

Saving for stability: Greece's Recovery and Resilience Plan and its impact on the external position

This paper presents a small open-economy general equilibrium model to track the dynamic effects of the RRP/RRF on savings, investment, and external balances in Greece.



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For over two decades, Greece's external position has been characterised by current account deficits and negative net foreign assets. The Recovery and Resilience Plan (RRP), supported by the EU's Recovery and Resilience Facility (RRF), is a large-scale investment and reform programme, which may improve Greece's economic and external prospects. How will a successful implementation of this plan affect the evolution of the country's external position over the long term? Using a dynamic small open-economy general equilibrium model, we track the dynamic response of savings, investment, and external balances. We find that: (i) a successful RRP/RRF can go a long way towards unwinding Greece's external imbalances, due to large increases in public savings; (ii) the RRP/RRF is, however, no magic bullet, and domestic policies remain critical. If macroeconomic policies stimulate domestic demand over and above the impulse generated from higher investments (through new tax cuts or looser macroprudential policies), even a successful RRP/RRF would fail to make a substantial dent in Greece's net international investment position.

Keywords: Greece; external position, national savings and investment, Recovery and Resilience Facility, fiscal policy, macroprudential policies

JEL codes: C54, E21, E61, F45, F47

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Abstract

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1. INTRODUCTION

Greece has a long history of large external deficits. In the period between joining the European Monetary Union in 2001 and 2008/09, Greece's current account deficit averaged almost 10% of GDP. These deficits left the country vulnerable to changes in external financing conditions during the global financial crisis, which then morphed into the sovereign debt crisis in the euro area. These persistent current account deficits reflected underlying structural weaknesses in the Greek economy, including low competitiveness, high indebtedness, and over-consumption (Gourinchas et al., 2016). In the eyes of some, large persistent current account deficits were "the linchpin" of the sovereign debt crisis (Baldwin and Giavazzi, 2016).

Recent forecasts are foreseeing, again, large current account deficits well into the future. The European Commission (EC), the International Monetary Fund (IMF), and the Organization for Economic Cooperation and Development (OECD) expect only mild improvements in the current account in the foreseeable future (Table 1). Importantly, these external "flow" deficits occur against a backdrop of large "stock" deficits: Greece's net international investment position (NIIP) stood at -136% of GDP at end-2023. The IMF expects the NIIP improve to above -130% of GDP by 2028, whereas the EC sees the NIIP improve only temporarily before weakening below its current level by 2033. Both forecasts agree that Greece's NIIP will remain the weakest in the euro area (EC, 2024b; and IMF, 2024b).

Table 1. Forecasts of Greece's current account balance, % of GDP

<i>Institution</i>	2022	2023	2024	2025	2026	2027	2028	2029
IMF (April 2024)	-10.1	-6.9	-6.5	-5.3	-4.5	-3.6	-3.1	-3.0
EC (May 2024)	-10.6	-5.8	-5.2	-4.8	-	-		
OECD (May 2024)	-10.1	-6.7	-6.0	-4.0	-	-		

Source: IMF (2024a), EC (2024c), OECD (2024)

These projections may appear concerning. But Greece can also count on unprecedented financial support from the EU's Recovery and Resilience Facility (RRF), which may materially affect the interpretation of the country's large external deficits. Under the RRF, Greece receives about €36 billion (split into €18.2 billion of grants and €17.7 billion in subsidised loans, representing 16% of Greece's GDP in 2023) over the period 2021-26. In exchange for the financial support, Greece is implementing a comprehensive set of investments and reforms (specified under its Recovery and Resilience Plan, RRP), aimed at structurally overhauling the Greek economy. The investments and reforms are designed to address Greece's specific economic vulnerabilities and bottlenecks that have stymied productivity and potential growth. Sectors that will receive significant new investments include green energy, digital infrastructure, health, and education and lifelong learning. Reforms aim at strengthening the efficiency

of the public administration, the judicial system, tax administration, and public investment management.

Several studies suggest that the Greek economy will draw significant benefits from the financial support thanks to higher investments, labour force participation, and productivity, although the magnitude of the positive effect varies. Most studies focus on growth dividends from the RRP and put the likely benefit somewhere between 2%-6% of GDP by 2026 (Bańkowski et al. 2022; EC, 2024; Malliaropoulos et al., 2021, Pfeiffer et al. 2023).

In this paper, we analyse the impact of the significant ramp-up in public investment and reforms (supported by the RRF) on Greece's external position. We ask the following question: will a successful RRP/RRF imply that Greece's external deficits will correct over the medium to long term? The answer to this question depends on how we calibrate the impact of the RRP/RRF. Let us consider one extreme scenario, in which all economic benefits are transitory, and the Greek economy reverts back to the trajectory that it would have achieved without the RRP/RRF. Under that assumption, it is tautological to state that the RRP/RRF will not significantly correct Greece's external deficits.

The opposite case is more interesting and the subject of our paper. If we assume that the RRP/RRF unleashes its economic potential, how will this affect the evolution of the external position over the long term? Our paper aims at answering this question using a dynamic general-equilibrium model of a small open economy to trace the impact of the RRP/RRF on Greece's external position. We start by calibrating our baseline scenario to align it with the growth benefits described in Malliaropoulos et al. (2021), which offers the most optimistic ex-ante assessment of effectiveness of the RRP/RRF. We then analyse the trajectory of savings and investment following a successful RRP/RRF. Understanding the evolution of savings and investment also allows us to examine the current account, external debt and the overall NIIP (the external balance sheet).

Our analysis is based on the Debt Investment Growth (DIG) class of models, as they have three features that we consider crucial for understanding Greece and the possible impact of the RRP/RRF: (i) the relationship between public investment scale-ups, output growth, and debt; (ii) a detailed fiscal sector with several types of public debt and multiple fiscal instruments and rules; and (iii) and a balance of payments that is affected by household choices and government policies. The DIG model is widely used to conduct policy experiments in the context of investment scale-ups and structural reforms (Gurara et al., 2019). Moreover, the model distinguishes between optimising households who can borrow abroad and financially constrained households, as well as between firms operating in traded and

non-traded good sectors. This complexity allows us to conduct some simple yet instructive policy experiments to track the impact on Greece's external position following changes in fiscal, macroprudential, and structural policies.

Our main findings are twofold. First, we confirm that a successful RRP/RRF will go a long way towards unwinding Greece's external deficits and moving the economy towards a position where external sustainability improves. Our results show that the current account improves by up to 2% of GDP (relative to a no RRP/RRF scenario) in 10 years, which improves the NIIP by close to 30% of GDP over the same period. An improvement of this scale would bring Greece's NIIP close to the average of the euro area.

We decompose the improvement in the current account using the savings-investment balance of the public and private sectors of the economy. The biggest contribution comes from the public sector, as the successful RRP/RRF generates a substantial fiscal dividend—fiscal balances rise by about 2 percentage points of GDP. Under our baseline calibration, the government uses this fiscal dividend to repay external debt, with large effects on the net international investment position. The private sector, in contrast, experiences a temporary surge in (gross) savings before they revert to the initial trajectory. Importantly, the private sector does not offset the increase in public savings, breaking Ricardian equivalence and leaving aggregate savings permanently higher.

Second, we use alternative scenarios to show that there is nothing automatic about the large improvement in the external position—the RRP/RRF is no magic bullet. That is because a successful RRP/RRF could, paradoxically, sow the seeds of a new threat to external sustainability. Intuitively, an investment-led economic boom creates pressures (political and otherwise) to use some of the economic dividend to boost consumption instead of repaying debt. We capture this idea in our model in two ways: (i) by making fiscal policy more responsive to accruing fiscal surpluses, the government implements consumption tax cuts instead of using the surpluses to repay external debt; (ii) by enabling households to borrow at lower costs from abroad (against higher future income), domestic demand would boom in the short term but at the expense of higher imports, less employment, and more external debt.

We interpret our findings as underscoring the importance of the domestic policy follow-up to the investment surge and reforms under the RRP/RRF. It is possible that Greece would fail to make a substantial dent in its net international investment position even if the RRP/RRF is implemented successfully, but macroeconomic policies turn out to be overly stimulative. Greece's own recent economic experience in the run-up to the sovereign debt crisis in the euro area illustrates the

detrimental effects of inappropriately loose macroeconomic policies. Our model highlights three policy levers: (i) fiscal policy to channel public savings towards the repayment of external debt; (ii) macroprudential policies to dissuade overborrowing from abroad for the purpose of financing current consumption; and (iii) structural policies to facilitate the penetration of Greek exports into world markets.

Related literature

Our paper builds on recent studies that have examined the possible impact of the financial support under the EU's Recovery and Resilience Facility on the Greek economy. These studies emphasise the impact of the RRF/RRP on Greece's GDP through increased investments, productivity, and labour force participation (Bańkowski et al. 2022; EC, 2024; Malliaropoulos et al., 2021; Pfeiffer et al. 2023). In turn, these studies build on the literature on the economic effects of the EU's structural funds, which are often framed as a fiscal loosening inside a monetary union (Becker et al. 2013; Brueckner et al. 2023, Canova, 2004; Canova and Pappa, 2007 and 2022; Coelho; 2019).

Our paper is also related to the strand of the literature focussing on the role of domestic savings for external balances and the net foreign asset position. Feldstein and Horioka (1980) found that in OECD countries, higher domestic savings are often accompanied by an increase in domestic investment. In contrast, we find that domestic savings may permanently increase (due to fiscal policy restraint), whereas the boom in investment is temporary. Our findings are more in line with later evidence that emphasises the divergence of savings and investment with implications for current account balances (Blanchard and Giavazzi, 2002; Chinn and Prasad, 2003; Giannone and Lenza, 2010). As Greece is capital-poor relative to the rest of the euro area, the current account deficits projected over the medium term by international organisations could also be consistent with an intemporal model of the current account: countries import capital when they are (capital-)poor and return to exporting capital surpluses when the investments pay off (Lucas, 1990; Obstfeld and Rogoff, 1995).

Another tangent to the existing literature is our discussion of external sustainability. Our analysis builds upon the extensive body of work examining the drivers and implications of persistent current account imbalances and external debt accumulation (Milesi-Ferretti and Razin, 1996; Obstfeld and Rogoff, 2009; Lane and Milesi-Ferretti, 2012). We integrate into the analysis the RRF as a critical determinant of Greece's macroeconomic outlook, as well as the impact of possible policy responses to the RRF/RRP and how they shape the trajectory of external balances.

Finally, our analysis is related to the existing body of work on the use dynamic general equilibrium models to assess the macroeconomic consequences of significant public investment scale-ups (Berg et al., 2013; Guara et al. 2019; Melina et al., 2016; Deléchat et al., 2015; and Aligishiev and Moreau, 2024).

By integrating these various strands of literature, our paper offers a holistic perspective on the interplay between the RRF, domestic policies, savings, and external balances over the long run in Greece. The rest of the paper flows as follows: Section 2 characterises Greece's external position; Section 3 presents a simple explanation for why the RRP/RRF is a critical determinant for domestic savings, the current account, and net foreign assets; Section 4 presents our model and Section 5 presents the results of our simulations as well as a set of downside risk scenarios. Section 6 concludes.

2. GREECE'S EXTERNAL POSITION

Figure 1 shows Greece's net international investment position (NIIP) over time and compared with those of the other euro area countries that received financial assistance during the sovereign debt crisis. Greece's NIIP was the most negative across all euro area countries at the end of 2023. The large negative NIIP in Greece and other crisis-hit countries is related to the legacy of the sovereign debt crisis in the 2010s. In the run-up to the crisis, Greece recorded large current account deficits, which translated into a sharp increase in external indebtedness. In the aftermath of the global financial crisis, the size of the Greek economy started shrinking precipitously, worsening the debt burden—from peak to trough, real GDP per capita declined by 25%, an economic depression unparalleled in modern economic history (Chodorow-Reich et al., 2023). Amid the collapse in GDP, Greece suffered large fiscal deficits, which added to the country's external debt burden. A severe banking crisis created additional external financing needs.

Greece is a large net debtor to the rest of the world. Typically, high external debt leaves a country susceptible to swings in external financing conditions (Lane and Milesi-Ferretti, 2012). But this worry only applies to a limited extent to Greece over the next few years. About two-thirds of Greece's external liabilities are held by public-sector creditors at ultra-long maturities with low interest rates. This liability structure gives rise to relatively low external financing needs, which go a long way towards insulating Greece from vagaries in external financing conditions.

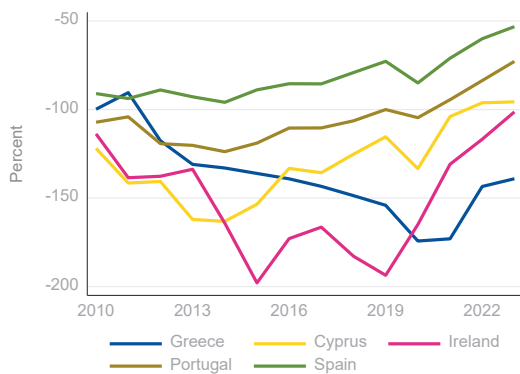
Ultimately, however, the net debtor position implies that Greece will need to generate external surpluses for a sustained period in the future to improve its NIIP. Looking at Greece's own history in generating external surpluses would justify some scepticism. For over 40 years, Greece's current account was never in surplus, averaging -5% of GDP (compared to a surplus of +1% of GDP for the EU/EA over the same period).

Can the RRP/RRF be the decisive factor that will enable Greece to break with its history of external deficits? Figure 2 shows that the Greek economy has suffered a sharp decline in its (net) capital stock, which in turn helped boost the return on capital—suggesting greater potential for new productive investment. The RRP/RRF promises to reduce this investment gap, replenishing the capital stock and enhancing the economy's long-term growth potential. If RRF-funded investments are allocated efficiently, they will generate returns over and above the cost of funds of the external liabilities that Greece incurred to finance the current account deficits. To assess whether the returns on RRF-funded

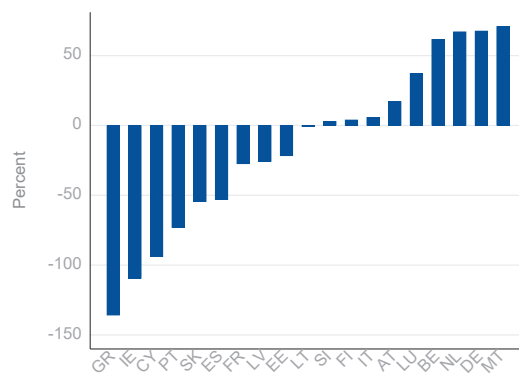
investments will be sufficient to justify the current account deficits, we will have to examine the potential impact of the RRF/RRP on national savings—the topic we address in the next section.

Figure 1: Net international investment position (in % of GDP)

1.a Euro area countries with financial assistance programs during the sovereign debt crisis



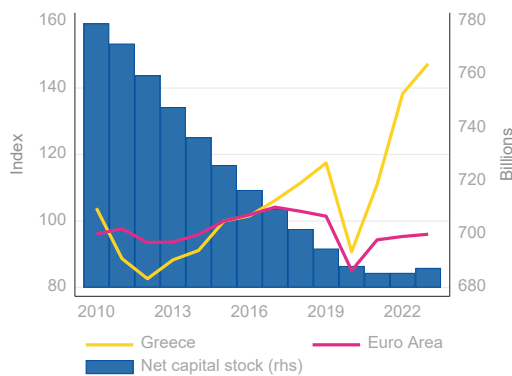
1.b Euro area countries at end-2023



Note: The first panel shows the net international investment position (in % of GDP) of the five euro-area countries that received financial assistance during the sovereign debt crisis. The second panel shows the net international investment position as of Q4 2023.

Source: AMECO and Eurostat.

Figure 2: Return on capital (Index; 2015=100) and net capital stock (in € billion)



Note: The chart shows returns on capital, calculated as net domestic income minus compensation of employees, divided by the current price of the net capital stock and expressed as an index that is equal to 100 in 2015. The net capital stock at constant prices is calculated as last year's value of the capital stock plus gross fixed capital formation minus the consumption of fixed capital.

Source: AMECO (Spring 2024).

3. NATIONAL SAVINGS AND THE RRP/RRF

The current account is equal to the difference between gross national savings and gross capital formation (investment). Over time, the current account determines the net international investment position (along with changes in the value of external assets and liabilities often associated with exchange rate movements). Understanding Greece's negative net international investment position and long-standing current account deficits requires us to examine national savings compared to investments.

Figure 3 shows the long-run average of the savings-investment balance for public and private sectors in Greece and the euro Area. Greece's external deficits over the past ten years are rooted in weak private-sector savings, rather than in the public sector. True, before the sovereign debt crisis, the savings-investment balance of the public sector in Greece was deeply negative. However, under the macroeconomic adjustment programmes (2010-18), fiscal balances adjusted significantly, which helped to bring the public savings-investment balance close to the average of the euro area. The private savings-investment balance held up well during the first part of the sovereign debt crisis but deteriorated from 2015 onwards.

A more detailed look into the private-savings investment balance reveals that the household sector saves abnormally little in Greece, whereas corporate savings are close to the euro area average (IMF, 2022). The causes of low household savings in Greece are manifold: low labour force participation (especially by females and youth), low income per capita (Greece's income per capita at purchasing power parity is among the lowest in the euro area), and informality (estimates of informal income range between 20-30% of the size of the official economy; see Schneider and Asllani, 2022). Being underemployed, poor, and embedded in informal economic structures all contribute to reduced savings (Le Blanc et al., 2016).

The relationship between informality and savings deserves special attention. Pervasive informality is associated with low productivity and wages, and limited access to formal financial services (La Porta and Shleifer, 2014). People active in the informal economy often face low and unstable income. Low incomes relative to the cost of living constrain the ability to save: only 9% of the poorest 40% of the adult population in Greece were able to save any money (GPII and World Bank, 2021). Informality may have also been a main transmission channel in the sovereign debt crisis in Greece, when large tax increases drove an increasing share of activity in the shadow economy, reducing tax revenue and precipitating a fiscal doom loop (Dellas et al. 2024).

In the context of low incomes and pervasive informality, the RRP/RRF can be particularly effective in stimulating savings. Two channels are worth highlighting:

- The RRF-financed investments and reforms directly aim at shrinking the size of the informal sector (EC, 2021), by making formal sector participation more attractive, easier to achieve, and harder to avoid. Modernising and digitalising government processes aim at lowering bureaucratic hurdles. Investments in improving tax collection capacity (rolling out electronic invoicing and real-time reporting systems) raise the threshold for businesses to operate informally. Financial and technical assistance to small and medium-sized enterprises (SMEs) provide additional support in formalising their operations.
- RRF investment will raise the stock of public capital, which could positively affect the productivity of all other factors of production. Investments in green energy, 5G/fibreoptic infrastructure, and digital labour skills address binding growth constraints in Greece, which could significantly increase the number of higher-paying jobs in the formal economy.

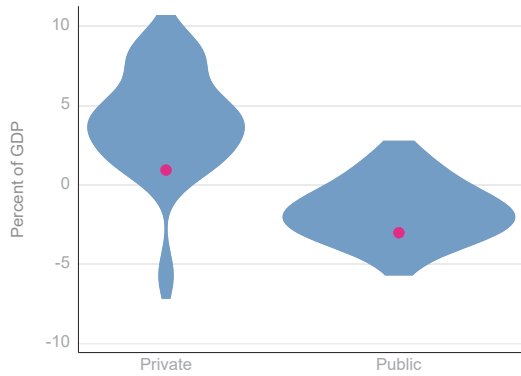
The reduction in informality is expected to lead to more stable and predictable income for poor households. The shift towards formal employment may increase access to financial services and savings instruments, further facilitating savings (Karlan et al., 2014). Simultaneously, the productivity gains from RRF investments would lift incomes onto a higher trajectory.

At the time of writing, it is too early to determine whether the RRP/RRF will succeed in generating these results. But some early promising signs exist. Appendix A shows that Greece is the main beneficiary of financial support under the RRF (when measured relative to the size of the economy) and implementation of the investment and reforms has been progressing relatively well—Greece has successfully unlocked about half of its allocated resources as of the first quarter of 2024. This progress suggests that the mechanisms for potentially boosting national savings are being put into place, though their full impact remains to be seen.

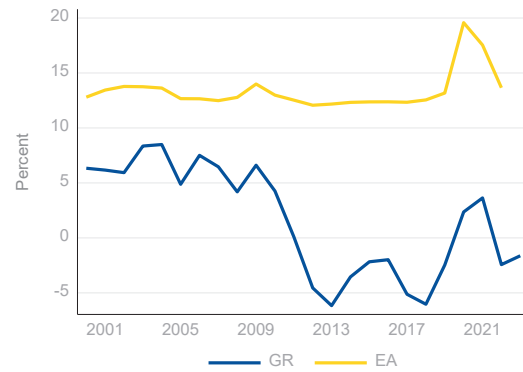
The next section explores the link between the RRP/RRF, national savings, and external balances in a systematic fashion. We show that although it is plausible to believe that national savings (as a share of income) will increase, the relationship is not automatic.

Figure 3: National savings and investment

3.a Distribution of euro area public and private savings-investment balances



3.b Greece's household savings rate



Note: The first panel shows the density distribution of the 10-year average savings-investment balance of private and public sectors for all euro area countries (weighted equally). The width of the curve corresponds to the frequency of the data, estimated using VIOLINPLOT (Jann, 2022). The pink dot marks the 10-year average for Greece. The second panel shows the household savings rate for Greece and the euro area aggregate.

Source: AMECO and authors' calculations.

4. MODELLING THE IMPACT OF THE RRP/RRF ON SAVINGS AND THE EXTERNAL POSITION

Our starting point is a variant of the Debt, Investment, Growth (DIG) model (Melina et al., 2016).¹ This model is a small open-economy dynamic general equilibrium model that aims to trace the macroeconomic effects of public investment scale-ups and economic reforms on long-run debt sustainability (Gurara et al., 2019). In our analysis, we focus on the paths of the investment-savings balance and external sector variables (the current account, external debt and the net international investment position), which are determined by the underlying behaviour of optimising households and firms. We solve the model with a fully non-linear perfect foresight solution method, where households know the government's fiscal reaction function and anticipate their future income path. This section highlights the main features of the model and their relationship with the external position. For the full set of equations, see Appendix D.

Production

Firms operate in the tradable and non-tradable sectors, with a representative firm in each sector optimally selecting investment, capital stock, and labour input to maximise discounted lifetime profits. The public investment scale-up from the RRP/RRF is assumed to be productive but subject to diminishing returns. Following Fournier and Koske (2010), we capture the productivity-enhancing and product market reforms (part of the RRP package) through a permanent, gradual increase in total factor productivity. Higher public capital and total factor productivity raise productivity of private factors and increases real output through:

$$y_{i,t} = z_{i,t} (k_{i,t-1})^{1-\alpha_i} (L_{i,t})^{\alpha_i} (k_{G,t-1})^{\alpha_G} \quad \text{for } i = T, NT$$

where $y_{i,t}$ is the real sectoral output; $z_{i,t}$ is the total factor productivity; $L_{i,t}$ is labour input; $k_{i,t}$ and $k_{G,t}$ are private and public capital stocks respectively. $\alpha_G \in (0, 1)$ and $\alpha_i \in (0, 1)$ govern the return on public capital and the labor share in production, respectively. i indexes the *traded* and *non-traded* sectors of production. The level of public capital at any given year is a sum of the stock of capital in the previous year, net of depreciation, and the new effective public investment expenditure. Formally:

$$k_{G,t} = (1 - \delta_{G,t})k_{G,t-1} + \epsilon(g^I + \varepsilon_t^{I,RRP})$$

¹ We use the latest member of the family, known as DIGNAR-19 model (Aligishiev et al., 2021). We can use TFP shocks and shocks to the disutility of labour to match model-based projections to external projections from other sources. We use this approach to align the model to the key results in Malliaropoulos et al. (2021); see Appendix D for details.

where $g_t^I = g^I + \varepsilon_t^{I,RRP}$ is the total public investment expenditure, including the RRP investment spending; $\delta \in (0, 1)$ is the depreciation rate; and $\epsilon \in (0, 1]$ governs the efficiency of public investment. Higher public investment expenditure translates into higher capital stock, which in turn increases the marginal product of private capital. Similarly, reforms directly increase the marginal product of capital. Higher marginal product of capital incentivises the private sector to match higher public expenditure with more private investments.

The increase in public investment and total factor productivity also lifts domestic interest rates, since the domestic risk-free interest rate is linked to the expected return on domestic private physical capital (in both sectors) through:

$$R_t = (1 - \delta_i) + E_t \left[(1 - \tau^k)(1 - \theta_{t+1})(1 - \alpha_i)p_{i,t+1} \frac{y_{i,t+1}}{k_{i,t}} \right] \quad \text{for } i = T, NT$$

where zero adjustment costs are assumed for simplicity, R_t is the gross interest rates on domestic bonds, $(1 - \tau^k)(1 - \theta_t)(1 - \alpha_i)p_{i,t} \frac{y_{i,t}}{k_{i,t-1}}$ is the marginal product of capital in traded and non-traded good sectors. The marginal product of capital is subject to a constant distortionary capital tax τ^k and a capital market distortion θ_t , which lowers investment. The degree of distortions reacts to the reforms under the RRP/RRF:

$$\frac{\theta_t}{\bar{\theta}} = \exp(-\eta_\theta(k_{G,t-1} - \bar{k}_G))$$

where η_θ governs the sensitivity between public investment scale-ups and distortions. This relationship basically allows the model to capture the positive effects of the RRP/RRF public-investment surge on private investment. The surge in public investment will lower distortions (and increase in rates of returns) and stimulate private investment in productive capital in the economy.

Households

The model incorporates two types of households. Both optimising households and rule-of-thumb (RoT) households optimally set their labour supply. The RRP/RRF contains various reforms aimed at upskilling the labour force, reducing labour market barriers (e.g., in healthcare), and expanding childcare services. These measures are modelled through a shock to the disutility of labour, which boosts employment and lowers the real wage at which households are willing to work (see Malliaropoulos et al.,2021). Formally, the household's labour supply is given by:

$$\varepsilon_t^k \kappa^j = \lambda_t^j (1 - \tau^L) w_t (L_t^j)^{-\psi} \quad \text{for } j = OPT, ROT$$

where L_t^j is the labour supply by each household type, w_t is the aggregate wage index, τ^L is the labour tax, λ_t^j is the marginal utility of consumption, and $\psi \geq 0$ is the inverse of Frisch elasticity of labour supply. $\kappa^j > 0$ is a parameter affecting the disutility of labour, while ε_t^k is a shock to the disutility of labour from structural reforms. Negative values of ε_t^k increase the labour supply and put downward pressure on wages.

The response of aggregate consumption to a positive shock to productivity and investment depends on several factors. Optimising households maximise life-time utility. Anticipating higher future income due to the RRP/RRF, they will want to increase current consumption. On the other hand, higher real domestic interest rates and the anticipated changes in the consumption tax rate are reasons to defer consumption to later periods. The relative strength of these two opposing channels is determined by the degree of risk aversion (Fournier and Koske, 2010). The Euler equation is as follows:

$$\left(\frac{c_{t+1}^{OPT}/i_{t+1}}{c_t^{OPT}/i_t} \right)^\sigma = \beta R_t \frac{(1 + \tau_t^c)}{(1 + \tau_{t+1}^c)} \left(\frac{i_{t+1}}{i_t} \right)^{-\sigma}$$

where c_t^{OPT} denotes consumption of the optimising households, i_t denotes income of the optimising household, τ_t^c is a distortionary consumption tax rate. $\sigma \geq 0$ and $\beta \in (0, 1)$ are the risk aversion parameter and the discount factor respectively. Larger values of σ amplify the impact of tax and interest rate changes on consumption.

RoT households do not respond to anticipated improvements in productivity, which dampens the relationship between aggregate consumption and future productivity gains. RoT households are unable to smooth consumption over time. Aggregate consumption is given by:

$$c_t = \omega c_t^{OPT} + (1 - \omega) c_t^{ROT}$$

where c_t^{ROT} is the consumption of the RoT household and ω is the share of optimising households. Consumption of the representative RoT household rises only when income rises or when consumption taxes are lowered. The introduction of user fees for public capital and the reduction in wages due to labour market reforms exert downward pressure on current income:

$$c_t^{ROT} = \frac{(1 - \tau^L) w_t L_t^{ROT} + s_t r m + z - \mu k_{G,t-1}}{(1 + \tau_t^c)}$$

where s_t is the real effective exchange rate, rm_t^* are remittances received from abroad, z denotes government transfers, and $\mu k_{G,t-1}$ are the user fees for using government infrastructure. Lower values of ω reduce the positive relationship between aggregate consumption and future income growth.

Relative prices

Relative prices play an important role in determining the effects of the RRP/RRF. The model explicitly considers three relative prices for goods: the price of domestically produced traded good $p_{TH,t} \equiv \frac{P_{TH,t}}{P_t}$, the price of non-traded good $p_{N,t} \equiv \frac{P_{N,t}}{P_t}$, and the real effective exchange rate $s_t \equiv \frac{P_{F,t}}{P_t}$, which reflects the domestic price of the foreign (imported) good. These relative prices are directly linked to the composition of demand, and therefore affect exports and imports.

A key determinant of relative prices is the home bias in private and public expenditure. Increases in consumption and investment due to the RRP/RRF, whether public or private, generally raise prices of domestically produced goods. However, relative prices in one sector may rise more than in another due to expenditure bias. For example, consider the relative demand functions for private consumption:

$$\begin{aligned} p_{N,t}^\chi c_{N,t} &= \varphi c_t \\ p_{T,t}^{\chi-\chi^T} p_{TH,t}^{\chi^T} c_{T,t} &= \varphi^T (1 - \varphi) c_t \end{aligned}$$

where $c_{T,t}$ and $c_{N,t}$ denote the domestic consumption of traded and non-traded goods, respectively. The parameter $\varphi \in (0,1)$ indicates the share of non-traded goods in aggregate consumption, and $\varphi^T \in (0,1)$ denotes the share of domestically produced tradable goods in the total consumption of traded goods.² The response of relative prices in two sectors of the economy (to an increase in aggregate consumption) is governed by the respective spending biases and the intra-temporal elasticities of substitution: $\chi > 0$ for traded vs. non-traded goods, and $\chi^T > 0$ for domestically produced vs imported traded goods. The impact of RRP on exports is higher when the share of non-traded goods φ is larger than the share of traded goods $\varphi^T (1 - \varphi)$ in aggregate consumption. A similar logic applies to biases in investment and government expenditure, which we exclude here to avoid redundancy.

Changes in labour market also affect relative prices. On the demand side, higher productivity lifts sectoral output, lowers relative prices, raises labour demand, and increases average wage in both sectors through:

² The total steady-state home bias in domestic consumption is given by $\varphi^T (1 - \varphi) + \varphi$.

$$\frac{w_{i,t}L_{i,t}}{p_{i,t}} = \alpha_i y_{i,t} \quad \text{for } i = T, NT$$

where $w_{i,t}$ is the average sectoral wage and $\alpha_i \in (0,1)$ is the labour share in production. A higher α_i leads to a larger wage increase.

On the supply side, the labour market reforms increase the supply of labour in the two sectors, lowering wages and prices through:

$$\left(\frac{w_{i,t}}{w_t}\right)^{-\rho} L_{i,t} = \theta_i L_t \quad \text{for } i = T, NT$$

where $\theta_i \in (0,1)$ denotes the steady-state share of each sector's aggregate labour supply, and $\theta_T + \theta_N = 1$, and $\rho \geq 0$ governs the degree of labour mobility. Higher θ_i translates into larger reduction in wages following labour market reforms. The model accounts for differences in labour share in output and imperfect mobility between sectors, allowing for asymmetric effects on sector prices and changes in relative prices due to the RRP/RRF.

External sector

The trade balance reflects the relative response of domestic absorption and output, which in turn depends on composition of the RRP/RRF—such as the split between public investment and consumption, the impact on labour disutility and productivity. Formally, the resulting trade balance can be represented as:

$$tb_t = y_t - c_t - i_t - p_t^G (g^I + g^C) - \Theta_t^{OPT*}$$

where $tb_t \equiv p_{TH,t}x_t - s_t m_t$ represents the trade balance, which is equal to total exports minus total imports, expressed in terms of the domestic consumption basket price. y_t denotes aggregate output, $p_t^G (g^I + g^C)$ is total government expenditure (including spending under the RRP/RRF), c_t and i_t are aggregate consumption and investment, respectively. Θ_t^{OPT*} are portfolio adjustment costs.

However, the current account also depends on primary and secondary income flows, such as those associated with the RRP/RRF and the costs for servicing Greece's external debt:

$$ca_t^d = tb_t + s_t rm_t + s_t gr_t^* - (\bar{R}_d - 1)s_t d_{t-1} - (R_{dc,t-1} - 1)s_t d_{c,t-1} - (R^* - 1)s_t b_{t-1}^*$$

where $s_t rm_t^*$ denote net remittances, $s_t gr_t^*$ denote official grants, $(R^* - 1)s_t b_{t-1}^*$ are interest payments on external private debt, while $(\bar{R}_d - 1)s_t d_{t-1}$ and $(R_{dc,t-1} - 1)s_t d_{c,t-1}$ are interest payments on external public commercial and concessional debt, respectively.

The sign and magnitude of the current account balance response, combined with the valuation changes stemming from real effective exchange rate adjustments, determine the path of the NIIP during and after the implementation of the RRP/RRF:

$$NIIP_t = \frac{s_t}{s_{t-1}} NIIP_{t-1} + \frac{ca_t^d}{s_t}$$

Improvement in the current account balance has an additional effect on the NIIP through the financial account. In turn, the financial account depends on fiscal policy, as any fiscal surpluses are used to repay external public debt. Formally:

$$ca_t^d = s_t fa_t = s_t (\Delta d_t + \Delta d_{c,t} + \Delta b_t^*)$$

where fa_t is the financial account balance, b_t^* is the external private debt, while $d_{c,t}$ and d_t are the external public concessional and commercial debt, respectively. Δ denotes the first difference of a variable.

Fiscal rule and debt repayment

The reaction of fiscal policy to the stimulus generated by the RRP/RRF is a critical factor for the trajectory of the external position. Expansionary fiscal policies can fuel consumption and imports, create wage pressures that undermine exports, and reduce the resources available to the government to repay foreign debt. The government uses distortionary consumption taxes to adjust the fiscal balance with a lag to deviations from a balanced budget rule, which is equivalent to stabilising the debt-to-GDP ratio over the long term:

$$\tau_t^C - \tau_{t-1}^C = \zeta \left(\bar{\tau}^C + \frac{GAP_t}{c_t} - \tau_{t-1}^C \right)$$

where $\frac{GAP_t}{c_t}$ is the deviation from the target position of a balanced budget (positive values correspond to a fiscal deficit), relative to consumption, and $\zeta \geq 0$ is the parameter that governs the speed with which the government closes the fiscal gap through changes in consumption taxes. We assume that consumption taxes are the only domestic fiscal instrument available to the government to stabilise debt. The logic of the rule is that the government raises (cuts) the tax rate in response to increases (decreases) in the fiscal deficit but does so gradually.

Public debt therefore accommodates a temporary mismatch between revenues and expenditures. The government chooses between domestic and external commercial debt according to:

$$\kappa \Delta b_t = (1 - \kappa) s_t \Delta d_{c,t}$$

where $\kappa \in [0,1]$ governs this split, such that only external commercial debt is used to cover the fiscal gap when $\kappa = 1$. The responsiveness of the tax rate to (unexpected) changes in fiscal balances affects the external position through several channels. For example, if the tax rate drops quickly in response to fiscal surpluses (corresponding to a negative fiscal gap), aggregate consumption will increase. The intertemporal profile of the boost to consumption, however, depends on the entire expected path of fiscal surpluses. Additional cuts in the tax rate in the future encourage optimising households to shift some of their consumption to later periods (the trajectory of future tax rates is downward sloping). Tax adjustment also affects labour supply, as the marginal utility of consumption falls relative to the marginal utility of leisure, driving up wages. The subsequent reduction in labour input diminishes the marginal product of capital, thereby moderating the surge in private investment.

Higher wages, in turn, weaken exports and increase imports as the real exchange rate appreciates. Additionally, tax cuts result in smaller fiscal surpluses, which curtails the reduction in foreign debt and limits the improvement in the financial account.

Private capital inflows

More foreign borrowing amplifies the positive response of consumption during the initial phase of the RRP/RRF. In our setup, capital flows depend on macroprudential policies, which we capture through the parameter that governs the costs of issuing bonds to foreigners.

As domestic interest rates increase, the relative cost of borrowing from abroad declines, with the foreign interest rate fixed at R^* . The inflow of foreign capital causes the real exchange rate to appreciate. This stimulates imports (relative to the demand for domestically-produced goods) and weighs on exports. The strength of this channel depends on the elasticity of portfolio adjustment costs $\eta^* > 0$ through:

$$R_t = E_t \left[\frac{s_{t+1} R^*}{s_t - \eta (b_t^{OPT*} - b^{OPT*})} \right]$$

where $b_t^{OPT*} = \frac{b_t}{\omega}$ is the stock of foreign debt by the optimising households. These adjustment costs represent any extra costs the private sector faces when borrowing from abroad. In our interpretation, they depend on macroprudential policies that are a significant determinant of the costs of foreign borrowing. Looser macroprudential policies lower the costs of foreign borrowing, leading to an increase in private external debt.

Exports penetration and the terms of trade

The RRP/RRF affects exports through its effect on the supply of output of the traded sector and the relative demand for foreign goods. Formally:

$$\frac{x_t}{\bar{y}} = \left(\frac{s_t}{p_t^{TH}} \right)^{\chi^x}$$

where $\frac{s_t}{p_t^{TH}} = \frac{P_t^F}{P_t^{TH}}$ represents the terms of trade, \bar{y} is the external demand (exogenous to the model), and χ^x governs the sensitivity of exports to a change in the terms of trade. A lower χ^x implies that a larger reduction in relative prices is needed to achieve a given boost to exports—we think of the parameter as measuring the ease of export penetration in world markets.

If the RRP/RRF succeeds in lowering the relative price of domestically-produced tradeable output, exports will increase. If export penetration is challenging (implying a larger value for χ^x), the relative price decline will be larger, which entails: (i) a larger shift of domestic demand toward traded goods; (ii) lower wages and labour income in the tradeable sector; and (iii) lower marginal productivity of capital and lower investment. Higher domestic demand for traded goods, combined with reduced output in the traded sector, can (partly) offset the decline in demand for imports, limiting the improvement in the overall trade balance.

Before proceeding to the discussion of the calibration and results, we highlight several significant limitations of the DIG model. First, foreign direct investment is omitted from the model, and the RRF/RRP only affects domestic investment endogenously through higher public capital and productivity. Second, the model assumes complete markets domestically, ignoring the role of precautionary savings in the evolution of the savings-investment balance. Third, the model does not consider the possibilities of defaults and sudden stops, which means borrowing behaviour and conditions do not reflect these risks (for example, Mendoza, 2010; and Bianchi, 2011; incorporate these risks and show that they can lead to more cautious borrowing behaviour and higher current account balances than our model predicts). Fourth, the model does not cover the informal sector, which could amplify the benefits of the RRP. We recognise these limitations, and we leave their exploration in the DIG model for future research.

5. *PARAMETRISATION AND THE RRP/RRF SHOCK*

The RRP/RRF is at its core a significant ramp-up in public capital. The financial flows from the RRF (disbursements of grants and loans to Greece, as well as the associated spending by the government) correspond to the most recent publicly available schedule (Hellenic Republic, 2024). We model the RRP/RRF as follows: (i) grants of €18.2 billion lead to an increase in public investment; (ii) loans of €17.7 billion increase external liabilities in line with the current disbursement schedule and are carried forward indefinitely (as the repayment schedule is not fixed yet); (iii) reforms under the RRP lift TFP, reduce distortion in the marginal product of capital, and reduce the disutility of labour. The grant spending splits into 2/3 public investment spending and 1/3 public consumption (in line with current government plans).

We are interested to explore the case where the RRP/RRF is maximally efficient, delivering a permanent boost to output, productivity, and employment. The most optimistic study on the possible long-run effects of the RRP/RRF in Greece is from Malliaropoulos et al. (2021). We calibrate the impact on TFP and employment to match exactly the profile for GDP and employment from 2021 to 2030 in Malliaropoulos et al. (2021) (see Appendix C). According to their results, the overall effect of the RRP/RRF on GDP and employment is 7 and 3.9 percent (relative to the initial steady state), respectively, over a period of ten years.

The model is calibrated at an annual frequency by matching the steady state to the data on the Greek economy. The risk aversion parameter σ is set at 1.78, to match the intertemporal elasticity of substitution estimated for Greece in Havranek et al. (2015). Following Papageorgiou (2014), we assume that 65% of households are optimisers, the inverse-Frisch elasticity ψ is 1, and the output elasticity to public capital α_G is 0.0316.

The allocation of private demand across traded, non-traded, and imported goods is calibrated using Papageorgiou (2014), with home bias in consumption at 0.6697 and investment at 0.3457. 20% of traded goods demand is met by domestic firms ($\varphi^T = 0.2$). The elasticity of substitution between non-traded and traded goods ($\chi = 3.7005$) is from Papageorgiou (2014), and the elasticity of substitution between domestic traded and imported goods $\chi^T = 0.9$, reflecting limited substitutability.

Labor income shares in the traded and non-traded sectors are consistent with the economy-wide labour share of 0.6323, following Papageorgiou (2014). We assume that the traded sector is slightly more labour-intensive than the non-traded sector with $\alpha_T = 0.7$ and $\alpha_N = 0.56$.

The steady-state efficiency of public investment is set at 100%, suggesting that public investment projects are selected and implemented without waste. To account for the positive impact of the loan-financed component of the RRP on private investment, we set the adjustment costs for private capital at 5—only one-fifth of the value used by Melina et al. (2016). Exports are assumed to be responsive to the terms of trade, with an export penetration parameter χ^x of 2.5. The government's fiscal response to changes in the fiscal gap is small, with the fiscal reaction parameter ζ set to 0.02. This implies that the government accommodates changes in the fiscal gap primarily through net external borrowing—in our baseline, this assumption means that the government uses fiscal surpluses derived from the RRP/RRF for the repayment of external debt (i.e. we set $\kappa = 1$). Finally, optimising households face significant portfolio adjustment costs that limit their foreign borrowing under the baseline, with η^* set at 1.

Table 2 presents key parameter values necessary to pin down the steady state. Additional parameters follow Melina, Yang, and Zanna (2016).

Table 2. Baseline calibration

Definition	Value	Definition	Value
Initial Values			
Exports to GDP	0.3805	Domestic real interest rate	0.0102
Imports to GDP	0.3983	Real interest rate on external commercial Debt	0.0102
Government consumption to GDP	0.2013	Real Risk-Free Rate	0.0001
Government investment to GDP	0.0342	Foreign real interest rate on savings	0.0001
Private investment to GDP	0.0911	Real Interest rate on concessional debt	0.0000
Government domestic debt	0.2004	Labour income tax rate	0.30*
Private foreign debt to GDP	0.4935	Consumption tax rate	0.18*
Government external commercial Debt	0.7123	Tax rate on capital Income	0.20*
Concessional debt	0.9090	Share of non-traded goods in private demand	0.5339
Government revenue to GDP	0.4539	Share of domestic traded goods in overall traded goods consumption rate	0.2000
Grants to GDP	0.0031	Share of non-traded goods in government procurement	0.5214
Long-run GDP growth	0.0154	Share of domestic traded goods in overall traded goods procurement	0.2000
Parameters			
Labour income share in non-traded sector	0.56	Share of Optimising households	0.65*
Labour income share in traded sector	0.7	Elasticity of portfolio adjustment costs	1
Labour supply share to the non-traded sector	0.4750	Elasticity of substitution between traded domestic and imported Goods	0.9
Private capital depreciation rate	0.0670*	Elasticity of sovereign risk	0
Investment adjustment cost	5	Output Elasticity to public capital	0.0316*
Inverse of Frisch labour elasticity	1*	Depreciation rate of public capital	0.0421*
Risk aversion	1.78**	Steady-State efficiency of public investment	1
Intra-temporal substitution elasticity of labour (b/w T/NT)	0.5	Elasticity of exports to terms of trade	2.5
Elasticity of substitution between traded and non-traded goods	3.7005*	Elasticity of investment distortion to RRP/RRF	0.5
Fiscal adjustment share by consumption tax	1	Adjustment share by external commercial debt (relative to domestic debt)	1
Fiscal adjustment share by labour tax	0	Adjustment speed of consumption tax to target	0.02
Labour tax response to debt/GDP	0	Consumption tax response to debt/GDP	0
Adjustment speed of government consumption to target	1	Adjustment speed of labour tax to target	1
Fiscal adjustment share by transfers	0	Fiscal adjustment share by government consumption	0
Transfers response to debt/GDP	0	Government consumption response to debt/GDP	0
Adjustment speed of transfers to target	1		
Note: * Papageorgiou (2014); ** Havranek et al. (2015).			

6. BASELINE RESULTS

Given our assumptions, the basic macroeconomic narrative of our baseline scenario is straightforward (Figure 6 and Appendix B shows key macroeconomic variables under the baseline scenario). The new public investments under the RRF/RRP increase the stock of public capital, which in turn increases productivity of private capital and labour. Expected returns on capital increase, which puts upward pressure on domestic interest rates. As firms in traded and non-traded sectors build up their private capital stocks, diminishing returns on private capital set in while effect of productivity-inducing reforms slows down. Consequently, the expected marginal product of capital, Tobin's Q, and domestic interest rates decline over time.

Aggregate consumption initially rises rapidly, then much slower. Optimising households, anticipating higher future income, prefer to smooth their consumption over time. Facing lower rates abroad, households borrow against their future income, increasing foreign private debt to finance the initial consumption surge. Meanwhile, rule-of-thumb households gradually increase consumption, driven only by rising incomes and a reduction in the consumption tax rate. Labor market reforms play a key role in shaping early labour market outcomes, initially reducing real wages. This, combined with higher labour force participation, stimulates output while containing the growth of aggregate consumption.

Investment adjustment costs represent a friction that slows down the accumulation of capital by firms, dampening output growth and allowing domestic absorption to outpace—partly due to the rapid scale-up of government expenditure and debt-financed consumption. As productivity gains and wage compression reduce the relative price of traded goods, exports gradually increase. However, the lower labour intensity of non-traded goods translates into a smaller wage compression in the sector. This, combined with the larger share of non-tradables in consumption, initially pushes up the relative price of non-traded goods, leading to a rise in imports. The initial increase in imports outweighs the rise in exports, worsening the trade balance as domestic absorption exceeds output. Over time, as productivity gains materialise fully, domestic goods become more attractive, reducing the share of imports in domestic demand. The larger economic pie also gives a significant boost to tax collection through permanent increases in consumption and employment, as well as a temporary higher capital rents.

We now turn to the dynamics of national savings, the current account, and the net international investment position. Figure 4 illustrates our main results: private savings increase *temporarily* but public savings are *permanently* higher. During the implementation of the RRF/RRP, private savings rise

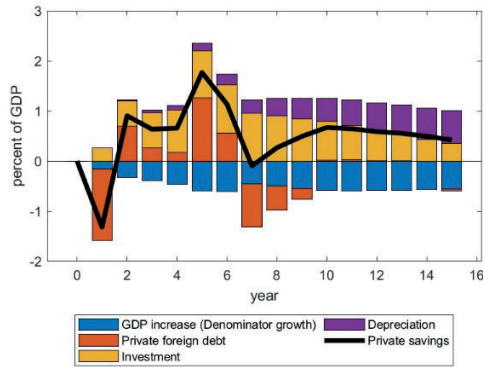
as much as 1.8 percentage points of GDP, mostly due to savings in the form of new capital (reflecting the ramp-up in investment). However, over time, private savings (relative to GDP) revert close to the initial levels as investment in new capital tapers off. A constant fraction of the new higher capital stock requires replacing every year, which stabilises private savings as a share of GDP over the long run. In contrast, public savings increase permanently because the government uses the increase in tax revenue and the relative decline in expenditures (relative to GDP) to boost fiscal balances, which then enable the repayment of outstanding external liabilities. The decline in public external debt therefore reflects the muted reaction of fiscal policy to changes in the fiscal gap in equation (4).

Greece's external position improves substantially, mirroring the permanent increase in national savings. The current account balance improves by 2 percent of GDP by 2035.³ The impulse to the current account generated by the RRF/RRP peaks at around 12 years after the start of the RRP and then gradually falls. This current account trajectory lends itself to a convenient interpretation. Consider that the most recent IMF WEO projections forecast a deficit of about 3 percent of GDP by 2029. The IMF's projection is conservative (less optimistic) in the assumed impact of the RRP/RRF on the level of GDP over the medium term. The effects we use to anchor our baseline scenario are significantly larger. The impact on the current account simulated by our model suggests that current account projections for the year 2029 with a more optimistic assumption about the success of the RRP/RRF may well be (much) closer to balance. The flipside of a permanently higher current account is the considerably more favourable net international investment position. The response of the NIIP-to-GDP ratio is on a steady upward trajectory, reaching close to 30 percent of GDP after 15 years. The bulk of the improvement owes to the repayment of public external debt. A partial negative offset comes from negative valuation effects (due to the depreciation of the real exchange rate) and the new RRF-related liabilities, which are carried forward indefinitely.

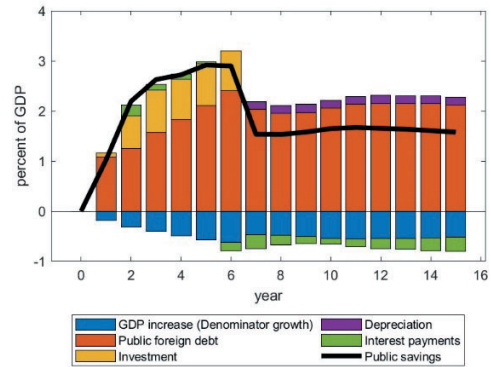
³ The current account does not deteriorate despite a reduction in the trade balance during the first six years of the RRF/RRF. Higher government expenditures on imports are funded by RRF-grants, neutralising the direct impact of the RRF/RRF on the current account.

Figure 4: Decomposition of RRP impact under the baseline scenario (in % of GDP)

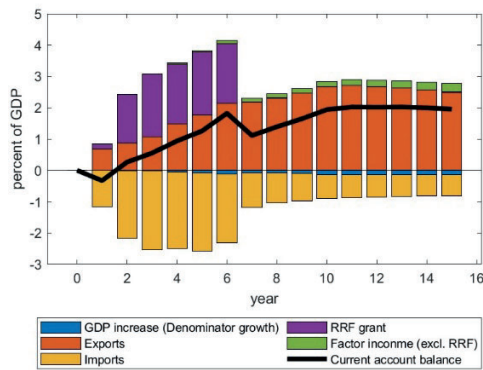
4.a Private savings



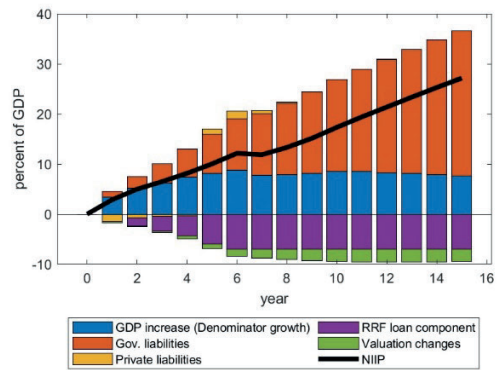
4.b Public savings



4.c Current account



4.d Net international investment position



Note: The top-left chart shows gross private savings, and the top-right chart shows public savings. The bottom-left chart shows the current account, and the bottom-right chart shows the net international investment position. All charts are expressed in percent of GDP and are measured relative to the initial steady state. Gross private savings in period t can be represented as the sum of the change in domestic bond holdings of households and investment in physical capital by firms in traded and non-traded good sectors less the change in external borrowing by households, i.e. $\Delta B_t + I_{T,t} + I_{N,t} - s_t \Delta B_t^*$. Gross public savings are the sum of government investment expenditure and repayment of public debt, i.e. $P_t^G I_t^G - \Delta B_t - s_t (\Delta D_t^C + \Delta D_t)$.

Source: Authors' calculations.

7. POLICY EXPERIMENTS

We acknowledge that our results in the preceding section paint an optimistic picture of Greece's prospects for rebalancing its external position. Are they too good to be true? This section substantiates why the answer may be affirmative. The second main result of our paper is that a successful RRP/RRF by itself is not enough to guarantee a return to external sustainability, even under optimistic assumptions regarding the productive nature of additional government spending and reforms. The large improvement in the external position is not pre-ordained, and economic outcomes over the long run critically depend on domestic policies. If economic policies do not prioritise savings and the reduction of external debt, Greece's external position would not necessarily improve relative to a scenario without the RRP/RRF. Through the lens of our model, supporting policies in three areas play a critical role to lock-in the positive impact on the external sector: (i) fiscal policy; (ii) macroprudential policy; and (iii) structural policies. Let us consider different policy settings in three alternative scenarios.

Scenario 1: fiscal slippages

This alternative scenario imagines a systematically different conduct of fiscal policy. Instead of channelling the "fiscal dividend" (the area under the baseline fiscal balance trajectory) towards repaying public external debt, the government may decide to lower distortionary taxes. We capture this idea by increasing the fiscal reaction parameter ζ to 0.25, making the consumption tax rate more responsive to rising tax revenues. While this improves fiscal balance and reduces public debt, the government responds to the accumulating surplus by cutting taxes, which slows the repayment of outstanding debt.

The result is higher aggregate consumption, reduced labour supply, and increased wages, which partly offset the reduction in domestic prices. This leads to higher imports and lower exports. Figures 5 and 6, along with Appendix B, illustrate the differences between our baseline and fiscal slippage scenario. Public external debt remains significantly higher—by over 20 percentage points of GDP—15 years into the RRP.

We emphasise that we abstract from the welfare analysis in this scenario. Using surplus tax revenue to cut distortionary tax rates stimulates domestic demand and consumption over and above the already strong impulse from the RRP/RRF. Household consumption is permanently higher, which under some household preferences could outweigh the positive effects from reducing external vulnerabilities by means of a higher net international investment position. Our scenario simply shows that if fiscal policy prizes other objectives in addition to external debt reduction, the improvement of Greece's external position arising from a successful RRP/RRF would diminish. In the *fiscal slippages*

scenario, the current account fails to improve relative to the initial steady state, and the net international investment position is only higher by about 5 percent of GDP (compared to the improvement under the baseline of around 27 percent of GDP).

Scenario 2: unproductive capital inflows

This scenario imagines that the costs for households when borrowing abroad diminishes. Under the baseline, optimising households borrow little in anticipation of rising incomes. Lower portfolio adjustment costs will amplify the increase in consumption and produce a larger increase in foreign private debt. To explore this channel, we lower the portfolio adjustment costs parameter to $\eta^*=0.0001$ (instead of 1 in the baseline).

Figures 5 and 6 show that with lower adjustment costs, households borrow more to smooth consumption in anticipation of future income growth. This higher consumption drives up domestic prices, particularly for non-traded goods, raising wages and worsening the trade balance due to increased imports. Private debt inflows also put pressure on the exchange rate to appreciate and minimise fluctuations in interest rate differentials. After 15 years, households would borrow an additional 10 percent of GDP, with this borrowing used solely for consumption—hence the term "unproductive capital inflows."

The recent economic history of Greece is a good example of how capital inflows can be misallocated and ultimately fail to boost productivity. In the period from joining the European Monetary Union to the Global Financial Crisis, Greece experienced large inflows (much of it short-term) into real estate, construction, and financing of ambitious expansions outside Greece (such as overseas mergers and acquisitions). In addition to fuelling a domestic consumption boom, unproductive inflows can have other undesirable economic effects (though not in our model) such as asset price bubbles and resource misallocation. If, by contrast, external borrowing takes the form of (productive) foreign direct investments, it could help further boost productivity through technology diffusion and deeper (human) capital. Conceptually, we interpret the parameter of portfolio adjustment costs as costs arising from macroprudential policies that affect the activities of the domestic banking sector. Macroprudential policies can generally be effective in influencing the ability of the domestic economy to borrow from abroad and in influencing the composition of the inflows (Ostry et al., 2011). This scenario drives home an important policy insight: a successful RRP/RRF, paradoxically, sows the seed of a new threat to external sustainability. Because of the expectation of a strong rise in income, households will preemptively increase consumption, due to the success of RRP in stimulating widespread productivity

growth. Domestic residents will have a growing incentive to borrow from abroad where interest rates are lower.

Scenario 3: Smaller export penetration

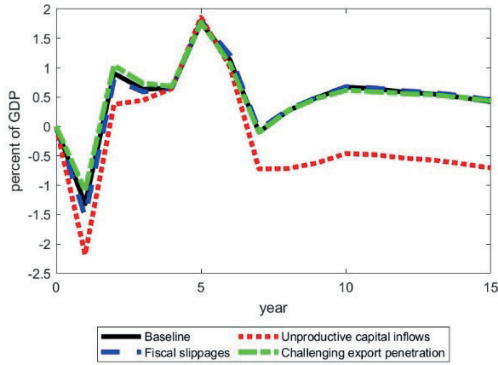
This scenario imagines that Greece's exporters have a more difficult time in penetrating world markets, compared to the baseline simulation. This situation could arise because some structural policies under the RRP/RRF that aim specifically at making Greek exports more competitive in world markets are only partially implemented. In our model, we lower the elasticity of exports to the real effective exchange rate to $\chi^x = 1$ to explore the effects of a structural decline in export competitiveness.

Figures 5 and 6, along with Appendix B, show that the lower prices in the traded sector, necessary to deliver an increase in exports, reduce wages, which, under limited labour mobility, lowers household incomes and consumption. Domestic demand shifts from imports to domestic goods, but output in the traded sector also declines due to reduced labour supply. This leads to a deterioration in the trade balance, as lower output in the traded sector and higher domestic consumption of traded goods dominate the reduction in imports.

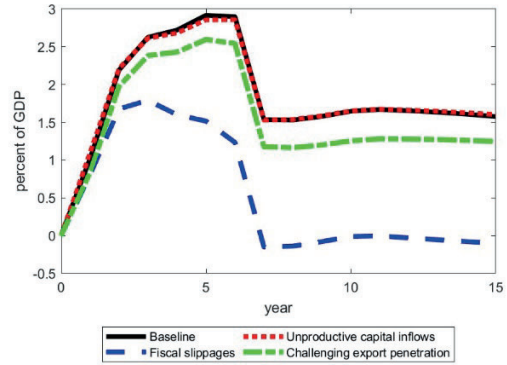
The depreciation of the exchange rate increases the negative valuation effect on external debt, reducing the improvement in the current account. As a result, the NIIP improves by significantly less than in the baseline scenario, by about 16 percentage points compared to the improvement under the baseline of 26 percentage points.

Figure 5: RRP/RRF impact under alternative scenarios (in % of GDP)

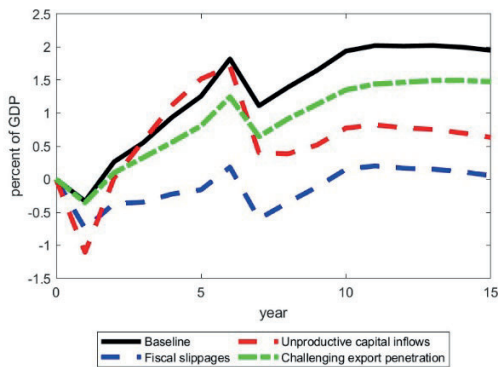
6.a Private savings



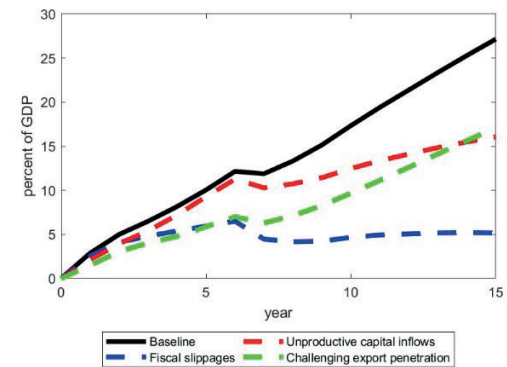
6.b Public savings



6.c Current account balance



6.d Net international investment position

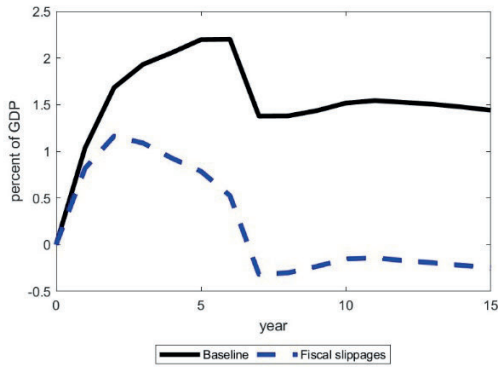


Note: The top-left chart shows the current account balance, and the top-right chart shows gross public savings. The bottom-left chart shows gross private savings, and the bottom-right chart shows the net international investment position. All charts are expressed in percent of GDP and are measured relative to the balanced growth path (which does not enjoy the benefits of the RRP/RRF).

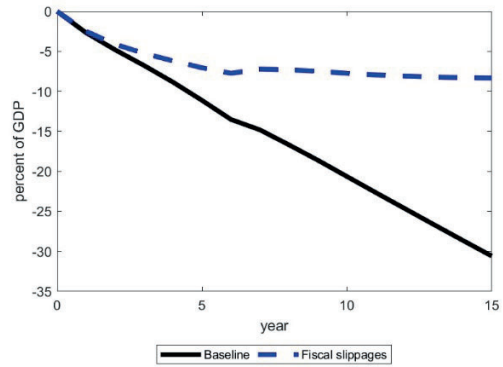
Source: Authors' calculations.

Figure 6: Fiscal policy and debt and the real exchange rate under alternative scenarios

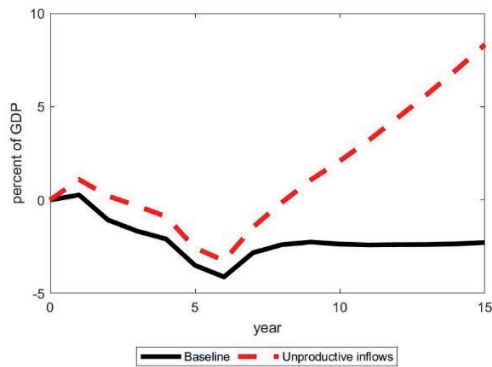
5.a Fiscal balance



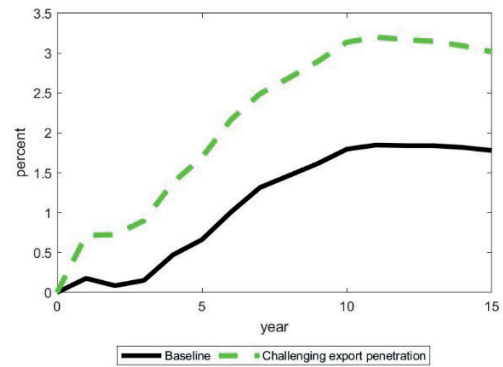
5.b External public debt



5.c External private debt



5.d Real exchange rate



Note: The top-left chart shows the public primary balance, and the top-right chart shows public external debt. The bottom-left chart shows private external debt, and the bottom-right chart shows a change in the index of the real exchange rate (increase means depreciation). All charts except the real exchange rate are expressed in percent of GDP and are measured relative to the initial steady state (which does not enjoy the benefits of the RRP/RRF). The real exchange rate growth is measured in percent deviations from the initial steady state.

Source: Authors' calculations.

8. DISCUSSION AND CONCLUSION

The RRP/RRF carries great promise for the Greek economy. But is a successful RRP/RRF enough to right Greece's external imbalances? Our baseline results show that the RRP/RRF can structurally boost the external position. A successful RRP/RRF that permanently boosts productivity and employment would *permanently* lift domestic savings, mostly because of higher public savings. Private savings, however, react only *temporarily* and eventually revert to the pre-RRP/RRF trajectory.

Our policy scenarios nuance the optimistic findings under the baseline by emphasising that the effect of the RRP/RRF on national savings under our baseline is not pre-ordained. If successful, RRF-driven investments would raise tax revenues and increase the permanent income of households, loosening budget constraints and potentially stimulating unproductive expenditures. We explore the impact of more expansionary fiscal policies and of a surge in borrowing from abroad in alternative scenarios. Both would result in public and private external debt declining far less than in the baseline scenario. Our results do not pass a judgement about the optimality of these different spending patterns, but we highlight that they would entail renewed pressure on Greece's external position and undermine the positive impact of the RRP/RRF on resolving Greece's external imbalances.

The case for fiscal prudence that prioritises debt reduction is well-known and internalised in policymaking in Greece. However, the possibility of a new surge in foreign borrowing (capital inflows) has received less attention. Our paper serves as a call to study and prepare macroprudential policies for such capital inflows, which could be a natural byproduct of successful RRP/RRF investments. Macroprudential policies can help influence financial conditions during times of capital inflows with a view to dampen pro-cyclicality in borrowing.

Further research is needed to explore additional policy options aimed at improving Greece's external position through private sector savings. One promising area is encouraging private savings for retirement through more favourable tax incentives for contributions to the fully-funded auxiliary pension system, particularly for low- and middle-income households. Strengthening capital markets by promoting strong corporate governance, transparency, and investor protection is another. Finally, Greece could benefit from tilting the composition of portfolio inflows towards foreign direct investment (FDI). Given FDI's critical role in knowledge transfer and technological advancement, establishing a world-class regulatory framework for FDI and joint ventures, along with targeted incentives in strategic sectors such as advanced manufacturing, renewable energy, and research and development, could be highly effective.

REFERENCES

- Aligishiev, Zamid, Giovanni Melina, and Luis-Felipe Zanna. 2021. "DIGNAR-19 Toolkit Manual," *IMF Technical Notes and Manuals* 2021/007, International Monetary Fund.
- Aligishiev, Zamid and Flavien Moreau. 2024. "Diversification in Sight? A Macroeconomic Assessment of Saudi Arabia's Vision 2030." forthcoming. *International Economics*.
- Bańkowski, Krzysztof, Othman Bouabdallah, João Domingues Semeano, Ettore Dorrucchi, Maximilian Freier, Pascal Jacquinot, Wolfgang Modery, Marta Rodríguez Vives, Vilém Valenta, and Nico Zorell. 2022. "The economic impact of Next Generation EU: a euro area perspective." *ECB Occasional Paper* 2022/291.
- Becker, Sascha O., Peter H. Egger, and Maximilian Von Ehrlich. 2013. "Absorptive capacity and the growth and investment effects of regional transfers: A regression discontinuity design with heterogeneous treatment effects." *American Economic Journal: Economic Policy* 5, no. 4: 29-77.
- Berg, Andrew, Rafael Portillo, Shu-Chun S. Yang, and Luis-Felipe Zanna. 2013. "Public investment in resource-abundant developing countries." *IMF Economic Review* 61, no. 1: 92-129.
- Bianchi, Javier. 2011. "Overborrowing and Systemic Externalities in the Business Cycle." *American Economic Review* 101 (7): 3400-3426.
- Blanchard, Olivier, and Francesco Giavazzi. 2002. "Current Account Deficits in the Euro Area: The End of the Feldstein-Horioka Puzzle?" *Brookings Papers on Economic Activity* 2002, no. 2: 147-209.
- Brueckner, Markus, Evi Pappa, and Akos Valentinyi. 2023. "Geographic cross-sectional fiscal spending multipliers and the role of local autonomy: Evidence from European Regions." *Journal of Money, Credit and Banking* 55, no. 6: 1357-1396.
- Brueckner, Markus, Wojtek Paczos, and Evi Pappa. 2020. "On the relationship between domestic saving and the current account: evidence and theory for developing countries." *Journal of Money, Credit and Banking* 52, no. 5: 1071-1106.
- Canova, Fabio and Evi Pappa. 2007. "Price differentials in monetary unions: the role of fiscal shocks." *Economic Journal*, 117: 717-739.
- Canova, Fabio. 2004. "Testing for convergence clubs in income per capita: a predictive density approach." *International Economic Review* 45, no. 1: 49-77.
- Chinn, Menzie D., and Eswar S. Prasad. 2003. "Medium-Term Determinants of Current Accounts in Industrial and Developing Countries: An Empirical Exploration." *Journal of International Economics* 59, no. 1: 47-76.
- Chodorow-Reich, Gabriel, Loukas Karabarbounis, and Rohan Kekre. 2023. "The macroeconomics of the Greek depression." *American Economic Review* 113, no. 9: 2411-2457.
- Coelho, Maria. 2019. "Fiscal stimulus in a monetary union: Evidence from eurozone regions." *IMF Economic Review*, 67: 573-617.
- Deléchat, Corinne, John Clark JR, Pranav Gupta, Malangu Kabedi-Mbuyi, Mesmin Koulet-Vickot, Carla Macario, and Toomas Orav. 2015. "Harnessing resource wealth for inclusive growth in fragile states." *IMF Working Paper* 15/25. International Monetary Fund.
- Dellas, Harris, Dimitris Malliaropoulos, Dimitris Papageorgiou, and Evangelia Vourvachaki. "Fiscal policy with an informal sector." *Journal of Economic Dynamics and Control* 160 (2024): 104820.

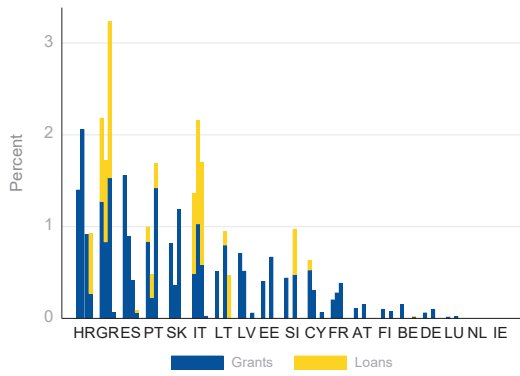
- European Commission (EC). 2021. "Recovery and Resilience Plan for Greece." https://ec.europa.eu/info/sites/default/files/greece-recovery-resilience-factsheet_en.pdf.
- . 2024a. "Mid-term evaluation of the Recovery and Resilience Facility." Commission Staff Working Document. Brussels: Publications Office of the European Union.
- . 2024b. "In-Depth Review 2024, Greece." Institutional Papers 281. Luxembourg: Publications Office of the European Union.
- . 2024c. "European Economic Forecast, Spring 2024." Institutional Papers 286. Luxembourg: Publications Office of the European Union.
- Feldstein, Martin, and Charles Horioka. 1980. "Domestic Saving and International Capital Flows." *The Economic Journal* 90, no. 358: 314-329.
- Financial Action Task Force (FATF). 2023. "International Standards on Combating Money Laundering and The Financing of Terrorism and Proliferation: The FATF recommendations." Paris: Financial Action Task Force.
- Fournier, Jean-Marc, and Isabell Koske. 2010. "A Simple Model of the Relationship Between Productivity, Saving and the Current Account," OECD Economics Department Working Papers 816, OECD Publishing.
- Giannone, Domenico, and Michele Lenza. 2010. "The Feldstein-Horioka Fact." In *NBER International Seminar on Macroeconomics 2009*, edited by Lucrezia Reichlin and Kenneth D. West, 103-117. Chicago: University of Chicago Press.
- GPFI (Global Partnership for Financial Inclusion) and World Bank. 2021. "The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19." https://www.gpfi.org/sites/gpfi/files/sites/default/files/5_WB%20Report_The%20impact%20of%20COVID-19%20on%20digital%20financial%20inclusion.pdf.
- Gurara, Daniel, Giovanni Melina, and L-F Zanna. 2019. "Some Policy Lessons from Country Applications of the DIG and DIGNAR Models." IMF Working Paper, WP/19/62. Washington: International Monetary Fund.
- Havranek, Tomas, Horvath, Roman, Irsova, Zuzana, and Marek Rusnak. 2015. "Cross-country heterogeneity in intertemporal substitution." *Journal of International Economics*, Volume 96, Issue 1, pp. 100-118.
- Hellenic Republic. 2023. Greece, Stability Programme 2023.
- International Monetary Fund (IMF). 2022. "Can Greece's Savings be Saved: Trends, Drivers, and Policy Implications". IMF Country Report No. 22/174.
- . 2024a. World Economic Outlook April 2024.
- . 2024b. Greece 2023 Article IV Consultation. IMF Country Report No. 24/23.
- Jann, B. (2022). VIOLINPLOT: Stata module to draw violin plots. Available from <https://ideas.repec.org/c/boc/bocode/s459132.html>.
- Karlan, Dean, Aishwarya Lakshmi Ratan, and Jonathan Zinman. 2014. "Savings by and for the Poor: A Research Review and Agenda." *Review of Income and Wealth* 60, no. 1: 36-78.
- La Porta, Rafael, and Andrei Shleifer. 2014. "Informality and Development." *Journal of Economic Perspectives* 28, no. 3: 109-126.

- Lane, Philip R., and Gian Maria Milesi-Ferretti. 2012. "External Adjustment and the Global Crisis." *Journal of International Economics* 88, no. 2: 252-265.
- Le Blanc, Julia, Alessandro Porpiglia, Federica Teppa, Junyi Zhu and Michael. Ziegelmeier. 2016. "Household saving behaviour in the Euro area". *International Journal of Central Banking* 12(2), 15-69.
- Lucas, Robert E., Jr. 1990. "Why Doesn't Capital Flow from Rich to Poor Countries?" *The American Economic Review* 80, no. 2: 92-96.
- Malliaropoulos, Dimitris, Papageorgiou, Dimitris, Vasardani, Melina, and Evangelia Vourvachaki. 2021. "The Impact of The Recovery and Resilience Facility on the Greek Economy." Economic Bulletin №53. Athens: Bank of Greece.
- Medina, Leandro, and Friedrich Schneider. 2018. "Shadow Economies Around the World: What Did We Learn Over the Last 20 Years?" IMF Working Paper WP/18/17.
- Mendoza, Enrique G. 2010. "Sudden Stops, Financial Crises, and Leverage." *American Economic Review* 100 (5): 1941-66.
- Melina, Giovanni, Shu-Chun S. Yang, and Luis-Felipe Zanna. 2016. "Debt sustainability, public investment, and natural resources in developing countries: The DIGNAR model." *Economic Modelling* 52 (2016): 630-649.
- Milesi-Ferretti, Gian Maria, and Assaf Razin. 1996. "Current Account Sustainability." *Princeton Studies in International Finance*, no. 81.
- Obstfeld, Maurice, and Kenneth Rogoff. 1995. "The Intertemporal Approach to the Current Account." In *Handbook of International Economics*, vol. 3, edited by Gene M. Grossman and Kenneth Rogoff, 1731-1799. Amsterdam: Elsevier.
- Organisation of Economic Co-operation and Development (OECD). 2024. *OECD Economic Outlook, Volume 2024 Issue1*, OECD Publishing, Paris.
- Ostry, Jonathan D., Atish R. Ghosh, Marcos Chamon, and Mahvash S. Qureshi. 2011. "Capital controls: when and why?" *IMF Economic Review* 59: 562-580.
- Papageorgiou, Dimitris. 2014. "BoGGEM: a dynamic stochastic general equilibrium model for policy simulations." Working Papers 182, Athens: Bank of Greece.
- Pfeiffer, Philipp, Janos Varga, and Jan in 't Veld. 2023. "Quantifying Spillovers of Coordinated Investment Stimulus in the EU." *Macroeconomic Dynamics* 27, no. 7: 1843–65. <https://doi.org/10.1017/S1365100522000487>.
- Schmitt-Grohé, Stephanie, and Martín Uribe. 2003. "Closing Small Open Economy Models." *Journal of International Economics* 61 (1): 163-185.
- Schneider F. and A. Asllani, 2022, "Taxation of the Informal Economy in the EU," Policy Department for Economic, Scientific and Quality of Life Policies - A Study for the European Parliament.
- Schneider, Friedrich. 2015. "Size and Development of the Shadow Economy of 31 European and 5 other OECD Countries from 2003 to 2015: Different Developments." *Journal of Self-Governance and Management Economics* 3, no. 4: 7-29.

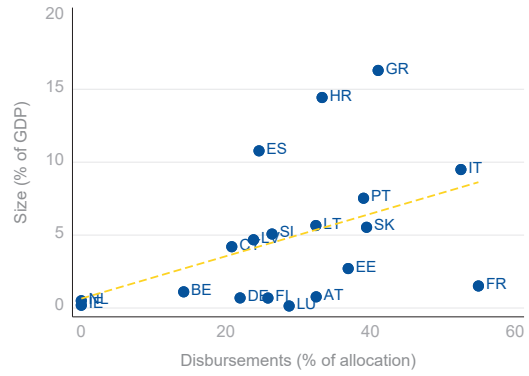
APPENDIX A: RRF IMPLEMENTATION IN GREECE

Figure A-1: EU's Recovery and Resilience Facility

A-1.a Disbursements of financial support under the EU's RRF by type (in % of GDP)



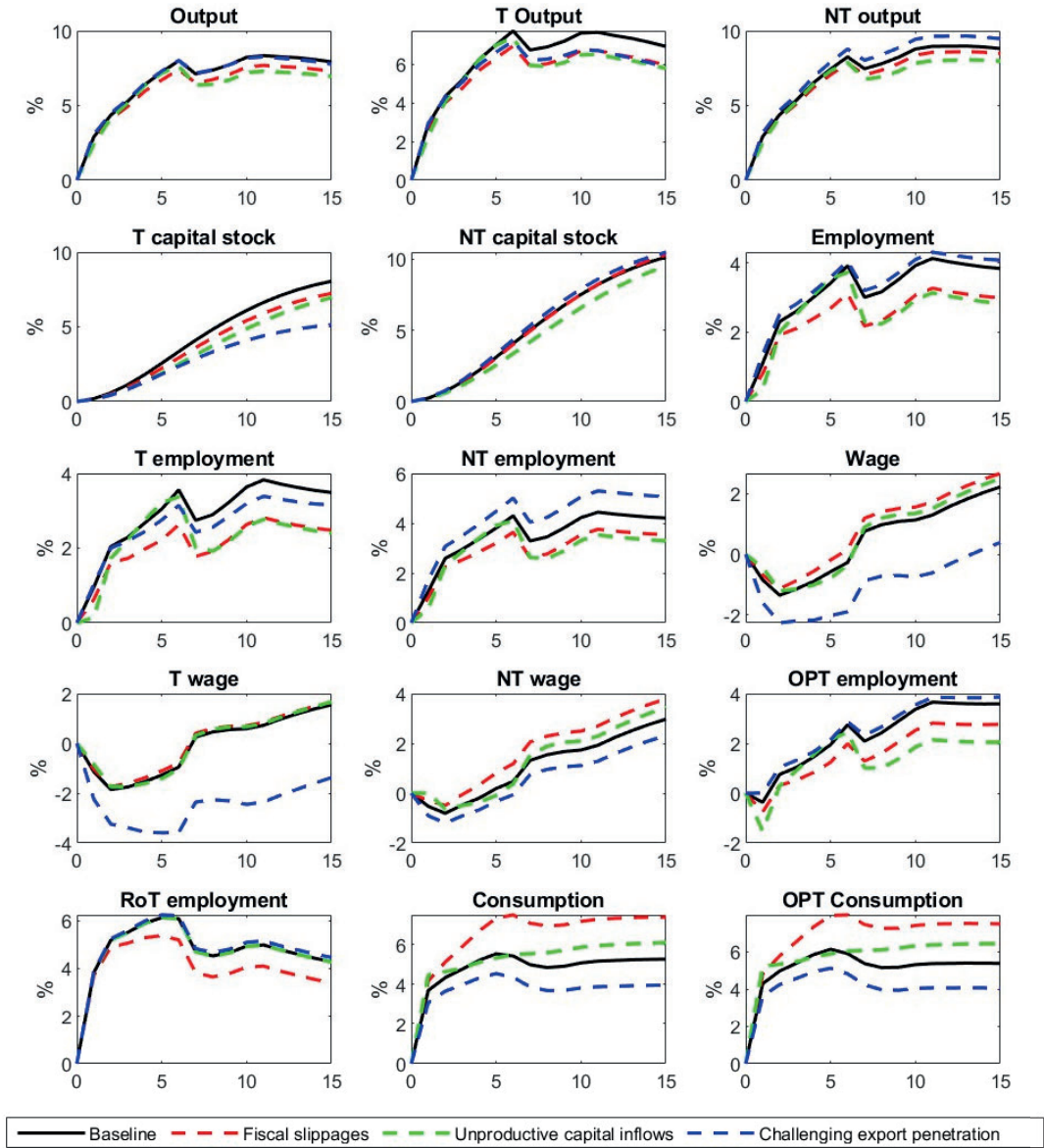
A-1.b Total RRF allocation relative to disbursed funds

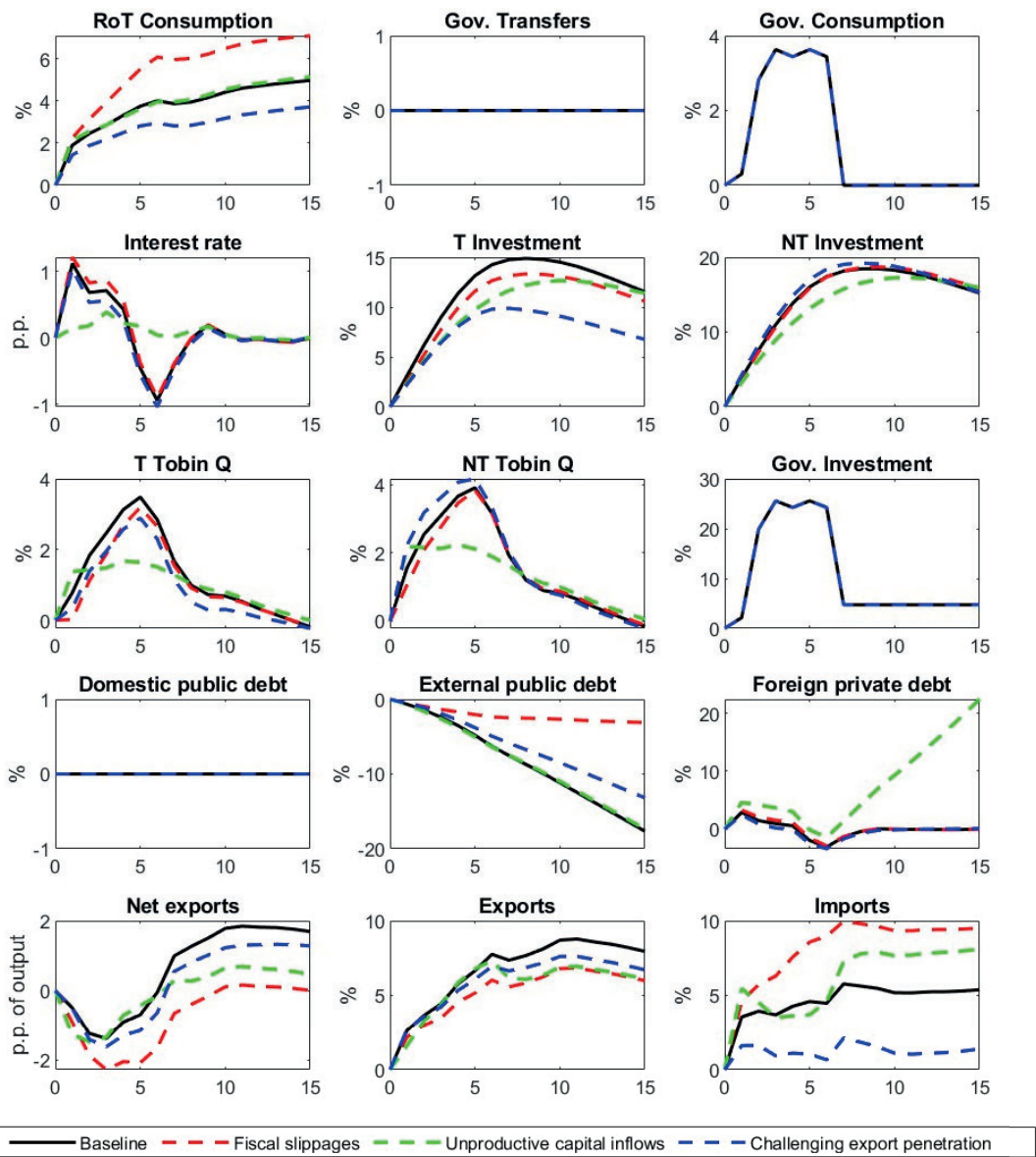


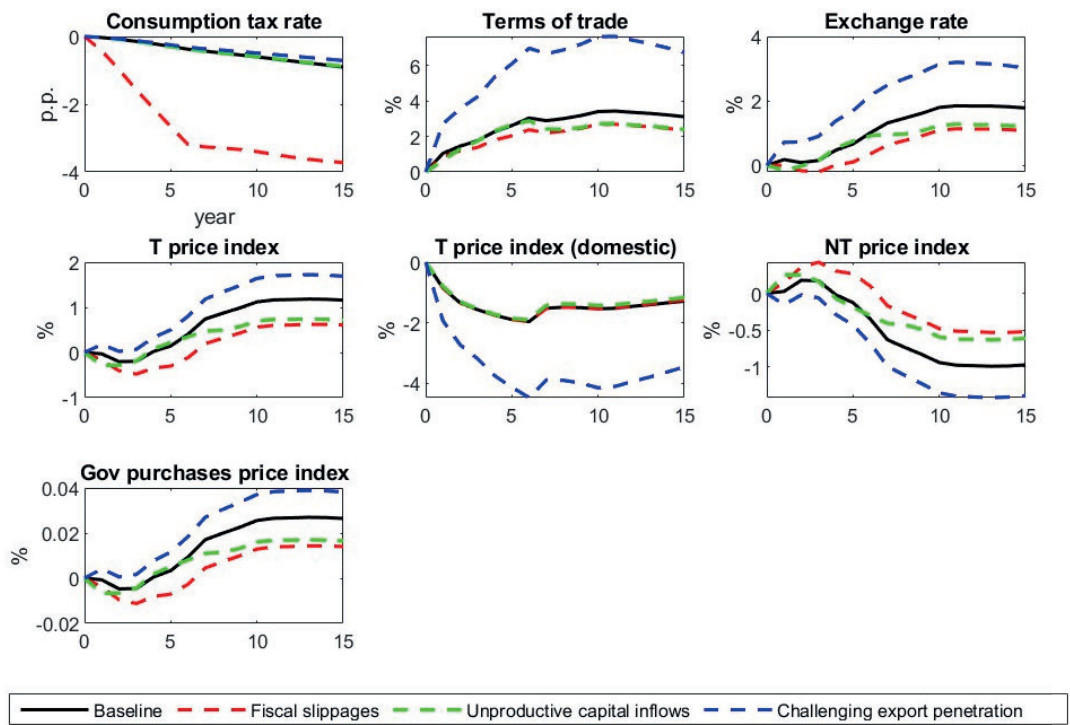
Note: Allocation already disbursed is presented as of Q1 2024.

Source: European Commission.

APPENDIX B: MODEL VARIABLES AND SCENARIOS

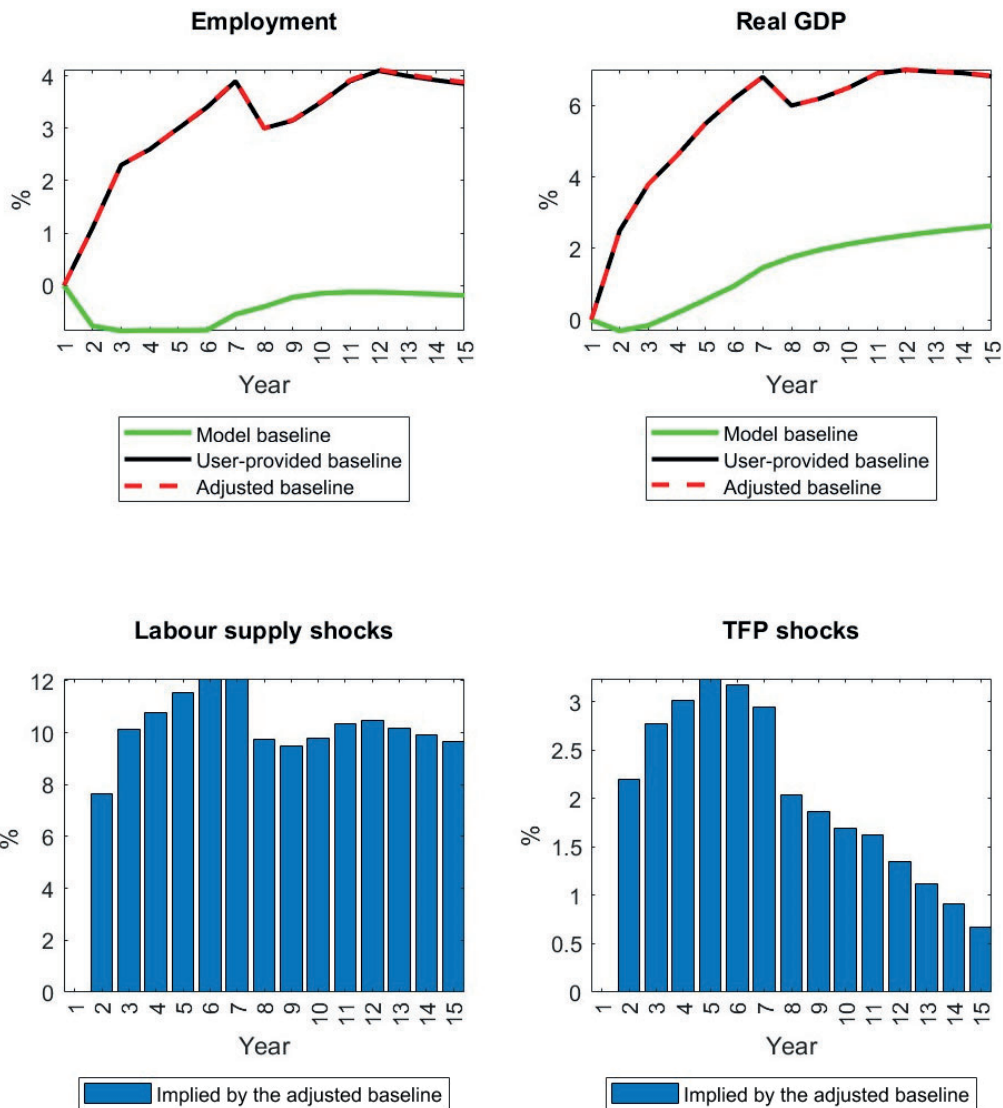






APPENDIX C: MATCHING BASELINE SIMULATION TO MALLIAROPULOS ET AL. (2021)

To align our projections with those in Malliaropoulos et al. (2021), we have identified sequences of shocks to the dis-utility of labour and total factor productivity (ε_t^K and ε_t^Z). These shocks enable our model to replicate the paths of employment and output for the first twenty years following the initiation of RRF/RRP, assuming that the gains achieved by year 20 are permanent relative to the balanced growth path. The figures below illustrate these shocks, as well as the employment and output trajectories in the absence of these shocks.



9. APPENDIX D: EQUILIBRIUM CONDITIONS

In this appendix, we provide additional information about the model. The steady state is calculated numerically by solving a system of non-linear equations (using Matlab's fsolve function). The non-linear model is solved under perfect foresight. For simplicity, the below equilibrium conditions ignore trend growth rate under the balanced growth path.

1. Households

Unit price of the consumption basket

$$1 = [\varphi p_{N,t}^{1-\chi} + (1-\varphi)P_{T,t}^{1-\chi}]^{\frac{1}{1-\chi}}$$

Price of the traded good basket

$$P_{T,t} = [\varphi_T p_{TH,t}^{1-\chi_T} + (1-\varphi_T)s_t^{1-\chi_T}]^{\frac{1}{1-\chi_T}}$$

Relative labour supply to tradable sector

$$L_{T,t} = (1-\theta) \left(\frac{w_{T,t}}{w_t} \right)^\rho L_t$$

Relative labour supply to non-traded good sector

$$L_{N,t} = \theta \left(\frac{w_{N,t}}{w_t} \right)^\rho L_t$$

Real wage index:

$$w_t = [\theta w_{N,t}^{1+\rho} + (1-\theta)w_{T,t}^{1+\rho}]^{\frac{1}{1+\rho}}$$

Marginal utility of consumption (Optimizers)

$$\lambda_t(1 + \tau_t^C) = (c_t^{OPT})^{-\sigma}$$

Labour supply (Optimizers)

$$\varepsilon_t^\kappa \kappa^{OPT} (L_t^{OPT})^\psi = \lambda_t(1 - \tau_t^L)w_t$$

Euler equation 1 (Optimizers)

$$\lambda_t = \beta E_t(\lambda_{t+1}R_t)$$

Euler equation 2 (Optimizers)

$$\lambda_t = \beta E_t \left[\frac{\lambda_{t+1} s_{t+1} R_{t+1}^*}{s_t - \eta (b_t^{OPT*} - b^{OPT*})} \right]$$

Risk premium for private debt (Optimizers)

$$R_t^* = R_{dc,t} + u$$

Consumption demand (Rule of Thumb)

$$(1 + \tau_t^C) c_t^{ROT} = (1 - \tau_t^L) w_t L_t^{ROT} + s_t r m_t^* + z_t - \mu k_{G,t-1}$$

Labour supply (Rule of Thumb)

$$L_t^{ROT} = \left[\frac{1}{\varepsilon_t^K K^{ROT}} \frac{1 - \tau_t^L}{1 + \tau_t^C} (c_t^{ROT})^{-\sigma} w_t \right]^{\frac{1}{\psi}}$$

Aggregation

$$\begin{aligned} c_t &= \omega c_t^{OPT} + (1 - \omega) c_t^{ROT} \\ L_t &= \omega L_t^{OPT} + (1 - \omega) L_t^{ROT} \\ b_t^* &= \omega b_t^{OPT*} \\ b_t &= \omega b_t^{OPT} \end{aligned}$$

2. Firms

Production function (Non-traded good)

$$y_{N,t} = z_{N,t} (k_{N,t-1})^{1-\alpha_N} (L_{N,t})^{\alpha_N} (k_{G,t-1})^{\alpha_G}$$

Capital law of motion (Non-traded good)

$$k_{N,t} = (1 - \delta_N) k_{N,t-1} + \left[1 - \frac{\kappa_N}{2} \left(\frac{i_{N,t}}{i_{N,t-1}} - 1 \right)^2 \right] i_{N,t}$$

Demand for labour (Non-traded good)

$$w_{N,t} = \alpha_N p_{N,t} \frac{y_{N,t}}{L_{N,t}}$$

Tobin's Q (Non-traded good)

$$q_{N,t} = E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \left((1 - \delta_N) q_{N,t+1} + (1 - \tau^K) (1 - \vartheta_{t+1}) (1 - \alpha_N) p_{N,t+1} \frac{y_{N,t+1}}{k_{N,t}} \right) \right]$$

Investment (Non-traded good)

$$\frac{1}{q_{N,t}} = 1 - \frac{\kappa_N}{2} \left(\frac{i_{N,t}}{i_{N,t-1}} - 1 \right)^2 - \kappa_N \left(\frac{i_{N,t}}{i_{N,t-1}} - 1 \right) \frac{i_{N,t}}{i_{N,t-1}} + E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \kappa_N \frac{q_{N,t+1}}{q_{N,t}} \left(\frac{i_{N,t+1}}{i_{N,t}} \right)^2 \left(\frac{i_{N,t+1}}{i_{N,t}} - 1 \right) \right]$$

Production function (Traded good)

$$y_{T,t} = z_{T,t} (k_{T,t-1})^{1-\alpha_T} (L_{T,t})^{\alpha_T} (k_{G,t-1})^{\alpha_G}$$

Capital law of motion (Traded good)

$$k_{T,t} = (1 - \delta_T)k_{T,t-1} + \left[1 - \frac{\kappa_T}{2} \left(\frac{i_{T,t}}{i_{T,t-1}} - 1 \right)^2 \right] i_{T,t}$$

Demand for labour (Traded good)

$$w_{T,t} = \alpha_T p_{T,t} \frac{y_{T,t}}{L_{T,t}}$$

Tobin's Q (Traded good)

$$q_{T,t} = E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \left((1 - \delta_T)q_{T,t+1} + (1 - \tau^K)(1 - \vartheta_{t+1})(1 - \alpha_T)p_{T,t+1} \frac{y_{T,t+1}}{k_{T,t}} \right) \right]$$

Investment (Traded good)

$$\frac{1}{q_{T,t}} = 1 - \frac{\kappa_T}{2} \left(\frac{i_{T,t}}{i_{T,t-1}} - 1 \right)^2 - \kappa_T \left(\frac{i_{T,t}}{i_{T,t-1}} - 1 \right) \frac{i_{T,t}}{i_{T,t-1}} + E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \kappa_T \frac{q_{T,t+1}}{q_{T,t}} \left(\frac{i_{T,t+1}}{i_{T,t}} \right)^2 \left(\frac{i_{T,t+1}}{i_{T,t}} - 1 \right) \right]$$

Investment distortion

$$\frac{\vartheta_t}{\bar{\vartheta}} = \exp(-\eta_\theta (K_{t-1}^G - \bar{K}^G))$$

Total factor productivity

$$z_{T,t} = \bar{z}_T \varepsilon_t^z$$

$$z_{N,t} = \bar{z}_N \varepsilon_t^z$$

3. The government

Fiscal gap

$$gap_t = f_{out,t} - f_{in,t}$$

$$gap_t = \Delta b_t + s_t \Delta d_{c,t} + (\tau_t^C - \bar{\tau}^C) c_t + (\tau_t^L - \bar{\tau}^L) w_t L_t - p_t^G (g_t^C - \bar{g}^C) - (z_t - \bar{z})$$

$$f_{in,t} = \bar{\tau}^C c_t + \bar{\tau}^L w_t L_t + (1 - \vartheta^K) \bar{\tau}^K (r_{T,t}^K k_{T,t-1} + r_{N,t}^K k_{N,t-1}) + \mu k_{G,t-1} + s_t a_t^* + s_t gr_t^* + s_t \Delta d_t$$

$$f_{out,t} = p_t^G g_t^I + p_t^G \bar{g}^C + \bar{z} + (\bar{R}_d - 1) s_t d_{t-1} + (R_{dc,t-1} - 1) s_t d_{c,t-1} + (R_{t-1} - 1) b_{t-1}$$

Financing the fiscal gap

$$\kappa \Delta b_t = (1 - \kappa) s_t \Delta d_{c,t}$$

Fiscal targets

$$\tau_{target,t}^C = \bar{\tau}^C + \lambda_1 \frac{gap_t}{c_t}$$

$$\tau_{target,t}^L = \bar{\tau}^L + \lambda_2 \frac{gap_t}{w_t L_t}$$

$$z_{target,t} = \bar{z} + \lambda_4 gap_t$$

Fiscal rules

$$\begin{aligned}\tau_t^C &= \tau_{t-1}^C + \zeta_1(\tau_{\text{target},t}^C - \tau_{t-1}^C) + \zeta_2 \left(\frac{b_{t-1} + s_{t-1}d_{c,t-1}}{y_{t-1}} - \frac{\bar{b} + \bar{s}\bar{d}_c}{\bar{y}} \right) \\ \tau_t^L &= \tau_{t-1}^L + \zeta_3(\tau_{\text{target},t}^L - \tau_{t-1}^L) + \zeta_4 \left(\frac{b_{t-1} + s_{t-1}d_{c,t-1}}{y_{t-1}} - \frac{\bar{b} + \bar{s}\bar{d}_c}{\bar{y}} \right) \\ \frac{z_t}{\bar{z}} &= \frac{z_{t-1}}{\bar{z}} + \zeta_7 \frac{(z_{\text{target},t} - z_{t-1})}{\bar{z}} - \zeta_8 \left(\frac{b_{t-1} + s_{t-1}d_{c,t-1}}{y_{t-1}} - \frac{\bar{b} + \bar{s}\bar{d}_c}{\bar{y}} \right)\end{aligned}$$

Government spending

$$\begin{aligned}g_t &= g_t^C + g_t^I \\ g_t^C &= \bar{g}^C + \varepsilon_t^{RRFC} \\ g_t^I &= \bar{g}^I + \varepsilon_t^{RRFI}\end{aligned}$$

Government purchases price index

$$p_t^G = [v p_{N,t}^{1-\chi} + (1-v) p_{T,t}^{1-\chi}]^{\frac{1}{1-\chi}}$$

Price index for government purchases of traded goods

$$p_{T,t}^G = [v^T p_{TH,t}^{1-\chi^T} + (1-v^T) s_t^{1-\chi^T}]^{\frac{1}{1-\chi^T}}$$

Law of motion for public capital

$$k_{G,t} = (1 - \delta_{G,t}) k_{G,t-1} + \varepsilon g_t^I$$

Debt-elastic risk premium on external government debt

$$R_{dc,t} = R^f + v_{dc} \exp \left[\eta_{dc} \left(\frac{d_t + d_{c,t}}{y_t} - \frac{\bar{d} + \bar{d}_c}{\bar{y}} \right) \right]$$

4. The external sector, identities and market clearing conditions

Exports

$$\frac{x_t}{\bar{x}} = \left(\frac{s_t}{p_{TH,t}} \right)^{\chi^X}$$

Imports

$$s_t m_t = p_{TH,t} x_t + c_t + i_{N,t} + i_{T,t} + p_t^G g_t + \Theta_t^{OPT*} - y_t$$

Current account deficit

$$ca_t^d = p_{TH,t} x_t - s_t m_t + s_t r m_t^* + s_t g r_t^* - (\bar{R}_d - 1) s_t d_{t-1} - (R_{dc,t-1} - 1) s_t d_{c,t-1} - (R_{t-1}^* - 1) s_t b_{t-1}^*$$

Balance of payment condition

$$\frac{ca_t^d}{s_t} = \Delta d_t + \Delta d_{c,t} + \Delta b_t^*$$

Total output

$$y_t = p_{N,t}y_{N,t} + p_{TH,t}y_{T,t}$$

Market clearing condition for non-traded goods

$$y_{N,t} = \varphi p_{N,t}^{-\chi} (c_t + i_{N,t} + i_{T,t} + \Theta_t^{OPT*}) + \nu p_t^{G-\chi} g_t$$

Market clearing condition for traded goods

$$y_{T,t} = \varphi^T \left(\frac{p_{TH,t}}{P_{T,t}} \right)^{-\chi^T} (1 - \varphi) P_{T,t}^{-\chi} (c_t + i_{N,t} + i_{T,t}) + \nu^T \left(\frac{p_{TH,t}}{p_{T,t}^G} \right)^{-\chi^T} (1 - \nu) \left(\frac{p_{T,t}^G}{p_t^G} \right)^{-\chi} g_t + \theta x_t$$

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