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# CORPORATE CREDIT BOOMS, PUBLIC INDEBTEDNESS AND THEIR GROWTH CONSEQUENCES

***Key points***

- *The post-Global Financial Crisis build-up of corporate and public debts among major economies has been a perennial concern. However, the existing literature largely treats corporate and public debts as separate sources of vulnerability, and there is a dearth of research on the risks created by their joint presence.*

- *This paper fills the void by presenting empirical evidence, using data from a panel of 17 advanced economies since 1950, that high public indebtedness can aggravate the drag by corporate credit booms on subsequent real GDP growth.*

- *A plausible explanation is one of public debts distorting risk-taking in corporate credit markets. We find that, during credit cycle upturns, high public debt compresses yield spreads and drives credit flows to riskier firms. Such findings are consistent with the "safe assets" literature, which predicts that an abundance of safe assets (government debts) satiates investors' demand for safety and leads them to pursue more risky investments. When the financial boom subsequently ends, the initial credit market buoyancy translates to a more pronounced widening of risk premium, which predicts a larger economic contraction.*

- *A key implication of this study is that, even during good times, high government indebtedness has adverse macroeconomic consequences by encouraging greater risk-taking behaviour. It highlights the case for strengthening regulation on more risky corporate borrowing and prudent public finance. This study also does not see the current low interest rate environment as justification for excessive deficit-financed government spending as along the line of Modern Monetary Theory (MMT) advocates.*

*Prepared by: Jacky (Ngai Yiu) Lee*[†]

*Economic Research Division, Research Department*

*Hong Kong Monetary Authority*



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## I. INTRODUCTION

The 2008-09 Global Financial Crisis (GFC) has highlighted important interactions between credit and business cycles. The run-up in household debt, in particular, was found to play a key role in precipitating the crisis (see for example, Glick and Lansing (2010), Mian and Sufi (2015)). Contrary to the proliferative pre-crisis household borrowings, in the post-GFC period, major economies have instead seen a marked increase in corporate and government debt.

The outstanding global stock of non-financial corporate debt reached an all-time high of US$13.5 trillion as at end-2019, doubling the levels in real terms seen in end-2008[1]. It is well-recognised that corporate leverage could amplify negative shocks and exacerbate an economic downturn (Bernanke, Gertler and Gilchrist (1996) and Kaplan (2019)). In addition to its sheer size, compared to previous credit cycles, the current corporate debt stock also has lower overall credit quality, longer maturities, inferior covenant protection and higher payback requirements (IMF (2019), OECD (2020)) — all of these fuel financial vulnerabilities.

Meanwhile, the post-crisis fiscal responses have led to a significant rise in public debt stock, with world government debt-to-GDP standing close to 90% as of end-2019, from under 60% in 2007. [2] The present coronavirus shock and the sizable stimulus measures implemented are expected to result in further deterioration of governments' fiscal position, depleting their fiscal space to respond to the next downturn. Empirical research suggests that countries that enter a financial crisis with high government debt tend to subsequently experience a more severe recession (Jordà, Schularick and Taylor (2016), Romer and Romer (2018)). High public debt is found to be especially detrimental following a period of rapid private credit expansion, when private sector demand is severely hampered by debt overhang and the need for deleveraging.

Given that rapid private borrowings and high public debts could both have adverse macroeconomic consequences, one would be interested to know if these two risk factors reinforce one another. Empirical investigation on this question is, however, scant.[3] In this study, rather than treating private credit and public debt as separate sources of vulnerability, we study their interplay, focusing on the interaction between

[1] OECD (2020) "Corporate Bond Market Trends, Emerging Risks and Monetary Policy".
[2] April 2020 IIF Global Debt Monitor.
[3] To the best of our knowledge, Jordà, Schularick and Taylor (2016) is the only study that attempts the question. They conclude that constrained government balance sheet can magnify the contractionary effect of private credit boom in the aftermath of a financial recession. By examining only recession periods and not distinguishing between household and corporate credits, however, they leave out channels working in a financial boom that may be helpful for explaining the bust, one of them being the focus of our paper.

corporate debt boom and government indebtedness.[4] Unlike prior studies that highlight the post-crisis negative effect of high public debt (i.e. a *bust* effect), we instead examine how government debt could potentially distort a financial *boom*. In particular, we show that high public indebtedness makes a corporate credit boom riskier, amplifying subsequent output losses when the credit cycle reverts.

We begin by documenting a systematic empirical relation between corporate debts, government debts and economic growth across 17 advanced countries from 1950-2016. We find that a corporate debt boom against a background of high public indebtedness will predict a sharper slowdown in GDP growth through the medium term. We argue that these empirical findings cannot be readily accounted by the fiscal space channel alone.

After examining this empirical relation, we look for explanations that can account for our findings. We hypothesise, and find empirical evidence, that high government debt induces credit misallocation and more favourable pricing of credit risks in a corporate debt boom, which subsequently predicts greater credit spread widening and a more severe economic downturn when the credit cycle reverts.

Our analysis carries two policy implications. First, it suggests that the post-GFC expansion in corporate credit could pose negative consequence on growth, especially given that governments in many countries are also heavily indebted. There is therefore a case for enhanced regulations on lending to more risky corporates (e.g. leveraged loans). Second, our study reinforces the importance of maintaining a prudent fiscal policy during boom times. Sound public finance not only strengthens the ability of the fiscal authorities to respond to future downturns (the usual "fiscal space" argument), but also helps to prevent the build-up of financial vulnerabilities. Crucially, our study implies that elevated government debt may be costly, in ways other than fiscal and default cost.[5] In that sense, we do not see the current low interest rate environment as justification for excessive deficit-financed government spending as along the line of Modern Monetary Theory (MMT) advocates.

*Related Literatures and Contributions* — A large body of research documents the detrimental impact of private credit boom. Jordà, Schularick and Taylor (2012) and Dell'Ariccia et al. (2016) show that private credit expansion predicts future financial

[4] For the sake of completeness, we also explore the impact of government debt on a household credit boom.
[5] Blanchard (2019) shows that the fiscal and welfare costs of increasing public debt levels are low under the current low interest rate environment.

crisis. Household credit boom is shown be associated with lower medium-term growth (Mian, Sufi and Verner (2017)) and a more severe recession (Jordà, Schularick and Taylor (2014)). Some studies (e.g. Giroud and Mueller (2017) also find that high firm leverage can amplify the effect of local demand shocks.

Debt distress in the sovereign sector has also been linked to major episodes of financial crises (Reinhart and Rogoff (2009a, 2010)). More recently, studies (see, for example Jorda, Schularick and Taylor (2016), Romer and Romer (2018)) show that high public debt impairs a country's ability to counteract a financial downturn. In this paper, we explore the joint vulnerability of private and public debts. Doing so, we are not only able to unveil new empirical facts, but also identify alternative channels at which high public debt levels could destabilise a financial system.

Our study also relates to the branch of literature that assigns a central role for government debt in asset pricing. Krishnamurthy and Vissing-Jorgensen (2012) present a theory in which Treasuries supply determines the price of liquidity and safety. They empirically show that higher Treasuries supply lowers the yields of illiquid and risky corporate securities relative to Treasuries and other safe assets. By reducing the premium of holding safe assets, higher government debts are found to crowd out corporate lending to (debt financing of) credit-worthy firms that issue securities which are of closer substitutes to government debt (Demirci et al. (2019)). Our innovation is then to show that this crowding-out effect distorts credit allocations and pricing of risk in a corporate credit boom, which in turn has adverse macroeconomic consequences on the real economy.

Thirdly, this study contributes to a recent body of research (Gorton and Ordonez (2016), Ritcher et al. (2020)) on identifying bad credit booms from good ones. Distinguishing between the two is important for crisis detections and macroeconomic surveillance. Our findings suggest that high government indebtedness during periods of corporate credit booms can be one of the risk factors to take into consideration.

The reminder of this article is organised as follows. Section II describes the data and reports key trends. Section III presents the baseline motivating results. Section IV illustrates a plausible mechanism that can explain the empirical findings. Section V discusses endogeneity concerns and presents robustness checks, and Section VI concludes with key policy implications.

## II. DATA

The major data source is the Jordà-Schularick-Taylor (JST) Macrohistory Database, which includes information on bank loans to the non-financial corporate and household sectors, government debt-to-GDP ratios and other key macroeconomic variables such as national income data, inflation, interest rates and exchange rates. The data are annual and range from 1870-2016, covering 17 advanced economies.[6] We start our sample from 1950 since breakdown of private credit by sector (corporate, household) for most countries is only available from then. We complement the JST database with data on corporate credit and sovereign yield spreads, military spending and firm-level fundamentals from various sources. Details on variable descriptions and sources are provided in Appendix A. Here we describe in detail the variables measuring non-financial corporate and household credits and government debt.

In line with other researchers[7], we measure corporate (household) credit boom as the 3-year change in corporate (household) debt-to-GDP ratio. For robustness, we also employ alternative measures such as trend deviation of debt-to-GDP ("credit-gap"). Credit is defined narrowly as bank lending to corporates and households[8], which excludes loans from nonbank financial institutions and debt securities such as bonds and short-term papers. We choose to focus on bank lending due to a lack of high quality cross-country data on non-bank (shadow banking) credit. Despite the importance of other forms of financing, bank credit historically accounted for a large and often predominant form of private sector borrowing in industrial countries. On the public sector side, we define government indebtedness as general government debt-to-GDP. It is worth to note that public debt does not include contingent liabilities of the public sector arising from implicit guarantees for financial sector assets.

The top panel of Figure 1 shows the average evolution of private bank credit-to-GDP ratio and government debt-to-GDP ratio between 1950-2016 across 17 advanced economies. Over the 30 years following the end of WWII in the Bretton Wood era, there has been a sustained decline in government debt. Since the late 1970s, public debt has embarked on a mostly upward trend until the mid-1990 before improving somewhat in the decade leading to the GFC. The 2008 recession has

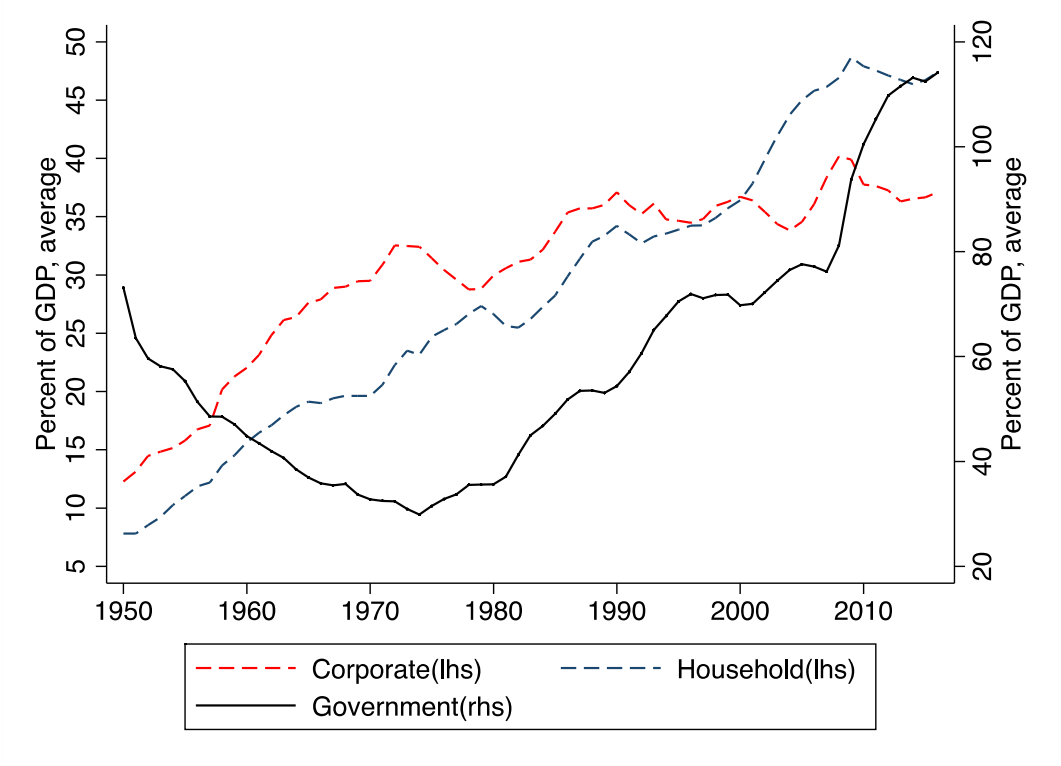
[6] Australia (AUS), Belgium (BEL), Canada (CAN), Switzerland (CHE), Germany (DEU), Denmark (DNK), Spain (ESP), Finland (FIN), France (FRA), United Kingdom (GBR), Italy (ITA), Japan (JPN), Netherlands (NLD), Norway (NOR), Portugal (PRT), Sweden (SWD), United States (USA).

[7] Empirical evidence suggests that a credit boom typically lasts for 3-4 years (e.g Mian, Sufi and Verner (2017)). For studies that used a 3-4 years horizon of private credit changes to examine the effect of debt boom on macroeconomic and financial outcomes, see for example, King (1994), Mian and Sufi (2014), Baron and Xiong (2017).

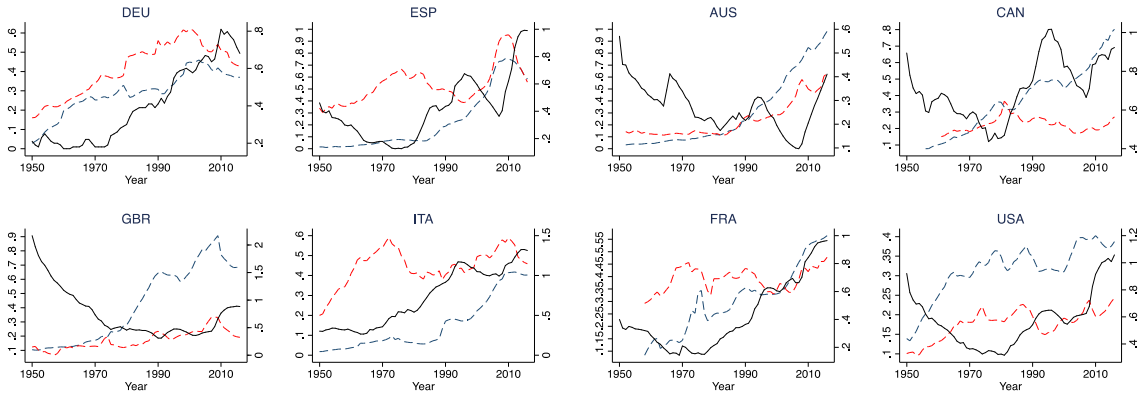
[8] Bank lending is in domestic currency by domestic banks.

considerably deteriorated public finance with government debt now standing at its post-war high. On the private credits side, household and non-financial corporate debt share broadly similar path throughout the episode shown. They both rose steadily between 1950 and 1970, increasing significantly in the following decades to unprecedented levels. The first wave of the surge occurred in the 1980s against the backdrop of financial deregulation. The second wave of heavy private sector leverage build-up was evident prior to GFC, driven predominantly by the rise in household debt and to a lesser extent corporate debt. In the aftermath of GFC, both the household and corporate sectors have undergone some deleveraging, but their indebtedness has since increased over the past few years. It is worth to note the cross-country differences in the post-crisis period (bottom panel).[9] While banks in several European countries (e.g. Germany, Spain, Italy, UK) have notably reduced their exposure to private sector debt, bank lending to both household and corporates continue to rise in others to levels that exceed the pre-GFC peak (e.g. US, France, Canada, Australia).

**Figure 1. Public debt and bank credit to household and non-financial corporate sector, 1950-2016**




[9] See Appendix A Figure A1 for a plot on all the 17 countries in the sample.




Notes: Black solid line (rhs): government debt-to-GDP, blue dotted line (lhs): household debt-to-GDP, red dotted line (lhs): corporate debt-to-GDP. The top panel shows the average debt levels across the 17 advanced economies, weighted by real GDP in 1970. The bottom panel presents selected countries' debt-to-GDP ratio. Public debt is the face value of the total general government debt outstanding. Private credits is measured as banks loans, excluding inter-bank and foreign currency lending.

## III. KEY RESULTS

We begin by documenting several facts about the relation between private credit booms, public indebtedness and economic growth.

In Table 1, we use a panel regression framework in the spirit of Mian, Sufi and Verner (2017) to illustrate the full dynamic relation between GDP growth and changes in corporate and household debt.[10] To capture potential interactions between private and public debt, we allow the GDP growth path following a private credit boom to vary with the level of government indebtedness. Let $y_{it}$ be log real GDP per capita, $\alpha_i$ be the country fixed effects, $\Delta_3$ denotes changes over three years, $d_{it}^{HH}$, $d_{it}^{CP}$ and $d_{it}^{PUB}$ be the household, corporate and government debt to GDP ratios respectively. Level of public indebtedness is measured as deviation from the country's specific mean $\widetilde{d_{it}^{PUB}} = d_{it} - \bar{d}_i$ .The coefficients on the private credit – public debt interaction terms $\{\theta_{HH.PUB}, \theta_{CP.PUB}\}$ can therefore be interpreted as the marginal effect high government indebtedness on the aftermath of private credit booms. $\beta_{HH}$ and $\beta_{CP}$ measure the corresponding business cycle effect of credit booms when government debt is at its

[10] To check for non-stationarity, we perform the Fisher-type unit-root test. We are able to reject the null of non-stationarity at the 1% level for most variables used in the regression analyses throughout this study. The case for the government debt-to-GDP variable is somewhat less clear-cut (while we can reject non-stationarity in the Philips-Perron test, we cannot do so in the case of Dicky-Fuller test if we do not allow for drift). Indeed, the stationarity issue on public debt is somewhat unsettled in the literature. But as Bohn (1998) argues, evidence exists of mean-reversion once one controls for cyclical fluctuations in output. As a robustness check, we also use alternative measures of public indebtedness (e.g. trend deviation of public debt-to-GDP) whose stationarity is less of a concern. Our baseline results continue to hold.

average level. $\boldsymbol{X_{it-1}}$ is a vector of controls containing lagged GDP growth for the preceding three years. Table 1 reports estimates of the following regression:

$$\Delta_3 y_{it+k} = \alpha_i + \beta_{HH}\Delta_3 d_{it-1}^{HH} + \beta_{CP}\Delta_3 d_{it-1}^{CP} + \gamma_{PUB}\widehat{d_{it-1}^{PUB}} + \theta_{HH.PUB}\Delta_3 d_{it-1}^{HH} * \widehat{d_{it-1}^{PUB}} + \theta_{CP.PUB}\Delta_3 d_{it-1}^{CP} * \widehat{d_{it-1}^{PUB}} + \Gamma' \boldsymbol{X_{it-1}} + u_{it+k} \quad (1)$$

for $k = 0, \ldots, 6$.

**Table 1. Private credit boom, government debt and future 3-year GDP growth**

| VARIABLES | (1) $\Delta_3 y_{it}$ | (2) $\Delta_3 y_{it+1}$ | (3) $\Delta_3 y_{it+2}$ | (4) $\Delta_3 y_{it+3}$ | (5) $\Delta_3 y_{it+4}$ | (6) $\Delta_3 y_{it+5}$ | (7) $\Delta_3 y_{it+6}$ |
|---|---|---|---|---|---|---|---|
| $\Delta_3 d_{it-1}^{HH}$ | -0.0369 | -0.109 | -0.229*** | -0.382*** | -0.453*** | -0.472*** | -0.443*** |
| | (0.0783) | (0.0755) | (0.0867) | (0.106) | (0.112) | (0.103) | (0.0911) |
| $\Delta_3 d_{it-1}^{CP}$ | -0.0859 | -0.151* | -0.144* | -0.0824 | -0.00189 | 0.0645 | 0.103** |
| | (0.0854) | (0.0885) | (0.0830) | (0.0804) | (0.0829) | (0.0733) | (0.0525) |
| $\Delta_3 d_{it-1}^{HH} * \widehat{d_{it-1}^{PUB}}$ | 0.187 | 0.311 | 0.264 | 0.0454 | -0.0633 | -0.0117 | 0.170 |
| | (0.273) | (0.300) | (0.332) | (0.361) | (0.323) | (0.263) | (0.243) |
| $\Delta_3 d_{it-1}^{CP} * \widehat{d_{it-1}^{PUB}}$ | -0.253* | -0.342*** | -0.434*** | -0.428*** | -0.456*** | -0.469*** | -0.508*** |
| | (0.147) | (0.124) | (0.128) | (0.155) | (0.139) | (0.0955) | (0.0643) |
| Country FE | YES | YES | YES | YES | YES | YES | YES |
| $\beta_{HH} = \beta_{CP}, p$ | 0.74 | 0.77 | 0.55 | 0.06 | 0.01 | 0.00 | 0.00 |
| $\theta_{HH.PUB} = \theta_{CP.PUB}, p$ | 0.22 | 0.06 | 0.03 | 0.21 | 0.29 | 0.13 | 0.01 |
| Observations | 904 | 887 | 870 | 853 | 836 | 819 | 802 |
| R-squared | 0.248 | 0.212 | 0.233 | 0.268 | 0.275 | 0.267 | 0.254 |

Notes: Sample: 1950-2016. This table reports results from estimating specification (1). Each column shows the three-year change in log real GDP per capita, gradually leads the left-hand side variable by one year. Reported R-squared values are from within-country variation. Standard errors are in parentheses and are dually clustered on country and year. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

The term $\Delta_3 d_{it-1}^{HH}$ enters with a negative coefficient that is statistically significant at 1% for $k = 2$ to $k = 6$ (columns (4)-(7)). An expansion in household debt over a three-year period is negatively correlated with medium-term GDP growth, approximately three years after the initial boom. On the other hand, the rise in corporate debt has little predictive power on future economic activities. Notably, it does not pose a significant drag on growth as in the case of a household credit boom. [11] The coefficient on $\Delta_3 d_{it-1}^{CP}$ is mostly insignificant for the horizon shown (it is negative and only marginally significant at $k = 1$ and $k = 2$).

[11] Our finding that corporate credit boom is in general less detrimental than household debt boom in line with other literatures, e.g. Mian, Sufi and Verner (2017), Alter et al. (2018).

Nevertheless, corporate credit boom has notably different macro effect under high level of government debt. The coefficient on $\Delta_3 d_{it-1}^{CP} * \widehat{d_{it-1}^{PUB}}$ enters with a statistically significant negative sign across the whole horizon shown (highly significant at 1% for $k = 1$ to $k = 6$), suggesting that an expansion in corporate credit amid high public indebtedness is associated with a persistent decline in GDP growth. For the 6-year horizon shown, when government debt is 10 percentage points above mean, corporate credit boom predicts three-year GDP growth that is on average 3-4 percentage points lower than otherwise would be. On the other hand, the level of public indebtedness does not significantly alter the dynamics between household credit expansion and subsequent economic growth. In particular, unlike the case of corporate credit expansion, higher government debt does not appear to make a household debt boom more contractionary.

In Appendix B, we investigate the dynamic relation with an alternative specification, estimating impulse responses using Jordà (2005) local projections. The impulse responses presented in Figure A2 and Table A2 suggest that a corporate credit expansion shock, at a state of high government indebtedness, indeed predicts a more contractionary (both economically and statistically significant) output growth path than otherwise.

## IV. MECHANISMS

Higher government debt worsens the aftermath of a corporate credit boom. What can account for this?

One possible explanation could be highly indebted governments lack the fiscal capacities to pursue financial stabilisation measures and to offset the drag from debt overhang after private credit boom goes bust. This fiscal space argument has some empirical support. For instance, Jordà, Schularick and Taylor (2016) and Romer and Romer (2018) find that countries which enter a financial crisis with higher government debts subsequently experience a more severe downturn.

The "fiscal space" channel alone, however, cannot explain all of our findings. First, our analysis does not condition on a recession. One should therefore interpret the estimated negative impact of public debt as an average (boom-bust) effect through the business cycle rather than being purely a recession/crisis effect.[12] Second, the

[12] Indeed, as discussed above, we find that a corporate credit boom conditioning on high government debt is also associated with slower boom-time growth.

distortions of government debt appear have a corporate sector-specific dimension, underpinning another potential mechanism at which high public indebtedness could point to more costly credit boom. Indeed, our main results in Table 1 continue to hold if we include three-year changes in fiscal deficit-to-GDP ratios in the model specification, as a control for changes in fiscal space.[13]

One way at which public debt could potentially distort a credit boom is through crowding-out. Some prior works find that an increase in public debt disproportionately crowds out credit and debt-financing by credit-worthy firms (e.g. Graham et al. (2014), Demirci et al. (2019)), whose debt securities are perceived to be closer substitutes to government bonds.[14] By reducing credit flows to good firms, it is likely that the excess availability of credits in a debt boom will eventually find their way to the risky and less productive segments of the corporate sector, which now face less competition for credits. Implicit in this discussion is the premise that high government debt could potentially make bad corporate credit booms more likely[15], i.e. one that fuels risk-taking and with a higher probability of going bust.

*IV.A. Government Debt and Credit Allocation Across Firms*

To test the hypothesis that high public indebtedness points to a riskier corporate credit boom, we first examine how government debt affects the quality of firm-level credit allocation. We find that conditioning on a state of high public indebtedness, a corporate credit boom tends to feature higher debt-financing by risky firms relative to low-risk firms.

To gauge the riskiness of credit allocation, we use the ISS index of Greenwood and Hanson (2013). The ISS index gives an indication of borrowers' default risk and the cross-sectional distribution of credit flow. Specifically, it compares the average vulnerability of high and low quintile debt issuers in a given year. The $ISS$ index is assigned a higher value when vulnerable firms issue more debt relative to the low-risk firms i.e. when there is more credit misallocation. Firm vulnerability is based on a range of metrics commonly used in the literature which include leverage, size, profitability, interest coverage ratio (ICR), debt-to-EBITA ratio (DERAT). The ISS index, computed for each country $c$ in our sample, is defined as follow:

[13] Results are available upon request.
[14] Financial institutions that hold more government debt and otherwise want to maintain a fixed proportion of debt and equity in their portfolio are more likely to trade out of their corporate debts (Friedman (1986)).
[15] It is well-recognised that not all credit booms lead to economic bust. Corporate credit booms can be growth-enhancing if they are associated with a more efficient allocation of financial resources (see e.g. Greenwood and Jovanovic (1990) and Larrain and Stumpner (2017)).

$$ISS_{ct}^{V} = \frac{\sum_{i \in Top_{Issuer_{Quntile}}} Decile_{ict}^{V}}{N_{ct}^{Top_{Issuer_{Quntile}}}} - \frac{\sum_{i \in Bottom_{Issuer_{Quntile}}} Decile_{ict}^{V}}{N_{ct}^{Bottom_{Issuer_{Quntile}}}} \quad (2)$$

where $V \in \{leverage, size, profitability, ICR, DERAT\}$, $Decile^{V}$ is the decile of the distribution of the firm level vulnerability indicator $V$,[16] $N$ is the number of firms, $i$ is the firm, $c$ is the country and $t$ is the year. Information on firm capital structure and other accounting data are obtained from the Compustat North America and Global databases, with data available from mid-1980 onwards.[17]

To examine how the level of public indebtedness affects the dynamics of the composition of corporate credit flows, we estimate the following regression over the sample period 1987-2012[18]:

$$ISS_{ct}^{V} = \alpha_c + \beta_1 \Delta_3 d_{it}^{CP} + \beta_2 \widetilde{d_{it}^{pub}} + \theta \Delta_3 d_{it}^{CP} * \widetilde{d_{it}^{pub}} + \Gamma' \boldsymbol{X_{it}} + \varepsilon_{it} \quad (3)$$

in which $ISS_{ct}^{V}$ denotes the riskiness of credit allocation based on firm vulnerability indicator $V$ for country $i$ at time $t$, $\Delta_3 d_{it}^{CP}$ is the three-year change in corporate debt-to-GDP, $\widetilde{d_{it}^{pub}}$ is the deviation of public debt level from the country-specific mean, $\boldsymbol{X_{it}}$ is a vector of control variables that include GDP growth and domestic currency depreciation against the dollar. The coefficeint of interst is $\theta$, which measures the marginal effect of high government debt on the riskiness of credit allocation in a corporate boom.

Results are reported in Table 2. The riskiness of credit allocation in a corporate credit boom increases with higher government debt. The coefficient on the corporate-government interaction term enters with a positive sign for four of the five vulnerability metrics (it is highly significant at 1% for $leverage$, negative for $size$ but

[16] A firm is in a higher vulnerability decile if it is more leveraged, smaller, less profitable, has a smaller interest coverage ratio and a higher debt-to-EBITA ratio.

[17] The Compustat database does not allow us to distinguish bank debt from a firm's total private debt. For the North America (US and Canada) dataset, we are however able to proxy for bank debt using the difference between other long term debt (DLTO) and commercial paper (CMP).

[18] We are restricted to use a shorter sample period since information on most non-US firms from Compustat is only available from mid-1980. As a robustness check, we rerun our estimation using a longer sample dating back to 1950. Despite the fact that earlier years results are predominantly driven by US firms, we obtain qualitatively similar results.

the coefficient is otherwise statistically insignificant). There is some evidence that high government debt crowds out good-quality firm credits, consistent with prior research showing that financing policies of more credit-worthy firms are more sensitive to variation in government debt levels than firms with lower credit quality (Graham et al. (2014), Demirci et al. (2019)).[19] By contrast, the coefficient on the 3-year change in corporate credit-to-GDP term is statistically insignificant for all the vulnerability indicators considered (first row of the table). A corporate credit expansion is therefore not generally associated with a deterioration of credit quality. As will be shown in the next section, an increase in government debt predicts lower risk premium (price of safety) during a corporate credit boom, conceivably reducing the relative attractiveness of holding safe assets.[20] This underpins a mechanism for the more pronounced crowding out effect among good credits.

**Table 2. Corporate credit boom, public indebtedness and riskiness of credit allocation**

| VARIABLES | (1) $ISS^{leverage}$ | (2) $ISS^{size}$ | (3) $ISS^{profit}$ | (4) $ISS^{ICR}$ | (5) $ISS^{DERAT}$ |
|---|---|---|---|---|---|
| $\Delta_3 d_{i,t}^{CP}$ | 0.303 | 0.762 | 1.037 | 0.0825 | -0.572 |
| | (0.514) | (0.804) | (0.739) | (0.449) | (0.598) |
| $\widetilde{d_{i,t}^{pub}}$ | -1.466*** | 0.555 | -0.212 | -0.110 | -0.692** |
| | (0.347) | (0.358) | (0.223) | (0.134) | (0.291) |
| $\Delta_3 d_{i,t}^{CP} * \widetilde{d_{i,t}^{pub}}$ | 2.404*** | -2.254 | 4.297* | 1.709* | 3.691* |
| | (0.143) | (1.805) | (2.434) | (0.985) | (2.005) |
| $\Delta y_{i,t}$ | 17.32*** | -8.944** | -9.734*** | -0.803 | 11.15*** |
| | (5.175) | (4.403) | (3.113) | (1.316) | (3.026) |
| $\Delta e_{i,t}$ | 0.000784** | -0.00172*** | -0.00154 | 0.00196*** | -0.000103 |
| | (0.000375) | (0.000364) | (0.00102) | (0.000477) | (0.000549) |
| Country FE | YES | YES | YES | YES | YES |
| Observations | 360 | 360 | 360 | 360 | 360 |
| R-squared | 0.174 | 0.051 | 0.046 | 0.024 | 0.074 |

Notes: Sample: 1987-2012. This table reports results from estimating specification (3). In each column, $ISS^V$ denotes the difference between the vulnerability deciles of high and low debt issuers in each year for the specified vulnerability metrics: $leverage, size, profit, ICR, DERAT$. $leverage$ is defined as the ratio of total debt (sum of short-term and long-term debt) to one-year lagged total assets. $size$ is measured as a firm's total assets, with smaller firms assigned to a higher decile. $profit$ is measured as a firm's return on asset with less profitable firm assigned to a higher decile. $ICR$ is defined as the ratio of EBITA to one-year lagged interest

[19] This can work through both a bank portfolio substitution channel (banks purchase more government bonds and buy less high credit-quality corporate debt) and a firm substitution channel (credit-worthy firms absorb the increase in supply of government bonds and reduce their claims on debts issued by banks).

[20] This is consistent with theoretical model of Friedman (1978), which shows that when wealth effects are present in investor's portfolio decisions, government borrowing will alter the relative return of assets in a manner that depends on the substitutability of the assets.

expense with firms that have a lower ICR assigned to a higher decile. $DERAT$ is computed as the ratio of total debt to EBITA. Reported R-squared values are from within-country variation. $\Delta y_{i,t}$ is real GDP growth and $\Delta e_{i,t}$ is domestic currency depreciation against the dollar. Standard errors are in parentheses and are dually clustered on country and year. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Having established our main thesis that high government indebtedness crowds out good credits, we then explore the consequences of such crowding-out on subsequent economic growth. More specifically, we investigate the relation using our baseline specification (1), replacing the government debt variable with ISS index on each of the five dimensions of firm vulnerability in the regression. Results are mixed, with an increase in only two of the five ISS indices (ICR and DERAT) found to predict a slowdown in medium-term GDP growth, while the rest having no statistically significant impact on medium-term growth (results available upon request). The inconclusive results may be due to some technical factors.[21] More importantly, though, we view such findings as a suggestion that the crowding-out of good credits is probably not the complete story. In the next sub-section, we explore a related idea: Does high government debt drives more lenient pricing of risks?

### *IV.B. Government Debt and Corporate Credit Pricing*

We find some evidence that high government indebtedness points to riskier credit flows. Is such credit misallocation associated with more aggressive pricing of risk? [22] To test this, we estimate the following regression to examine the behaviour of credit spreads through the corporate credit cycle.[23] Prior studies (Giesecke et al. (2011), Gilchrist and Zakrajšek (2012)) suggest that credit spread is a good proxy of risk premium[24].

$$\Delta spr_{i,t+h} = a_i + \delta_t + \beta_1 \Delta d_{i,t-1}^{CP} + \beta_2 \widehat{d_{i,t-1}^{PUB}} + \theta \Delta d_{i,t-1}^{CP} * \widehat{d_{i,t-1}^{PUB}} + \Gamma' \boldsymbol{X_{i,t-1}} + \varepsilon_{i,t+h} \quad (4)$$

[21] Insignificant results may simply reflect a somewhat small estimation sample — the estimation sample only starts from 1987 due to a lack of firm-level data before that. Existing research (Brandão-Marques et al.2019) also suggests that the detrimental effect of deteriorating credit quality on growth is only evident at the left tail of the growth distribution, while our estimation technique (OLS) only reveals mean responses.

[22] As noted by Greenwood and Hanson (2013), the pricing of risk tends to be associated with the riskiness of credit allocation. The major insight is that aggressive pricing of risk disproportionately lowers the financing cost of riskier firms, which thereby respond by increasing their debt financing.

[23] Data on corporate credit spread is obtained from the Global Financial Data, and is defined as the yield spread between corporate bonds (corporate lending rates for some countries) and 10-year government bond. For the US, corporate credit spread is the Baa-Aaa spread.

[24] The pricing of credit risk in the bond market is closely linked to the pricing of credit risk in the banking system (Lòpez-Salido et al. (2017)).

for $h = 0, 1,2,3,4$. $a_i$ are the country-fixed effects; $\delta_t$ are the year fixed effects; $\Delta spr_{i,t+h}$ denotes the one-year change in corporate credit spread; $\Delta d_{i,t}^{CP}$ the one-year change in corporate debt-to-GDP; $\widehat{d_{i,t-1}^{PUB}}$ is government debt-to-GDP measured in deviation from country-specific mean;[25] $\boldsymbol{X_{i,t-1}}$ is a vector of control variables that include past lagged credit spread level and GDP growth. Again, our main coefficient of interest is $\theta$, which captures the marginal effect of higher public debt on credit spreads in a corporate credit boom.

Table 3 presents the estimation results. Consider the third row. The corporate credit – public debt interaction term enters with a negative coefficient at $t + 1$ and positive coefficients from $t + 2$ to $t + 4$ (the coefficients are at least 5% statistically significant). There is some evidence that the level of government debt influences credit pricing in a corporate credit boom. Relative to a corporate debt boom that materialises under modest government debt level, at a state of high public indebtedness, corporate credit expansion is associated with an initial tightening of credit spreads followed by subsequent widening.[26]

In a sense, by initially compressing credit spreads, high public debt amplifies the subsequent repricing of risk when the credit cycle reverts.[27] Indeed, a salient feature of costly credit boom, as documented in Krishnamurthy and Muir (2017), is that the price of credit appears too low during boom, which presages greater repricing and tightening credit conditions when the boom ends. We will show in the next section that this subsequent widening of spreads at the turn of the credit cycle will predict an economic downturn.

[25] This specification is motivated by findings from Muir (2017) which shows that credit spreads are correlated with credit conditions and the health of the financial sector. On the other hand, he finds that the consumption-based asset pricing model has difficulty reconciling with the variation in risk premia shown in the data.

[26] In Appendix C Table A3, we report results controlling also for household credit growth (and its interaction with public indebtedness) in specification (4). It has does change our main conclusion i.e. it has little effect on the corporate credit growth-public indebtedness coefficient of interest.

[27] In general, our findings align with asset pricing literature that assigns a dual role to government debt: on one hand, higher government debt supply reduces the price of liquidity and safety which implies a lower risk premium (Krishnamurthy and Vissing-Jorgensen (2012)). On the other hand, high government debt encodes sovereign risk and uncertainty which commands a positive risk premium under poor macroeconomic conditions (Coresetti (2013), Pastor and Veronesi (2012, 2013), Kelly, Pastor, and Veronesi (2016), Corce et al. (2019)).

**Table 3. Private credit boom, public indebtedness and corporate yield spread**

| VARIABLES | (1) $\Delta spr_{i,t}$ | (2) $\Delta spr_{i,t+1}$ | (3) $\Delta spr_{i,t+2}$ | (4) $\Delta spr_{i,t+3}$ | (5) $\Delta spr_{i,t+4}$ |
|---|---|---|---|---|---|
| $\Delta d_{i,t-1}^{CP}$ | 1.693* | 0.413 | -0.748 | -0.434 | -1.295 |
| | (0.987) | (1.021) | (0.649) | (1.288) | (0.853) |
| $\widetilde{d_{i,t-1}^{PUB}}$ | -0.0950 | -0.0310 | -0.104* | -0.0100 | 0.0285 |
| | (0.141) | (0.0926) | (0.0536) | (0.0894) | (0.0729) |
| $\Delta d_{i,t-1}^{CP} * \widetilde{d_{i,t-1}^{PUB}}$ | -2.832 | -4.644** | 7.017*** | 8.616** | 7.422** |
| | (4.003) | (2.335) | (2.071) | (3.542) | (3.125) |
| Country FE | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES |
| Observations | 583 | 564 | 545 | 527 | 510 |
| R-squared | 0.490 | 0.416 | 0.380 | 0.368 | 0.366 |

Notes: Sample: 1950-2014. The top panel of the table reports results from estimating specification (4). Each column shows the one-year change in corporate credit spread, gradually leads the left-hand side variable by one year. Reported R-squared values are from within-country variation. Standard errors are in parentheses and are clustered on country. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

*IV.C. Credit Repricing at the turn of the Credit Cycle Forecasts Economic Downturn*

We find some support that high public indebtedness amplifies risk re-pricing when a corporate credit boom subsequently reverses. To underpin the remaining half of our proposed transmission mechanism, we now show that such credit spread widening will predict future economic downturn.

As a forward-looking indicator, credit spreads may respond to anticipated changes in future economic activities that are unrelated to credit factors. To address reverse causality issue, we follow the two-step regression approach in López-Salido et al. (2017), by first extracting a predictable component of credit spreads based on past evolution of the credit cycle. In their original first-stage forecasting equation, López-Salido et al. (2017) projects current change in spreads on two-year lagged spreads level. In our case, since we are interested in how corporate credit growth and government debt jointly predict future changes in credit spreads,[28] we augment their forecasting equation with these quantity variables:[29]

$$\Delta spr_{i,t} = a_i + \beta_1 \Delta_3 d_{i,t-2}^{CP} + \beta_2 \widetilde{pub}_{i,t-2} + \theta \Delta_3 d_{i,t-2}^{CP} * \widetilde{pub}_{i,t-2} + \gamma spr_{i,t-2} + \varepsilon_{i,t} \qquad (5)$$

[28] In López-Salido et al. (2017), they focus on how past reversal of investor optimism determines future asset price movement.

[29] Our augmented specification is motivated by the literature which shows that both the quantity and the price of credit have explanatory power on how credit boom drives asset prices and the business cycles (see Mian, Sufi and Verner (2015) and López-Salido et al. (2017) for more detailed discussion).

where $spr_i$ is the corporate-government bond yield spread, $d_i^{CP}$ is corporate debt-to-GDP, $\widetilde{pub}_i$ is government debt-to-GDP expressed in deviation from the country-specific mean.

We then take the fitted values $\widehat{\Delta spr_{i,t}}$, which we interpret as capturing the shift of risk appetite (credit losses) at the turn of the corporate credit cycle, and use them in the second-stage regression to forecast future output growth $\Delta y_{i,t}$:

$$\Delta y_{i,t} = c_i + \delta \widehat{\Delta spr_{i,t}} + \Delta y_{i,t-1} + \varepsilon_{i,t} \qquad (6)$$

Table 4 presents results from estimating the system of equations (5) and (6). In the first-stage credit spread auxiliary regression (column (2)), the coefficient on the interaction term $\Delta_3 d_{i,t-2}^{CP} * \widetilde{pub}_{i,t-2}$ , which measures the marginal impact of higher government debt on credit spreads movement in a corporate credit boom, enters with a positive sign and is highly significant at 1% level. A corporate credit boom from $t-5$ to $t-2$, under a state of high public indebtedness, will predict a widening of credit spread two years later. Notably, this predicted rise in spread does not reflect mean-reversion of sentiments, which is captured by the negative coefficient on the two-year lag credit spread level term $spr_{i,t-2}$ included in the auxiliary regression.

Column (1) reports results from the second-stage growth forecast equation. The term $\widehat{\Delta spr_{i,t}}$ enters with a positive coefficient (statistically significant at 5% level), implying that the predicted spreads widening following the end of a corporate credit boom eventually predicts an economic downturn. The contractionary effect on growth can be attributed to credit losses induced by the repricing of risk, amplified under a state of high public indebtedness due to looser credit pricing initially.[30] This mechanism fits well with empirical evidence (Krishnamurthy and Muir (2017)) showing that credit spreads fall and appear too low prior to a financial crisis[31] and theoretical financial

[30] It is worth to note that the identified negative effect on growth also captures the contractionary impact from past reversal of sentiment. Our results hold qualitatively after partialling out this sentiment component — The predicted increase in spread still predicts negative growth, although the coefficient is statistically insignificant. In practice, it may simply reflect the difficulty in disentangling the sentiment effect and public indebtedness effect empirically, e.g. high public debts could reinforce sentiment reversal.

[31] As also argued in their paper, credit spreads are not merely passive forecasters of future GDP outcomes. If spreads simply reflect expected default risk that itself is correlated with expected macroeconomic conditions, the level of credit spread at $t$ rather than the changes in spread at $t$ should better predict output declines.

accelerator models such as He and Krishnamurthy (2013) which imply that the widening of spreads reflects a tightening of credit which causes a reduction in output.

**Table 4. Corporate credit boom, credit repricing and subsequent economic growth**

| VARIABLES | $\underline{SS}$ $\Delta y_{i,t}$ (1) | $\underline{Aux}$ $\Delta spr_{i,t}$ (2) |
|---|---|---|
| $\Delta_3 d_{i,t-2}^{CP}$ | | 0.635 |
| | | (0.493) |
| $\widetilde{pub}_{i,t-2}$ | | 0.117 |
| | | (0.0911) |
| $\Delta_3 d_{i,t-2}^{CP} * \widetilde{pub}_{i,t-2}$ | | 1.420*** |
| | | (0.496) |
| $spr_{i,t-2}$ | | -0.258*** |
| | | (0.0363) |
| $\widehat{\Delta spr_{i,t}}$ | -0.0127** | . |
| | (0.00543) | |
| Observations | 542 | 542 |
| Kleibergen-Paap LM statistic P-value | . | 0.072 |
| Kleibergen-Papp F statistic | . | 12.57 |

Note: Sample: 1950-2014. This table reports results from estimating the system of equations (6)-(7). Column (2) presents results from the first-stage auxiliary regression. Dependent variable: Change in corporate credit spread from $t-1$ to $t$. Explanatory variables: 2-year lagged 3-year change in corporate debt-to-GDP, 2-year lagged government debt level (expressed in deviation from mean), an interaction term of corporate credit growth and government debt level, 2-year lagged corporate credit spread level. Column (1) shows results from the second-step regression, using the predicted value of the change in credit spread from the auxiliary regression to forecast GDP growth. Standard errors are in parentheses and are clustered on country. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

## V. ADDRESSING ENDOGENEITY CONCERNS AND ROBUSTNESS

Variation in government debts may capture latent variation in expected and realised overall economic conditions. If high government indebtedness simply proxies for bad economic outcomes, this would introduce a negative bias on our estimated coefficient of interest. Our empirical strategies presented so far go some way to mitigate such endogeneity concern. First, we control for confounding variation by ways of a set of macroeconomic observables (e.g. past GDP growth, inflation, interest rate). Second, we underscore a credit allocation and pricing channel in which high government indebtedness increases the riskiness of corporate credit boom. Crucially, we find that high government debt predicts an initial tightening of corporate credit spreads (and

relative increase in credit flows to riskier firms), opposite of what would have been the case if high public indebtedness merely reflects deteriorating macroeconomic fundamentals. In concert, they provide evidence that significantly limits the scope for alternative interpretations.

To further address omitted variables or reverse causality issues, we instrument for variation in public debt levels. Appendix D Table A4 presents results from the IV specification using military spending (as a ratio of GDP) as an instrument for government debt-to-GDP.[32] As in the OLS case, we find an economically and statistically significant relation between government debt and economic growth following a firm debt boom. A qausi-natural experiment based on the pre-GFC euro area example also highlights the detrimental effect of high government indebtedness when the corporate sector is heavily leveraged up (see Appendix D Table A5 and Figure A3 for details).

We run a battery of other robustness checks. In particular, we show that our key baseline results are not sensitive to the inclusion of other prominent predictors of credit and business cycles in the forecasting equations (Appendix E Tables A6 and A7), alternative definitions of public indebtedness (Appendix E Table A8), excluding the post-GFC period and controlling for fixed effects. [33]

## VI. CONCLUSION

In this study, we investigate the impact of government debt on the aftermath of private credit boom, using data on 17 advanced countries between 1950-2016. Our empirical investigation allows us to see the distinct contribution of private sector borrowing and public debt (and their interaction) to future growth risk. While household debt booms are in general detrimental, their output costs are not exacerbated by high levels of public debt. A corporate debt boom on average has modest effect on business cycle but the impact could become more severe in the presence of high government debt, leading to a prolonged period of sub-par economic performance. Exploring the mechanism, we find that the distortion takes the form of credit misallocation and loose credit pricing in a corporate debt boom.

[32] Military spending is well-correlated with government debt. Although not completely exogenous, arguably less sensitive to business cycle developments compared to other components of government expenditure. For literature examples that also use military expenditure as instrument for fiscal variables, see e.g Nakamura and Steinsson (2014) and Demirci et al. (2019).

[33] Results for this battery of robustness checks are available upon request.

Our analysis carries two policy implications. First, the post-GFC rapid expansion in corporate debt could pose financial stability risks, especially given that many advanced economies have also run up their government debt. Our results suggest that a credit boom is generally more detrimental if it involves more mispricing of risk. In the current environment, there already emerged signs of credit quality deterioration with the surge in bank-syndicated leveraged loans and CLOs, mainly used to finance risky activities such as leveraged buyouts and mergers and acquisitions, in economies with high public debt levels, such as the US. More stringent regulations on risky corporate borrowing may be warranted.

Second, our study shows that excess government debt can be detrimental not only during an economic downturn in terms of limiting fiscal space, but also during the boom phase by distorting credit allocation and reducing boom-time growth. There is hence an additional ground for maintaining prudential public finance during economic upturn (especially during a period of rapid firm borrowing), beyond reserving fiscal buffer. More fundamentally, our study suggests that government debt can be costly even if fiscal cost and default risk are minimal. In that sense, we do not see the current low interest rate environment as justification for extreme form of deficit spending as along the line of Modern Monetary Theory (MMT) advocates.

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# Appendix A. Data

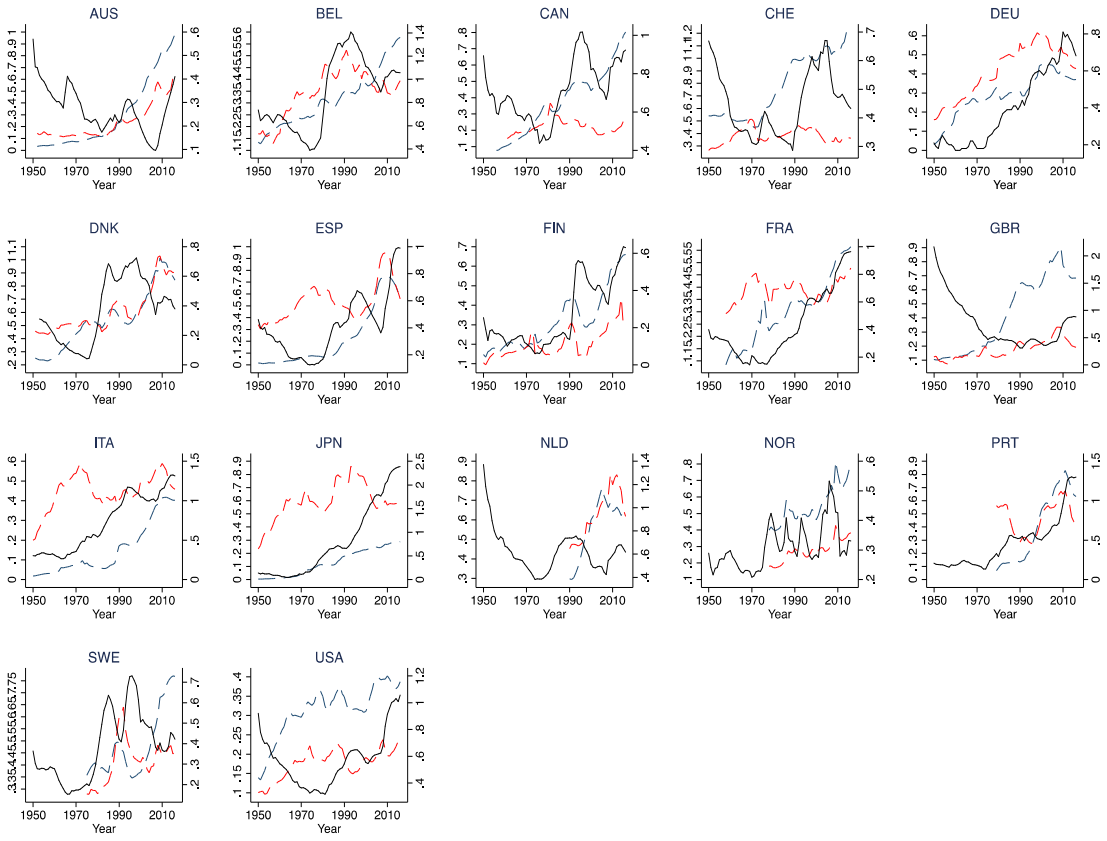
**Table A1. Data description and sources**

| Variable | Description | Sources |
|---|---|---|
| *Macro variables:* | | |
| Corporate credit-to-GDP | Domestic bank loan to firms (in domestic currency) / nominal GDP | JST |
| Household credit-to-GDP | Domestic bank loan to household (in domestic currency)/ nominal GDP | JST |
| Public debt-to-GDP | General government debt (excluding contingent liabilities) / nominal GDP | JST |
| Corporate credit spread | Difference between the corporate bond yield and the 10-year government bond yield. For Finland, France, Ireland and Portugal, corporate lending rates are used instead of corporate bond yields. For US, the corporate credit spread is the Baa-Aaa spread (average of Q4 monthly values) | Global Financial Data |
| Sovereign yield spreads | Difference between the 10-year government bond yield and the 10-year US Treasury yield | Global Financial Data |
| Real GDP per capita | Index (2005=100), 1870 – 2004: Barro & and J. Ursúa (2010)( accessible online at: http://scholar.harvard.edu/barro/publications/barro–ursua– macroeconomic–data) , 2005 – 2016: constant 2010 US$ | JST |
| Inflation | Percentage change in CPI index (1990=100) from previous year | JST |
| Short-term interest rates | Money market rate, Treasury bills | JST |
| Long-term interest rates | Interest rates on government bonds and securities | JST |
| Investment | Gross fixed capital formation, computed as the total value of a producer's acquisitions, less disposals of fixed assets during the accounting period, plus certain additions to value of non-produced assets | JST |
| Current account balance | Balance of exports and imports of goods and services, payment of income, and current transfer between residents of a country and non-residents in local currency | JST |
| Exchange rate | Nominal USD exchange rate (local currency/USD) | JST |

| | | |
|---|---|---|
| Military expenditure to GDP ratio | Military spending in local currency at current prices / nominal GDP | SIPRI Military Expenditure Database |
| *Firm-level data:* | | |
| Leverage | Ratio of total-debt (sum of short-term and long-term debt) to one year-lagged total assets | Compustat |
| Profit | Return on Assets (ROA), defined as income before extraordinary items divided by total assets multiplied by 100 | Compustat |
| Interest Coverage Ratio (ICR) | Ratio of EBITA to one-year lagged interest expense | Compustat |
| Debt-to-EBITDA ratio | Ratio of total debt (sum of short-term and long-term debt) to EBITDA | Compustat |

Note: JST: Jorda-Schularick-Taylor Macrohistory Database

**Figure A1. Public debt and private credits, 17 advanced countries, 1950-2016**




Notes: Black solid line (rhs): government debt-to-GDP, blue dotted line (lhs): household debt-to-GDP, red dotted line (lhs): corporate debt-to-GDP. This figure presents debt-to-GDP ratio for the 17 advanced countries. Public debt is the face value of the total general government debt outstanding. Private credits is measured as banks loans, excluding inter-bank and foreign currency lending.

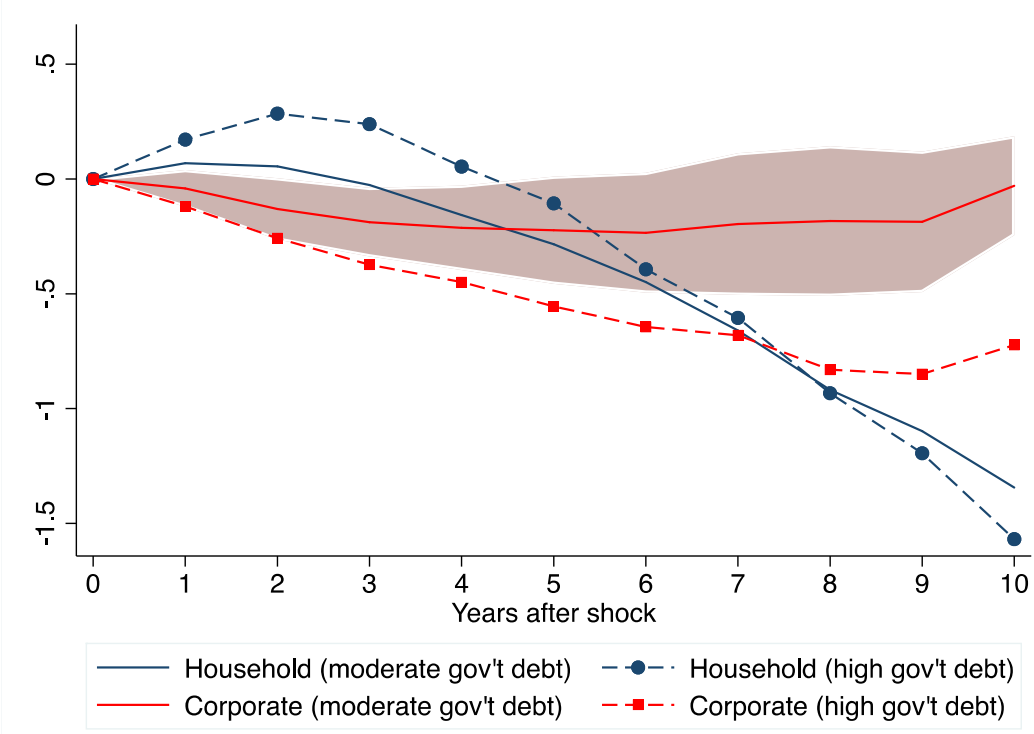
## Appendix B. Alternative specification: Jordà local projections

We estimate impulse responses using Jordà (2005) local projections. Local analysis with local projections has several advantages over a VAR framework. First, it can easily allow for inclusion of control variables and hence for non-linearity which takes the form of modulation via the level of public indebtedness. Second, it gives more flexibility and allows for inference directly on the estimated impulse responses.

For $k = 1,2,\dots,10$, the sequence of OLS coefficients $\{\beta^k_{HH,1}, \beta^k_{CP,1}\}$ and $\{\beta^k_{HH,1} + \theta^k_{HH,1}, \beta^k_{CP,1} + \theta^k_{CP,1}\}$ estimated from the following specification trace out the impulse responses of cumulative output growth to corporate and household credit shocks conditioning on moderate and high government indebtedness, respectively:

$$\Delta_k y_{i,t+k} = \alpha^k_i + \sum_{j=0}^{l} \beta^k_{HH,j}\, \Delta d^{HH}_{i,t-j} + \sum_{j=0}^{l} \beta^k_{CP,j}\, \Delta d^{CP}_{i,t-j} + \sum_{j=0}^{l} \gamma^k_{G,j}\, \widetilde{d^{PUB}_{it-j}} + \sum_{j=0}^{l} \theta^k_{HH.PUB,j} \Delta d^{HH}_{i,t-j} * \widetilde{d^{PUB}_{it-1}} + \sum_{j=0}^{l} \theta^k_{CP.PUB,j} \Delta d^{CP}_{i,t-j} * \widetilde{d^{PUB}_{it-1}} + \sum_{j=0}^{l} \Gamma' \boldsymbol{X_{i,t-j}} + u^k_{it} \quad \text{(A1)}$$

**Figure A2. Local projection impulse responses of GDP to credit expansion shock**




Note: Sample: 1950-2016. This figure presents impulse responses from Jordà (2005) local projections estimated in first differences. The estimated specification is (*A*1). The solid lines depict the cumulative GDP growth path following a household (blue) and corporate (red) expansion shock at time 0 when public debt level is at its mean. The dotted lines denote the corresponding growth paths when public debt is set as one standard deviation above its mean. The shaded region represents

the 95% confidence interval in corporate debt boom case under moderate government indebtedness, computed using standard errors dually clustered on country and year.

where $d_{it}^{HH}$ and $d_{it}^{CP}$ denote household and corporate debt-to-GDP, respectively; $\widetilde{d_{it}^{PUB}}$ is government debt-to-GDP expressed in deviation from its country-specific mean; $\boldsymbol{X_{i,t-j}}$ is a vector of control variables[34].

Figure A2 displays the cumulative change in log real GDP in respond to a credit expansion shock at time 0, under different scenarios of public indebtedness. Table A2 provides a detailed look at the coefficient estimated behind the responses reported in Figure A2. The coefficient on the corporate credit-public debt interaction term $\theta_{CP,0}^{k}$ is negative and 1% significant across the whole horizon. The coefficient measuring the output effect of corporate debt boom conditioning on high government debt, $\beta_{CP}^{k} + \theta_{CP}^{k}$ , is negative and 1% statistically significant for all the 10-year horizons shown.

[34] In addition to past lag of real GDP growth, change in private credit-to-gdp, and governemnt debt-to-gdp, we also control for contemporaneous and past values of CPI inflation, change in short-term and long-term interests rates, real per capita investment growth and current account balance (as % of GDP).

**Table A2. Local projection impulse response of GDP to credit expansion shock**

| VARIABLES | (1) T+1 | (2) T+2 | (3) T+3 | (4) T+4 | (5) T+5 | (6) T+6 | (7) T+7 | (8) T+8 | (9) T+9 | (10) T+10 |
|---|---|---|---|---|---|---|---|---|---|---|
| $\Delta d_{i,t}^{HH}$ | 0.0688 | 0.0549 | -0.0260 | -0.157 | -0.284** | -0.449*** | -0.660*** | -0.918*** | -1.098*** | -1.344*** |
| | (0.0572) | (0.0771) | (0.0815) | (0.109) | (0.145) | (0.164) | (0.222) | (0.259) | (0.286) | (0.272) |
| $\Delta d_{i,t}^{CP}$ | -0.0413 | -0.131* | -0.188** | -0.213** | -0.223* | -0.234* | -0.196 | -0.183 | -0.187 | -0.0294 |
| | (0.0409) | (0.0682) | (0.0761) | (0.0939) | (0.119) | (0.133) | (0.157) | (0.166) | (0.156) | (0.110) |
| $\Delta d_{i,t}^{HH} * \widehat{d_{it}^{PUB}}$ | 0.291* | 0.662** | 0.777* | 0.630 | 0.543 | 0.172 | 0.173 | -0.0463 | -0.309 | -0.723 |
| | (0.158) | (0.271) | (0.441) | (0.756) | (1.040) | (1.097) | (1.334) | (1.308) | (1.429) | (1.602) |
| $\Delta d_{i,t}^{CP} * \widehat{d_{it}^{PUB}}$ | -0.221** | -0.367*** | -0.544*** | -0.707*** | -1.011*** | -1.274*** | -1.524*** | -2.064*** | -2.125*** | -2.235*** |
| | (0.0862) | (0.0944) | (0.133) | (0.259) | (0.381) | (0.420) | (0.471) | (0.274) | (0.274) | (0.405) |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| $\theta_{HH.PUB} = \theta_{CP.PUB}, p$ | 0.03 | 0.00 | 0.00 | 0.04 | 0.05 | 0.08 | 0.07 | 0.05 | 0.18 | 0.38 |
| $\beta_{CP}^{k} + \theta_{CP.PUB} = 0, p$ | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Observations | 918 | 901 | 884 | 867 | 850 | 833 | 816 | 799 | 782 | 765 |
| R-squared | 0.349 | 0.347 | 0.370 | 0.379 | 0.380 | 0.393 | 0.394 | 0.403 | 0.402 | 0.401 |

Notes: Sample: 1950-2016. This table reports results from estimating the following specification (A1). Each column shows local projections of the cumulative change in log real GDP per capita for years 1–10. Reported R-squared values are from within-country variation. Standard errors are in parentheses and are dually clustered on country and year. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

## Appendix C. Full specification: controlling for household credit expansion in the credit pricing equation

**Table A3. Private credit boom, public indebtedness and corporate yield spread**

| VARIABLES | (1) $\Delta spr_{i,t}$ | (2) $\Delta spr_{i,t+1}$ | (3) $\Delta spr_{i,t+2}$ | (4) $\Delta spr_{i,t+3}$ | (5) $\Delta spr_{i,t+4}$ |
|---|---|---|---|---|---|
| $\Delta d_{i,t-1}^{HH}$ | 0.0884 | 2.724 | -3.483** | -0.283 | 3.658** |
| | (1.132) | (1.702) | (1.755) | (2.326) | (1.584) |
| $\Delta d_{i,t-1}^{CP}$ | 1.620* | 0.0689 | -0.393 | -0.401 | -1.763** |
| | (0.980) | (0.999) | (0.609) | (1.229) | (0.872) |
| $\widehat{d_{i,t-1}^{PUB}}$ | -0.127 | -0.0673 | -0.0429 | -0.00905 | 0.0244 |
| | (0.145) | (0.0884) | (0.0670) | (0.0828) | (0.0767) |
| $\Delta d_{i,t-1}^{HH} * \widehat{d_{i,t-1}^{PUB}}$ | 4.993 | 6.742 | -12.01* | -0.299 | 1.972 |
| | (10.29) | (8.791) | (6.892) | (13.34) | (9.230) |
| $\Delta d_{i,t-1}^{CP} * \widehat{d_{i,t-1}^{PUB}}$ | -3.416 | -5.677** | 8.507*** | 8.699** | 6.243** |
| | (3.532) | (2.510) | (2.265) | (3.867) | (2.781) |
| Country FE | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES |
| Observations | 583 | 564 | 545 | 527 | 510 |
| R-squared | 0.490 | 0.420 | 0.386 | 0.368 | 0.370 |

Notes: Sample: 1950-2014. The top panel of the table reports results from estimating specification (4), controlling for household credit growth $\Delta d_{i,t-1}^{HH}$ and its interaction with public indebtedness $d_{i,t-1}^{HH} * \widehat{d_{i,t-1}^{PUB}}$. Each column shows the one-year change in corporate credit spread, gradually leads the left-hand side variable by one year. Reported R-squared values are from within-country variation. Standard errors are in parentheses and are clustered on country. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

## Appendix D. Addressing endogeneity: IV specification

*I. Military Expenditure as an Instrument for Public Debt* [35]

To further address omitted variables or reverse causality issues, we use military expenditure (as a share of GDP) to instrument for variation in public debt levels.

Table A4 (Panel A) presents [36] We estimate a bare-bone specification of equation (1), regressing 3-year GDP growth (for various horizons) on lagged 3-year change in corporate credit-to-GDP, an interaction term between corporate credit growth and the instrumented government indebtedness dummy (equals to one when government debt level is above mean and zero otherwise) and lagged GDP growth. The first stage regression (not reported here) gives Kleibergen-Paap p-values of less than 0.03 for all horizons, comfortably passing the test of under-identification. The second stage regression indicates an economically and statistically significant negative relation between the instrumented government-corporate debt interaction term and economic growth from $t+2$ onwards, same as the OLS case (Panel B) but larger in magnitudes.

**Table A4. Instrumental variable specifications**

Panel A: IV result

| VARIABLES | (1) $\Delta_3 y_{it}$ | (2) $\Delta_3 y_{it+1}$ | (3) $\Delta_3 y_{it+2}$ | (4) $\Delta_3 y_{it+3}$ | (5) $\Delta_3 y_{it+4}$ | (6) $\Delta_3 y_{it+5}$ | (7) $\Delta_3 y_{it+6}$ |
|---|---|---|---|---|---|---|---|
| $\Delta_3 d_{it-1}^{CP}$ | 0.187 | 0.250 | 0.368 | 0.373* | 0.345** | 0.395*** | 0.484*** |
| | (0.254) | (0.274) | (0.244) | (0.191) | (0.137) | (0.139) | (0.167) |
| $\Delta_3 d_{it-1}^{CP} * I(\widehat{d_{it-1}^{PUB}} > 0)$ | -0.527 | -0.837 | -1.203** | -1.177** | -0.887*** | -0.853*** | -0.938*** |
| | (0.461) | (0.511) | (0.500) | (0.464) | (0.294) | (0.283) | (0.303) |
| Country FE | YES | YES | YES | YES | YES | YES | YES |
| Observations | 887 | 870 | 853 | 836 | 819 | 802 | 785 |

Panel B: OLS result

| VARIABLES | (1) $\Delta_3 y_{it}$ | (2) $\Delta_3 y_{it+1}$ | (3) $\Delta_3 y_{it+2}$ | (4) $\Delta_3 y_{it+3}$ | (5) $\Delta_3 y_{it+4}$ | (6) $\Delta_3 y_{it+5}$ | (7) $\Delta_3 y_{it+6}$ |
|---|---|---|---|---|---|---|---|
| $\Delta_3 d_{it-1}^{CP}$ | 0.0231 | -0.0414 | -0.0441 | -0.00747 | 0.115 | 0.181 | 0.214* |
| | (0.104) | (0.136) | (0.139) | (0.132) | (0.128) | (0.123) | (0.124) |
| $\Delta_3 d_{it-1}^{CP} * I(\widehat{d_{it-1}^{PUB}} > 0)$ | -0.168 | -0.212 | -0.298** | -0.354*** | -0.446*** | -0.443*** | -0.404*** |

[35] Greenwood, Hansen and Stein (2015) propose an instrument for high-frequency fluctuation in Treasury supply, exploiting variation in T-bill supply caused by the federal tax calendar. The instrument used in our paper, instead, is one for lower frequency movement in public debt.

[36] In the first stage regression, we regress government debt-to-GDP on military expenditure, the public indebtedness (which takes the form a dummy which equals to one when debt level is above country-specific mean and zero otherwise) interaction term with corporate credit growth on the interaction term between military expenditure dummy (defined similarly as the government indebtedness dummy) and corporate credit growth.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | (0.129) | (0.135) | (0.120) | (0.102) | (0.123) | (0.118) | (0.120) |
| Country FE | YES | YES | YES | YES | YES | YES | YES |
| Observations | 904 | 887 | 870 | 853 | 836 | 819 | 802 |
| R-squared | 0.138 | 0.092 | 0.111 | 0.108 | 0.098 | 0.085 | 0.090 |

Note: This table reports result from estimating the IV specification where government debt-to-GDP is instrumented by military expenditure-to-GDP, and the interaction term between government indebtedness dummy (which takes a value one when government debt-to-GDP is above its country-specific mean) and corporate credit growth instrumented by an interaction term between an military expenditure dummy (defined similarly as the government indebtedness dummy) and corporate credit growth. The regression is estimated by local projection of cumulative real GDP growth on corporate credit growth, government debt-to-GDP, the government debt-corporate credit growth interaction term, and lagged GDP growth. The standard errors are dually clustered at the country and year level. *, ** and *** denotes significance level at the 10%, 5% and 1%, respectively.

*II. Euro Area Quasi-Natural Experiment*

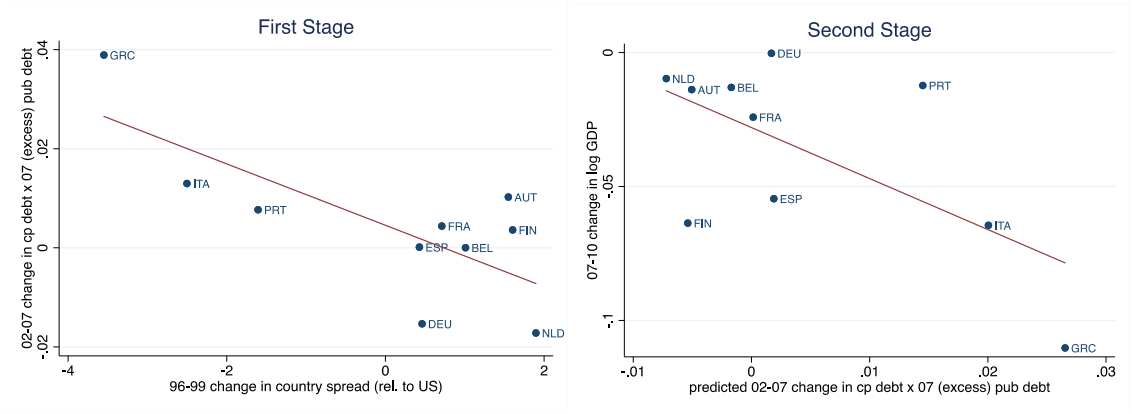
We use the eurozone experience prior to GFC as a quasi-natural experiment to show in a cross-sectional setting the relation between interest spreads, government indebtedness, corporate debt changes and economic growth. The establishment of the currency union has dramatically reduced borrowing costs for peripheral countries, which subsequently experienced a significant run-up in both private and public sector debt. This accumulation in debt reflected institutional changes and hence were arguably exogenous to future business cycle developments. In the IV specification, we use the convergence in eurozone countries sovereign yield spread over the US Treasuries between 1996 and 1999 $\Delta_{96-99} z_i$ as an instrument for the government indebtedness (expressed in deviation from mean) in 2007 $\widetilde{d_{07,i}^{pub}}$ *:

$$\widetilde{d_{07,i}^{pub}} * \Delta_{02-07} d_i^{CP} = \alpha^f + \theta^f * \Delta_{96-99} z_i + u_i^f \tag{A2}$$

$$\Delta_{07-10}\, y_i = \alpha^s + \beta^s \Delta_{02-07} d_i^{CP} + \theta^s \widehat{d_{07,i}^{pub}} * \widehat{\Delta_{02-07} d_i^{CP}} + \Gamma\, \Delta_{02-07} y_i + u_i^s \tag{A3}$$

The left panel of Figure A3 and column (2) of Table A5 illustrate that countries which saw a bigger decline in their real spread from 1996 to 1999 ended up accumulating more government and corporate debt prior to GFC. Our instrument, the change in sovereign yield spread explains 72% of the variation in government and corporate debt in the first stage regression. The predicted rise in government and corporate debt, in turn, predicts a more severe recession from 2007 to 2010.

**Figure A3. Euro area quasi-natural experiment**




Notes: This figure illustrates the relation between the change in real sovereign spreads between 1996 and 1999, the expansion in corporate credit between 2002 and 2007 and government indebtedness in 2007, and the change in log real GDP per capita from 2007 to 2010 for 10 euro area countries.

**Table A5. Euro area quasi-natural experiment**

| | (1) | (2) |
|---|---|---|
| VARIABLES | $\Delta_{07-10} y_i$ | $\Delta_{02-07} d_i^{CP} * \widetilde{pub}_{07,i}$ |
| $\widetilde{d_{07,i}^{pub}} \Delta_{02-07} d_i^{CP}$ | -1.905*** | . |
| | (0.486) | |
| $\Delta_{02-07} d_i^{CP}$ | -0.0731*** | . |
| | (0.0224) | |
| $\Delta_{02-07} y_i$ | -0.161 | . |
| | (0.165) | |
| $\Delta_{96-99} s_i$ | | -0.00620*** |
| | | (0.00130) |
| Eq | IV | FS |
| Observations | 10 | 10 |
| R-squared | 0.731 | 0.717 |

Notes: This table reports instrumental variables regressions of GDP growth from 2007 to 2010 on the expansion in corporate credit from 2002 to 2007 and government debt levels (in deviation from mean) in 2007.Column (1) presents results from the second-stage growth forecast regression. Column (2) shows results from the first-stage regression, using the change in the real sovereign spread (nominal spread minus inflation difference) with respect to the United States during 1996–1999 as an instrument for the 2002–2007 expansion in corporate debt to GDP and 2007 government indebtedness. Standard errors in parentheses are robust to heteroskedasticity. *,**,** indicate significance at the 0.1, 0.05, 0.01 levels, respectively.

## Appendix E. Robustness

*I. Government debt as a proxy for risk premium*

An alternative explanation for our result could be high government debt, rather than being a distinct predictor of risk premium, may simply proxy for the rise in corporate credit spread that itself depresses output. To test between the two hypotheses, we include both government debt and corporate credit spread debt in the baseline growth regression (1). Results are reported in Table A6. The credit spread variable (and its interaction term with credit quantity variable) indeed enter with the expected negative sign i.e. a corporate debt boom ends more badly when spreads (credit losses) are higher. But crucially, our estimated coefficient of interest on the government-corporate debt interaction term, continues to stay negative and statistically significant at 1%. Thus, the power of high government debt in predicting a costly corporate credit boom is not a mere reflection of the subsequent spike in credits spread. In other words, government debt has adverse effect on the macro consequence of corporate credit boom for reasons not completely subsumed by financial crisis dynamics.

**Table A6. Robustness to credit spread as a predictor for future GDP growth**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| VARIABLES | $\Delta_3 y_{it+3}$ | $\Delta y_{it+1}$ | $\Delta_3 y_{it+3}$ | $\Delta y_{it+1}$ |
| $\Delta_3 d_{i.t-1}^{HH}$ | -0.498** | -0.095** | -0.441*** | -0.0764*** |
| | (0.167) | (0.0561) | (0.155) | (0.0548) |
| $\Delta_3 d_{i.t-1}^{CP}$ | 0.0965 | 0.00420 | 0.0272 | -0.0174 |
| | (0.112) | (0.0473) | (0.0918) | (0.0430) |
| $spr_{i,t-1}$ | -0.00130 | -0.000767 | -0.00230 | -0.000912 |
| | (0.00283) | (0.00156) | (0.00307) | (0.00148) |
| $\widehat{d_{\iota,t-1}^{PUB}}$ | | | -0.0720*** | -0.0274*** |
| | | | (0.0175) | (0.00622) |
| $\Delta_3 d_{i,t-1}^{HH} * \widehat{d_{\iota,t-1}^{PUB}}$ | | | 0.516 | 0.379 |
| | | | (0.548) | (0.233) |
| $\Delta_3 d_{i,t-1}^{CP} * \widehat{d_{\iota,t-1}^{PUB}}$ | | | -0.420*** | -0.0953*** |
| | | | (0.139) | (0.0297) |
| $\Delta_3 d_{i,t-1}^{HH} * spr_{i,t}$ | 0.0287 | -0.0141 | 0.0137 | -0.0230 |
| | (0.0857) | (0.0307) | (0.0777) | (0.0290) |
| $\Delta_3 d_{i,t-1}^{CP} * spr_{i,t}$ | -0.0958*** | -0.0351* | -0.0944* | -0.0351 |
| | (0.0340) | (0.0205) | (0.0409) | (0.0237) |
| Country FE | YES | YES | YES | YES |
| Observations | 596 | 613 | 595 | 592 |
| R-squared | 0.257 | 0.138 | 0.354 | 0.201 |

Notes: This table reports robustness to controlling for corporate credit spreads at $t-1$ in our main baseline forecasting equation for GDP growth. All columns include country fixed effects and three lags of GDP growth. Reported R-squared values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. *, **, *** indicate significance at the 0.1, 0.05 and 0.01 level, respectively.

*II. Risk-taking under low interest rate*

There is a concern that our estimated public debt effect may also be convoluted by other macroeconomic trends. Notably, high government indebtedness may coincide with a period of low interest rate (Borio (2019), the latter tends to fuel banks risk-taking and may hence be responsible for the adverse aftermath of a credit boom. To address this, we include a measure of nominal short-term interest rate in the regression.[37] We find that it has little effect (both statistically and economically) on the estimated negative relation between government debt and output growth following a corporate credit boom. This gives us some reassurance that government debt does not merely proxy risk-taking under a low interest rate environment.

**Table A7. Robustness to risk-taking effect induced by a low-interest rate environment**

| VARIABLES | (1) $\Delta_3 y_{it+3}$ | (2) $\Delta_3 y_{it+3}$ | (3) $\Delta y_{it+1}$ | (4) $\Delta y_{it+1}$ |
|---|---|---|---|---|
| $\Delta_3 d_{it-1}^{HH}$ | -0.367*** | -0.372*** | -0.0893** | -0.0880*** |
| | (0.120) | (0.111) | (0.0348) | (0.0321) |
| $\Delta_3 d_{it-1}^{CP}$ | -0.0530 | -0.0809 | -0.0426 | -0.0517** |
| | (0.0855) | (0.0782) | (0.0277) | (0.0261) |
| $\widetilde{\iota_{it-1}}$ | 0.112 | -0.00368 | 0.0296 | -0.00575 |
| | (0.130) | (0.117) | (0.0409) | (0.0424) |
| $d_{it-1}^{PUB}$ | | -0.0562** | | -0.0197*** |
| | | (0.0234) | | (0.00669) |
| $\Delta_3 d_{it-1}^{HH} * \widetilde{d_{it-1}^{PUB}}$ | | 0.0424 | | 0.0862 |
| | | (0.321) | | (0.104) |
| $\Delta_3 d_{it-1}^{CP} * \widetilde{d_{it-1}^{PUB}}$ | | -0.428*** | | -0.159*** |
| | | (0.120) | | (0.0410) |
| $\Delta_3 d_{it-1}^{HH} * \widetilde{i_{it-1}}$ | -0.682 | 0.0780 | -0.758 | -0.388 |
| | (2.503) | (2.018) | (0.736) | (0.695) |
| $\Delta_3 d_{it-1}^{CP} * \widetilde{i_{it-1}}$ | 0.275 | -0.179 | -0.280 | -0.703 |
| | (1.406) | (1.217) | (0.466) | (0.492) |
| Country FE | YES | YES | YES | YES |
| Controls | YES | YES | YES | YES |
| Observations | 856 | 847 | 907 | 898 |
| R-squared | 0.205 | 0.269 | 0.115 | 0.155 |

Notes: This table reports robustness to controlling for short-term nominal interest rate at $t-1$ in our baseline growth specification. $\widetilde{\iota_{it-1}}$ is defined as deviation of interest rate from its country-specific mean. All columns include country fixed effects and three lags of GDP growth. Reported R-squared values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. *, **, *** indicate significance at the 0.1, 0.05 and 0.01 level, respectively.

[37] The interest rate variable is also defined as deviation from its country-specific mean.

*III. Baseline result using alternative definition of public indebtedness*

We re-estimate our baseline 3-year growth equation (1) using alternative definitions of government indebtedness: (i) Hamilton-filtered government debt-to-GDP, (ii) a dummy variable with value one when government debt-to-GDP is above country-specific mean and zero otherwise.

**Table A8. Alternative measures of government indebtedness**

| $d_{it-1}^{PUB^{Hamilton}}$: Hamilton-filtered government debt-to-GDP | | | | | | | |
|---|---|---|---|---|---|---|---|
| VARIABLES | (1) $\Delta_3 y_{it}$ | (2) $\Delta_3 y_{it+1}$ | (3) $\Delta_3 y_{it+2}$ | (4) $\Delta_3 y_{it+3}$ | (5) $\Delta_3 y_{it+4}$ | (6) $\Delta_3 y_{it+5}$ | (7) $\Delta_3 y_{it+6}$ |
| $\Delta_3 d_{it-1}^{HH}$ | -0.0856 | -0.158* | -0.262*** | -0.393*** | -0.458*** | -0.478*** | -0.455*** |
| | (0.0794) | (0.0829) | (0.0980) | (0.118) | (0.122) | (0.113) | (0.102) |
| $\Delta_3 d_{it-1}^{CP}$ | -0.100 | -0.144 | -0.119 | -0.0670 | 0.0126 | 0.0856 | 0.131* |
| | (0.0969) | (0.108) | (0.106) | (0.0992) | (0.0978) | (0.0877) | (0.0674) |
| $\Delta_3 d_{it-1}^{HH} * d_{it-1}^{PUB^{Hamilton}}$ | 0.0974 | 0.353 | 0.962*** | 0.972** | 0.549 | 0.230 | 0.353 |
| | (0.235) | (0.292) | (0.356) | (0.491) | (0.517) | (0.458) | (0.414) |
| $\Delta_3 d_{it-1}^{CP} * d_{it-1}^{PUB^{Hamilton}}$ | -0.128 | -0.318 | -1.051** | -1.603*** | -1.509*** | -0.962** | -0.453 |
| | (0.425) | (0.399) | (0.471) | (0.542) | (0.485) | (0.419) | (0.417) |
| Country FE | YES | YES | YES | YES | YES | YES | YES |
| Observations | 881 | 864 | 847 | 830 | 813 | 796 | 779 |
| R-squared | 0.169 | 0.108 | 0.132 | 0.178 | 0.180 | 0.163 | 0.151 |
| $I\left(\widehat{d_{it-1}^{PUB}} > 0\right)$: Dummy (=1 when government debt-to-GDP above mean) | | | | | | | |
| VARIABLES | (1) $\Delta_3 y_{it}$ | (2) $\Delta_3 y_{it+1}$ | (3) $\Delta_3 y_{it+2}$ | (4) $\Delta_3 y_{it+3}$ | (5) $\Delta_3 y_{it+4}$ | (6) $\Delta_3 y_{it+5}$ | (7) $\Delta_3 y_{it+6}$ |
| $\Delta_3 d_{it-1}^{HH}$ | -0.0661 | -0.158 | -0.269** | -0.385*** | -0.412*** | -0.447*** | -0.457*** |
| | (0.111) | (0.106) | (0.106) | (0.123) | (0.126) | (0.119) | (0.117) |
| $\Delta_3 d_{it-1}^{CP}$ | -0.0292 | -0.0735 | -0.0444 | 0.0159 | 0.131 | 0.211* | 0.248** |
| | (0.118) | (0.143) | (0.136) | (0.120) | (0.117) | (0.112) | (0.110) |
| $\Delta_3 d_{it-1}^{HH} * I(\widehat{d_{it-1}^{PUB}} > 0)$ | 0.0697 | 0.121 | 0.108 | 0.0351 | -0.0392 | -0.0115 | 0.0622 |
| | (0.121) | (0.118) | (0.0944) | (0.0978) | (0.101) | (0.110) | (0.119) |
| $\Delta_3 d_{it-1}^{CP} * I(\widehat{d_{it-1}^{PUB}} > 0)$ | -0.101 | -0.139 | -0.199 | -0.199* | -0.240** | -0.260*** | -0.263*** |
| | (0.127) | (0.138) | (0.129) | (0.116) | (0.118) | (0.0956) | (0.0995) |
| Country FE | YES | YES | YES | YES | YES | YES | YES |
| Observations | 904 | 887 | 870 | 853 | 836 | 819 | 802 |
| R-squared | 0.193 | 0.153 | 0.185 | 0.225 | 0.243 | 0.246 | 0.240 |

Notes: This table reports robustness to using alternative measures of government indebtedness in the baseline 3-year GDP growth equation. In the top panel, government indebtedness is measured as deviation of government debt-to-GDP from a trend obtained using Hamilton filter, where the trend is computed as the predicted value from running the following time series regression separately for each country: $d_{it+4}^{PUB} = a + \sum_{j=1}^{4} d_{it-4}^{PUB} + u_{i+4}$. In the bottom panel, government enters as a dummy with value one when government debt-to-GDP is above its country-specific mean and zero otherwise. Each column shows the three-year change in log real GDP per capita, gradually leads the left-hand side variable by one year. Reported R-squared values are from within-country variation. Standard errors are in parentheses and are dually clustered on country and year. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.