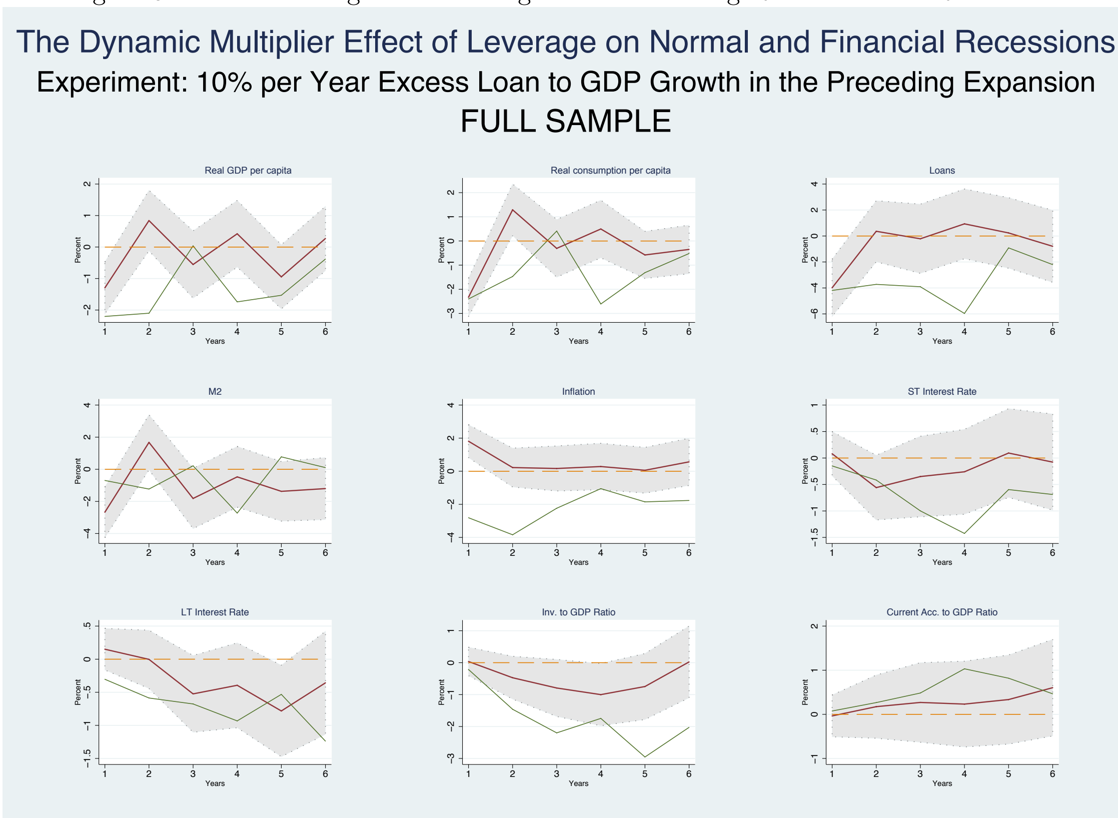
4.3 Leverage and the Recession Path

In this section we explore more formally where these differences come from by exploring the year-to-year dynamic paths of the variables in our system as the economy falls into recession and then begins to recover. That is, instead of showing cumulated effects as above we show the non-cumulated year by year marginal effects.

Figure 3 presents the results of this exercise, which breaks down the analysis by whether the type of recession we consider is financial in nature or not. To facilitate the interpretation of the figure, we choose an experiment in which the excess leverage rate brought in at the start of the recession is 10% in magnitude for the same reasons described in the previous section. The individual charts in figure 3 are calculated for each year of the recession and recovery phases. Since recessions last between one and two years on average, the observations for years one and two will typically represent what happens during recessions. Observations for years three to six will be most often associated with the recovery phase.

Figure 3 represents with the thick solid line in red and 95% grey-shaded confidence bands the *marginal* effect of excess leverage in the amount of 10% coming into a normal recession. The thin green line represents instead the same effect but when the recession is financial in nature. The differences are quite clear and correspond very well with intuition, and with the patterns we have already seen in the cumulated forecasts of the last section.

Figure 3: Excess Leverage and its Marginal Effect During Recessions and Recoveries



Notes: See text.

During normal recessions, 10% excess leverage is associated with a further one percent decline in output from norm at the start of the recession but this effect is relatively short lived. During financial crisis recessions, the same amount of leverage generates a decline that is twice as large, nearing two percent, and its effect is felt over many years (except for a mild recovery in the third year). Two to three years into the recovery output remains depressed by an extra one percent.

The effect on consumption is similar overall but with some intriguing differences. The decline in consumption during a normal recession is larger than the decline in output, in fact nearing two percent. However, consumption recovers strongly the year after and the effects of leverage die out perhaps even more quickly than they did with output. In contrast, during financial crisis recessions consumption appears to follow a similar pattern to output, the effect seemingly disappearing by year three but then returning with a decline for years four-to-six that is on a par with or even higher than the decline in output.

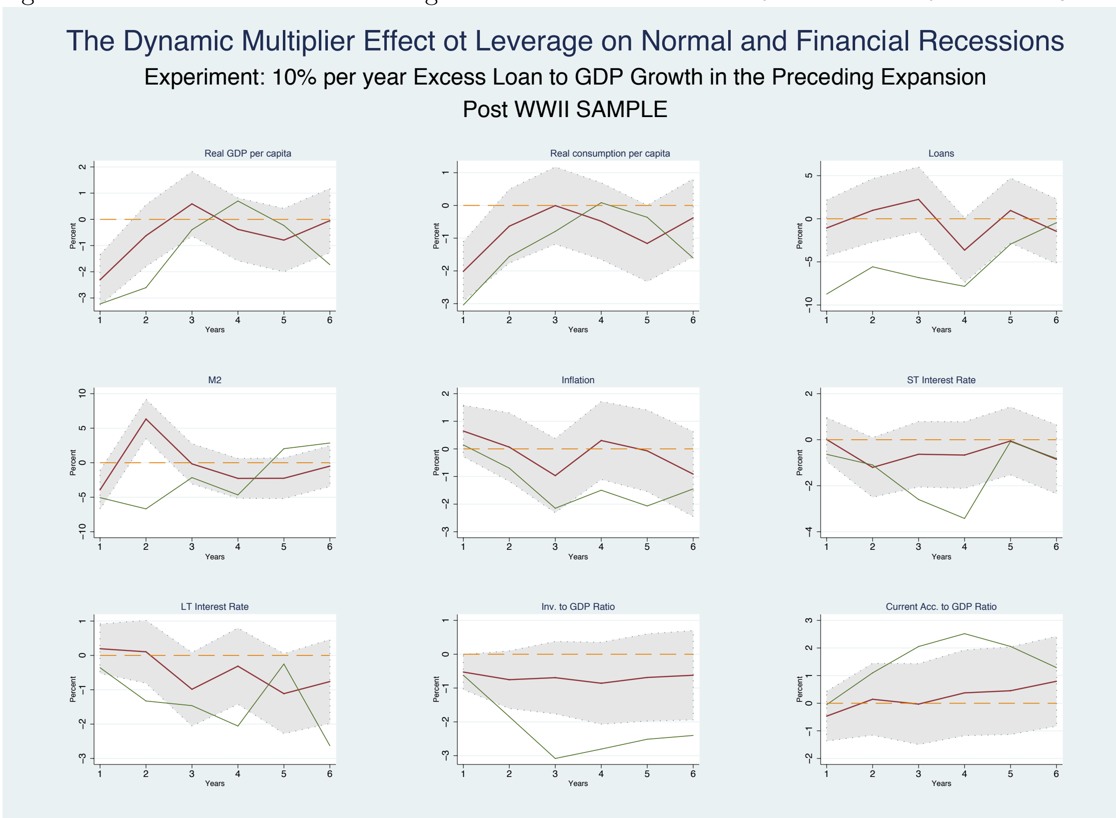
Investment is typically the most cyclically sensitive component of GDP. It is not a surprise then that the behavior of the investment to GDP ratio offers the best opportunity to observe how leverage affects the cycle. In normal recessions, excess leverage has an effect, but it is rather mild and contrasts with the much steeper and protracted declines seen during financial crisis recessions. Whereas by year six the effect of leverage on investment is zero for a normal recession, for a financial crisis recession investment falls by as much as three percent but remains depressed over the entire six years displayed, at which point it is still two percent below norm.

To see what may be behind this behavior we turn now to what happens to lending activity and interest rates. Perhaps not surprisingly, excess leverage has a negative effect making recessions worse. But whereas the effect is felt in the first year of a normal recession, it dissipates relatively quickly after. In financial crisis recessions, bank lending reaches a nadir of six percent by year four and remains two percent below norm by year six. Such a dramatic decline in lending activity is perhaps the clearest dimension in which normal and financial recessions differ.

What is behind the sharp drop in credit growth? Our research design does not allow us to draw strong inferences, but we find that the decline in lending goes hand in hand with a decline in short term interest rates on government securities. It is clearly possible that private sector borrowing rates stay high as lenders cut back on credit provision. But if the interest rate decline is genuine and representative of credit conditions in the wider economy, it could be an indication that credit demand, not credit supply, is the key factor behind weak credit growth. In such a scenario, consumers and companies seek to reduce leverage after a credit-fueled boom, repair balance sheets and abstain from borrowing despite low interest rates. This could also be a reason why despite low interest rates, inflationary pressures remain subdued for many years, in particular in financial recessions. Yet even in normal recessions, we find that lower interest rates do not trigger meaningful price pressures when excess leverage is high.

Again, one might be concerned that the results we just presented could be driven by the rather dramatic declines in output and prices experienced during the Great Depression. For this reason, Figure 4 repeats the exercise in Figure 3 using only post–World War II data. This eliminates the most dramatic events of the nineteenth and early twentieth centuries although the sample available to identify financial events is considerably smaller. Even so, the robustness of the results seen in Figure 4 serves to reinforce our findings. The amount and shape of the effects is strikingly similar and all responses shown have preserved the salient properties we just discussed.

Figure 4: The Effect of Excess Leverage on Normal and Financial Recessions: A Robustness Check



Notes: See text.

4.4 A Calibrated Thought Experiment

A practical interpretation of the results in Figure 3 can be obtained by considering the U.S. as an example. Excess per year leverage coming into the financial crisis of 2008 was about one third that displayed in Figure 3, although allowing for the shadow banking system, this number would be probably closer to one half, possibly more. Thus, if we choose 5% excess credit growth in the expansion phase as a reference point for the U.S. case (meaning that the above forecast paths should be scaled by one half), it is easy to see how one might use the results we report from a U.S. policy perspective. Any forecast of real GDP should probably be trimmed by about 75 basis points in 2012 to 2014, whereas forecasts of inflation should be trimmed by up to 100 basis points over the same period, as compared to a normal recession path. Ignoring the after-effects of the leverage build-up during the expansion would lead to forecasts that considerably overestimate both growth and inflation trends.

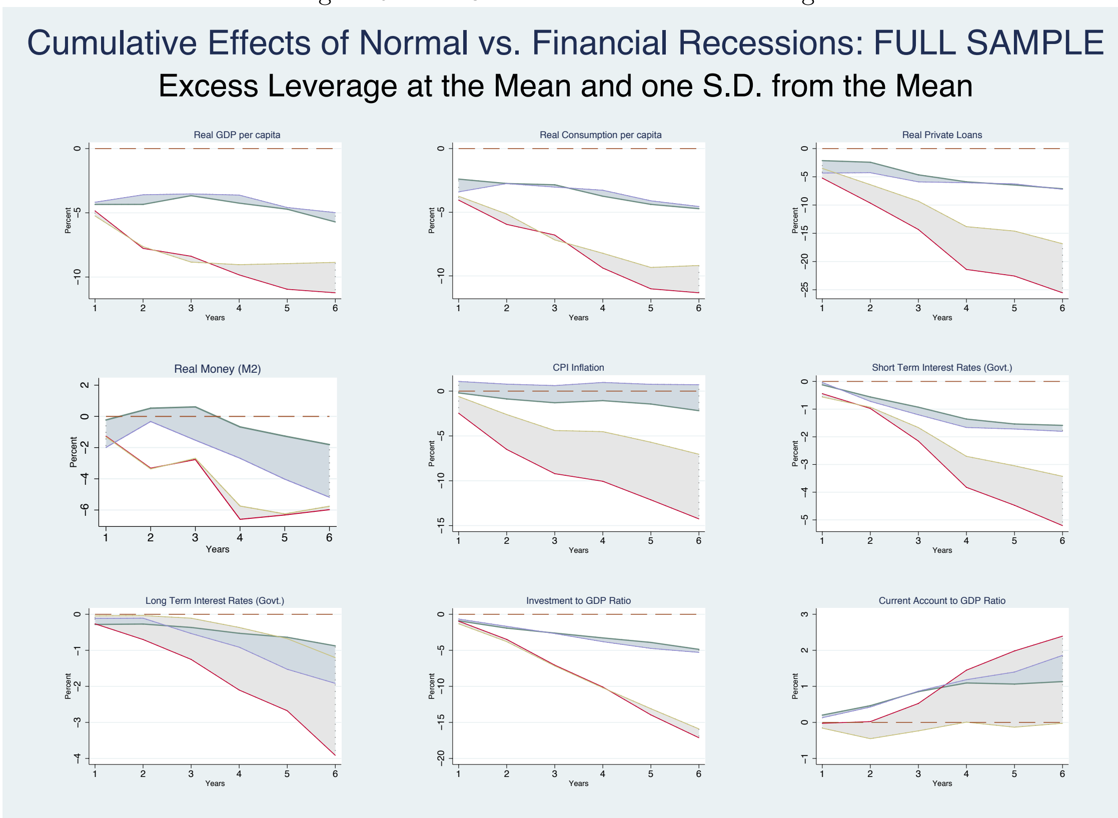
5 Leverage and the Cost of Financial Crises

Finally we ask, how do our findings speak to the debate over the costs of financial crises? It is by now commonly accepted that financial crises can have long-lasting effects on the macroeconomy, and the recent literature emphasises the point. In Cerra and Saxena (2008), Reinhart and Rogoff (2009ab, 2010), Teulings and Zubanov (2010), and Schularick and Taylor (forthcoming), the idea that financial crises have long-lasting negative effects on output has become widely accepted. Terrones, Scott and Kannan (2009) as well as Jordà, Schularick and Taylor (2011) provide evidence that recessions associated with financial crises are far costlier than normal recessions. Claessens, Kose and Terrones (2011) and Howard, Martin and Wilson (2011) arrive at similar conclusions.

Using our long-run data, by-and-large we confirm these results and the plausibility of the magnitudes typically assumed. But as the results in this literature are typically average unconditional effects, we aim advance the analysis further. Hence, this section has two goals: the first is to calculate the cumulated losses from normal and financial recessions to benchmark our results against those in the literature, and complement the discussion with results for the other variables in our system. The second, and perhaps more important, is to show how these cumulated effects can vary drastically by the amount of excess per year leverage incurred during the preceding expansion. The procedures required to report these results deserve further explanation.

The methodological approach is rather straightforward. First we calculate the per-period response of the variable of interest to an indicator variable for whether the recession is financial in nature or not and by including the excess per year leverage variable we have constructed interacted with this indicator variable. When evaluated at the in-sample average, the calculation is equivalent to what is common in the literature: normalize the paths of the variable of interest at the start of the recession, calculate the per-period average, and finally look at the change from the origin at each period. However, because the excess per year leverage variable is continuous, we can separately identify its interacted coefficient estimate, which we then use to examine the effects of variation in excess per year leverage on the cumulated losses. In particular, we experiment with excess per year leverage calibrated at the in-sample mean plus one-standard deviation. This set of experiments is reported in Figure 5.

Figure 5: The Cumulative Effects of Leverage



Notes: See text.

5.1 Main Results

The figure displays the average cumulated value of the nine variables in our system in normal versus financial recessions when excess per-year leverage varies from its in-sample mean to the mean plus one standard deviation. This variability is depicted with shaded regions for normal versus financial recessions. We remark that these bands should not to be interpreted in a statistical sense, such as the depiction of impulse responses with confidence bands. Instead, the bands are meant to provide a visual guide on the range of possible paths that the variable of interest can take as one varies excess per year leverage away from its mean by as much as one standard deviation.

The charts in Figure 5 speak for themselves. Using the full sample of data reaching back to 1870, in a normal recession the cumulated loss in output is of the order of 5% after six years, half of the cumulated loss during financial crises. This order of magnitude is in line with what is commonly reported in the literature. However, excess leverage can have more significant consequences during financial recessions. A one standard deviation difference can result in about a 2%–3% difference in the cumulated path of real GDP per capita at the six year mark. The patterns in consumption, not surprisingly, mirror those in output.

The more interesting differences are hidden in the remaining variables. Consider the behavior of private lending. In a normal recession the drop in private loans mirrors the drop in real GDP per capita and the amount of leverage appears to have almost no effect. Thus at the six year mark, the cumulated drop is also about 5%. Contrast that with the severe contraction in lending during a financial crisis recession. With average levels of excess leverage, lending activity drops by three times more than in normal times, about 15%. Measured against the decline in output during the same circumstances, the ratio is about 2-to-3. However, when excess leverage rises by one standard deviation, the drop in lending activity can reach near a 25% decline at the six year mark, far exceeding the concomitant drop in real GDP per capita.

Is this a demand- or a supply-of-credit driven response? As discussed before, our data do not permit a definitive answer because our interest rate data are for government securities, whose yields may reflect flight-to-quality considerations. But the behavior of interest rates appears to hint at a balance-sheet repair story. In a normal recession, the decline in interest rates is modest at about 1% after 6 years, and virtually unaffected by the amount of leverage at the start of the recession. During a financial crisis recession, short-term interest rate drops are 3%–5%, with the 2% percent range solely generated by the high excess leverage scenario relative to mean.

Clear differences are also visible in the behavior of inflation. In normal recessions, fluctuations in excess leverage during the expansion appear to have almost no impact on inflation (in fact the range of outcomes encapsulates zero over the entire six year span). But the story is entirely different in a financial crisis recession, with downward pressure on prices in the 5%–15% range, the bigger drop being that associated with the high excess leverage scenario. One may be concerned that such a dramatic impact is the result of the Great Depression and we will investigate this explanation momentarily by excluding from our analysis any data prior to World War II. As we will show then, the overall message remains unchanged although in the case of inflation, the declines in financial crises are bounded in the 2%–7% range, which aligns better with modern notions of price behavior.

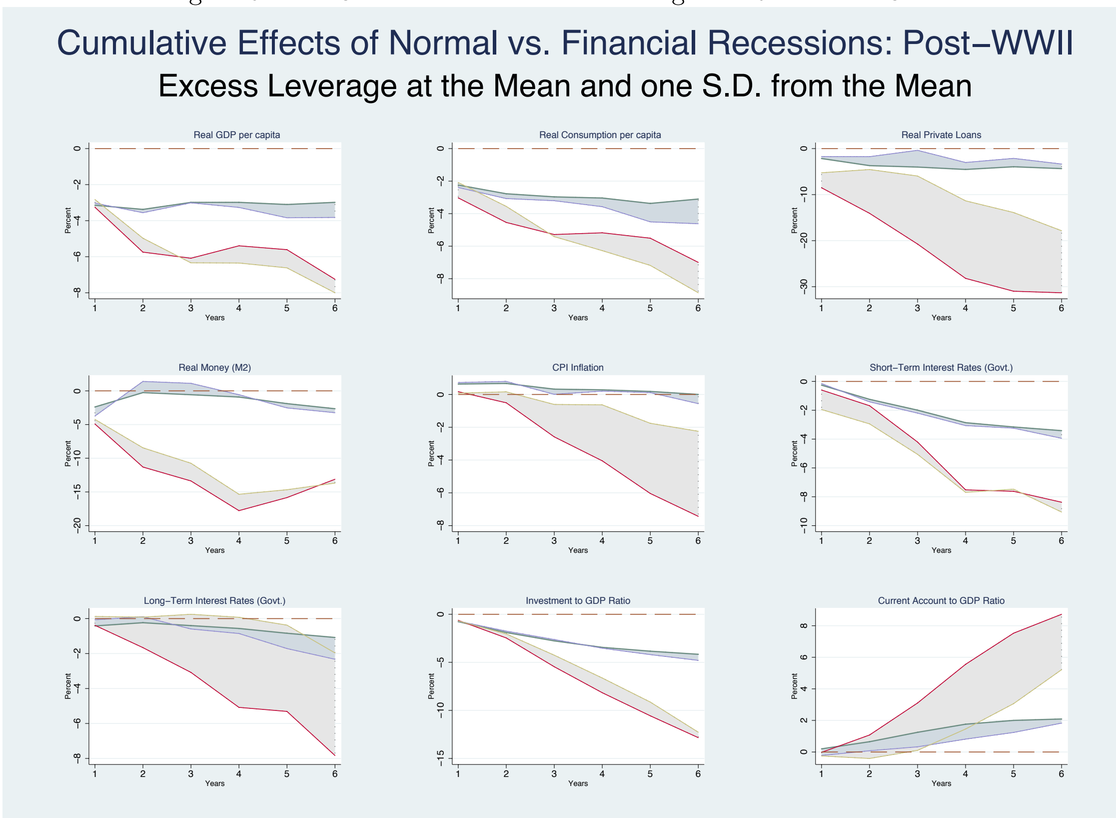
If real consumption seems to fall by a similar amount to real GDP, where is the drop in lending most acutely felt? The answer can be found in the behavior of investment and the current account. In normal recessions, the cumulative decline in the investment to GDP ratio is roughly on a par with the decline in output (but since we report the ratio, this naturally means that investment is declining faster than output). These declines are far more dramatic during financial crisis recessions, almost three times as large in magnitude. In contrast, changes in the current account are more modest although here the choice of sample can make a considerable difference in the magnitudes, as we shall see. During normal recessions the current account improves by about one percent and in financial crisis recessions that range extends from zero to two percent. On that score, the differences between normal and financial recessions appear to be economically small.

5.2 Robustness

The Great Depression was indeed a very dramatic historical event and it is undeniable that the first half of our sample is characterized by far more turbulent variation in our data than the latter half. It is fair to ask whether the dramatic results that we report above are the consequence of those far away turbulent times. We answer this question by repeating the previous exercise using post-World War II data only and recalibrating the mean and standard deviation of our excess leverage variable to this period. It is important to renormalize the data to the sample considered: for the full sample, on average the excess leverage variable is about 1.2% in normal recessions and 2.3% in financial crisis recessions, with a standard deviation of about 6.5% in both cases. In the post-World War II period, the numbers are an average excess leverage of 2.9% in normal recessions, 5.8% in financial crisis recessions, but with a slightly smaller standard deviation in the range of 4%–5%. This is another manifestation of the significant differences in leverage trends that we have discussed in previous sections.

Do the results from the previous section hold up in the post-World War II sample? By and large, yes, as Figure 6 shows. The losses in real GDP per capita are more moderate, about cumulative 3% in normal recessions and up to 8% in financial crisis recessions, which is about two percent better in both cases than what we had been reporting for the full sample. Lending follows virtually the same pattern and quantitative values, except that the differences during financial crisis recessions between excess leverage at the mean and shifted by one standard deviation from the mean become more pronounced at about 10%. Short-term interest rates decline more aggressively, by about 2% rather than 1% percent during normal recessions, and by 8% cumulative

Figure 6: The Cumulative Effects of Leverage: A Robustness Check



Notes: See text.

versus 5% earlier during financial crisis recessions. Perhaps because of this more aggressive decline in interest rates, inflation is now slightly positive during normal recessions and the declines experienced during financial crisis recessions are about half as large as we had reported in the full sample. Investment declines are similar, albeit slightly more moderate in the post-World War II sample. And finally, some differences in the behavior of the current account start to emerge more clearly. Whereas in the full sample at the six year mark the improvement in the current account position was in the 1%–2% range, those numbers remain the same for normal recessions but now become 5%–8% during financial crisis recessions.

6 Conclusion

Based on the study of nearly 200 recession episodes in the past 140 years, the key finding of this paper is that the credit-intensity of the boom matters for the path of the recession. This is a new and potentially important stylized fact about the nature of the modern business cycle. Using local projections we tracked the effects of leverage in normal and financial crisis recessions. While there can be no doubt that the effects are particularly pronounced when the recession coincides with a financial crisis, we observe similar dynamics and marginal effects in normal recessions. The aftermath of leveraged booms is associated with somewhat slower growth, investment spending and credit growth than usual. If the recession coincides with a financial crisis, these effects are compounded and typically accompanied by pronounced deflationary pressures. Looking at the economic costs of recessions and financial crises, this study basically confirmed the plausibility of the ranges of estimates typically found in the literature. Yet we also show that the economic costs of crises vary considerably depending on the run-up in leverage during the preceding boom.

Our aim was to demonstrate these effects without imposing a tight theoretical frame *a priori*. Generally speaking, a leverage build-up during the boom seems to heighten the vulnerability of economies to shocks. Our results do not speak as to the causes of credit accelerations nor can we make strong inferences yet about the net effects of leverage booms, these being goals of our ongoing work. Yet our results would generally seem compatible with the idea that financial factors play an important role in the business cycle. Potential explanations for the observed effects include the possibility that financial accelerator effects are larger with more highly-leveraged balance sheets; that Fisherian debt-deflation pressures are more acute after leveraged booms; or that expectational shifts have more serious effects when credit intensity has risen in a more extreme fashion. Investigating these different channels is an important task for future research. At this stage, we content ourselves with the documentation of these new facts about the role of leverage in the modern business cycle.

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