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Does Public Debt Impair Total Factor Productivity?

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Abstract

What explains the persistent slowdown in total factor productivity (TFP) growth across advanced economies? This paper identifies rising public debt as a key structural driver. Using a panel of 25 OECD countries from 1980 to 2019, we provide robust empirical evidence that sustained debt accumulation has significantly contributed to the TFP deceleration, consistent with a hysteresis mechanism whereby temporary fiscal shocks leave long-lasting scars on productivity levels. To account for this evidence, we develop a theoretical model grounded in a stochastic endogenous growth setup. In the deterministic equilibrium, higher public debt ratios reduce TFP growth via a long-run crowding-out effect. In the stochastic setting, we uncover a new procyclical amplification mechanism, whereby debt adjustments amplify fluctuations in TFP. Our model reproduces the observed negative correlation between cyclical components of public debt and TFP without relying on persistent exogenous shocks, offering a novel perspective on the drivers of the productivity slowdown.

Keywords: Total factor productivity; Endogenous growth; Public debt.

JEL Codes: E62, H62, O41

Declarations of interest: none

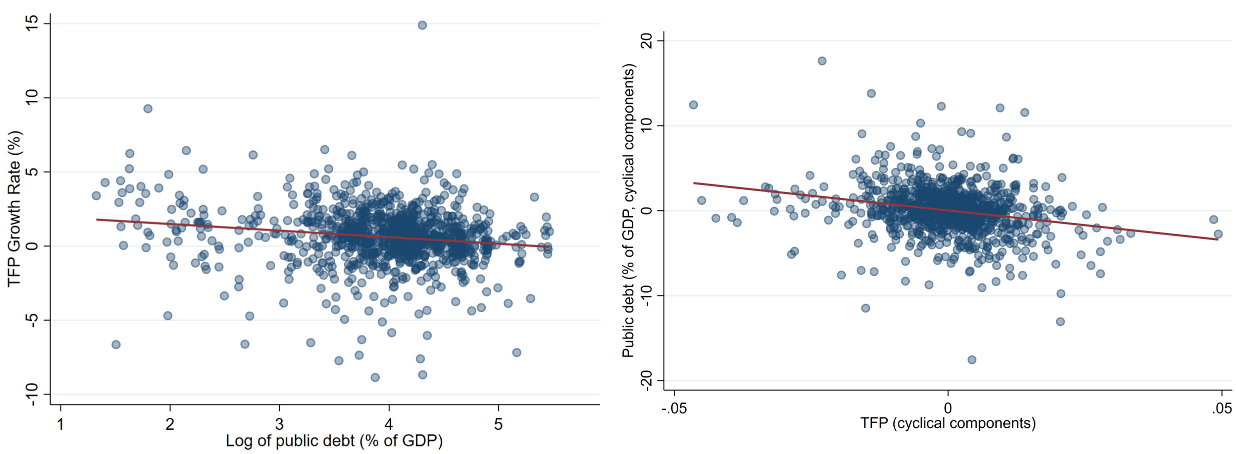
1. Introduction

One of the most puzzling stylized facts since the early 2000s is the persistent slowdown in total factor productivity (TFP). This trend raises serious concerns about the long-term growth potential of advanced economies, even fueling fears of a period of secular stagnation (Summers, 2016).[1] In OECD countries, average annual TFP growth fell from 1.2% in 1990-2004 to 0.3% in 2005-2019. Crucially, this slowdown predates the Great Recession (Fernald, 2015), suggesting its underlying causes extend beyond cyclical downturns. Understanding the drivers of this TFP slowdown is essential for assessing the future growth potential of advanced economies.

[1] This slowdown appears to be a widespread phenomenon (Eichengreen et al., 2017). In 2014, global TFP growth stagnated around zero for the third consecutive year, a sharp decline from the 1% growth observed during the "glorious decade" (1996-2006) and the 0.5% growth in 2007-2012 (see the Conference Board's Total Economy Database).

This paper proposes a novel explanation: the accumulation of public debt. The persistent deceleration in TFP growth has strikingly coincided with a steady rise in public-debt-to-GDP ratios across developed economies. Similarly, the continuous increase in debt ratios are not merely a temporary consequence of countercyclical policies implemented in response to the Great Recession or the COVID-19 pandemic; rather, it represents a structural characteristic of developed economies since at least the 1970s.[2] Figure 1a motivates our paper, showing a negative correlation between public debts ratios and TFP growth rates across OECD countries from 1980 to 2019.

These two stylized facts—the TFP slowdown and the sustained accumulation of public debt—now stand as defining features of macroeconomic dynamics in developed economies. This paper aims to explore whether, and through what mechanisms, the former may be causally linked to the latter.



(a) (b)

Figure 1: Negative link between public debt and TFP growth

Note. Panel (a) shows the relationship between the log of public debt (as a % of GDP) and TFP growth rates. Panel (b) plots the cyclical components of public debt and TFP (HP filter with $\lambda = 6.25$). Both panels use annual data for 25 advanced economies from 1980 to 2019. Each dot is a country-year observation. The maroon line is a local polynomial (lowess) fit. Debt data are from the IMF; TFP from the 2021 Penn World Table (Feenstra et al., 2015).

The TFP slowdown has been attributed to both structural and cyclical factors.[3] On the structural side, scholars have highlighted the declining ability of advanced economies to convert technological progress into productivity gains (Gordon, 2012), the sharp decline in research productivity (Bloom et al., 2020), inefficient capital allocation across firms (Hsieh and Klenow, 2009; Gopinath et al., 2017), or the weakening of knowledge

[2] Prior to the Great Recession—between the early 1970s and the mid-2000s—the average public deficit among OECD countries was around 2.5% of GDP.

[3] For a detailed discussion of the various drivers of TFP, see Fernald (2015) and Esfahani et al. (2024).

diffusion (Akcigit and Ates, 2021). Cyclically, demand-side shocks can lead to resource underutilization and a weakening of innovation incentives, shocks on financial markets may increase credit constraints struggling investment in productivity-enhancing technologies (Aghion et al., 2019; Duval et al., 2020), while trade shocks can disrupt knowledge spillovers and innovation invectives (Gopinath and Neiman, 2014; Autor et al., 2020).

More broadly, short-term shocks may generate lasting productivity losses through hysteresis effects, whereby temporary downturns lead to persistent reductions in investment, innovation, and technological progress (Furlanetto et al., 2025). This perspective suggests that the prolonged stagnation in TFP growth could partly reflect the cumulative, long-run consequences of past adverse shocks. The inverse comovement between debt ratios and TFP along the business cycle—illustrated in panel (b) of Figure 1—supports this view, pointing to a potential mechanism through which cyclical fluctuations in public debt may contribute to enduring productivity slowdowns.

This paper provides empirical and theoretical insights into the relationship between public debt and TFP. We begin by documenting new empirical evidence that rising public debt significantly reduces TFP in advanced economies, with persistent effects indicative of hysteresis. Using a panel of 25 OECD countries over the period 1980–2019, we estimate an unrestricted error-correction autoregressive distributed lag (ARDL) model with Pooled Mean Group (PMG) estimators. Our results reveal that a 10-percentage point increase in the public-debt-to-GDP ratio is associated with a significant 1% decline in TFP, both in the short and long run. These findings are robust to concerns of endogeneity and reverse causality. In particular, we confirm them using a system Generalized Method of Moments (GMM) estimator.

To deepen our understanding of how debt shocks dynamically propagate, we apply local projection methods (Jordà, 2005), leveraging the previously obtained GMM estimates. The results provide evidence of hysteresis: debt shocks impose long-lasting negative effects on productivity, with TFP remaining persistently below its pre-shock path for at least a decade. Specifically, in our baseline sample covering the period 2000-2019, a one-percentage-point increase in the debt-to-GDP ratio is associated with a cumulative decline of approximately 0.2% in the TFP level after ten years. This finding proves robust across different subsamples: for the United States and European Union countries over the extended period 1980-2019, a comparable debt shock results in a TFP reduction of about 0.3% after a decade.

Motivated by these empirical patterns, we propose a theoretical mechanism linking public debt accumulation and productivity stagnation: As public debt rises, the burden of debt service tightens fiscal constraints, prompting governments to reduce productivity-enhancing expenditures—such as investment in infrastructure, education, or health. These cuts depress TFP, which further weakens public finances, reinforcing the initial rise in debt. This gives rise to a feedback loop where rising debt and declining productivity mutually reinforce one another.

We formalize this argument in a tractable stochastic Romer (1986)-type endogenous growth model. Methodologically, we choose an endogenous growth framework for two key reasons: first, it allows for long-run public debt accumulation, unlike exogenous growth setups (Menuet et al., 2024); and second, these models offer an endogenous mechanism for temporary shocks to generate lasting impacts on macroeconomic variables (Fatás, 2000). In our model, TFP depends on (*i*) a (stochastic) technological factor, and (*ii*) a non-technological factor—the economy-wide stock of knowledge. The government provides two types of public spending: productivity-enhancing public investment and "unproductive" spending (assimilated to public consumption expenditure). Public debt and persistent deficits are introduced by relaxing the standard balanced-budget rule hypothesis, and we consider a fiscal rule that requires the debt-to-GDP ratio to reach a long-term numerical limit—a common feature of rule-based fiscal frameworks (Lledó et al., 2017).

Our analysis yields three main theoretical results:

(*i*) In the deterministic equilibrium, higher public debt reduces long-run productivity growth. Indeed, while public debt can serve to fund productivity-enhancing public investment, debt service diverts resources away from such investment. In the long run, the transversality condition implies that the crowding-out effect dominates. This theoretical result aligns with our empirical evidence of a long-run negative impact of public debt on TFP in OECD countries.

(*ii*) Temporary technology shocks induce permanent effects (hysteresis) on macroeconomic variables. The mechanism unfolds as follows: a negative technology shock initially raises the debt-to-GDP ratio. In response, the government reduces public investment to maintain fiscal rule compliance, which in turn depresses the knowledge stock and, consequently, productivity. This further deteriorates output and fiscal balances, thereby exacerbating the initial shock. This creates a procyclical amplification channel where rising debt and declining productivity are self-reinforcing—a dynamic we identify as a *public-debt accelerator*.

(*iii*) Calibrating our model to US post-war data, we demonstrate that even with a small persistence of shocks, the simulated dynamics successfully replicate the observed negative correlation between the cyclical components of public debt (as a % of GDP) and TFP—a robust stylized fact documented across nearly all OECD countries over the

1980-2019 period, as shown in Figure 1b.

In a nutshell, our paper develops a simple theoretical framework to explain how the accumulation of public debt can account for the TFP slowdown observed in developed countries over the past four decades. These two phenomena—rising debt and decelerating productivity—are not merely temporary consequences of public policies. Instead, our model reveals a self-reinforcing mechanism where a temporary shock can worsen over time due to fiscal adjustment policies. This stems from public debt dynamics, which transmit past productivity shocks into current productivity levels. Our model thereby highlights the detrimental role of fiscal rules, which, while necessary for ensuring fiscal sustainability, inadvertently lead to a procyclical bias in fiscal policies.

Plan. The paper is organized as follows. The next subsection delves into the related literature. Section 2 provides empirical evidence on the impact of public debt on TFP across OECD countries. Subsequently, we formalize our theoretical argument: Section 3 presents the model framework. Section 4 examines the long-run impact of debt on TFP in the deterministic steady state, while Section 5 extends this analysis to a stochastic environment, where we detail our amplification mechanism. Finally, Section 6 offers concluding remarks.

1.1. Related Literature

This paper contributes to the literature on the macroeconomic implications of public debt by providing both empirical and theoretical evidence that debt accumulation depresses total factor productivity—a central engine of long-run economic growth.

Our first contribution is to highlight the critical role of productivity in understanding the long-term consequences of public indebtedness. While existing empirical studies often document a negative and potentially nonlinear relationship between public debt and economic growth (see, e.g., Reinhart and Rogoff, 2010; Pattillo et al., 2011; Baum et al., 2013; Eberhardt and Presbitero, 2015), the specific mechanisms remain debated. Some studies, such as Kumar and Woo (2010), argue that the observed debt-growth nexus is primarily driven by reduced productivity, itself a result of declining public and private investment.[4] Our theoretical framework builds on this insight by explicitly modeling how government debt, via its crowding-out effect on productivity-enhancing public investment, translates into lower long-run TFP and growth.

[4] For instance, Salotti and Trecroci (2016) estimate that a 30-percentage point rise in the debt-to-GDP ratio leads to a 0.26% reduction in annual productivity growth among 20 OECD countries over 1970—2009.

Our second contribution concerns the role of fiscal rules in shaping this debt-TFP relationship. In our model, the adverse effect of rising debt on TFP operates through a fiscal adjustment mechanism: the government curtails productive investment in response to higher debt levels to satisfy a fiscal rule. This rule reflects institutionalized debt constraints commonly implemented across advanced economies—for example, the 60% debt-to-GDP ceiling established by the European Union's Stability and Growth Pact, or statutory borrowing limits such as the federal debt ceiling enforced in the United States. A growing empirical literature suggests that the adoption of such "first-generation" fiscal rules—centered around numerical deficit or debt targets—may constrain governments' ability to conduct countercyclical fiscal policy, particularly in downturns, thereby introducing a procyclical bias (see Roubini and Sachs, 1989; Alesina and Perotti, 1996; Lane, 2003; Fatás and Mihov, 2006).[5]

In most of these studies, the amplification mechanism operates through a Keynesian demand-side channel: following a recessionary shock, fiscal resources decline, compelling the government to reduce public spending to adhere to the fiscal rule, which negatively impacts GDP through a fiscal multiplier effect. By contrast, our model proposes a supply-side channel: a negative technology shock reduces TFP, which increases the debt-to-GDP ratio. The fiscal rule then compels the government to cut public investment, further weakening TFP via a reduction in the knowledge stock. This feedback loop creates a dynamic amplification mechanism—what we refer to as *the public-debt accelerator.*

Our third and final contribution is theoretical. We expand the literature on stochastic endogenous growth by explicitly modeling public debt dynamics. Early works by King et al. (1988) and Stadler (1990) showed that disturbances in production can lead to persistent fluctuations.[6] This occurs because non-decreasing marginal returns in production technology allow transitory shocks to have permanent effects (hysteresis). These frameworks help explain stylized facts such as the persistence of business cycles and the long-term effects of fiscal policy (see, e.g. Fatás, 2019, 2000; Pelloni, 1997)). However, most of this literature either abstracts from public debt or imposes a balanced-budget constraint. By relaxing this assumption, we introduce a new mechanism by which temporary shocks can permanently affect the trajectories of debt, TFP, and output. Our model thus uncovers a new hysteresis channel—mediated by fiscal rules and knowledge externalities—through which transitory shocks are transformed into enduring structural impediments to growth.

[5] These studies indicate that public investment is the most procyclical form of government expenditure, which is consistent with recent evidence (Bamba et al., 2020).

[6] Further developments include stochastic stocks in "AK" models (see, e.g. Jones et al., 2000; Turnovsky, 2000).

2. Public debt and TFP: An econometric analysis

This section provides empirical evidence on the relationship between public debt and TFP using a panel dataset comprising 25 OECD countries from 1980 to 2019.[7] Our empirical approach proceeds in two steps: First, we estimate the short- and long-run effects of public debt on TFP by employing an unrestricted error-correction autoregressive distributed lag (ARDL) model. Second, we investigate whether these effects exhibit persistence over time, suggesting a hysteresis phenomenon where temporary public-debt shocks can have lasting impacts on productivity.

2.1. Short- and long-Run effects of public debt on TFP

We begin by specifying a baseline equation in which TFP is regressed on the debt-to-GDP ratio and a set of macroeconomic controls:

$$\text{TFP}_{i,t} = \mu_i + \alpha_i \text{Debt}_{i,t} + \beta_i Z_{i,t} + \delta_t + \varepsilon_{i,t}, \tag{1}$$

where i and t denote countries and years, respectively. $\text{TFP}_{i,t}$ is measured using the index provided by the 2021 edition of Penn World Table (Feenstra et al., 2015). $\text{Debt}_{i,t}$ denotes the debt-to-GDP ratio, and $Z_{i,t}$ is a vector of control variables. μ_i captures country fixed effects, δ_t accounts for time effects, and $\varepsilon_{i,t}$ is the error term.

Control variables (Z) are chosen based on established growth theory.[8] We first control for technological progress through R&D expenditures (in % of GDP), which serve as a proxy for the accumulation of knowledge (Romer, 1990; Griffith et al., 2004). Human capital is captured using two standard proxies: primary school enrollment rates ($\text{Education}_{i,t}$), and labor force participation rates ($\text{Labor force}_{i,t}$), capturing the mobilization of the working-age population (Lucas, 1988). To account for potential technology spillovers, we include trade openness ($\text{Trade openness}_{i,t}$), which is widely regarded as a transmission channel for innovation. Institutional quality is proxied by an index of governance quality ($\text{Governance}_{i,t}$), as institutions influence the returns to innovation and the efficiency of knowledge diffusion.

We also include a dummy variable ($\text{Crisis}_{i,t}$), equal to 1 from 2008 onwards, to capture the structural effects of the global financial crisis on productivity trajectories. Since our sample includes only OECD countries—characterized by relatively stable political institutions in our time period—we omit controls for regime type, and additional time-invariant

[7] Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Poland, Slovakia, Slovenia, South Korea, Sweden, United Kingdom, United States.

[8] See Isaksson (2007) or Kim and Loayza (2019) for comprehensive reviews of the TFP determinants.

institutional features are absorbed by country fixed effects. Appendix Tables A.4 and A.5 provide variable definitions, data sources, and summary statistics.

To capture both short- and long-term dynamics, we employ an ARDL framework. With one lag for all variables,[9] the ARDL (1;1) can be written as the following equation:

$$\begin{aligned}\Delta \text{TFP}_{i,t} = \phi_i(&\text{TFP}_{i,t-1} - \theta_0 - \theta_1 \text{Debt}_{i,t} - \theta_2 \text{Trade openness}_{i,t} - \theta_3 \text{R\&D}_{i,t} \\ &- \theta_4 \text{Education}_{i,t} - \theta_5 \text{Labor force}_{i,t} - \theta_6 \text{Governance}_{i,t} - \theta_7 \text{2008 crisis}_{i,t}) \\ &- \delta_{1i} \Delta \text{Debt}_{i,t} - \delta_{2i} \Delta \text{Trade openness}_{i,t} - \delta_{3i} \Delta \text{R\&D}_{i,t} - \delta_{4i} \Delta \text{Education}_{i,t} \\ &- \delta_{5i} \Delta \text{Labor force}_{i,t} - \delta_{6i} \Delta \text{Governance}_{i,t} - \delta_{7i} \text{2008 crisis}_{i,t} + \varepsilon_{i,t}.\end{aligned} \tag{2}$$

We choose the Pesaran et al. (1999)'s estimator, the so-called pooled-mean group estimator (PMG), allowing long-run coefficients (θ) to be homogeneous across countries while short-run dynamics (δ_i) are country-specific. This specification is well-suited to macroeconomic panel data, where structural parameters such as the long-term responsiveness of productivity to debt are expected to be similar across countries, while short-term movements may vary due to country-specific factors, such as political cycles or institutional constraints. Stationarity tests confirm that the key variables are integrated of order one, which validates the use of a cointegration approach. Table A.6 in Appendix A reports the results of cross-sectionally augmented Dickey-Fuller (ADF) tests (Pesaran, 2007) for TFP, public debt, and other macroeconomic aggregates, accounting for potential cross-sectional dependencies.

Table 1 presents the estimation results. The presence of a cointegrating relationship is confirmed by the significant and negative error-correction term. This indicates that deviations from the long-run equilibrium are gradually corrected over time. Specifically, approximately 5.5% of the deviation from the equilibrium TFP level is corrected each year. In the long run, public debt (in % of GDP) has a negative and significant effect on TFP. A 10-percentage point increase in the debt-to-GDP ratio is associated with a reduction in TFP of approximately 1%. This result highlights the structural cost of high public debt levels on the productive capacity of advanced economies. The estimates for the control variables display the expected signs: R&D expenditure, governance quality, labor force participation, trade openness, each have a significant positive effect on TFP, consistent with predictions from growth theory. Although the coefficient for education is positive, it is not statistically significant.

[9] The number of lags is determined based on the Schwarz Bayesian Information Criterion (BIC).

Short-run dynamics also show a statistically significant negative impact of public debt on TFP, suggesting that debt affects productivity not only in the long run but also in the short-term adjustment process. The 2008 crisis dummy is significantly negative, reflecting the enduring impact of global financial turmoil on productivity.

Table 1: Total Factor Productivity and Public Debt—PMG results

Dependent variable:	TFP
Error-correction term	-0.055**
	(0.027)
Long run relationship	
Debt	**-0.001*** **
	(0.000)
Trade openness	0.001***
	(0.000)
Governance quality	0.496***
	(0.108)
R&D expenditure	0.047***
	(0.014)
Education	0.002
	(0.001)
Labor force participation	0.012***
	(0.003)
2008 crisis	-0.051***
	(0.017)
Short-run relationship	
Debt	**-0.001*** **
	(0.000)
Trade openness	0.001***
	(0.000)
2008 crisis	-0.018***
	(0.005)
Cointegration test	-1.539*
	[0.06]
Observations	618
No of countries	25

Note. Numbers in parenthesis are standard errors. Number in brackets is the p-value. We follow the cointegration tests developed by Westerlund (2005) that account for cross-sectional dependencies. All specifications include a maximum of one lag. The total number of lags is chosen according to the Schwarz criterion (BIC). *, ** and *** denote significance at 10%, 5% and 1% levels.

As a robustness check, we complement our baseline analysis by using the system GMM estimator (Blundell and Bond, 1998). This method allows us to control for unobserved heterogeneity, potential simultaneity between debt and productivity, and the endogeneity of key explanatory variables. In our setting, we treat TFP and public debt as endogenous and use lagged levels and differences as instruments, carefully limiting the instrument count to avoid overfitting and weak identification. Estimation results confirm our main finding (see Table 2): public debt has a significant negative effect on TFP in the short run. While the control variables are less precisely estimated, coefficient on debt remains negative and significant across specifications, supporting a robust causal relationship.

Table 2: Total Factor Productivity and Public Debt— GMM-system results

Dependent variable:	TFP
TFP	0.799***
	(0.130)
Debt	**-0.001****
	(0.000)
Trade openness	-0.000
	(0.000)
R&D expenditure	0.002
	(0.003)
Labor force participation	-0.000
	(0.000)
Autocorrelation test:	
AR(1)	-2.40**
AR(2)	-1.66
Observations	464
No of countries	25

Note. Numbers in parenthesis are robust standard errors. The estimation period covers from 2000 to 2019. TFP and Debt are instrumented. Instrument set is limited to the first lags of the instrumented variable. We do not reject the null hypothesis of Sargan's test for instrument validity. Year-fixed effects are also included in order to control for unobserved factors common to all countries. ** and *** denote significance at 5% and 1% levels.

2.2. Evidence of hysteresis effects

Having established that public debt has a significant negative effect on TFP in both the short and long run, we now examine whether temporary shocks to public debt have persistent effects on productivity. Specifically, we investigate the presence of hysteresis, whereby transitory fiscal disturbances can lead to enduring deviations in the trajectory of TFP.

To assess this, we employ a local-projection GMM model (Jordà, 2005), which is well-suited for estimating dynamic treatment effects in panel data settings with endogenous regressors. This method involves estimating a sequence of regressions at each forecast horizon h, allowing us to trace the cumulative impact of a debt shock on TFP over time without imposing strong parametric assumptions on the adjustment path. The GMM-system structure allows us to correct for unobserved heterogeneity and simultaneity by instrumenting endogenous regressors with their own lagged values. This combination of local projections with GMM techniques provides a robust framework to estimate the medium- to long-term effects of temporary fiscal shocks across countries with potentially heterogeneous responses.

This combination of local projections with GMM techniques provides a robust framework to estimate the medium- to long-term effects of temporary fiscal shocks across countries with potentially heterogeneous responses. The specification is given by:

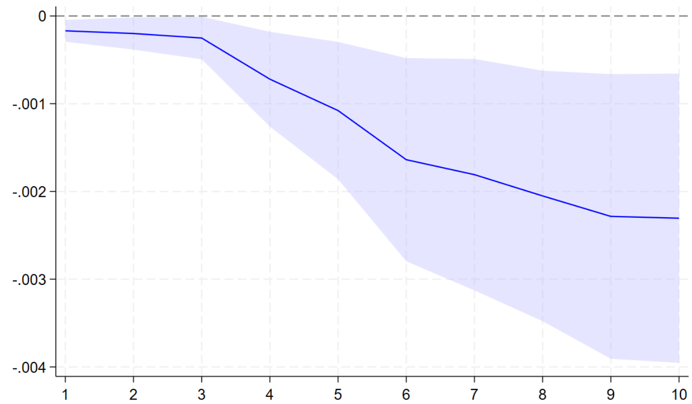
$$\text{TFP}_{i,t+h} - \text{TFP}_{i,t} = \mu_i + \alpha_h \text{Debt}_{i,t-1} + \beta Z_{i,t-1} + \delta_t + \varepsilon_{i,t+h},$$

where μ_i and δ_t are country and time fixed effects, respectively. $Z_{i,t-1}$ includes lagged controls for R&D expenditure, trade openness, and labor force participation. The parameter α_h captures the cumulative effect of a debt shock h years after its occurrence.

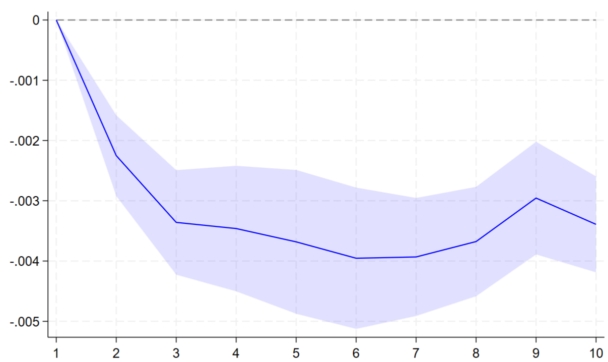
Figure 3a displays the impulse response of TFP to a one-percentage-point increase in the public debt-to-GDP ratio, estimated over the full sample of 25 OECD countries from 2000 to 2019. This figure quantifies the dynamic effect of public debt on productivity: a one-point rise in the debt ratio leads to a cumulative decline of approximately 0.2% in the level of TFP after a 10-year horizon.

This result is robust across subsamples. As shown in Figure 3b and Figure 3c, similar dynamics are observed for the United States and for a panel of European countries over the longer period 1980–2019, respectively. In both cases, a debt shock leads to a TFP decline of around 0.3% after 10 years. This evidence is particularly noteworthy given that our theoretical model will be calibrated using U.S. post-war economic data.

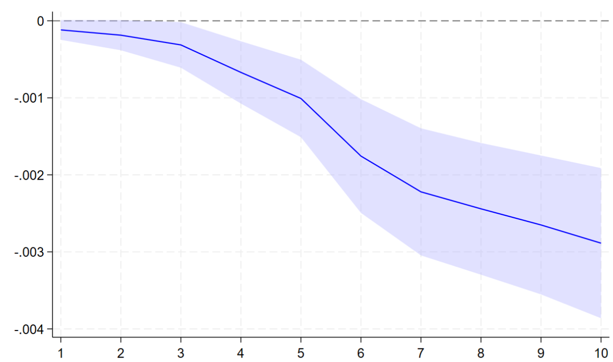
The persistence and amplification of the debt shock on the TFP level provide strong evidence of a hysteresis effect. This suggests the existence of an underlying procyclical propagation mechanism through which temporary shocks affect the dynamics of TFP over time. From a policy perspective, the macroeconomic cost of public debt accumulation goes far beyond short-term fiscal pressures, entailing long-lasting structural risks for productivity growth and long-run economic potential. In the remainder of the paper, we develop a theoretical framework to account for this mechanism and shed light on the underlying transmission channels.



(a) Full sample (2000–2019)



(b) United-Stated (1980–2019)



(c) European Union (1980-2019)

Figure 2: Aggregate Panel LP Cumulative IRF

Note. The response and impulse variables correspond to TFP and public debt (as % of GDP), respectively, over a 10-year horizon with a 95% confidence interval. The impulse response functions are estimated using local projections for the full sample (2000–2019), the United States (1980–2019), and European Union countries (1980–2019).

3. The Model

Our empirical analysis yields two key findings: First, rising public debt (as a % of GDP) is robustly associated with declines in TFP, both in the short and long run. Second, we document evidence of hysteresis: temporary shocks to public debt have persistent and cumulative negative effects on productivity. These results point to a structural mechanism linking debt accumulation and the long-term stagnation of productivity growth observed in many advanced economies in recent decades.

To rationalize these findings, we propose the following argument: As public debt increases, the cost of debt service rises, constraining fiscal space and prompting governments to curtail productivity-enhancing expenditures—such as investment in infrastructure, education, or health. These cuts depress productivity, which further deteriorates fiscal balances, reinforcing the initial rise in debt. This dynamic sets off a self-reinforcing cycle in which debt accumulations and productivity losses feed into each other—a procyclical amplification mechanism we term "*the public debt accelerator*". Through this channel, even transitory adverse shocks can give rise to persistent, long-term declines in productivity.

To formalize this mechanism, we adopt a stylized stochastic endogenous growth model in the spirit of King et al. (1988). The economy consists of three infinitely lived agents with rational expectations: a representative household, a representative firm, and a government.

3.1. The firm

The output of the individual firm (Y_t) is produced with physical (K_t) and human (Z_t) capitals using a Cobb-Douglas technology

$$Y_t = \Phi_t K_t^{\alpha} Z_t^{1-\alpha}, \tag{3}$$

where $\alpha \in (0, 1)$ is the physical capital share in production. Φ_t is a stochastic technological factor, namely $\Phi_t = A \exp(q_t)$, where $A > 0$ is a scale parameter, and q_t is assumed to follow a first-order autoregressive process

$$q_t = \psi q_{t-1} + \nu_t, \tag{4}$$

with $0 < \psi < 1$ as the autoregressive coefficient, and $\nu_t \sim \mathcal{N}(0, \sigma^2)$.

Following Romer (1986), human capital is produced using a flow of raw labor (L_t) and the economy-wide stock of knowledge (X_t), namely $Z_t = X_t L_t$. We assume that knowledge is produced by the economy-wide stock of physical capital $\bar{K}_t$ and public capital H_t, namely $X_t = \bar{K}_t^{1-\varepsilon} H_t^{\varepsilon}$, with $\varepsilon \in (0, 1)$ is the elasticity of knowledge to public capital. The individual firm treats $\bar{K}_t$ and H_t as given when solving its optimization problem.

Our model builds on a slightly modified version of Barro (1990)'s, following Futagami et al. (1993) or Cassou and Lansing (1998). We incorporate a productivity-enhancing public capital stock (H_t), which enters the production function as a non-rival, non-excludable public good. This stock reflects cumulative public investments—such as in infrastructure, health, or education—that support knowledge accumulation and raise firm's marginal productivity through a positive externality, captured by the parameter $\varepsilon > 0$. Consequently, our production function (3) relies on an endogenous total factor productivity (TFP_t):

$$Y_t = \text{TFP}_t K_t^{\alpha} L_t^{1-\alpha}, \text{ with } \text{TFP}_t = \Phi_t \left[\bar{K}_t \left(\frac{H_t}{\bar{K}_t} \right)^{\varepsilon} \right]^{(1-\alpha)}.$$

The TFP depends on (i) technological stochastic shocks (Φ_t); and (ii) the stock of knowledge through its positive externality on human capital ($[\bar{K}_t(H_t/\bar{K}_t)^{\varepsilon}]^{(1-\alpha)}$).[10]

The accumulation of private capital comes from investment (I_t), net of depreciation. Let $\delta_k \in (0,1)$ denote the depreciation rate of private capital. The law of motion for private capital is $K_{t+1} = I_t + (1-\delta_k)K_t$. Assuming a proportional tax on output at rate $\tau \in (0,1)$, the firm's first-order condition for profit maximization implies

$$r_t = \alpha(1-\tau)\frac{Y_t}{K_t} - \delta_k, \tag{5}$$

which equates the net-of-tax marginal product of capital ($(1-\tau)\partial Y_t/\partial K_t$) to its user cost (comprising the real interest rate and depreciation, $r_t + \delta_k$)).

At the aggregate level (i.e. $\bar{K}_t = K_t$), with population normalized to one ($L_t = 1, \forall t$), the production function (3) takes the form

$$Y_t = \Phi_t K_t \left(\frac{H_t}{K_t} \right)^{(1-\alpha)\varepsilon}. \tag{6}$$

This formulation exhibits constant returns-to-scale in the two accumulable factors (K_t and H_t), allowing for the emergence of a balanced growth path in the long run. The elasticity of output to public capital ($(1-\alpha)\varepsilon$) is lower than in the specification of Futagami et al. (1993). By calibrating the parameter ε appropriately, this elasticity can be aligned with empirical estimates.[11]

[10] This formulation aligns with the empirical consensus on the positive relationship between TFP and the stock of knowledge. In our empirical results (see Table 1), a 1-percentage point increase in R&D expenditure (in % of GDP)–a proxy of knowledge accumulation—is associated with an increase in TFP of approximately 4.7% in the long run.

[11] From a quantitative standpoint, most empirical studies estimate a significantly lower elasticity of output with respect to public spending than the early benchmark of 0.39 reported by Aschauer (1989). For example, Baxter and King (1993) and Lynde and Richmond (1993) find values ranging between 0.05 and 0.25, consistent with more recent findings by Hurlin and Minea (2013). Accordingly, our baseline calibration sets $\alpha = 0.275$ and $\varepsilon = 0.2$, yielding an output elasticity with respect to public capital of $(1-\alpha)\varepsilon = 0.145$.

3.2. The household

At each period, the representative household is endowed with a fixed amount of labor, normalized to unity.[12] Preferences are described by the inter-temporal welfare that depends on the consumption path $\{C_t\}_{t\geq 0}$

$$U = \mathbb{E}_t \left[\sum_{i=0}^{+\infty} \left(\frac{1}{1+\beta} \right)^i u(C_{t+i}) \right], \tag{7}$$

where $\mathbb{E}_t$ is the expectation operator on the information set available at date t, and $\beta > 0$ is the subjective discount rate. We adopt a standard isoelastic specification:

$$u(C_t) = \begin{cases} \frac{1}{1-1/\phi} \left[C_t^{1-1/\phi} - 1 \right] & \text{if } \phi \neq 1 \\ \log(C_t) & \text{if } \phi = 1 \end{cases},$$

with $1/\phi$ the constant intertemporal elasticity of substitution.

The household uses its income (Y_t) to consume (C_t), to invest ($I_t = K_{t+1} - (1-\delta_k)K_t$), and to buy government bonds (B_t) that return the real interest rate r_t. It pays taxes (τY_t, where $\tau \in (0,1)$ is the proportional income tax rate). All variables are defined in real terms; hence, the following budget constraint

$$B_{t+1} + K_{t+1} = (1+r_t)B_t + (1-\tau)Y_t - C_t - (1-\delta_k)K_t. \tag{8}$$

First-order conditions with respect to B_{t+1} and K_{t+1} for the maximization of the representative household's program lead to the two following dynamics equations, respectively

$$C_t^{-1/\phi} = \mathbb{E}_t \left[\left(\frac{1+r_{t+1}}{1+\beta} \right) C_{t+1}^{-1/\phi} \right], \tag{9}$$

$$C_t^{-1/\phi} = \mathbb{E}_t \left[\left(\frac{\alpha(1-\tau)Y_{t+1}/K_{t+1} + 1 - \delta_k}{1+\beta} \right) C_{t+1}^{-1/\phi} \right], \tag{10}$$

under the set of transversality conditions

$$\lim_{t \to +\infty} \left(\frac{1}{1+\beta} \right)^t \frac{K_{t+1}}{C_t} = 0, \text{ and } \lim_{t \to +\infty} \left(\frac{1}{1+\beta} \right)^t \frac{B_{t+1}}{C_t} = 0. \tag{11}$$

Eqs. (9) and (10) ensure optimal allocation between government bonds and private

[12]This simplifying assumption enhances tractability by excluding endogenous labor supply decisions, which are known to introduce local or global indeterminacy in endogenous growth models with public debt (Menuet et al., 2024). Our objective is to develop a parsimonious framework that isolates a novel channel of shock propagation driven by fiscal policy dynamics, rather than by labor market fluctuations. While endogenous labor could be incorporated, doing so would not qualitatively alter our main results.

capital in household's portfolio, respectively. At equilibrium, given relation (5), they imply the standard no-arbitrage condition between the two assets.

3.3. The government

The government levies taxes, borrows from the household, and provides two types of expenditure: public investment ($H_{t+1} - (1-\delta_h)H_t$, where $\delta_h \in (0,1)$ is the rate of public capital depreciation), and a flow of unproductive public spending that is assimilated to public consumption (G_t). The government deficit is financed by issuing debt (B_{t+1}); hence, the following budget constraint

$$B_{t+1} = (1 + r_t)B_t + H_{t+1} - (1 - \delta_h)H_t + G_t - \tau Y_t. \tag{12}$$

We introduce the possibility of persistent fiscal deficits, whereby the level public debt (B_t) can grow over time.[13] The only requirement for the transversality conditions (11) to hold is that the growth rate of public debt must be less than the real interest rate in equilibrium (i.e., the no-Ponzi game constraint).

To close the model, we need to specify the variable that adjusts the government's budget constraint. In reported fiscal consolidation experiences, the effectiveness of fiscal adjustments crucially depends on the type of public expenditure that is subject to budget cuts. The consensus in the empirical literature is that debt consolidations lead more likely to reductions in public investment programs rather than in transfers or wages expenditures.[14] Alesina and Perotti (1997) and Alesina et al. (2008) explain this evidence by political realities suggesting a greater ease to cut back investment spending than current expenditures. Accordingly, we assume that a constant share $g \in (0,1)$ of aggregate output is devoted to public consumption ($G_t = gY_t$), and that public investment is the adjustment variable in the government's budget constraint (12).

Finally, we consider that the government is subject to the following fiscal rule

$$\frac{B_{t+1}}{Y_{t+1}} - \frac{B_t}{Y_t} = \mu\left(\theta - \frac{B_t}{Y_t}\right), \tag{13}$$

where $\theta > 0$ is the targeted debt-to-output ratio and $\mu > 0$ is the speed of adjustment of the debt ratio to its target.

[13] The stationary properties of endogenous growth setups are compatible with the existence of a permanently growing public debt (see, e.g Minea and Villieu, 2012; Menuet et al., 2018).

[14] See, for example, de Haan et al. (1996) and Balassone and Franco (2000), or more recently Warner (2014). Roubini and Sachs (1989) argue that during fiscal consolidations "*capital expenditures are the first to be reduced (often drastically) given that they are the least rigid component of expenditures*".

This fiscal rule is part of the widely recognized category of first-generation rules, characterized by numerical ceilings or targets expressed as a proportion of GDP (see Kopits and Symansky, 1998). Setting a public debt ceiling is a common feature in fiscal policy frameworks.[15] Finally, from (12) and (13), the government's fiscal policy instruments are: the tax rate (τ), the targeted debt-to-output ratio (θ), and the speed of adjustment of the current debt to its long-term target (μ).

3.4. Equilibrium

A *competitive equilibrium* is a path $\{C_t, K_t, H_t, B_t, Y_t\}_0^\infty$ which solves Eqs. (5), (9), (12), (13), and satisfies the goods market equilibrium $K_{t+1} - (1-\delta_k)K_t = (1-g)Y_t - C_t - H_{t+1} + (1-\delta_h)H_t$ and the transversality conditions.

To solve the model, we deflate all growing variables by the private physical capital stock, namely: $c_{k,t} := C_t/K_t$, $h_{k,t} := H_t/K_t$, $b_{k,t} := B_t/K_t$, $y_{k,t} := Y_t/K_t$, and the growth rate of private and pubic capitals are $\gamma_{k,t} := K_{t+1}/K_t - 1$ and $\gamma_{h,t} := H_{t+1}/H_t - 1$, respectively. Thus, the reduced-form of the model is characterized by a system with seven unknowns $(c_{k,t}, y_{k,t}, h_{k,t}, b_{k,t}, r_t, \gamma_{k,t}, \gamma_{h,t})$ and seven equations:

$$c_{k,t}{}^{-1/\phi} = \mathbb{E}_t\left[\left(\frac{1+r_{t+1}}{1+\beta}\right)\left[c_{k,t+1}(1+\gamma_{k,t})\right]^{-1/\phi}\right], \tag{14}$$

$$y_{k,t} = \exp(q_t)Ah_{k,t}^{(1-\alpha)\varepsilon}, \tag{15}$$

$$r_t = \alpha(1-\tau)y_{k,t} - \delta_k, \tag{16}$$

$$\gamma_{k,t} = (1-g)y_{k,t} - c_{k,t} - (\gamma_{h,t}+\delta_h)h_{k,t} - \delta_k, \tag{17}$$

$$h_{k,t+1} = h_{k,t}\left(\frac{1+\gamma_{h,t}}{1+\gamma_{k,t}}\right), \tag{18}$$

$$b_{k,t+1} = \frac{(1+r_t)b_{k,t} + h_{k,t}(\gamma_{h,t}+\delta_h) + (g-\tau)y_{k,t}}{1+\gamma_{k,t}}, \tag{19}$$

$$\frac{b_{k,t+1}}{y_{k,t+1}}y_{k,t} = b_{k,t} + \mu(\theta y_{k,t} - b_{k,t}). \tag{20}$$

Eq. (14) is the Keynes-Ramsey relationship, derived from (5), (9), and (10). Eqs. (15) and (16) describe the output ratio and the real interest rate, respectively, and are obtained from (5) and (6). Eq. (17) corresponds to the goods market equilibrium, while

[15] Almost all developed countries in our sample have implemented an explicit fiscal rule since the early 1990s. In particular, the member states of the European Union adopted the 60% debt-to-GDP target following the Maastricht criteria (1993), while the United States implemented a balanced-budget rule for the federal government as early as 1986 (see Lledó et al., 2017, for further details). In 2015, 70 countries worldwide implemented explicit public debt limits, with gross debt ceilings typically ranging between $\theta = 60\%$ and $\theta = 70\%$.

Eq. (18) specifies the law of motion for the public capital ratio. On the policy front, Eqs. (19) and (20) are derived from the government's budget constraint (12) and the fiscal rule (13), respectively.

As our model is stochastic, we employ a perturbation method to solve this system using the @Dynare software. As is standard, we first compute the deterministic steady state (i.e., the steady state in the absence of stochastic shock). Subsequently, we perform a first-order Taylor approximation in the neighborhood of this deterministic steady state. Finally, stochastic simulations of shocks are implemented in @Dynare. The following section details the computation of the deterministic steady state and the calibration of the model.

4. Debt versus TFP: The long-run deterministic relationship

In the deterministic steady state—all the shocks are set to zero (i.e. $\nu_t = 0, \forall t$)—the economy reaches a balanced-growth path (BGP), namely a competitive equilibrium where consumption, private capital, public capital, public debt, and output grow at the same (endogenous) rate γ^*, while the real interest rate and all capital-deflated variables are constant.

The steady-state public debt ratio is $b_k^* = \theta y_k^*$, and from Eq. (19) it follows that

$$h_k^*(\gamma^* + \delta_h) = (\tau - g)y_k^* - (r^* - \gamma^*)b_k^* = [\tau - g - (r^* - \gamma^*)\theta]y_k^*. \tag{21}$$

Eq. (21) has an interesting implication: in the absence of long-run public debt ($\theta = 0$), the equilibrium level of public investment ($h_k^*(\gamma^* + \delta_h)$), aligns with the solution of Futagami et al. (1993), reflecting fiscal resources net of public consumption—that is, $h_k^*(\gamma^* + \delta_h) = (\tau - g)y_k^*$. By contrast, when long-run public debt is present ($\theta > 0$), public investment is reduced because the transversality condition imposes $r^* > \gamma^*$ (see Minea and Villieu, 2012). The underlying mechanism behind this crowding-out effect operates as follows: public deficits generate (i) a permanent inflow of new resources for public investment ($B_{t+1} - B_t$), but also (ii) a permanent inflow of unproductive expenditures, namely the debt service cost ($r_t B_t$). In the long run, the no-Ponzi-game condition ($r^* > \gamma^* = (B_{t+1} - B_t)/B_t$) ensures that the burden of debt servicing ultimately outweighs the additional investment resources. As a result, any fiscal rule permitting permanent deficits imposes net long-term costs on public finances. Yet importantly, along the adjustment path, public debt can temporarily enhance the stock of public capital, boost productivity, and stimulate economic growth—since, in the short term, the positive investment effect can exceed the negative burden effect.

By denoting $\chi := (1-\alpha)\varepsilon \in (0,1)$, the steady-state output ratio is $y_k^* = A^{1/(1-\chi)}[\tau - g - (r^* - \gamma^*)\theta]^{\chi/(1-\chi)}$. As usual in endogenous growth models, the steady-state BGP is derived from the crossing-points of two mappings between the real interest rate r^* and the economic growth rate γ^*.

The first one comes from the Keynes-Ramsey relationship (Eq. 14)

$$\gamma^* = \gamma_c = \left(\frac{1+r^*}{1+\beta}\right)^{\phi} - 1. \tag{22}$$

The second is derived from the policy side (Eqs. 19 and 20)[16]

$$\gamma^* = \gamma_b = \frac{\tau - g - r^*\theta - \frac{1}{A}\left(\frac{r^*+\delta_k}{A\alpha(1-\tau)}\right)^{(1-\chi)/\chi}\delta_h}{\frac{1}{A}\left(\frac{r^*+\delta_k}{A\alpha(1-\tau)}\right)^{(1-\chi)/\chi} - \theta}. \tag{23}$$

Proposition 1. *There is a unique deterministic steady-state BGP.*

Proof: See Appendix B.

The existence and uniqueness of the deterministic steady state is analytically ensured by Proposition 1 and graphically depicted in Figure 3.[17]

Eq. (22) defines an upward-sloping relationship shaped by households' optimal saving behavior: as the real interest rate rises, the growth rate of private consumption increases. In contrast, Eq. (23) characterizes a downward-sloping relationship, reflecting the governments budget constraint: a higher real interest rate amplifies the debt burden, reducing public investment and, in turn, economic growth. Under mild parameter conditions, these two curves, (22) and (23), intersect exactly once at positive values, thereby determining a unique steady-state equilibrium, denoted by $(\tilde{r}^*, \tilde{\gamma}^*)$.

[16]From (20), we derive $b_k^* = \theta y_k^*$. Introducing in (19), it follows that $\gamma^*[\frac{h_k^*}{y_k^*} - \theta] = \tau - g - r^*\theta - \frac{h_k^*}{y_k^*}\delta_h$. From (15) and (16), we obtain $\frac{h_k^*}{y_k^*} = \frac{1}{A}\left(\frac{r^*+\delta_k}{A\alpha(1-\tau)}\right)^{(1-\chi)/\chi} - \theta$. For Eq. (23) to be well defined, we assume $r^* > \underline{r} := A\alpha(1-\tau)(A\theta)^{\chi/(1-\chi)} - \delta_k$.

[17]Figure 2 is built for $\phi = 1$, consistent with our baseline calibration (see the next subsection).

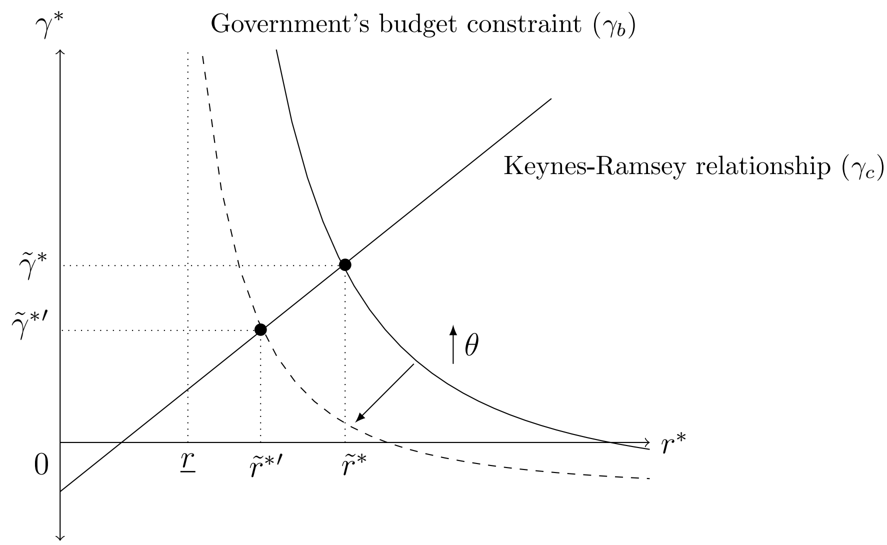


Figure 3: Steady state

Our simulations emphasize that this steady state exhibits saddle-path stability, thereby ensuring both the local and global determinacy of the model. The following comparative statics result is derived.

Proposition 2. *In the steady state, the debt ratio (θ) negatively impacts the public investment ratio and the total factor productivity (TFP) growth rate.*

Proof: See Appendix B.

In the long run, as discussed above, the transversality condition induces a crowding-out effect: an increase in the debt ratio reduces the public investment ratio. Since public investment generates positive externalities on TFP by the stock of knowledge, a higher debt ratio ultimately leads to a slower TFP growth rate. Graphically, a higher debt ratio (θ increases) shifts downward the government-budget-constraint curve (γ_b), while the Keynes-Ramsey relationship line remains unchanged. This is because raising the debt target tightens the government's budget constraint, which further constrains economic growth. As a result, the steady-state growth rate declines from $\tilde{\gamma}^*$ to $\tilde{\gamma}^{*\prime}$, and the marginal return on capital—that is, the real interest rate—falls from $\tilde{r}^*$ to $\tilde{r}^{*\prime}$.

This finding is of particular interest in light of the observed long-term productivity slowdown in developed economies (Jones, 2007). A number of empirical studies suggested public debt may reduce economic growth through the TFP channel (Pattillo et al., 2011; Salotti and Trecroci, 2016), but without specifying the underlying transmission mechanism. Our model bridges this gap by demonstrating that a high debt ratio reduces the stock of public capital and curtails knowledge accumulation, thereby undermining TFP growth.

4.1. Calibration

Our simulations are conducted using parameter values grounded in plausible empirical estimates (see Table 3). We adopt a standard discount rate of $\beta = 0.02$, consistent with long-run historical data on the risk-free real interest rate. The consumption elasticity of substitution (inverse of the risk aversion coefficient) is set at $\phi = 1$ as a benchmark value.

In terms of technology, the parameter $A = 0.55$ is chosen to yield realistic economic growth rates, while the capital share in output is calibrated to $\alpha = 0.275$, as in Gomme et al. (2011), p. 272. The parameter $\varepsilon = 0.2$ is selected to obtain an elasticity of output to public spending ($\chi = (1 - \alpha)\varepsilon = 0.145$) that aligns with recent empirical findings (see footnote 10). The depreciation rates for private and public capital are both set at $\delta_k = \delta_h = 0.05$, consistent with average depreciation rates reported by Gomme and Rupert (2007).

On the fiscal policy side, the model is calibrated using long-run average data from the US. The debt-to-GDP target is fixed at its long-run average value $\theta = 0.572$ (over the 1950-2019 period, source: BEA), and the tax rate on output $\tau = 0.24$ reflects the average income tax rate in the US (as reported by the OECD *Taxing Wages*). Using BEA data, the average ratio of government consumption expenditure is $g = 0.14$ over the period 1946-2019. Finally, we examine various values for the speed of adjustment, with a benchmark calibration at $\mu = 0.05$ (μ does not affect the deterministic steady state).

PARAMETERS

β	0.02	Discount rate
ϕ	1	Intertemporal elasticity of substitution
A	0.55	Scale parameter
α	0.275	Capital share in the production function
ε	0.2	Elasticity of knowledge to public spending
δ_k	0.05	Private capital depreciation rate
δ_h	0.05	Public capital depreciation rate
τ	0.24	Income tax rate
θ	0.572	Long-run debt-to-GDP ratio target
g	0.14	Public consumption-to-GDP ratio
μ	0.05	Speed of adjustment of the debt ratio

TARGET VALUES

	Model	Data	Source
Long-run economic growth	0.034	0.033	BEA, 1950-2019
After-tax return of capital	0.054	0.051	Gomme et al. (2011)
Public debt to GDP	0.572	0.572	BEA, 1950-2019
Public investment to GDP	0.088	0.088	BEA, 1946-2019
TFP Growth rate (in %)	0.49	0.5	Penn World Table 2021, 1980-2019

Table 3: Baseline Calibration

The baseline calibration yields results that closely align with postwar US annual data. The BGP is characterized by a 3.4% long-run rate of economic growth (3.3% in the data). Our calibration also replicates key values: the after-tax rate of return on capital is 5.4%, close to the 5.1% average from 1954-2008 (Gomme et al., 2011); the public investment-to-GDP ratio is 8.8%, matching the data; and the average TFP growth rate is 4.9%, nearly identical to the 5% average from 1980-2019.

5. Debt versus TFP: The pro-cyclical shock-amplification mechanism

Beyond the deterministic steady state—where public debt exerts a negative influence on TFP growth—our model also allows for an exploration of the debt-TFP relationship over the business cycle, as reflected in our econometric findings. This section focuses on analyzing the propagation of transitory stochastic shocks.

Figure 4 depicts the impulse response functions (IRFs) to a negative technology shock ($\nu_t < 0$). The stochastic process (4) is characterized by an autoregressive coefficient of $\psi = 0.95$ and a standard deviation of $\sigma = 0.07$. The adverse shock causes an immediate recession, resulting in a jump of the debt-to-GDP ratio. For public debt to adjust to its long-run target, fiscal surpluses need to increase. This amplifies the recession. During the adjustment, the net debt burden increases,[18] which impairs public investment and growth. This mechanism is more pronounced as the speed of public debt adjustment (μ) increases (compare $\mu = 0.1$ with $\mu = 0.5$ in Figure 4). A rapid adjustment of public debt, as seen in "cold turkey" strategies, is likely to generate significant instability in the public capital ratio.

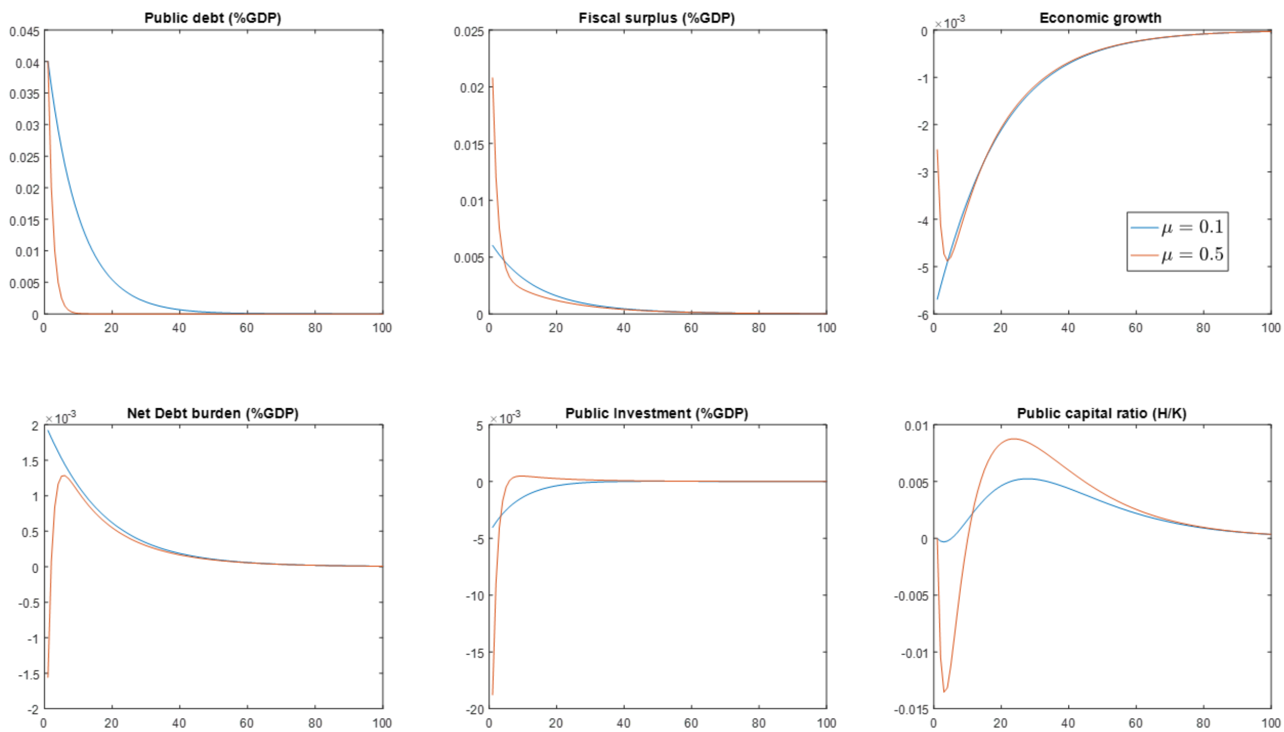


Figure 4: Adjustment to a negative technology shock (deviation from the steady-state, in %)

Figure 5 illustrates the core mechanism driving this amplification mechanism what we term the *public-debt accelerator*. Following a temporary negative shock, both TFP and output decline, causing the debt-to-GDP ratio—and thus the debt burden—to rise. In response, the government tightens the primary deficit by cutting public investment to keep the debt ratio aligned with the fiscal rules target. This reduction in public investment diminishes the stock of public capital, which in turn amplifies the downturn, further deepening the recession.

[18]The net debt burden is defined as $(r_t - \gamma_t)B_t$, and reflects the effective debt burden in public finance.

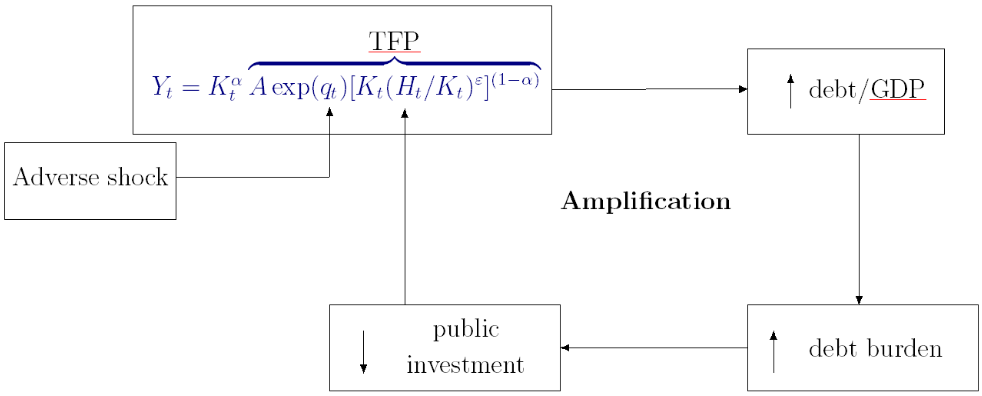


Figure 5: The propagation and amplification mechanism—*the public-debt accelerator*

This amplification mechanism allows for the reproduction of persistent fluctuations without requiring exogenous technological shocks to be highly autocorrelated. Figure 6 illustrates this feature by considering (very) low autoregressive coefficients, specifically $\psi = 0.1$ (top line) and $\psi = 0.3$ (bottom line). Although the technological shock fades rapidly, the gradual adjustment of public debt is sufficient to induce a fairly persistent dynamic, with persistence being more pronounced when the speed of adjustment is lower.

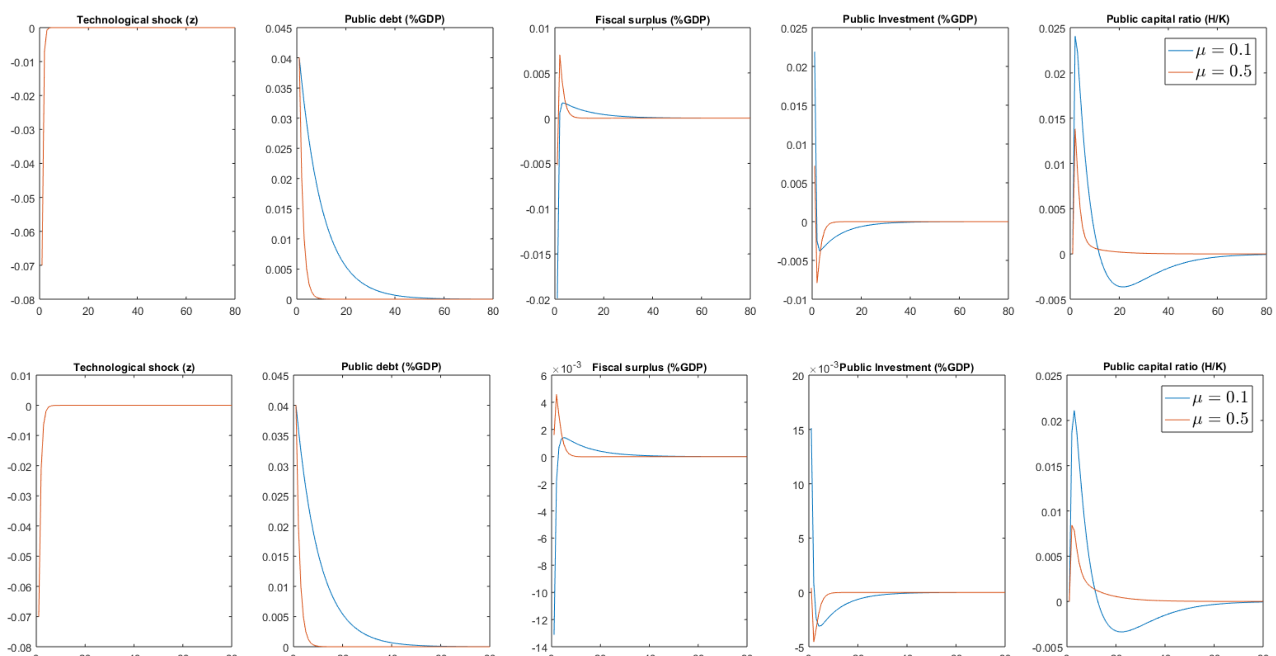
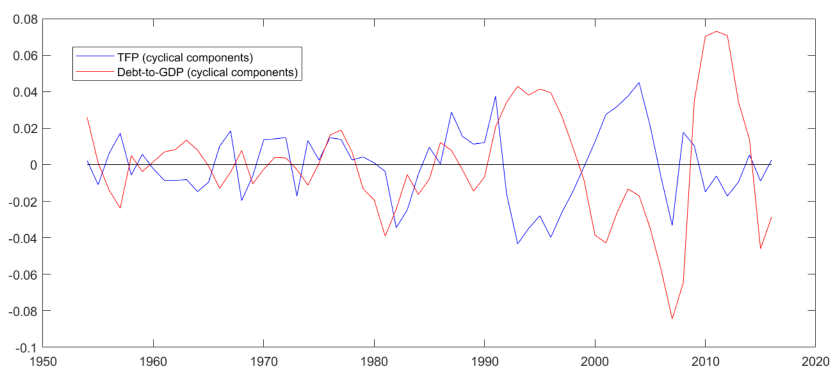


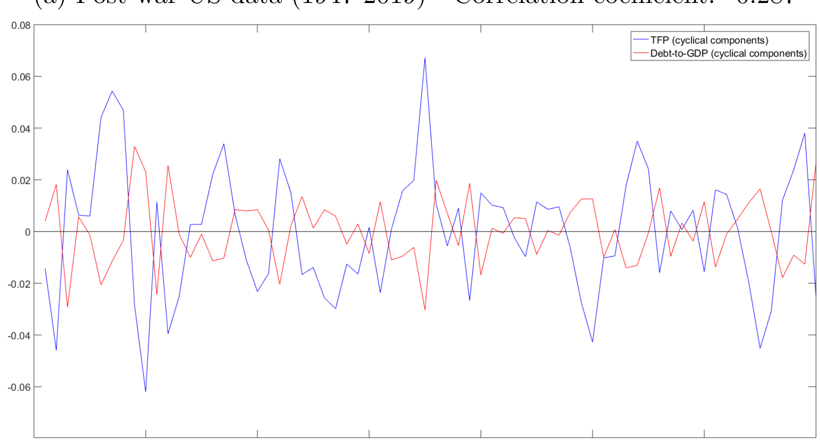
Figure 6: Adjustment to a negative technology shock (deviation from the steady-state, in %) with an autoregressive coefficient of $\psi = 0.1$ (top line) and $\psi = 0.3$ (bottom line).

In our model, the core transmission channel operates through endogenous TFP. The initial negative shock affects TFP both directly and indirectly, via the positive externalities associated with public capital. As a result, even shocks with low persistence can generate large fluctuations in both TFP and output. Furthermore, the model allows for a negative correlation between public debt and TFP, suggesting that real-side channels play a substantial role in shaping productivity dynamics

To illustrate the importance of the TFP-debt relationship over the business cycles, Figure 7 presents results replicating key features of the postwar U.S. economy. The top chart shows the HP-filtered cyclical components of the annual public debt-to-GDP ratio and TFP in the U.S. over the postwar period (1947–2019). The bottom chart reports the HP-filtered cyclical components from simulated series generated by our model. The data reveal the oscillatory nature of TFP dynamics and a negative correlation between the cyclical components of TFP and the debt ratio—specifically, a correlation of -0.287 for the U.S. data and -0.27 in our U.S.-calibrated simulation.



(a) Post-war US data (1947-2019) - Correlation coefficient: -0.287



(b) The model ($\psi = 0.5$) - Correlation coefficient: -0.27

Figure 7: Correlations between debt-to-GDP and TFP (cyclical components)
Note. We apply a HP filter with a smoothing parameter $\lambda = 6.25$ to extract the cyclical components of both TFP and the debt-to-GDP ratio.

This negative correlation is also observed across nearly all developed countries. For example, among other G7 members (see Figure 8), using our reference dataset for the period 1980-2019, the cyclical movements of the debt-to-GDP ratio and TFP display negative correlations ranging from -0.574 for France to -0.097 for the United Kingdom. By varying the persistence parameter of the shocks (ψ), our model is able to replicate this stylized fact even under very low persistence of technology shocks.

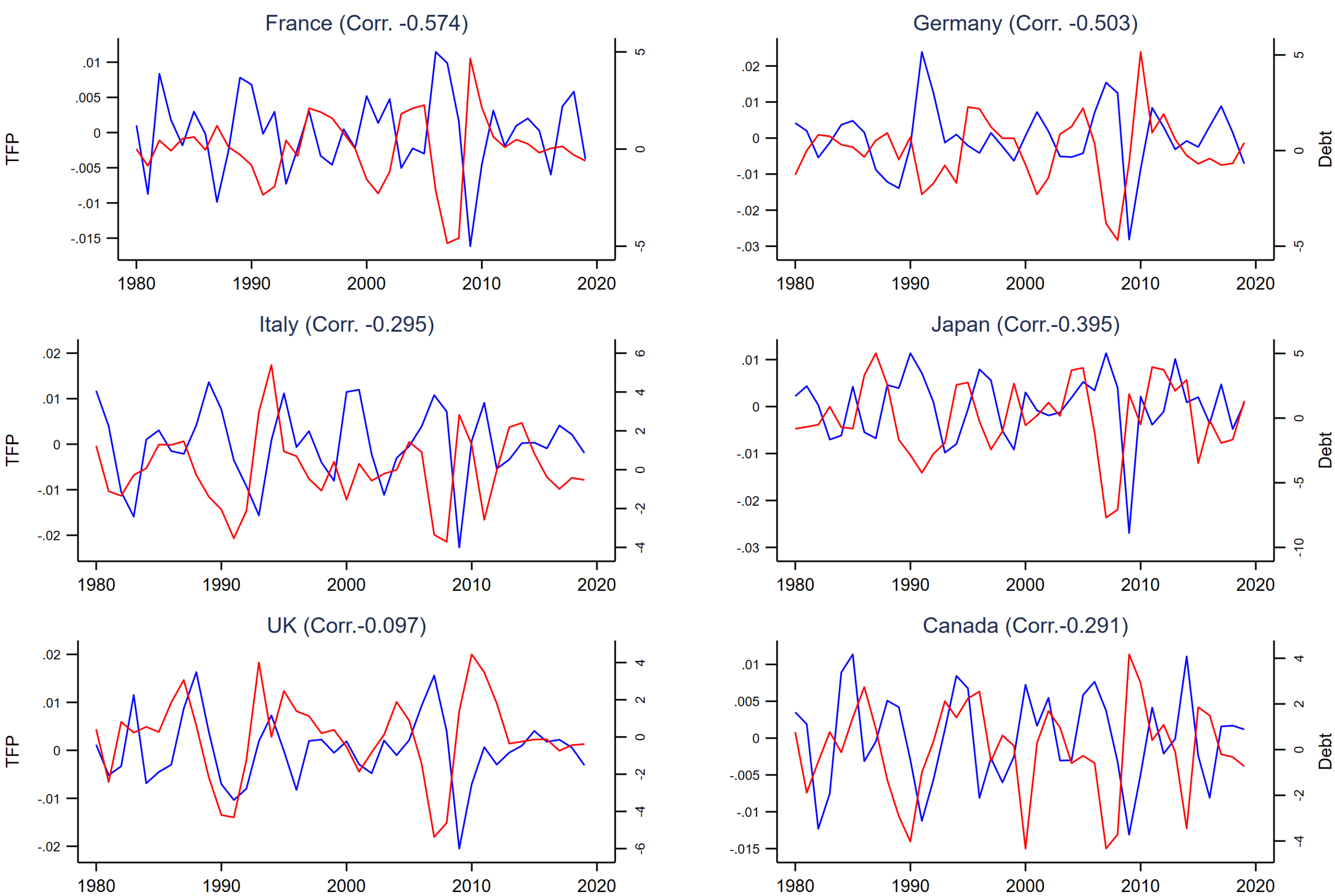


Figure 8: Correlations between debt-to-GDP and TFP (cyclical components)
Note. The red curves depicts the cyclical components of the debt-to-GDP ratio and the blue curves the cyclical components of the TFP.We apply a HP filter with a smoothing parameter $\lambda = 6.25$.

Methodologically, our model offers a theoretical framework that accounts for the observed negative correlation between the debt-to-GDP ratio and TFP across the business cycle in developed economies, particularly in recent decades. This negative correlation emerges from two interconnected channels tied to endogenous TFP dynamics: first, a negative shock lowers output and fiscal revenues, driving up the debt-to-GDP ratio; second, under the fiscal rule, a higher debt ratio compels the government to cut public investment, further reducing output and productivity.

This theoretical mechanism sheds light on two critical empirical findings: (i) the impact of public debt on output growth operates primarily through its effects on TFP, rather than on private capital accumulation (Pattillo et al., 2011); and (ii) TFP has been substantially shaped by non-technological forces, notably fiscal policy choices (Shea, 1998). In our framework, such contamination occurs even within a perfect competitive model. These insights suggest that conventional measures of TFP should be recalibrated to account for fiscal shocks—particularly fluctuations in public debt—to better capture the true drivers of productivity dynamics.

6. Concluding remarks

This study investigates the relationship between public debt accumulation and the persistent slowdown in total factor productivity (TFP) observed in advanced economies over recent decades. Drawing on a panel of 25 OECD countries spanning 1980 to 2019, we provide evidence that rising public debt significantly and persistently depresses productivity. This negative association—manifest in both short- and long-run dynamics—suggests the presence of a structural mechanism that propagates fiscal shocks into long-term economic stagnation.

Empirically, we estimate an error-correction ARDL model and confirm our results through a system GMM approach to address endogeneity. The findings indicate that a 10-percentage-point increase in the debt-to-GDP ratio is associated with a 1% reduction in TFP, ceteris paribus. Importantly, we document evidence of hysteresis: using local projection methods, we show that temporary increases in debt levels yield persistent productivity losses, with effects enduring for at least a decade. This persistence highlights the structural nature of the debt-productivity nexus and the inadequacy of cyclical explanations alone.

To account for these findings, we develop a stochastic endogenous growth model in which TFP evolves through both technological innovation and a non-technological component—namely, a knowledge stock supported by public investment. The government operates under a fiscal rule requiring long-run debt stabilization, modeled as a cap on the debt-to-GDP ratio. In this framework, debt accumulation constrains fiscal space, prompting reductions in productivity-enhancing public investment. This dynamic initiates a self-reinforcing feedback loop—termed the *public-debt accelerator*—where rising debt leads to declining productivity, which further deteriorates public finances, necessitating additional fiscal contraction.

Our model delivers three key theoretical results. First, in the deterministic steady state, public debt reduces long-run productivity growth due to the crowding-out of public investment. Second, transitory shocks—particularly negative technological disturbances—can have permanent effects via fiscal adjustment responses, giving rise to hysteresis. Third, calibrating the model to U.S. data, we replicate the negative cyclical correlation between TFP and public debt observed across most OECD countries.

The results carry important policy implications. Fiscal frameworks emphasizing rapid debt consolidation may impose significant long-term costs on productivity and potential output. Specifically, procyclical fiscal adjustments—driven by rigid fiscal rules—can entrench productivity slowdowns by reducing growth-enhancing expenditures precisely during downturns. Thus, fiscal policy design must carefully balance sustainability objectives with the preservation of productive capacity.

Future research could extend the model to incorporate political economy considerations, private sector responses, and nominal rigidities to better capture the interaction between fiscal policy, monetary dynamics, and long-run growth. Overall, this paper underscores the necessity of re-evaluating the macroeconomic role of public debt, not only as a financial burden but as a key determinant of long-term productivity and economic potential.

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Appendix A. Empirical analysis

Table A.4: Variables' Definitions and Sources

Variables	Description	Source
TFP	Total factor productivity index	Penn World Table (2021) Feenstra et al. (2015)
Debt	Gross government debt (% of GDP)	Historical Public Debt Database IMF
Trade openness	Trade (% of GDP)	World Bank
R&D expenditure	R&D expenditure (% of GDP)	OECD
Education	School enrollment, primary (% gross)	World Bank
Governance quality	Index that captures the quality of the bureaucracy, the strength of the legal system and assesses the corruption within the political system	International Country Risk Guide
Labor force participation	Labor force participation, total (% of total population ages 15+)	OECD

Table A.5: Summary Statistics

Variables	Mean	Std. Dev.	Min	Max	p25	Median	p75
TFP	0.918	0.106	0.537	1.149	0.856	0.946	0.992
Debt	60.257	36.441	3.765	236.378	37.274	55.928	76.538
Trade openness	90.365	54.737	15.723	382.348	55.327	74.624	112.465
R&D expenditure	1.859	0.785	0.447	4.364	1.225	1.777	2.423
Education	101.29	3.652	79.99	123.755	99.352	100.694	103.007
Gov. quality	0.854	0.132	0.472	1	0.75	0.889	0.958
Labor force part.	62.109	7.42	38.083	82.39	57.923	61.535	65.902

Table A.6: Panel unit root test

Variables	Level	First difference
TFP	0.034	-9.332***
Debt	1.056	-5.707***
Trade openness	-2.364***	-10.098***
R&D expenditure	1.776	-5.696***
Education	-1.454*	-10.117***
Governance quality	-7.941***	-12.143***
Labor force participation	-0.064	-9.502***

Note. *, ** and *** denote significance at 10%, 5% and 1% levels. The null hypothesis is the presence of unit root.

Appendix B. Mathematical proofs.

Proof of Proposition 1. The equilibrium interest rate is given by the implicit relation $\Psi(r^*) = 0$, where

$$\Psi(r^*) = \gamma_c(r^*) - \gamma_b(r^*), \tag{B.1}$$

with, using Eqs. (22)-(23),

$$\gamma_c(r^*) := \left(\frac{1+r^*}{1+\beta}\right)^{\phi} - 1, \tag{B.2}$$

$$\gamma_b(r^*) := \frac{\tau - g - r^*\theta - \frac{1}{A}\left(\frac{r^*+\delta_k}{A\alpha(1-\tau)}\right)^{(1-\chi)/\chi}\delta_h}{\frac{1}{A}\left(\frac{r^*+\delta_k}{A\alpha(1-\tau)}\right)^{(1-\chi)/\chi} - \theta}. \tag{B.3}$$

It is clear that $\gamma_c \in C^2(\mathbb{R}^+)$ and $\gamma_b \in C^2((\underline{r}, +\infty))$, where $\underline{r} := A\alpha(1-\tau)(A\theta)^{\chi/(1-\chi)} - \delta_k$. In our baseline calibration (see Table 3), we compute $\underline{r} = 0.0445$.

First, since $\gamma_c' > 0$ and $\gamma_b' < 0$, it follows that $\Psi' > 0$ (see Figure 3 for an illustration).

Second, since $\gamma_b(\underline{r}) = +\infty$ and $\gamma_c(\underline{r}) < +\infty$, we have $\Psi(\underline{r}) = -\infty$. Additionally, note that $\gamma_b(+\infty) = -\delta_h$, because $\chi < 1/2$ (in our baseline calibration, we consider $\chi = (1-\alpha)\varepsilon = 0.725 \times 0.2 = 0.145 < 0.5$).

Third, let $\hat{r} \in (\underline{r}, +\infty)$ be the value of the interest rate such that $\gamma_b(\hat{r}) = 0$. Hence, $\gamma_b(r^*) > 0$ if $r^* < \hat{r}$, and $\gamma_b(r^*) < 0$ if $r^* > \hat{r}$. In our baseline calibration, we have $\hat{r} = 0.0588$.

Consequently, if $\gamma_c(\hat{r}) > 0 \Rightarrow \Psi'(\hat{r}) > 0$, according to the Intermediate Value Theorem, there is a unique value $\tilde{r}^* \in (\underline{r}, \hat{r})$, such that $\Psi(\tilde{r}^*) = 0$. This value defines the equilibrium level of the real interest rate. The associated level of economic growth is $\tilde{\gamma}^* = (1+\tilde{r}^*)/(1+\beta) - 1 > 0$.

For example, if the consumption elasticity of substitution (ϕ) is equal to 1, as considered in our calibration exercise, the condition $\gamma_c(\hat{r}) > 0$ writes $\hat{r} > \beta$. Since $\hat{r}$ does not depend on β, and since the subjective discount rate (β) is small enough, such a condition is easily satisfied. Using our calibration, we find $\tilde{r}^* = 0.054$ and $\tilde{\gamma}^* = 0.034$. In addition, we numerically confirmed the existence of the steady state for different values of ϕ.

Proof of Proposition 2. From (B.1), we compute

$$\frac{\partial \Psi(r^*)}{\partial \theta} = -\frac{\partial \gamma_b(r^*)}{\partial \theta} = -\frac{-r^* f(r^*) + \tau - g - f(r^*)\delta_h}{[f(r^*) - \theta]^2},$$

where $f(r^*) = \frac{1}{A}\left(\frac{r^*+\delta_k}{A\alpha(1-\tau)}\right)^{(1-\chi)/\chi}$. After some simple algebra, we obtain

$$\frac{\partial \Psi(r^*)}{\partial \theta} = -\frac{\gamma_b(r^*) - r^*}{f(r^*) - \theta}.$$

In equilibrium ($r^* = \tilde{r}^*$ and $\gamma^* = \tilde{\gamma}^*$), the transversality condition ensures that $\tilde{\gamma}^* = \gamma_b(\tilde{r}^*) < \tilde{r}^*$; hence,

$$\left.\frac{\partial \Psi(r^*)}{\partial \theta}\right|_{r^*=\tilde{r}^*} > 0.$$

Consequently, since $\Psi' > 0$, according to the Implicit Function Theorem we conclude that $\partial\tilde{r}^*/\partial\theta < 0$ and $\partial\tilde{\gamma}^*/\partial\theta < 0$.

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