Does government debt crowd out capital formation?

A dynamic approach using panel VAR

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Abstract

We estimate a panel vector autoregression model using data for 127 countries from 1980 to 2017 in order to identify the dynamic relationship between public debt and the growth of capital formation. Our results provide evidence for the crowding-out effect of government debt and the subsequent drop in output growth. The impulse response functions for sub-samples of countries reveal two remarkable results. First, the response of capital formation to a shock in debt appears to be consistent across different income categories of countries, and does not depend on the size of debt-to-GDP ratio. Second, the magnitude and persistence of this effect is lower for the high-income countries. The results obtained are robust to various model specifications as well as for alternative proxies of debt and capital formation.

JEL classification: H6; C33; E22; E43

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1. Introduction

An analysis of the effects of federal government debt on various macroeconomic variables, such as, interest rates and investment spending, has been ongoing for decades (for example, Domar, 1944; Wallich, 1946). Nevertheless, there still is little empirical consensus regarding the direction and magnitude of these effects. The recent upswing of government debt has revived a debate about the consequences of a mounting public debt. A rise in debt can inhibit investment and consumption expenditure by increasing interest rates (Hubbard, 2012), thereby resulting in slower growth. A conventional view is that government borrowing is expansionary in the short run but contractionary in the long run (Elmendorf and Mankiw, 1999). According to Keynesian theory, if higher debt is brought about by tax cuts or spending increases, it may boost aggregate demand and result in growing income levels. Yet, if negative public saving is not fully offset by capital inflows and private saving, interest rates may rise, crowding-out capital formation and ultimately lowering output growth.

A number of empirical studies estimate the relationship between government debt and interest rates (see, for example, Elmendorf and Mankiw, 1999, Gale and Orszag, 2004, and Engen and Hubbard, 2005), and often find no systematic association between the two, explaining why reduced-form regressions are inconclusive about the crowding-out effect. This study estimates a panel vector autoregression (PVAR) model using a large panel data in order to detect the long-term association between public debt and capital formation.[2] A key advantage of using PVARs is that multiple variables can be simultaneously treated as endogenous (Holtz-Eakin et al., 1988), allowing for the endogenous interaction between debt, interest rates, capital formation, and income per capita in our case. This methodology exploits the cross-sectional dimension of our sample and, hence, allows us to obtain more efficient estimates by capturing the unobserved factors that are common to all economies. We find ample evidence in favour of the crowding-out effect of public debt. A comparison of the estimation results across income categories reveals that the response of capital formation to a growth in debt is qualitatively comparable across countries but the dynamics of this response varies by the level of income.

The remainder of the paper is organized as follows. Section 2 presents the econometric methodology. Section 3 describes the empirical results, and section 4 concludes.

2. Econometric methodology

In order to investigate the relationship between central government debt and capital formation, we estimate the following PVAR:

$$X_{it} = A(L)X_{it-1} + \mu_i + \varepsilon_{it} \quad (1)$$

[2] Our focus is on the effect of debt on capital formation, and not the overall level of investment. While capital formation is the principal component of investment, the latter also includes purchases of financial assets.

where X_{it} is a vector of endogenous variables, $A(L)$ is a matrix polynomial in the lag operator, and μ_i is a vector of country specific effects. X_{it} comprises of the growth rate (log-differences) of the following four endogenous variables: gross government debt per capita ($\triangle$D), real interest rate ($\triangle$R), gross fixed capital formation per capita ($\triangle$K), and real GDP per capita ($\triangle$Y).[3] Lastly, ε_{it} represents a vector of idiosyncratic errors.

We use forward-mean differencing or orthogonal deviations (the Helmert procedure), following Love and Zicchino (2006) instead of the fixed-effects estimator. The transformation preserves homoscedasticity and does not induce serial correlation since each observation is weighted in order to standardize the variance (Arellano and Bover, 1995). Furthermore, this method estimates the coefficients by the generalized method of moment (GMM) by using the lagged values of regressors as instruments. The impulse-response functions (IRFs) are computed from the estimated PVAR given in Eq. (1) above.[4] We use Monte Carlo simulations to construct the confidence intervals of the IRFs.[5]

The computation of IRFs requires imposing a set of identifying restrictions which makes the order of the variables in X_{it} key for the estimation of a PVAR. We identify the shocks by assuming a recursive structure, i.e. fiscal spending, and thereby government debt, affects the other variables contemporaneously, while the reverse effect occurs only after a lag (Caldara and Kamps, 2008; Lof and Malinen, 2014). This postulation is commonly used in the literature (Bernanke and Blinder, 1992; Choi and Devereux, 2005). By imposing such a recursive structure on our PVAR estimation, we are able to disentangle fiscal policy shocks from real economy disturbances such as aggregate investment and output shocks.

We also test our baseline results by imposing alternative Cholesky ordering in the estimation of Eq. (1). This is motivated by the expectation that, since balance sheets are typically marked-to-market, the volume of public debt and interest rates are expected to be rather closely tied. If the endogenous variables in X_{it}, such as real income, have a contemporaneous effect on debt, the order of causation used in our identification scheme may possibly be problematic. We, thus, consider alternative orderings in our PVAR to ensure that our results are insensitive to the identifying restrictions embedded in our estimation. As discussed in the following section, this was indeed the case. Since the IRFs are robust to alternate causal specifications, the reduced-form errors are unlikely to be correlated and may well have a structural interpretation. Furthermore, extended models with additional endogenous variables in X_{it}, namely, consumption spending, rate of inflation, and government spending, are also estimated as a robustness check.

[3] We use gross fixed capital formation (net acquisitions of fixed assets by businesses, governments and households) in our baseline estimation, but also estimate Eq. (1) using gross capital formation under robustness tests.
[4] The VAR includes up to three-year lags of endogenous variables based on the Bayesian information criteria.
[5] We performed the Granger causality Wald tests, and checked the stability conditions of all estimates.

The dataset comprises of an unbalanced panel data for 127 countries over the period 1980-2017, of which 39 are high-income, 64 are middle-income, and 24 are low-income countries.[6] The income categories are based on each country's per capita income in 2017, in accordance with the World Bank's definitions. We obtain annual data for government spending and debt from the IMF's World Economic Outlook (WEO) database. Data for GDP per capita, real interest rate, gross capital formation, inflation rate, and consumption spending are sourced from the World Bank's World Development Indicators (WDI) dataset. Table 1 presents the summary statistics.

Table 1: Descriptive Statistics

	All countries		High-Income		Middle-Income		Low-Income	
	Obs.	*Mean*	*Obs.*	*Mean*	*Obs.*	*Mean*	*Obs.*	*Mean*
Government debt p.c.	2947	7654.25	1079	18308.09	1397	1884.69	471	360.39
Real interest rate (%)	3113	7.29	917	5.49	1691	7.19	505	10.91
Capital formation p.c.	3872	2653.09	1312	6475.48	1950	873.05	610	122.09
GDP p.c.	4486	10811.21	1363	29258.09	2264	3597.92	859	552.53
Government spending (%)	4355	15.70	1361	17.65	2157	14.97	837	14.41
Consumption spending p.c.	3930	8594.73	1327	20994.65	1993	2811.52	610	514.79
Price (%)	4106	51.42	1335	16.93	2024	75.54	747	47.68

Notes: Annual data is obtained from World Bank's WDI and IMF's WEO databases.

3. Estimation results

Figures (1)-(4) show the impulse-response functions obtained from the estimated PVAR in Eq. (1). Fig. 1 depicts the impact of a growth in government debt on gross fixed capital formation per capita (top right), GDP per capita (bottom left), and real interest rate (bottom right) for a period of eight years after a positive shock to debt (top left) for the complete sample of countries. The impulse responses indicate that the shock is characterized by an increase in the central government debt that fades out after about two years. There is a reduction in the growth of capital formation on impact and the response remains negative for approximately three years, although the positive effect on real interest rate is only transitory. Interestingly, the significant negative response of GDP per capita growth lasts for at least another year.

[6] See Table A.1 in the On-line Appendix for a list of countries included in our analysis.

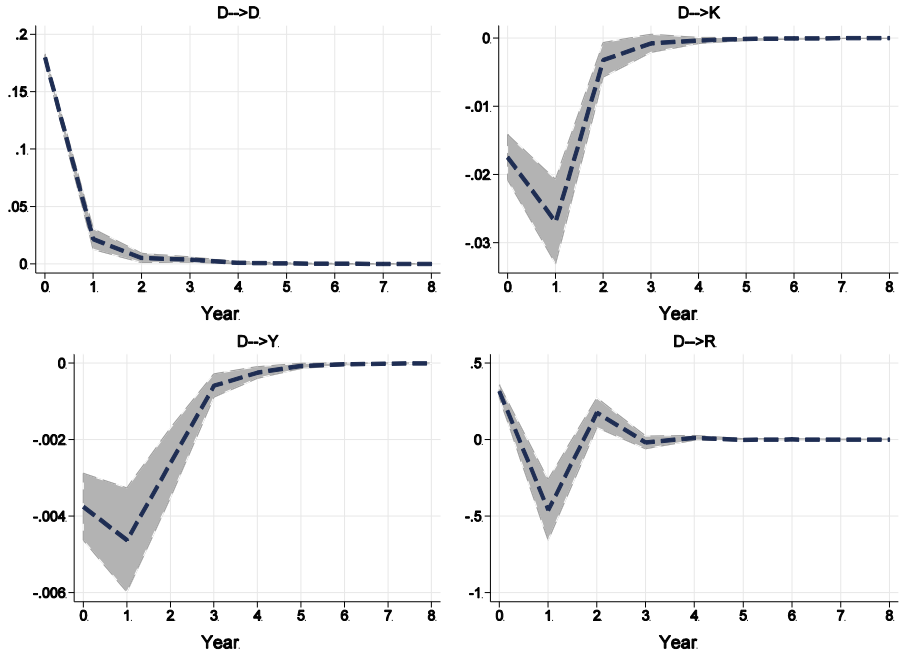

Fig. 1. Orthogonalized impulse-response functions computed from estimated PVAR (Eq. (1)) for the complete sample over the period 1990–2017. One-standard error bands are based on 200 Monte Carlo simulations.

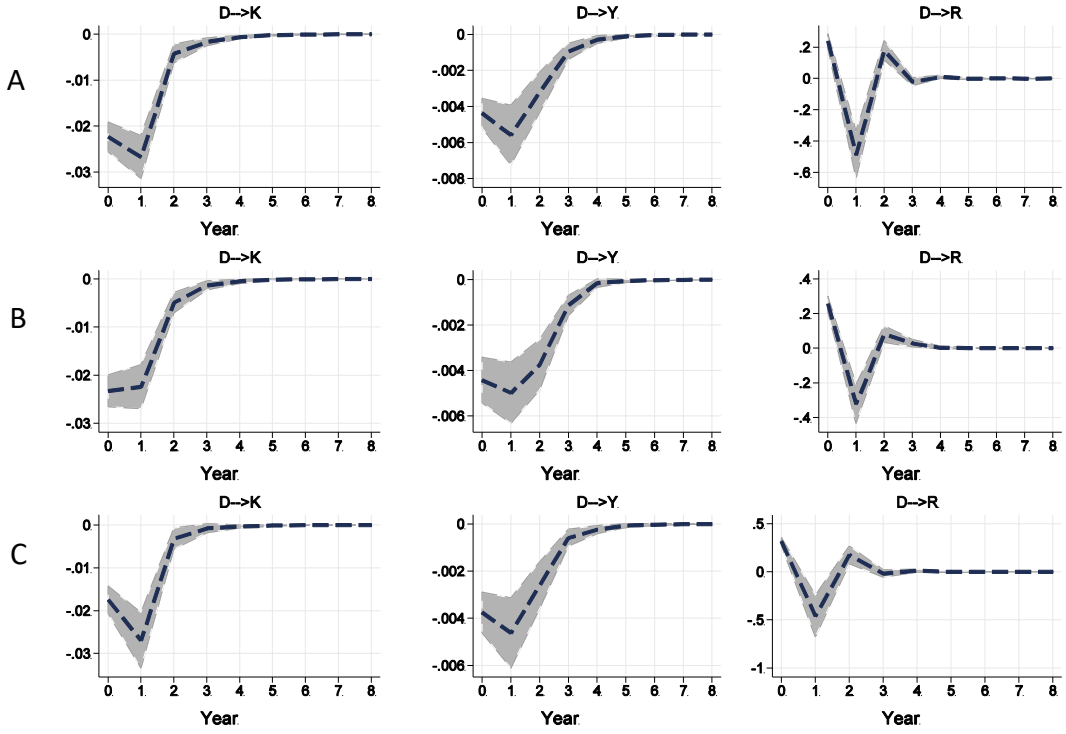

Fig. 2. IRFs computed from estimated PVAR using: (A) an extended model (including consumption spending and inflation rate); (B) including government spending in the extended model; and (C) alternative order of variables.

In order to check whether the above response functions are driven by our choice of endogenous variables or by the assumptions about recursive structure imposed, we consider an extended model in Eq. (1) with the inclusion of additional potentially relevant variables. In addition, Eq. (1) is estimated by reversing the recursive ordering assumed in Fig. 1. The IRFs depicted in Fig. 2 indicate that there is no significant change in either the direction or the magnitude of the response of capital formation to an innovation in public debt: (A) after including inflation rate and growth rate of consumption; (B) with the inclusion of government spending; and (C) using a reverse ordering of endogenous variables within the PVAR.

Do the results generated above hold for sub-samples of countries? In order to test whether the estimates based on the pooled sample hide variation across countries belonging to different income categories, we estimate Eq. (1) for different income groups separately. The impulse responses of capital formation to a shock in government debt are presented in Fig. 3.[7] Once again, we find strong evidence for the crowding-out effect of debt for all income categories. While the response functions in Fig. 3 mostly align with our baseline results pertaining to the effect of public debt on capital formation, we do observe some variation in the dynamics of this response across country groups. The degree and persistence of the crowding-out effect of debt appears to be much smaller in advanced countries, and the impact on capital formation tails off at least a year earlier than it does for the low or middle-income groups. The growth of capital formation continues to dwindle for the low or middle-income countries for almost one year after a positive shock to public debt growth, before the effect eventually begins to fade away.

As a final step to reveal the consistency in our estimation results across countries, we split our sample into two groups, and estimate Eq. (1) exclusively for countries with an average debt-to-GDP ratio either above or below fifty percent. This exercise is repeated by replacing the average debt percentage by the maximum debt-to-GDP ratio, whereby the maximum ratio is defined as the highest debt-to-GDP percentage incurred by each cross-sectional unit over the time period under consideration. Fig. 4 exhibits the impulse response functions of capital formation to a shock in public debt for countries with the mean debt-to-GDP ratio less than fifty percent (top left), mean ratio above fifty percent (top right), maximum debt percentage below ninety percent (bottom left), and maximum debt percentage greater than ninety percent (bottom right). Although the standard-error bands are slightly wider for the groups of countries having a debt ratio less than our two measures of public debt threshold, in general, countries both above and below the debt threshold levels display patterns largely comparable to our benchmark results.

[7] Due to a much smaller sample size of low-income countries, we also generate a response function for the low and middle-income groups combined.

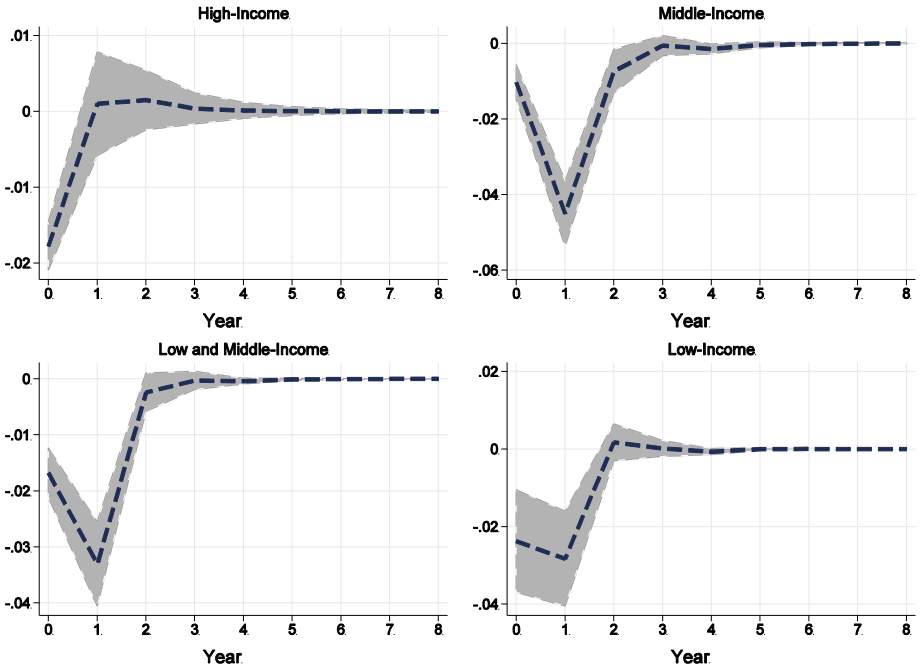

Fig. 3. IRFs computed from estimated PVAR for: (A) High-income; (B) Middle-income; and (C) Low- and Middle-income groups.

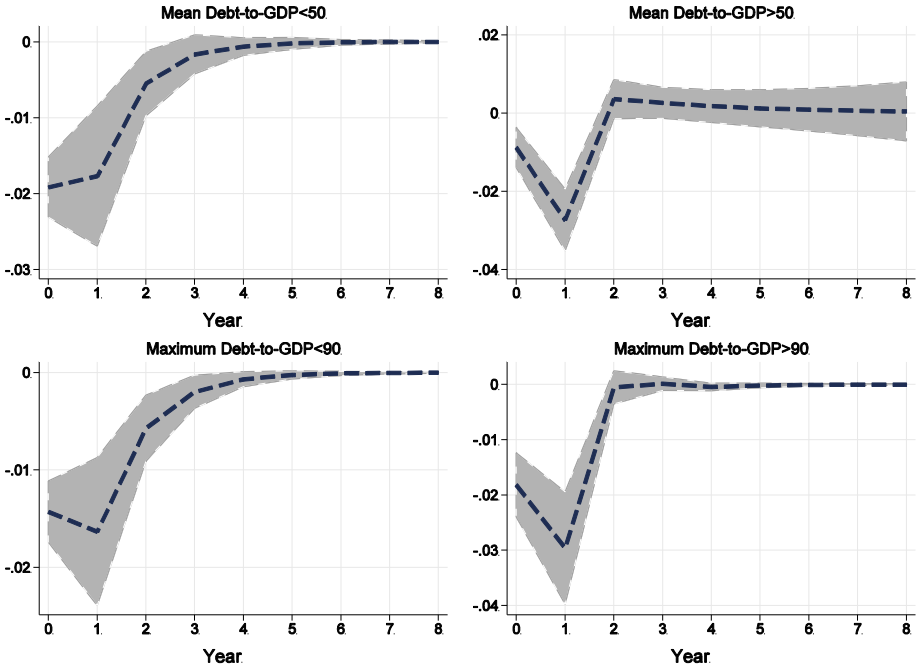

Fig. 4. IRFs of capital formation to a shock in debt computed from estimated PVAR for subsets of countries using different debt thresholds.

To sum up, we observe a significant negative association between government debt and capital formation, and this relationship holds across countries belonging to different income categories, regardless of the size of the debt-to-GDP ratio. It is well known that a number of general macroeconomic factors can influence the determination of interest rates, other than the stock of government debt, which may be vital for gauging the magnitude of the response of investment following a debt expansion. Assumptions regarding the Ricardian equivalence hypothesis, i.e. increases in government debt are offset by increases in private saving and hence the capital stock is unaltered by government debt, have been put to test by several studies. The intensity of the crowding-out effect of government debt can be somewhat attributable to the extent these assumptions hold.

We conduct a rigorous robustness analysis by using alternative variables in addition to testing the extended models described above: (a) replace gross fixed capital formation by gross capital formation; (b) use debt as a percentage of GDP instead of per capita debt; and (c) include yearly-fixed effects. Our benchmark estimates are robust to the above-mentioned specifications.[8]

4. Conclusion

We estimate a PVAR model using data for a large group of countries between 1980-2017 in order to identify the dynamic relationship between public debt and capital formation. The responses of capital formation and output growth offer support to the conventional view regarding the crowding-out effect of government debt. Compared to the prevailing evidence on the effect of public debt and fiscal policy shocks that are associated with a change in real interest rate, the response pattern of capital formation is unambiguous across countries belonging to different income groups, and is independent of the magnitude of the debt-to-GDP ratio. Nonetheless, the extent of the crowding-out effect of debt appears to be smaller in advanced countries.

The degree to which government debt crowds out investment depends on the type of policy innovation that brings forth debt growth (Traum and Yang, 2015). Distortionary fiscal financing, such as future increases in taxes necessary to offset debt accumulation, can be expected to have a negative impact on investment. Private sector debt incurred to raise consumption could also possibly crowd out capital formation. Consequently, a dynamic estimation approach which accounts for general macroeconomic factors is fundamental to the determination of the effects of debt. These additional factors are potential subjects for future empirical analyses.

[8] To conserve space, the results of these robustness tests are presented in the On-line Appendix.

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