An SFC model of public investment and debt dynamics

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Abstract

I develop a stock-flow consistent model that incorporates public sector into economy and offers a novel framework to evaluate long-term economic consequences of government budgetary decisions. In this model, both government consumption and investment enter the aggregate income, however, public investment adds up to the public capital stock. The productivity of the private capital depends on the public capital stock due to congestion effects. The composition of the public spending, however, depends on the fiscal rules. I simulate a balanced budget fiscal rule scenario and a scenario with a "golden rule of public investment". The investment-friendly fiscal rule requires higher deficits, but it induces a higher growth rate, a higher capacity utilization, and eventually, a lower debt-to-output ratio, than the balanced budget rule. Thus, the deficit aversion does not result in a lower debt ratio. The model could also be extended to analyse non-linear dynamics of public finance, by endogenizing interest rates, introducing carbon emissions, and more.

Keywords: Fiscal rules, Public investment, Sovereign debt

JEL Codes: E6, H54, H6

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1 Introduction

There is a well-grounded case for risky innovation projects, research and development as well as investment-intensive infrastructure to be financed by the state (Mazzucato & Semieniuk, 2017). A readily available example is an enormous investment requirement of the looming socio-ecological transformation. The estimates of the necessary additional green investment to achieve the 2030 climate and energy targets in Europe range from 260 billion Euro per year (European Commission, 2020) and up to 855 billion Euro annually (Wildauer, Leitch, & Kapeller, 2020). A notable portion of this sum falls onto the public sector. However, the capacity of the state to provide public investment has often been limited by financial constraints in the recent decades. First, the leeway of the state to finance investment has diminished due to the possibility of adverse "markets' reactions". Indeed, interest rates on government bonds can be subject to negative market sentiments disconnected from the underlying economic indicators (De Grauwe & Ji, 2013). Also, institutions, such as fiscal rules, have been increasingly implemented in most developed countries to restrict the government's autonomy in decisions of public finance.

In this way, a modern state is increasingly being charged with facilitating the structural change which requires a massive public investment, while being confronted with uncertainty on the financing side resulting from restrictions on public spending. It remains unclear if there will be sufficient room for government-financed projects under the political constraints on public spending and debt during the next decades. However, can a restrictive fiscal policy achieve its goal of bringing down the debt-to-GDP ratio in the long run, if public investment is crucial to enable economic stability and growth? To shed some light on this matter, this paper examines the dynamics of public investment and sovereign debt under two different fiscal rules scenarios with the help of a stock-flow consistent (SFC) macroeconomic model which allows to model complex interactions between sectors of the economy and integrate the real and financial sides of all economic activity (Godley & Lavoie, 2012; Nikiforos & Zezza, 2017).

I employ a simple SFC model à la Dafermos and Nikolaidi (2019) with private households, firms, and the government. The novelty of this paper is to explicitly introduce public investment into the SFC framework to analyse the dynamics of public investment and debt under spending constraints. Importantly, I make use of the assumption that public capital stock, such as mass transport, water and electricity infrastructure, streets, airports, but also educational and health care facilities, is a crucial factor determining productivity of an economy (Aschauer, 1989a). A weak provision of public capital results in a lower productivity of the private capital stock due to congestion effects. Therefore, on the one hand, public investment can induce growth of potential output and lead to a reduction of the debt burden in the future. On the other hand, debt-financing also piles up the outstanding liabilities in the short term and is thus subject to regulations regarding government budget and debt. This can translate into suboptimal public finance decisions and undermine public investment and long-term growth.

The public investment decision is accounted for in a set of fiscal rules. The first fiscal policy scenario is designed as a "Maastricht-like" fiscal rule where the government aims at achieving a balanced budget. Since government consumption is difficult to cut down in the short run due to fixed obligations, public investment must adjust to accommodate the spending ceiling in case of a shock. The second scenario implements a so-called "golden rule of public investment". In this way, government investment is growing at a given rate, whereas deficit spending must increase to accommodate it.

The modelled economy extended by the fiscal authority is then calibrated to the Euro area. Dynamic adjustments of the model are computed to investigate the development of the fiscal policy composition and the resulting path of the output growth and the debt accumulation, under various fiscal scenarios. The hypothesis is tested that foregone public investment (due to the spending ceiling in the first fiscal policy scenario) hinders growth and undermines fiscal stability in the long run. Indeed, insufficient provision of public capital is a detriment for the productivity of the economy. It results in lower investment activity of the private sector. All in all, I find that growth is lower and the debt-to-GDP ratio is higher in the scenario of the balanced budget rule than in the scenario of the investment-friendly fiscal rule.

The remainder of this paper is structured as follows. Section 2 offers a comprehensive review of the economic literature on productive public investment. Section 3 describes the model. Section 4 presents the baseline results of the simulations as well as the sensitivity tests and discusses useful extensions of the model to be pursued in the future. Section 5 concludes.

2 Literature review

Seminal research on the productivity of public investment was contributed by Aschauer (1989a, 1989b) who estimated the productivity of public capital and the macroeconomic effects of public investment empirically. He finds a very high elasticity of output to public capital of 0.39 (Aschauer, 1989a) and argues that the decline in the US productivity at that time was associated with a reduced government investment activity; he also presents empirical evidence that the net effect of public investment on private investment is positive since an increase in private sector earnings outweigh a possible crowding-out effect (Aschauer, 1989b). Munnell (1990) extended his work further and also estimated the elasticity of output to public capital in the range between 0.3 and 0.39. In line with their research, Fernald (1999) shows that productivity of automobile-intensive industries in the US depends positively on road-building. Furthermore, see Gramlich (1994) for a survey of early literature on productivity of US infrastructure.

Expanding on econometric tool kit, Pereira and Flores de Frutos (1999) use a vector-autoregressive approach to show empirically that public investment is productive and also find a large long-run elasticity of output to public capital. In addition, Pereira (2000) extends their analysis to the effects of public investment on private output and employment. He finds a large long-run multiplier of public investment of 4.5 and presents evidence that all categories of public investment crowd in on private investment. Moreover, Easterly and Rebelo (1993) confirm the finding that infrastructure is important for growth with data on developing countries. Calderón, Moral-Benito, and Servén (2015) use a multi-dimensional concept of infrastructure and show that public capital is productive with a large international dataset, while addressing non-stationarity, reverse causality and country-heterogeneity. Finally, Deleidi, Mazzucato, and

Semieniuk (2020) present panel data evidence that public direct investment mobilizes private investment in the energy sector.

Bom and Ligthart (2014) performed a meta-regression analysis of empirical literature on the productivity of public capital. They estimate that the elasticity of output to public capital amounts to approximately 0.08 in the short run and 0.12 in the long run. Moreover, the elasticity of the core infrastructure on the local level is twice as high. Also, see Ramey (2020) for an extensive review of the empirical and theoretical research on the productivity of public investment.

Coming to the theoretical literature, an early attempt to incorporate public capital into a neoclassical macroeconomic model was made by Arrow and Kurz (1970) who formulated an optimal public investment policy as an optimization over time while keeping the private saving rate constant. In the realm of perfect foresight, the initial debt level is important since it determines the level of interest payments and, thus, how much can be spent on investment. Notably, if the initial level of debt is low enough, financing public debt with borrowing is optimal to avoid double taxation of savings (Arrow & Kurz, 1970). Baxter and King (1993) investigated public spending effects on the output in a neoclassical real business cycle model. Concerning the long-run effect, they suggest that, if the labour is fixed, the direct expenditure effect of public investment is larger than the supply side effect. However, if the labour is variable, the multiplier associated with expanding the private productive capacity is higher than the immediate spending effect. The productivity parameter of public capital in their Cobb-Douglas production function determines the long-run effects on output.

Barro (1990) and Barro and Sala-i Martin (1990) analysed public spending in the context of neoclassical endogenous growth models. They find that, if social returns on investment exceed private returns, tax-financed productive public spending policy may be optimal, whereas different types of financing (lump sum tax or income tax) is optimal for different types of public goods. Futagami, Morita, and Shibata (1993) develop a model on the notion that the capital stock, such as the available infrastructure and the level of public education, is more relevant for the productivity of the economy than the current expenditure. They conclude that the tax rate to maximize welfare in this model is lower than the tax rate that achieves the highest growth. Fisher and Turnovsky (1998) analyse the role of congestion of public capital in private capital formation. In the absence of congestion, public infrastructure only leads to higher private accumulation rate if they are complements. By modelling congestion, they show how public and private capital can have a degree of substitutability and still, an increase in public capital stock induces an expansion of private capital, at least in the long run.

Greiner and Semmler (2000) also develop a growth model with a productive capital stock and test several budgetary regimes, where various public spending categories can be either financed with tax revenues or with borrowing. They demonstrate that debt-financed public investment can increase the growth rate, as long as the ratio of debt to private capital is stable. However, there is a threshold of the government borrowing after which the positive effect on growth is offset by the detrimental effect of the higher interest payments. In the same tradition, Ghosh and Mourmouras (2004) argue that optimal public investment policy depends on the chosen budgetary stance. Yakita (2008) employs an overlapping generations model to show that the initial stock of public debt matters for the borrowing to finance public investment to be sustainable. In addition, Kamiguchi and Tamai (2019) find that longer life-expectancy increases both the equilibrium tax rate and equilibrium debt-to-GDP ratio.

Futagami, Iwaisako, and Ohdoi (2008) expand this literature strand further and explore the possibility of multiple equilibria in endogenous growth models with productive public spending. They find that a high growth steady state is associated with a higher social welfare. Different financing instruments are optimal in the high and low equilibria in their modelling framework. Also Groneck (2010) analyses the government expenditure composition under different fiscal rules. He finds that a golden rule of public investment maximizes welfare in the long run, compared to the balanced budget or fixed deficit regimes. On the opposite, Minea and Villieu (2009) find that raising debt for public investment will lead to a lower balanced-growth path since, in their model, the return on public investment is lower than the costs of additional borrowing. Similarly, Teles and Mussolini (2014) find in their theoretical model that debt-to-GDP ratio has a negative impact on growth whereas their empirical evidence is mixed.

Agénor (2008) and Gupta and Barman (2010) extend the endogenous growth literature by introducing a variety of productive public spending categories, such as infrastructure and health, as well as environmental pollution into the model. This allows to show that increasing spending on infrastructure can actually lower the growth rate if it distracts resources from the health expenditure (Agénor, 2008) and that the emission-output coefficient determines the optimal public infrastructure expenditure and the balanced-growth path (Gupta & Barman, 2010).

To mention neoclassical models with a time-to-build delay, Leeper, Walker, and Yang (2010) show that government investment can be neutral or contractionary in the short run, albeit they obtain a positive long-run multiplier which size depends on the productivity parameter of public capital. Bouakez, Guillard, and Roulleau-Pasdeloup (2017), however, find a public investment multiplier which is substantially larger in a situation of a liquidity trap. Gallen and Winston (2021) argue that, due to infrastructure transition costs, i.e. construction delays, a large increase in GDP via infrastructure spending may not necessarily result in large welfare gains.

Taking account of Post-Keynesian literature, it is important to note that government expenditure generally plays a crucial role for growth in this paradigm. The reason is that aggregate demand is central to growth in Post-Keynesian, or Kaleckian, models. See Allain (2015) for an overview of the strand of literature and for his neo-Kaleckian growth model with autonomous demand components and private investment subject to Harrodian instability (Harrod, 1939). In his model, the long-term growth rate of the economy converges to the exogenous growth rate of autonomous public spending. In addition, autonomous government spending, under certain conditions, is able to stabilize the growth expectations of firms, thus solving the Harrodian knife-edge problem.

Moving further to discuss Post-Keynesian contributions with productive government expenditure, Dutt (2013) develops a model with government spending on consumption and investment. His model shows several mechanisms how government investment spending can increase growth. Besides a general positive effect on aggregate demand, public investment also crowds in private investment and promotes technological change, thus raising the natural rate of growth. In this framework, the debt-to-output ratio can be stable even if one allows for labour shortage problems and a financial crowding-out effect. Parui (2021) extends Dutt (2013) by introducing the dependence of private investment on the profit rate, workers' savings and a differentiation between investment categories. He is able to show that, while both public consumption and investment enhance growth, an optimal composition of public spending is determined by the (wage-led or profit-led) demand regime and the effect of public investment on labour productivity. Similarly, in a neo-Kaleckian model with government investment in human capital (Lima, Carvalho, & Serra, 2021), demand regime determines the optimal tax rate and thus the optimal human capital accumulation rate.

Tavani and Zamparelli (2016) develop a Post-Keynesian model with two types of government expenditure: transfers and investment. They compare a fixed wage closure of the model, which allows for endogenous growth, and a fixed labour supply closure where growth is exogenously given. In the first case, the chosen tax rate does not only determine the wage and the profit share, but also the growth rate; whereas in the second scenario, the government sector can only influence income redistribution. Tavani and Zamparelli (2017a) extend this analysis with government debt. They find that public debt has no impact on the growth rate in their model; however, in order to sustain the equilibrium, the growth rate of the economy must exceed the interest rate on government bonds. Also, see their overview of heterodox growth models with and without public investment (Tavani & Zamparelli, 2017b).

Deleidi and Mazzucato (2019) make a strong case for public investment in a Sraffian Supermultiplier model. This model utilizes the notion of autonomous demand components and makes use of a private investment function dependent on the aggregate demand. Extending this framework by consumptive and "industrial policies" government spending, they are able to show that both types of public spending induce a crowding-in effect and result in a higher growth rate through the multiplier-accelerator mechanism. However, productive ("mission-oriented") government spending generates the largest effect on output, private investment and productivity growth. They test their model on the US time series data and, indeed, find a very large long-run multiplier of the "mission-oriented" public spending (Deleidi & Mazzucato, 2021).

Finally, the relevant SFC literature should be mentioned here. A large range of contributions considered active fiscal policy. To mention some, Dafermos (2018) employs a Godley–Minsky cyclical model with a government sector. He tests two types of fiscal rules and concludes that a strict Maastricht-like debt rule exacerbates the cyclical dynamics in the model, whereas a countercyclical fiscal rule stabilizes the output and, importantly, also the government debt-to-GDP ratio. The most relevant to my analysis is the contribution of Dafermos and Nikolaidi (2019) who analysed government role in socio-economic transition via direct public investment or subsidies for green investment. They provide an insight that more spending on green investment reduces government debt, because green investment stimulates growth and reduces the climate change damage in their framework.

In addition, Bibi (2023) stands out by developing an SFC model with productive public investment. Namely, public investment adds to the capital stock and thus enhances the productivity of the labour force, increasing potential output. The author tests various fiscal policy scenarios as a reaction to an exogenous fall in private investment and concludes that a balanced budget fiscal scenario fails to reduce the debt-to-GDP level. Instead, the proactive government scenario, where the fiscal policy mix is chosen to support the macro-economy, results in the smoother recovery path, a lower debt-to-output ratio, and less interclass inequality. Also, Kappes, Milan, and Morrone (2022) employ an SFC model to compare macroeconomic outcomes under a variety of fiscal rule scenarios. They show that an expenditure rule results in a higher inflation, less unemployment, lower firms' leverage, but a higher debt-to-output ratio, than a debt rule, independent of the target values.

3 Model

3.1 Stock-flow consistent model of public investment

I employ a simple SFC model along the lines of Dafermos and Nikolaidi (2019) with private households, firms, and the government. For simplicity, the model is cast in real terms so I restrain from modelling prices. My central innovation to the model is an explicit formulation of the production function (PF) that includes public capital. This allows us to model the demand-side and supply-side effects of public investment. Indeed, public investment enters the demand side of the economy as a government expenditure which creates more demand for investment goods, and therefore induces an increase in production and income. Although this channel can also have long-lasting repercussions through increased private investment, as in Deleidi and Mazzucato (2019), I regard it as temporary. Instead, I model a long-term supply side effect of government investment which takes place by building up public capital stock.

First of all, public capital is itself a productive input, next to the private capital. In addition, since public capital comprises major infrastructure, it determines the productivity of the private capital stock. In more detail, there is a need for adequate infrastructure, which is provided on the public level, i.e. roads, bridges, energy grid, water supply, public institutions, etc., for the economy to function efficiently and to avoid congestion. Therefore, for the same level of the private capital stock, it can be more productive if the provision of public capital is higher.

To model the supply side of the economy, I start from a Leontief PF of the form: $Y = min\{aN, vK\}$, where N denotes available workforce and K stands for capital stock. Per simplifying assumption, labour does not constitute a binding constraint on output in our model. Full employment is never reached and there is a reserve army that can supply more labour, so that $Y = vK$. Also, I assume that the public capital stock KG is a productive input next to the private capital stock Kpr. Taking this into account, I settle upon the following equation for the potential output:

$$Y_t^* = (v_t * Kpr_t)^{(1-\rho)} * KG_t^{\rho}. \tag{1}$$

The Cobb-Douglas PF is a suitable choice since a certain substitutability between private and public capital is empirically observed (for example, private vs. public schools). This PF specification also allows me to turn to the literature on productive public capital and make use of the available estimates of the elasticity parameter ρ[1].

Furthermore, I assume that the productivity coefficient of the private capital stock v_t is variable and depends on the supply of public capital. The intuition behind, as discussed above, is that better public infrastructure increases productivity of the private capital stock through decreased congestion. Thus, whenever public capital stock is non-existent, the productivity of the private capital is also nil. However, public capital stock cannot increase the productivity of private capital indefinitely. It can, at most, bring about the full productive potential of the private capital, so that even with an infinitely large public capital stock, the coefficient v is not meant to exceed 1.

Thus, I assume that $v = f(KG)$, where f is increasing in KG, but is concave and bounded between 0 and 1 for all values of KG:

$$v_t = \sqrt{\frac{KG_t}{KG_t + 1}}. \tag{2}$$

This simple function satisfies all necessary properties, it is continuously differentiable at each positive value of KG, with the first derivative being positive, and the second negative. Therefore, at low values, an increase in public capital stock results in a larger improvement of the productivity coefficient. At larger values, the productivity gains decrease; and at some level of public capital, they become infinitely small. Importantly, this specification of the production function is different from the neoclassical congestion literature where the relation of public services to output is the relevant variable determining congestion (Fisher & Turnovsky, 1998). In our case, the stock of public capital (different to the flow variable in the conventional literature) determines the productivity coefficient of private capital.

Moving further, the basic model assumes that the wage share ω is constant, so the wages are determined straightforward as a fraction of the aggregate output:

$$W_t = \omega * Y_t. \tag{3}$$

Firms can borrow to finance investment in addition to retained profits and pay a fixed interest rate on the outstanding loans:

$$L_t = L_{t-1} + I_t - RP_t. \tag{4}$$

Therefore, firms' profits TP equal to the profit share less interest rate expenses of the firms, where a fraction RP is retained to repay the loans, and the rest DP is distributed to the households:

$$TP_t = (1 - \omega) * Y_t - int_L * L_{t-1}, \tag{5}$$

$$RP_t = s_F * TP_t, \tag{6}$$

[1] I use the estimate of Bom and Ligthart (2014) of 0.12. Due to the specification of the PF and the assumption of constant returns to scale, the exponent of the private capital $1 - \rho$ is thus probably overestimated. For an overview of research on elasticities of output to public capital the see Ramey (2020).

$$DP_t = TP_t - RP_t. \tag{7}$$

Money is endogenous and there are no restrictions on the amount of credit to the firms as well as the government, so banking sector only performs the function of credit supply in my model and banks fully redistribute the profits they make by giving out loans and holding government bonds, after paying interest on deposits, to the households:

$$BP_t = int_L * L_{t-1} + int_B * B_{t-1} - int_D * D_{t-1}. \tag{8}$$

Firms decide how much to investment with the help of a Bhaduri-Marglin type of investment function extended by a simple rule to prevent unlimited expansion of credit taking:

$$I_t = (\alpha_1 * r_{t-1} + \alpha_2 * u_{t-1} + \alpha_3 * lev_{t-1}) * Kpr_{t-1}, \tag{9}$$

assuming $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 < 0$, whereas the profit rate r_t, the capacity utilization rate of private capital u_t and the leverage ratio lev_t are specified as:

$$r_t = TP_t / Kpr_t, \tag{10}$$

$$u_t = Z_t / Kpr_t, \tag{11}$$

$$lev_t = L_t / Kpr_t. \tag{12}$$

Please note that the firms only care for the capacity utilization of private capital, so that the definition disregards the public capital stock. In addition, private capital stock is subject to depreciation at rate δ_{Kpr}, so that it develops according to:

$$Kpr_t = (1 - \delta_{Kpr}) * Kpr_{t-1} + I_t, \tag{13}$$

and its' growth rate equals to:

$$g_{Kprt} = \frac{Kpr_t - Kpr_{t-1}}{Kpr_{t-1}}. \tag{14}$$

Coming to the households and the public finance, since the government taxes all income from wage, profits and capital gains at a fixed tax rate τ, disposable income of the household is:

$$Y_{Ht} = (W_t + DP_t + BP_t + int_D * D_{t-1}) * (1 - \tau), \tag{15}$$

while government tax revenue net of interest payments on outstanding bonds is determined by:

$$T_t = \tau * (W_t + DP_t + BP_t + int_D * D_{t-1}) - int_B * B_{t-1}. \tag{16}$$

Private consumption is a fraction of disposable income and deposits:

$$C_t = c_1 * Y_{Ht-1} + c_2 * D_{t-1}, \tag{17}$$

where deposits develop according to:

$$D_t = D_{t-1} - C_t + Y_{Ht}. \tag{18}$$

Government consumption is a fixed proportion of the expected tax revenue, which is the tax revenue of the previous period anticipated to increase by a fixed rate λ (to ensure that growth is non-negative):

$$CG_t = \gamma_{CG} * T_{t-1} * (1 + \lambda). \tag{19}$$

In addition, government investment is determined by:

$$IG_t = (1 - \gamma_{CG}) * T_{t-1} * (1 + \lambda) + \gamma_{IG} * KG_{t-1}, \tag{20}$$

where γ_{IG} is specified by a fiscal rule, and the total government expenditure is the sum of government consumption and investment:

$$G_t = CG_t + IG_t. \tag{21}$$

I run simulations with two alternative fiscal rules. The first one corresponds to a Maastricht-like rule where the government pursues a balanced budget, meaning $G_t = T_{t-1} * (1 + \lambda)$ and, correspondingly, $\gamma_{IG} = 0$. The second scenario is defined as an investment-friendly fiscal rule where public investment is determined by the exogenous public capital accumulation rate $\gamma_{IG} > 0$. Public capital stock is determined as:

$$KG_t = (1 - \delta_{KG}) * KG_{t-1} + IG_t, \tag{22}$$

where δ_{KG} is the depreciation rate of the public capital stock, the growth rate of the public capital stock equals to:

$$g_{KGt} = \frac{KG_t - KG_{t-1}}{KG_{t-1}}. \tag{23}$$

The stock of outstanding government bonds develops according to the following equation:

$$B_t = B_{t-1} + G_t - T_t, \tag{24}$$

with the debt-to-GDP ratio and the government deficit in terms of output defined as:

$$debt_t = B_t / Y_t, \tag{25}$$

$$deficit_t = (T_t - G_t) / Y_t. \tag{26}$$

Last but not least, the aggregate demand equals to the overall spending of the private and public sector in our economy:

$$Z_t = C_t + I_t + G_t. \tag{27}$$

Importantly, explicit modelling of the supply side of the economy poses a particular challenge for the stock-flow consistency of the model since the production and the aggregate spending are determined by different factors and do not always coincide. In most periods, demand does not exceed potential output or $Z_t \leq Y_t^*$ and, thus, the overall income equals to the aggregate spending in the economy:

$$Y_t = Z_t. \tag{28}$$

However, in some periods of the simulation, aggregate demand might exceed potential output $Z_t > Y_t^*$, since it is possible to create loans and issue government bonds endogenously, and spending is not limited to current income. In this case, the overall income equals to the maximum production in the economy:

$$Y_t = Y_t^*, \tag{29}$$

and the rest of the demand must be satisfied with foreign goods. I model this as an outgoing financial transaction towards foreign countries and a separation of consumption and investment goods into home and foreign with superscripts H and F, correspondingly[2]:

$$\Delta Foreign_t = Y_t - Z_t. \tag{30}$$

Last, but not least, the stock-flow consistency of the model implies that the financial flows add up in each given period, according to:

$$\Delta D_t = \Delta B_t + \Delta L_t + \Delta Foreign_t, \tag{31}$$

where $\Delta Foreign_t$ is per definition a negative value, and the bank accounts balance:

$$D_t = B_t + L_t + Foreign_t. \tag{32}$$

Tables 1 and 2 (in Appendix) represent the balance sheet and the transaction matrices of the modelled economy.

3.2 Calibration of parameters

Parameters of the model are calibrated to Euro area. Table 3 (in Appendix) lists the parameters and the initial values of the main variables. Initial variables are normalized to $Y_1 = 1$. This section will briefly describe the parametrization.

First, I use the main national accounts data from the Eurostat (2023a) to determine the propensity to consume out of disposable income. For the value of the propensity to consume out of deposits, I turn to the literature (Dafermos & Nikolaidi, 2019). I use a long-term value for the wage share (ECB, 2023a) and the most recent, increased interest rate values from the ECB database (ECB, 2023b, 2023e). I calibrated the saving rate out of profits, although being somewhat lower than the empirically observed, to the highest value that does not result in a negative leverage under the chosen set of parameters. This is necessary since the firms in my model only can retain profits to invest and pay off the loans, which is not the same in the real business practice.

As mentioned earlier, I opt for the median long-term value of ρ found in the meta-regression analysis (Bom & Ligthart, 2014). The values for the depreciation rate of the public and private capital are

[2] I restrain from explicitly modelling international trade and do not account for the effect of the net import episodes on the terms of trade. This could be explored in more sophisticated versions of the model. For now, net foreign financial flows serve merely to maintain the stock-flow consistent quality of the model.

estimates from an IMF study (IMF, 2015). The tax rate is calibrated to fit the data for the tax revenue in percent of output (Eurostat, 2023b). Parameter λ is calibrated to prevent constant negative growth due to the depreciation of capital. The set of the private investment function parameters α_1, α_2, α_3 to produce a plausible multiplier and growth rates in a reasonable range. However, I test other sets of *alphas* in the sensitivity analysis chapter. The parameter of the government consumption share is calculated to fit the initial values of public consumption and investment. Last but not least, the parameter of the fiscal rule, i.e. the public investment target parameter γ_{IG}, is determined by the fiscal rule scenario.

Coming to the initial values of the main variables, I use the data from the Eurostat (2023a) for the aggregate output and spending. Potential output is calculated from Equation (1) and is only marginally higher than the actual output, so that our economy is assumed to start from operating close to full capacity. Private investment is taken from the main national accounts (Eurostat, 2023a), and the private consumption is calculated as a residual component of the aggregate spending (next to private investment and government spending).

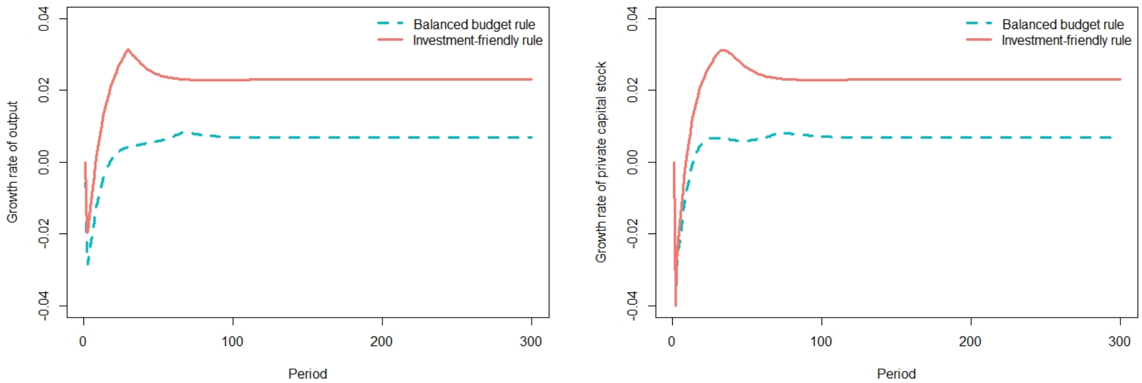
Furthermore, the values of public and private capital stock are taken from the IMF Capital Stock Dataset (IMF, 2021), and the productivity parameter of the overall capital stock is determined by the public capital stock as indicated earlier. The factor affecting the private investment, that is the profit rate, the capacity utilization rate of private capital, and the private leverage are calculated according to Equations (10), (11), and (12). Again, tax revenue is provided by the (Eurostat, 2023b). Government expenditure is assumed to be equal to the tax receipts, since I start from the balanced budget scenario in the first period of the simulation. Therefore, the initial value of the public deficit is, per assumption, equal to zero. Government consumption is calculated from the overall public spending according to Equation (19), and government investment is obtained by Equation (20). Lastly, I consult the ECB databases (ECB, 2023c, 2023d) to determine the value of outstanding loans and government securities as well as the current debt-to-GDP ratio. The value of the deposits in the first period is calculated as a residual from Equation (32), since the initial value for $Foreign_1$ is 0 per assumption.

4 Results

4.1 Baseline results

I begin with a simulation of the model, as described above, over 300 periods. This section presents the baseline simulation results of two fiscal rules scenarios, the Maastricht-like balanced budget rule, where $\gamma_{IG} = 0$, and an investment-friendly "golden" rule with $\gamma_{IG} = 0.02$. Later I proceed with discussing the sensitivity of the results to the parameters of the model.

Figure 1 displays the growth rates of output and of private capital stock under the two chosen fiscal rule scenarios. The yearly growth rates peak at 3.1% after 55 periods in the case of the investment-friendly fiscal rule and gradually converge to approximately 2.3% in the long run. However, growth remains much lower than that until the end of the simulation exercise in the case of balanced budget fiscal rule, only reaching a maximum of 0.7% and remaining there further on. This is the first central observation I make in the simulation exercise.



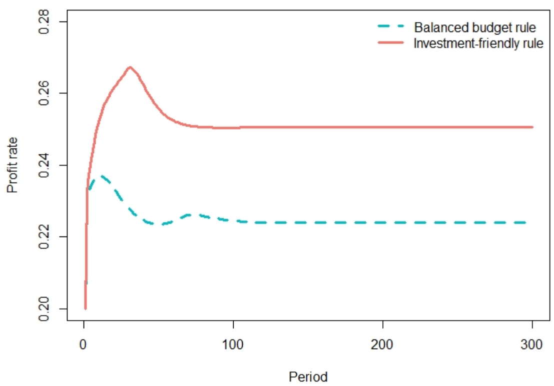
(a) Output

(b) Private capital

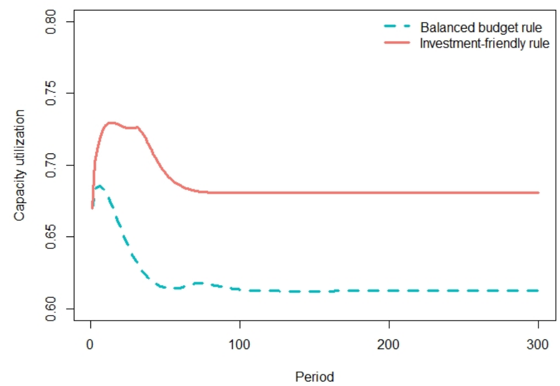
Figure 1: Growth rates

The higher growth rates under the scenario, where public investment is exempt from the spending ceiling, are explained by the factors determining accumulation of private capital in the model, i.e. profit rate, capacity utilization, and firms' leverage. These variables converge to higher values in the case of investment-friendly fiscal rule (see Figure 2). Namely, the profit rate increases significantly from the initial level to reach about 25%; however, it reaches a lower level of about 22.4% under the balanced budget fiscal rule (Figure 2(a)). Furthermore, the rate of private capacity utilization, after a brief increase, falls in the first 100 periods under the restrictive fiscal policy scenario and stays at a lower level of about 61%. On the contrary, it increases in the golden-rule scenario, peaks at approximately 73%, and stays at about 68% long-term (Figure 2(b)). Thus, the scenario of the investment-friendly fiscal policy results not only in higher growth of private capital, but also in a more intensive usage of productive capacity. Last but not least, a larger increase in profits under the investment-friendly fiscal rule allows firms to reduce their leverage a bit further, notwithstanding an accelerated investment activity (Figure 2(c)). The process is reinforced additionally by the decline of the interest expenses that firms bear. To conclude, all three factors determining the investment rate of the private firms are more favourable under the investment-friendly fiscal rule, resulting in a faster private capital accumulation and output growth.

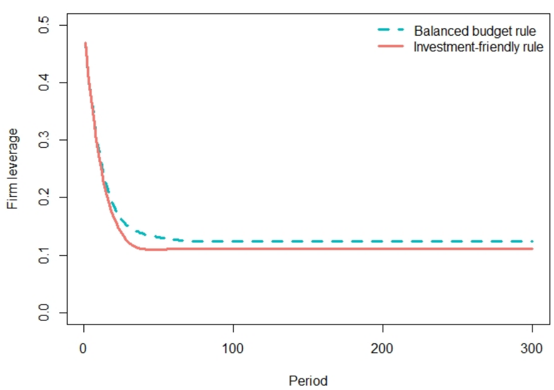
The development of the coefficient of productivity of the private capital stock is of central importance for the results of the simulation (Figure 2(d)). The value of the productivity coefficient increases steadily towards its maximum value of 1 under the investment-friendly rule scenario, whereas it falls first before it finally starts to increase later under the balanced budget rule. This happens because public capital stock is subject to depreciation, and thus, the productivity coefficient declines if not enough public investment to correct for the depreciation is undertaken. This replicates the empirically observed phenomenon that the private capital cannot be highly productive when public infrastructure is in a state of deterioration.



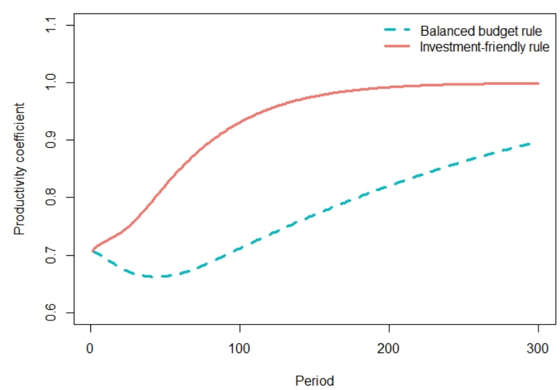
(a) Profit rate



(b) Capacity utilization



(c) Loans to private capital ratio

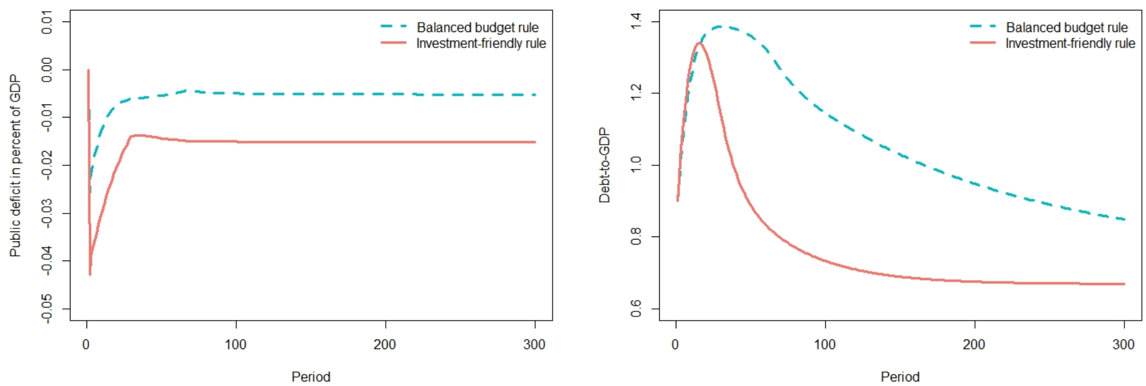


(d) Productivity coefficient v

Figure 2: Private investment determinants and capacity utilization

This is what is illustrated by the balanced budget rule scenario. The opposite is described by the golden rule scenario: Productivity is growing, thus creating more favourable business conditions. As a result, private investment activity is accelerating. The economy is booming and the profitability is increasing, reinforcing higher growth and, eventually, making it easier for the government to finance public investment and other spending.

Figure 3 shows the development of the key public finance variables. First, public deficit jumps to larger values in the scenario of the golden rule, but it stabilizes at the value of about 1.5% of the output after 30 periods. The debt-to-output ratio also increases sharply to the values of about 134% at the beginning of the simulation. However, it falls steadily thereafter until it reaches the value of slightly under 67% of GDP and stays there. In the Maastricht-like case, public deficits remain rather small (about 0.5%) for the major part of the simulation period. The goal of a balanced budget is, however, never attained since the state is confronted with the growth rate chronically lower than the expected growth rate of tax revenue λ. As a consequence of low growth and small but continuous deficits, the debt-to-output ratio



(a) Public deficit

(b) Public debt

Figure 3: Public finance

increases persistently within the first periods. Eventually, public debt reaches the peak of about 139% of output. When the growth rates reaches the long-term value and stabilizes there, the debt-to-output ratio starts to fall very slowly to about 85% of GDP. However, it never sinks below the level of the scenario where fiscal rules allow for higher public investment. In conclusion, aiming to achieve a balanced budget does not automatically result in a lower public debt ratio.

To sum up, the balanced budget rule scenario demonstrates lower growth rates of output as well as public and private capital. This scenario has as a consequence a significantly lower profitability, a much lower capacity utilization, a somewhat higher firms' leverage and a persistently lower productivity of capital stock. Notwithstanding smaller public deficits, the balanced budget rule simulation scenario results in a public debt-to-GDP ratio which stays higher, than under the investment-friendly rule, for a much longer period of time. Moreover, persistently low output growth and increasing debt-to-output ratio might trigger destabilizing behavioural reactions such as an increase in interest rates on government bonds. I keep this consideration for future research.

4.2 Sensitivity analysis

Up to now, I have presented the results of the simulations which possibly depend on some key parameters, such as the coefficients of the fiscal rule equation, the interest rate on government bonds, and the parameters of the private investment function. I have set their values exogenously, based on the available data and plausible assumptions. However, the values of these parameters can significantly influence my results. Therefore, this section will investigate the sensitivity of results to variation in these factors.

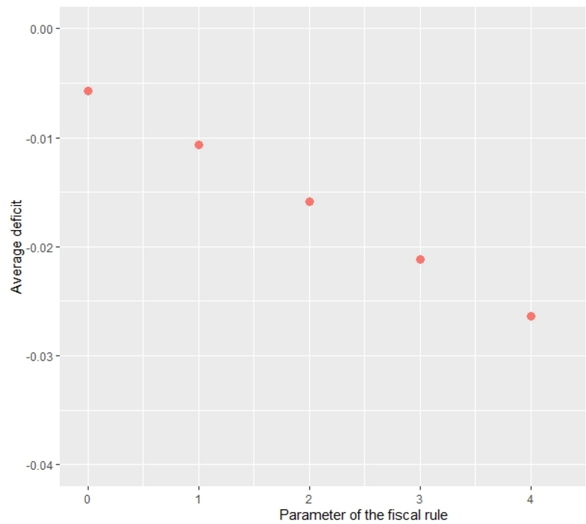
4.2.1 Fiscal rules parameters

The analysis in the previous subsection has been based on the exogenously set value for the investment-friendly fiscal rule parameter γ_{IG} of 0.02 (see Table 1 in Appendix). In this way, the designated golden rule helped to cover for deterioration of the existing public capital. The baseline simulation revealed that the golden rule of public investment resulted in a lower debt-to-GDP ratio in the long run, than the balanced budget rule. Now, increasing this parameter further could be economically beneficial, but it could also be the case that increasing the permitted rate of public investment would result in a higher indebtedness over the simulation period. Thus, I test a range of parameters of the fiscal rule to compare the outcomes for the main macroeconomic variables. More precisely, I run equivalent simulations, as in the baseline section, with the fiscal rules allowing for yearly public investment between 1 and 5 percent of the existing capital stock and compare the results to the outcome of the simulation with the Maastricht-like rule where $\gamma_{IG} = 0$.

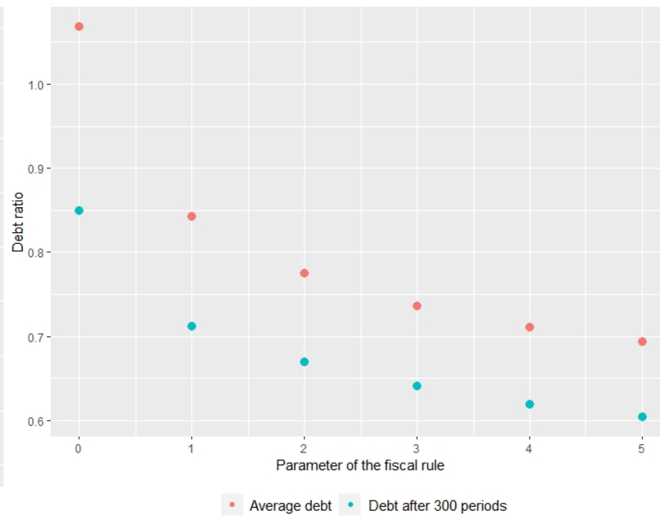
Figure 4 presents the main variables of interest under different fiscal rules. First of all, I show the mean values for the public deficit (Figure 4(a)). Indeed, an increase in the rate of public investment results in a higher average public deficit, where γ_{IG} of 0.05 leads to an average deficit larger than 3% of output. However, the public debt-to-GDP ratio is not increasing with γ_{IG} (Figure 4(b)). I compare the average debt-to-GDP ratio over the total simulation period as well as the final value of the ratio after 300 periods and find that any $\gamma_{IG} > 0$ results in a lower debt ratio, on average as well as after 300 periods. Also, larger values result in the debt-to-GDP ratio below the benchmark of 60% at the end of the simulation period. However, the improvements in the public debt ratio become smaller with further increases in γ_{IG}.

Furthermore, the utilization rate of private capital increases steadily with a higher parameter of the fiscal rule (Figure 4(c)). Indeed, private investment rate also increases with the public investment in my model, boosting the aggregate demand and, thus, capacity utilization. A long-run capacity utilization rate (after 300 periods) is approximately the same as the average rate, so that the result is not produced by the initial spike in utilization rate of private capital. Notably, the economy does need to import more in scenarios with a higher γ_{IG} because the demand largely exceeds the potential output (Figure 4(d)). Our modelled economy would need to increase imports by an average of almost 0.3% of the output to satisfy the aggregate demand in the scenario with the fiscal rule parameter $\gamma_{IG} = 0.05$. Also, it is worth highlighting that a $\gamma_{IG} = 0$ results in a larger average import ratio, than the moderate values of γ_{IG}, since the economy, on average, is less productive and the available supply capacity cannot satisfy the aggregate demand.

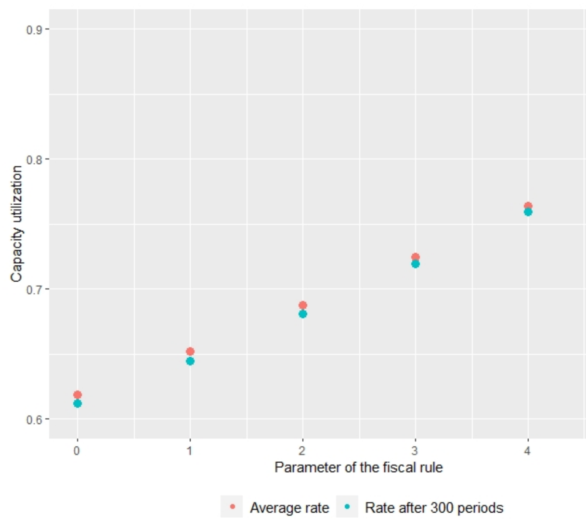
All in all, I show that the results are somewhat sensitive to the parameter of the fiscal rule. Higher values of γ_{IG} for the investment-friendly fiscal rule lead to larger deficits, higher capacity utilization, and a larger spike in imports. Nevertheless, an investment-friendly rule has consistently resulted in a lower debt-to-GDP ratio, across all values of γ_{IG}, than the balanced budget fiscal rule. Drawing a conclusion over the tested set of values, the choice of the parameter $\gamma_{IG} = 0.02$ seems reasonable since it induced a



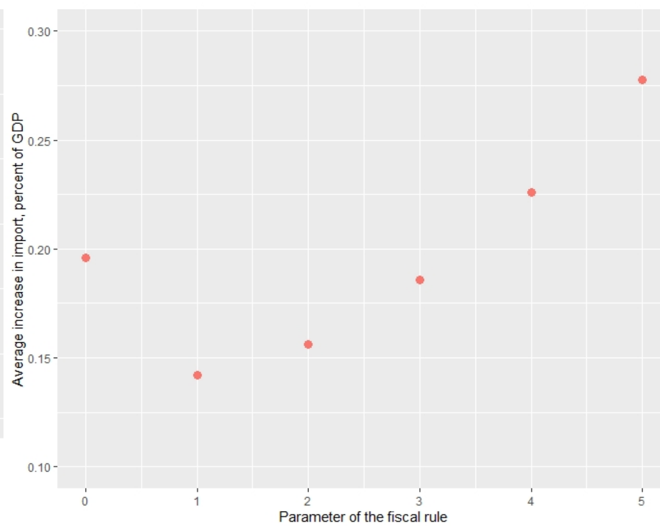
(a) Public deficit



(b) Public debt



(c) Capacity utilization



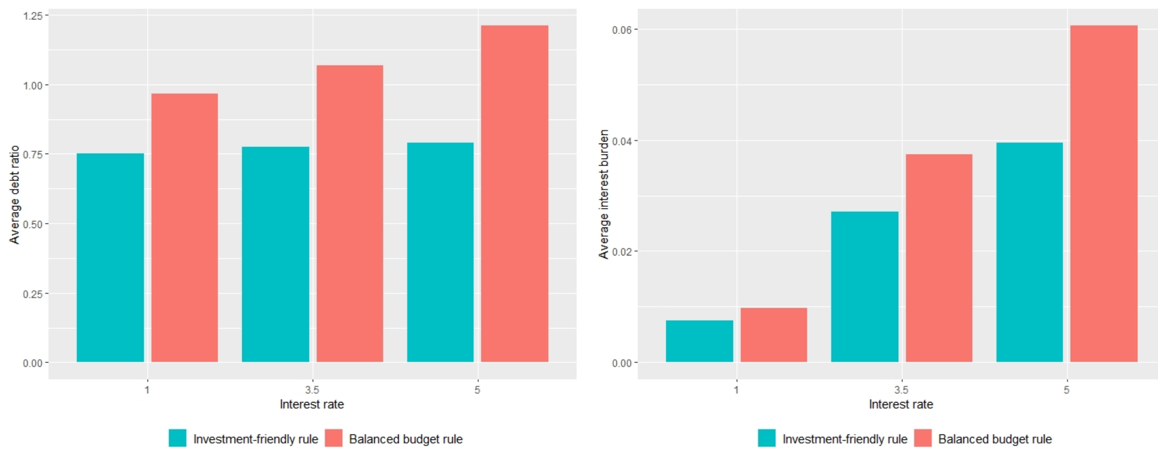
(d) Average increase in imports

Figure 4: Sensitivity to fiscal rule parameters

public debt ratio close enough to the 60%-benchmark at the end of the simulation period while avoiding a large spike in imports.

4.2.2 Interest rate on government bonds

In this section, I investigate the sensitivity of the results to the interest rate on government bonds. Possibly, this parameter affects the long-term public debt dynamics. So far, I assumed that interest rate on government bonds amounted to 3.5%. Now I simulate the model for the interest rate values of 1 and 5%. Figure 5 presents the results. Concerning the public debt-to-GDP ratio (Figure 5(a)), the change in interest rate hardly makes any difference at all for all scenarios with the investment-friendly fiscal rule. The average value of the debt ratio is not sensitive to the variation in interest rate. However, the average debt-to-GDP ratio increases noticeably with the interest rate in the scenario with the balanced budget fiscal rule. Looking at the interest burden (interest payments on government bonds in percent of output) presented in Figure 5(b), it is apparent that it reacts to the interest rate in a more pronounced way for the balanced-budget rule scenario. A higher interest rate on government bonds brings about an over-proportional increase in interest burden, since the government's capacity to finance public investment decreases with higher interest payments. This has a negative effect on the aggregate output and private investment through the productivity coefficient, reinforcing the detrimental effect on public finance.



(a) Public debt

(b) Interest burden

Figure 5: Sensitivity to interest rate on government bonds

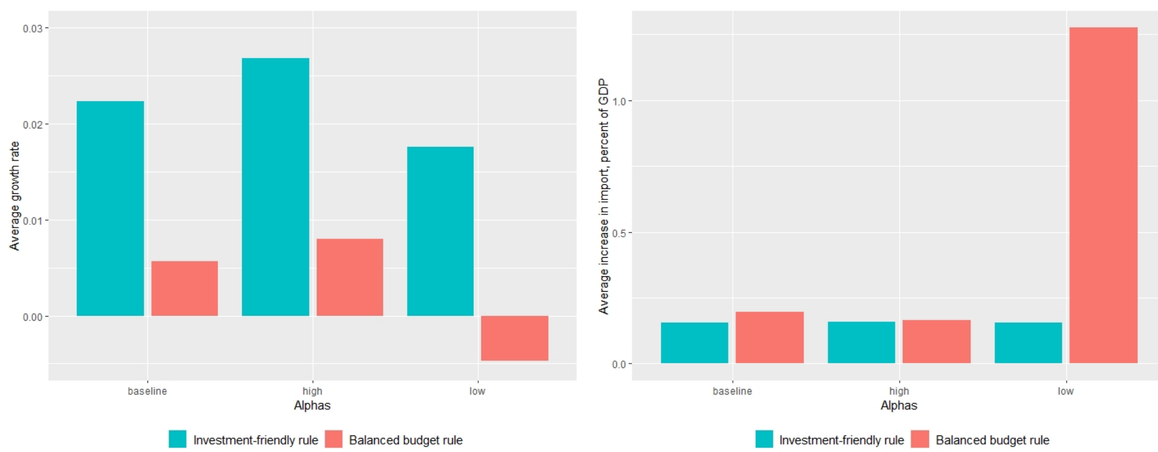
In conclusion, the scenario with the golden rule of public investment brings about a lower debt-to-GDP ratio under lower as well as higher interest rates on government bonds. Moreover, the debt-to-GDP ratio does not exhibit any significant sensitivity to the interest rate under investment-friendly fiscal rule. On the contrary, a higher interest rate induces a higher debt ratio in the balanced budget scenario since a greater interest burden restrains public investment and growth even further.

4.2.3 Parameters of the private investment function

Final and central assumption I tackle is the parametrization of the private investment function. To remind the reader, I specified the private investment as a function of the profit rate, the private capacity utilization and the leverage (see Equation 9). The elasticities of the private investment to these factors (correspondingly, α_1, α_2 and α_3) were chosen in order to induce a growth rate of output, a utilization rate of private capital, and a fiscal multiplier in a plausible range.

Figure 6 examines the sensitivity of my results to the size of alphas. The baseline scenario corresponds to $\alpha_1 = 0.15$, $\alpha_2 = 0.15$ and $\alpha_3 = -0.15$. The simulations with these values result in an average growth rate amounting to about 2.3% under the investment-friendly fiscal rule and 0.7% under the balanced budget rule. In this way, the average growth rates are plausibly close to the rate of public investment. Also, in this case the simulations deliver average private capacity utilization rates of a reasonable size between 0.6 and 0.75 and a large, but reasonable, long-term multiplier of 2.4. I test two alternative sets of alphas: “low” and “high”. Namely, the low alphas scenario is a set of parameters 20% lower the baseline scenario ($\alpha_1 = 0.12$, $\alpha_2 = 0.12$ and $\alpha_3 = -0.12$), and the high alphas scenario tests a set of parameters 20% larger than the baseline ($\alpha_1 = 0.18$, $\alpha_2 = 0.18$ and $\alpha_3 = -0.18$).

Firstly, the high alphas scenario induces an increase in growth rates and vice versa (Figure 6(a)). In the low alphas scenario, the average growth rate under the Maastricht-like rule flips the sign and becomes slightly negative. As a consequence of the negative average growth, the reduction of the productive capacity is so pronounced that the average import ratio increases significantly (Figure 6(b)). In this way, the scenario of the balanced budget scenario combined with low alphas illustrates the case of a structural loss of competitiveness of the modelled economy because of the gradual deterioration of the public infrastructure.



(a) Average growth rate

(b) Average increase in imports

Figure 6: Sensitivity to parameters of the private investment function

Figure 7 shows the simulation results for the debt ratio under the alternative sets of alphas. The average debt-to-GDP ratio proves to be sensitive to the parametrization of the private investment function. Indeed, the debt ratio is considerably smaller (larger) in the case of higher (lower) alphas. Again, in all cases, it holds that the fiscal rule, allowing for additional public investment, induces a significantly lower debt ratio than the balanced budget rule. Under the assumption of low alphas, the balanced budget fiscal rule results in a strong increase of public debt due to the negative average growth of output. All things considered, our findings in this chapter confirm the plausibility of the initial set of alphas for the baseline scenario since it delivered the most moderate result.

To conclude the sensitivity chapter, the tests presented here revealed that the baseline results remained fairly stable under alternative specifications of the model. Importantly, the main result of the analysis, i.e. the finding that the investment-friendly rule consistently induces a lower long-term debt-to-GDP ratio than the Maastricht-like fiscal scenario, holds under different sets of parameters for the model equations.

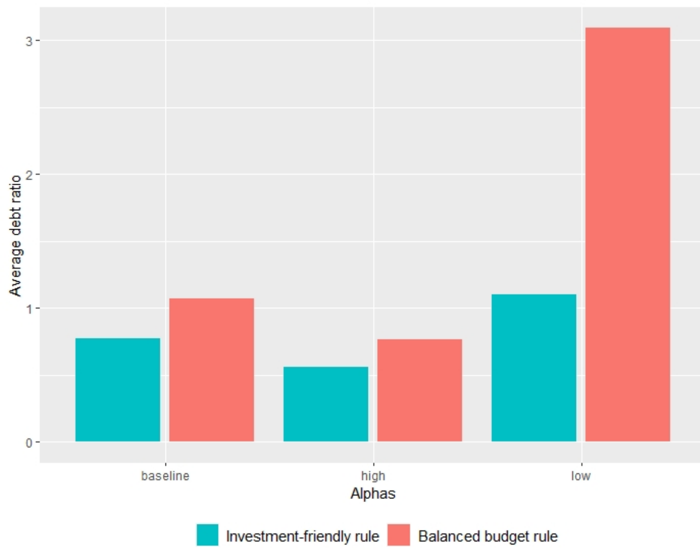


Figure 7: Sensitivity of public debt to parameters of the private investment function

4.3 Useful extensions of the model

Up to now, I have developed a simple stock-flow consistent model to analyse the composition of the government spending under various fiscal rules and how it affects the economy and the central fiscal policy indicators in the long run. I focused on the development of such (endogenous in our model) variables as the growth rate, the profit rate, the capacity utilization rate, the debt-to-GDP ratio, the interest burden, etc. Other crucial variables were fixed exogenously at a specific level. These include the interest rates on government bonds as well as deposits and loans, the wage share, the tax rate, the parameters of the private investment function, and so on.

Again, the model has been kept simple on purpose. It can be, however, extended in a large variety of ways to delve into specific topics of interest. It is indeed instructive to examine further alternations of the above mentioned variables, similar to the tests conducted in the sensitivity analysis chapter, and more complex specifications of the model. In this way, the analysis could be expanded with additional fiscal regime scenarios, such as taking into account the debt-to-GDP level (as opposed to deficit) or implementing a more flexible set of fiscal rules (allowing for suspension under distress), etc.

Moreover, persistently low or high output growth and increasing/decreasing debt-to-output ratio might trigger destabilizing dynamics which unfold in a non-linear way. Some extensions to the model could deal with these dynamics. As an example, this could be addressed via endogenizing certain parameters, such as interest rates. Indeed, interest rates on government bonds can be subject to less-than-rational behavioural reactions (De Grauwe & Ji, 2013). In my model, interest rates on government bonds can be hinged on a set of variables, such as the debt-to-output ratio, the growth rate, and others. This would make my model suitable to investigate some behavioural reactions of the markets discussed in the literature.

In addition, the model seems to be an appropriate tool to analyse the dynamics of the green transition. As already mentioned, the socio-ecological transformation demands massive infrastructure investment which has to be partly financed by the state. To accommodate this analysis, a consistent extension could be to introduce carbon emissions and green investment to the developed framework. The model could thus serve to study how the green investment could be accelerated to fulfil the climate goals.

Last but not least, a useful extension to the model could be implementing "delays to build". Right now, (public and private) investment expenditure directly enters the capital stock and affects the productivity parameter of the capital. Imposing lags on the adjustment of these variables would mimic the time needed for the construction work. This would enable simulation of the discrepancy between the fiscal policy and the real economy effects of the infrastructure that requires time to be built, potentially invoking insightful dynamics.

5 Conclusion

I develop a macroeconomic SFC model that incorporates public sector in the economy. In this model, government can consume and invest; both spending categories enter the aggregate income, however, government investment adds up to the public capital stock. The productivity of the private capital depends on the public capital stock due to congestion effects. The composition of public spending, in turn, depends on the fiscal rules. Two fiscal scenarios are then simulated: the one where the government is aiming to attain a balanced budget and the one where the government invests at a constant rate.

Baseline results show that the investment-friendly fiscal rule induces a higher profitability of private capital, a more intensive capacity utilization, a lower firms' leverage, and, as a consequence, stronger growth. The higher growth rates and accelerated capital accumulation under the golden rule of public investment, although associated with higher public deficits, result in a lower debt-to-output ratio. The sensitivity tests reveal that, in the long run, this holds under different sets of parameters. For the future research, the model can be extended to analyse non-linear dynamics of public finance, by endogenizing interest rates, introducing carbon emissions, and more.

To conclude, the deficit aversion does not necessarily bring about a reduction in debt. A restrictive fiscal policy does not seem to be the most efficient way to achieve a long-term debt sustainability if public investment is crucial for productivity. Moreover, as one of the sensitivity exercises shows, a structural loss of competitiveness may unfold under the gradual deterioration of the public infrastructure, triggering explosive sovereign debt dynamics. In addition to the economical, the ecological and political dimensions of the society may become more and more fragile in the multi-crisis, leaving less time and room for manoeuvre. Therefore, aligning government policy to the short-term indicators of the public finance, such as the deficit, becomes problematic. A smarter policy would include looking at the economic effects of various spending categories and prioritizing projects that boost the productivity of the economy.

A Appendix

Table 1: Balance sheet matrix

	Households	Firms	Commercial banks	Government	Foreign	Total
Deposits	$+D$		$-D$			0
Loans		$-L$	$+L$			0
Treasury bills			$+B$	$-B$		0
Foreign			$+F$		$-F$	0
Capital		$+K_{pr}$		$+K_g$		$+K$
Total (net worth)	$+D$	$+V_{pr}$	0	$+V_g$	$-F$	$+K$

Table 2: Transaction matrix

	Households	Firms		Commercial banks		Government	Foreign	Total
		Current	Capital	Current	Capital			
Private investment		$+I_{pr}^H$	$-I_{pr}$				$+I_{pr}^F$	0
Private consumption	$-C_{pr}$	$+C_{pr}^H$					$+C_{pr}^F$	0
Gov. investment		$+I_g^H$				$-I_g$	$+I_g^F$	0
Gov. consumption		$+C_g^H$				$-C_g$	$+C_g^F$	0
Gov. revenue	$-T$					$+T$		0
Wage bill	$+W$	$-W$						0
Interest on deposits	$+i_d D$			$-i_d D$				0
Interest on loans		$-i_l L$		$+i_l L$				0
Interest on treasury bills				$+i_b B$		$-i_b B$		0
Firms' profits	$+DP$	$-TP$	$+RP$					0
Com. banks profits	$+BP$			$-BP$				0
Change in deposits	$+\dot{D}$				$-\dot{D}$			0
Change in loans			$-\dot{L}$		$+\dot{L}$			0
Change in treasury bills					$+\dot{B}$	$-\dot{B}$		0
Financial outflows					$+\dot{F}$		$-\dot{F}$	0
Total	0	0	0	0	0	0	0	0

Table 3: Parameters and initial values of variables

Parameter	Definition	Value	Source
c_1	Propensity to consume out of disposable income	0.88	Main national accounts (Eurostat, 2023a)
c_2	Propensity to consume out of deposits	0.05	Dafermos and Nikolaidi (2019)
ω	Wage share	0.624	Long-term value (ECB, 2023a)
int_D	Interest rate on deposits	0.02	Bank interest rates (ECB, 2023b)
int_B	Interest rate on government bonds	0.035	Yield curves (ECB, 2023e)
int_L	Interest rate on loans	0.05	Bank interest rates (ECB, 2023b)
s_F	Saving rate out of profits	0.47	Calculated to fit lev_t
ρ	Output elasticity of public capital	0.12	Bom and Ligthart (2014)
$1-\rho$	Output elasticity of private capital	0.88	Calculated from $1-\rho$
δ_{Kpr}	Depreciation rate of private capital	0.10	Estimate for high-income countries (IMF, 2015)
δ_{KG}	Depreciation rate of public capital	0.046	Estimate for high-income countries (IMF, 2015)
τ	Tax rate	0.5	Calculated to fit RG_1
λ	Expected growth rate of government revenue	0.02	Calibrated to prevent negative growth
α_1	Investment function coefficient of profit rate	0.15	Selected from a plausible range
α_2	Investment function coefficient of capital utilization	0.15	Selected from a plausible range
α_3	Investment function coefficient of firms' leverage	-0.15	Selected from a plausible range
γ_{CG}	Consumption spending coefficient of government	0.9	Calculated to fit CG_1
γ_{IG}	Government investment target	0 / 0.02	Determined by fiscal rules

Variable	Definition	Initial value	
Y_1	Aggregate output	1	Main national accounts (Eurostat, 2023a)
Y_1^*	Potential output	1.01	Calculated from Equation (1)
Z_1	Aggregate spending	1	Main national accounts (Eurostat, 2023a)
I_1	Private investment	0.2	Main national accounts (Eurostat, 2023a)
C_1	Private consumption	0.39	Calculated to fit Z_1
KG_1	Public capital stock	1	IMF Capital Stock Dataset (IMF, 2021)
Kpr_1	Private capital stock	1.5	IMF Capital Stock Dataset (IMF, 2021)
v_1	Productivity coefficient of capital stock	0.707	Calculated from Equation (2)
r_1	Profit rate	0.20	Calculated from Equation (10)
u_1	Capacity utilization	0.67	Calculated from Equation (11)
T_1	Tax revenue	0.41	Total receipts from taxes (Eurostat, 2023b)
G_1	Government expenditure	0.41	Calculated to fit $deficit_1$
CG_1	Government consumption	0.369	Calculated from Equation (19)
IG_1	Government investment	0.041	Calculated from Equation (20)
L_1	Loans	0.7	Sector accounts (ECB, 2023d)
lev_1	Leverage	0.47	Calculated from Equation (12)
D_1	Deposits	1.6	Calculated from Equation (32)
$Foreign_1$	Trade balance	0	Per assumption
B_1	Bonds outstanding	0.9	Government debt (ECB, 2023c)
$debt_1$	Debt-to-GDP ratio	0.9	Government debt (ECB, 2023c)
$deficit_1$	Government deficit	0	Determined by fiscal rules

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