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Marrying fiscal rules & investment: a central fiscal capacity for Europe

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Abstract

The European fiscal governance framework remains incomplete, hindering policy coordination during economic shocks and affecting the transmission of the single monetary policy. High public debt and low public investment worsen resilience across Member States. Many policymakers, institutions, and academics support establishing a central fiscal capacity (CFC) as a solution. Against this backdrop, we propose a framework to assess a CFC in the euro area, aimed at stabilizing the business cycle, promoting sovereign debt sustainability, and reducing procyclicality in public investment. Our two-region DSGE model with a permanent CFC allocates resources based on the relative output gap while earmarking funds for public investment and imposing fiscal adjustment requirements for the high-debt region. The CFC enhances business cycle stabilization for both regions and significantly reduces the welfare cost of fluctuations. We also explore European bond issuance and a supranational investment strategy to address investment needs through European Public Goods.

Keywords: EU Governance, Public Debt Sustainability, Macroeconomic Stabilisation, European Public Goods.

JEL Codes: E12, E32, E62, F45

Non-technical summary

The European Economic and Monetary Union's (EMU) incomplete fiscal framework poses challenges. A single monetary policy navigating a landscape of disjointed national fiscal policies, further constrained by high public debt and heterogeneity in fiscal space, results in vulnerabilities and fragmentation risks, especially in the face of asymmetric shocks. This is apparent when considering historical European crises.

The sovereign debt crisis was triggered by the financial crisis that originated in the United States, but it impacted European countries unevenly due to their structural differences, also pertaining to higher debt burdens in some countries compared to others. These developments resulted in furthering European integration through the creation of the European Stability Mechanism (ESM), to provide conditional financial assistance to euro area members. In a similar fashion, Next Generation EU (NGEU) was introduced as a temporary tool to boost public investment and structural reforms in response to the pandemic financed by EU-wide common funds. Crucially, the severity of the economic and social impact of the pandemic on each Member State was a major factor determining resource allocation. While the Covid-19 crisis impacted the whole world, its economic consequences were asymmetric as the shock hit some sectors, regions, and Member States disproportionately, such that countries facing deeper recessions, higher unemployment rates, and greater public health challenges received a relatively larger share of the total envelope. Lastly, the Russian invasion of Ukraine and the energy crisis that ensued had a disproportionate impact on a subset of Member States on the basis of their dependence on Russian oil and gas imports, their industrial structure and their fiscal space.

Furthermore, crisis episodes led to public under-investment driven by pro-cyclical policies, while Europe faces substantial investment needs to further the green and digital transitions, as well as to promote investment in health, defence and innovation. Overall, asymmetric shocks can thus distort competitiveness within the European single market as regions experiencing economic downturns may struggle to compete with those less affected. In this context, the economic case for introducing a permanent central fiscal capacity (CFC) has gained traction.

This paper contributes to the ongoing discussion by putting forward a proposal for a CFC for the euro area with three primary goals: business cycle stabilisation, promotion of debt sustainability, and reduction of public investment procyclicality. We analyse the effects of such a CFC through the lens of a two-region DSGE model calibrated to the euro area, and subject to region-specific productivity shocks. Our findings provide support for the introduction of a sizable CFC operating in a countercyclical manner, hence providing reallocation of resources to the region hit by negative shocks. Moreover, we find that in response to a shock to the high-debt region, our proposed CFC effectively provides stabilisation, supports public investment, which in turn supports productivity over the medium run, and reduces public debt. At the euro area level, an active CFC has positive medium run effects on GDP, public investment and productivity, while taming the public debt burden. Despite these economic benefits, the introduction of a CFC almost inevitably raises moral hazard concerns, as the risk sharing framework might reduce incentives to improve economic resilience. These concerns are partially addressed in our framework, but mostly fall outside the scope of the analysis.

We also explore the option to finance the CFC through common bond issuance, smoothing the cost of the CFC over time, and find that countercyclical common bond issuance is optimal in our framework. Lastly, we put forward an alternative CFC design focused on euro area-wide investment in European Public Goods (EPGs). EPGs are meant to address exogenous investment needs stemming from shared challenges, such as the green transition, digitisation, promoting innovation and bolstering common defence. We assume that these underpin productivity across the entire bloc and advance strategic European goals. We model this investment as acyclical and introduce an alternative CFC formulation designed to reallocate their cost over the business cycle. The EPG-focused CFC, coupled with countercyclical bond issuance, also results in *de facto* stabilisation, while ensuring common investment needs are met.

Overall, this paper offers novel insights to support the introduction of a permanent CFC for the euro area. It shows that a well-designed CFC could provide macroeconomic stabilisation, significantly reducing the welfare cost of business cycles, promote public investment and public debt sustainability. Moreover, we are the first to conceptualise EPGs in a DSGE model, and we show that in a world with EPGs an alternative CFC can provide stabilisation through a cost redistribution mechanism. We offer policymakers a range of CFC designs to consider, along with insights into financing mechanisms, as the discussion about completing the EMU ensues.

1 Introduction

"The need for a permanent central fiscal capacity remains. Such a tool, if appropriately designed, could play a role in enhancing macroeconomic stabilisation and convergence in the euro area in the longer run, including through investment, thereby also supporting the single monetary policy."

Christine Lagarde (July 2023)[1]

The European Economic and Monetary Union (EMU) is a cornerstone of the European Union, unifying 20 European countries under a common currency. The decision to create a single currency without a corresponding political union was a pragmatic compromise driven by the desire to foster economic convergence. However, this institutional asymmetry has led to several challenges, particularly in times of economic crisis. The euro area's lack of a unified fiscal policy has made it difficult for the region to respond to economic shocks effectively, as a single monetary policy is overlaid on a patchwork of national fiscal policies constrained by heterogeneity in fiscal space. This represents an ever growing challenge for monetary policy in the euro area, as fiscal policy heterogeneity underpins fragmentation risks and hampers monetary policy transmission. For these reasons, in addition to the strive to further the banking union and the capital markets union, completing the fiscal union has been a subject of ongoing debate and reform efforts.[2]

The global financial crisis of 2008 and the subsequent euro area sovereign debt crisis highlighted the vulnerabilities of the single currency system and spurred calls for deeper integration. Both the Four Presidents' report (Van Rompuy et al., 2012) and the Five Presidents' report (Juncker et al., 2015) made the case for a euro area (EA) central fiscal capacity (CFC) to improve EMU resilience. These developments led to the establishment of the European Stability Mechanism (ESM) to provide financial assistance to euro area members, and later to the introduction of Next Generation EU (NGEU) as a temporary tool to respond to the Covid-19 crisis by boosting public investment and structural reforms. The introduction of NGEU also

[1] ECB Opinion on a proposal for economic governance reform in the Union.

[2] Cimadomo et al. (2023) document the interaction of private and public risk sharing in the euro area, and find that risk sharing through the fiscal channel complements private risk sharing through the capital and credit channel. Hence progress on the capital markets union and the banking union should be accompanied by policies to further the fiscal union as well.

addressed another major concern in EU policy circles: chronic public under-investment driven by pro-cyclical policies. Promoting public investment in Europe is considered crucial to support economic potential as well as to further the green and digital transitions (See e.g. Panetta (2022), Commission (2022) and Cipollone (2024)). In this spirit, the 2024 reform of European fiscal rules aimed to support both public debt sustainability and economic growth through public investment and structural reforms. Overall, and despite progress made, many policymakers, institutions and academics share the view that the European governance framework will remain incomplete without the establishment of a permanent CFC, whose precise design remains object of debate.[3]

This paper contributes to these discussions, as we put forward a calibrated two-region DSGE model, comprised of a high-debt and a low-debt region, and subject to region-specific shocks, to evaluate a proposal for a central fiscal capacity (CFC) for the euro area. We focus on region-specific shocks as all major economic shocks affecting the euro area since its inception had asymmetric impacts across regions. Moreover, we focus the analysis on shocks to the high-debt region as high public debt constituted a major factor underpinning vulnerabilities. Namely, the sovereign debt crisis affected a sub-set of countries characterised by high debts and the Covid-19 crisis was harder to weather in the absence of ample fiscal space. Nevertheless, the energy crisis that followed Russia's invasion of Ukraine disproportionally affected countries also on the basis of their dependence on Russian oil and gas imports and their industrial structure, thus supporting the view that low-debt regions could also benefit from a CFC.

We introduce a CFC with three main objectives. First, to achieve effective macroeconomic stabilisation. Second, to support public debt sustainability. Third, to reduce public investment procyclicality at the national level. We calibrate the strength and direction of the CFC stabilisation function to maximise welfare over the business cycle and find that it is optimal for the stabilisation function of the CFC to be sizable and for the CFC to operate countercyclically. We then analyse the impact of a negative supply shock as well as a negative demand shock to region A, which is calibrated as a high-debt region, and find that in both cases an active CFC stabilises macroeconomic fluctuations, reduces the procycicality of investment and tames govern-

[3] See Arnold et al. (2018), Arnold et al. (2022), Burriel et al. (2020), Buti et al. (2021), Buti & Papaconstantinou (2022), Giovannini et al. (2022), and Romanelli et al. (2022), among others.

ment debt. Moreover, the CFC supports both the demand and the supply side of the economy, such that trade-offs with monetary policy are limited. We extend the baseline specification by allowing EA bond issuance of a safe asset to finance the CFC. We find that countercyclical bond issuance is optimal in our framework as it enables the burden of CFC financing to be smoothed over time.

Lastly, we further modify the baseline framework to explore an alternative CFC design. We enable EA level investment in European Public Goods (EPGs). These are meant to capture common investment needs, such as efforts to further the climate and digital transitions, promote innovation and boost defence, raising productivity for the entire block. We assume that investment in EPGs should be acyclical, and introduce an alternative CFC formulation to redistribute their cost over the business cycle. We find that such alternative CFC is also optimal in our framework, enhancing stabilisation and welfare in the currency union. Moreover, countercyclical bond issuance remains optimal in this alternative framework. This is an important contribution of this paper, as to the best of our knowledge, we are the first to put forward a framework for EPGs in a DSGE model, and to show that such a framework could *de facto* provide stabilisation while also pursuing common objectives of the Union.

Overall, our work supports the introduction of a sizable central fiscal capacity in the euro area, financed through countercyclical common bond issuance. We provide supporting evidence on the merits of introducing a CFC with the objective to stabilise business cycle fluctuations, promote debt sustainability and support public investment, and we also propose an alternative design to achieve such objectives, offering a menu for policymakers.

Our work contributes to an established literature on stabilisation in a currency union subject to asymmetric shocks. In a seminal contribution, Kenen et al. (1969) argued that fiscal integration was critical to a well-functioning currency union, and such ideas were later developed by Farhi & Werning (2017), who proposed a New Keynesian model to analyse the role of a fiscal union within a currency union as an optimal international risk-sharing arrangement. They concluded that international fiscal transfers in response to asymmetric shocks enhance macroeconomic stabilisation in a currency union.

Common concerns discussed when considering the introduction of a CFC pertain to the possibility of moral hazard, as incentives to conduct sound fiscal policies and structural reforms could be reduced by the scheme, and several contributions offer a discussion. See for example Beetsma et al. (2021), Burriel et al. (2020), Wyplosz (2020), Koester & Sondermann (2018) and Arnold et al. (2018). In our framework, we only partially incorporate moral hazard concerns by embedding fiscal adjustment requirements for high-debt countries, *i.e.* capturing requirements to adhere to fiscal rules. A rich theoretical literature explores the trade-off between risk-sharing and moral hazard in depth, and discusses how this can give rise to different *equilibra*. Notable examples include Atkeson (1991), Persson & Tabellini (1996), Müller et al. (2019) and Abrahám et al. (2022), but we deem such analysis outside the scope of this paper. Another common concern in the CFC debate is the possibility of permanent transfers across regions, which could be politically unpalatable (Juncker et al., 2015), (Arnold et al., 2018). The latter are ruled out in steady state in our framework by construction as our baseline CFC is set to zero in steady state.[4] Nevertheless, our analysis highlights how some of the contributions made are *de facto* rebated back to the donor region through the trade channel, thus reducing the real size of transfers. This paper contributes to the growing literature evaluating the implications of the introduction of a CFC in Europe, which considers stabilisation as a core element, while introducing additional targets and goals.

The CFC proposal in our paper is closest in spirit with the qualitative considerations put forward by Buti et al. (2022), who provide a stylised aggregate demand-aggregate supply model to evaluate different CFC options, affecting either the demand side through a stabilisation function, or the supply side, by boosting potential output through reform and investment support or the supply of European Public Goods. They find that a CFC would reduce losses from recessions by providing stabilisation in the face of a demand shock and by boosting potential output in the event of a supply shock. While our paper shares several ideas with Buti et al. (2022), our contribution differs significantly as we provide an evaluation of CFC proposals through the lens of a two-region DSGE model in the spirit of Stähler & Thomas (2012).

Conversely, our model shares many characteristics with the analytical framework put forward by Bonam et al. (2022), who propose a two-region DSGE model with a CFC directing

[4]Since the transfer function is symmetric, a linear solution will also rule out permanent transfers in the long-run. However, due to inherent non-linearities of some model elements, permanent transfers are technically possible.

countercyclical transfers across regions in response to region-specific supply shocks. To mitigate moral hazard concerns, they assume that access to the CFC is conditional on a region's fiscal position, so that no transfer can occur in instances where the debt to GDP ratio exceeds a specified threshold. They find that the stabilisation function of such a CFC can improve welfare for both regions, even if one is a net donor on average, due to gains stemming from the trade channel. Moreover, the stabilisation function also reduces the frequency of very high-debt episodes. While our findings are broadly consistent with Bonam et al. (2022), our work differs in several dimensions. Firstly, our baseline CFC directly promotes public investment and productivity, and in an extension it embeds the provision of European Public Goods as well as EA bond issuance. Secondly, we introduce a fiscal adjustment requirement in the CFC for the high-debt region rather than impose conditional access to the CFC. This is meant to incentivise compliance with fiscal rules *ex ante*, mitigate moral hazard concerns, and capture the spirit of the EU fiscal framework in our model. Thirdly, we analyse the dynamic response of the economy to both supply and demand shocks. Overall, our work supports the view that the euro area would benefit from the introduction of a stabilisation function, and we provide novel insights on the implications of earmarking resources for public investment as well acyclical investment in area-wide public goods.

The rest of the paper is structured as follows: Section 2 discusses related literature, Section 3 describes the model, Section 4 explains the calibration, Section 5 relates results, Section 6 presents model extensions and section 7 concludes.

2 Related Literature

This paper relates to several additional academic contributions aimed at furthering the central fiscal capacity debate amidst different methodologies.

Beetsma et al. (2021) propose an export-based stabilisation capacity, where transfers are based on exogenous changes to world market conditions, thus reducing moral hazard concerns, and provide empirical estimates of how such transfers would have materialised in the euro area in the period 1996-2014. They find that transfers would have been broadly counter-cyclical and non-permanent. Furthermore, Beetsma et al. (2024) propose a regional stabilisation capacity, where transfers depend on regional output fluctuations driven by region specific shocks, country, and area-wide shocks. Through the lens of a multilevel Bayesian dynamic factor model employing regional macroeconomic data at NUTS3 level, they find that such fiscal capacity could result in substantial stabilisation while requiring reasonable borrowing capacity. Moreover, findings from the empirical literature of risk sharing provided support for the view that the euro area risk sharing mechanisms lag behind the United States (See e.g. Cimadomo et al. (2023); Burriel et al. (2020); Furceri & Zdzienicka (2015); Asdrubali & Kim (2004)).

Another strand of the literature on stabilisation facilities in the euro area advocates for the introduction of a European Unemployment Insurance (EUI). The latter builds on the idea that unemployment is a reliable cyclical indicator and that unemployment expenditure is directly linked to automatic stabilisers. Thus an unemployment insurance scheme could directly reinforce a country's stabilisation capacity, even though moral hazard concerns still emerge. In particular, such a mechanism might deter structural reforms to improve labour market resilience.

Several contributions in the literature have proposed EUI schemes and put forward solutions to moral hazard concerns. Most recently, Kaufmann et al. (2023) provided a quantitative evaluation of such ideas, through a two-region DSGE model calibrated to the euro area, and found that the latter could also provide effective stabilisation. Our framework shares many features with Kaufmann et al. (2023), both in terms of modelling assumptions and stabilisation objectives, while the focus differs fundamentally. Other contributions proposing common unemployment schemes include Ábrahám et al. (2023), Moyen et al. (2019), Enders & Vespermann (2021) and Ignaszak et al. (2020), among others. While consensus emerged on the potential merits of such unemployment insurance scheme for stabilisation in the short term, once moral hazard concerns are addressed, its medium-term effects on productive capacity remain mostly unexplored.

Overall, our paper contributes to this large and growing literature, by providing a quantitative evaluation of some of the ideas discussed and proposing new ones, as well as by exploring the medium-term implications of a central fiscal capacity on productivity.

3 Model

We propose a DSGE model comprising two regions in a monetary union, drawing from the work of Stähler & Thomas (2012), Kaufmann et al. (2023) and Coenen et al. (2013). The total population size of the union is normalised to unity, with a share ω living in the high-debt region and the share $1-\omega$ living in the low debt region. All variables are in per capital terms of their respective region. Households gain utility from private consumption, government services and value leisure. The production sector is comprised of final good producers and intermediate good producers, subject to nominal price frictions. Unions set wages and hours and introduce nominal wage rigidities. The government provides services and TFP-enhancing public capital, by raising taxes and accumulating debt. We introduce a central fiscal capacity managed by a supranational fiscal authority providing financing to governments depending on macroeconomic conditions. The central fiscal capacity has three objectives: stabilizing the business cycle, promoting debt stability, and reducing the procyclicality of public investment. The monetary authority sets the nominal interest rate according to a Taylor rule, factoring in the deviation of inflation from its target and the output gap. The following sections describe the behaviour of all agents in the model, from the perspective of region A, which we characterise as the high-debt region.[5] We follow the convention of denoting nominal variables in uppercase and real variables in lowercase if not specified otherwise. Aggregate variables are expressed in per capital terms of their respective region.

3.1 Households

There is a continuum of households of type $l \in [0,1]$ in high-debt region (A) each maximizing utility

$$\max_{c_t(l),i_t(l),k_{t+1}(l),b_{t+1}(l),b^I_{t+1}(l)} \quad U_t = E_t\left[\sum_{j=0}^{\infty}\beta^j\left(\frac{(\tilde{c}_{t+j}(l)-\chi\tilde{c}_{t+j-1}(l))^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \psi\frac{h^{1+\nu}_{t+j}(l)}{1+\nu}\right)\right] \tag{1}$$

where $\beta < 1$ is the time discount factor, $\tilde{c}$ is composite consumption, σ is the elasticity of intertemporal substitution in consumption, χ the degree of habit formation, ν regulates the

[5] If not specified otherwise, region B is modeled symmetrically.

degree of dis-utility from labour. Following Coenen et al. (2013) as well as Kaufmann et al. (2023), composite consumption is a constant elasticity of substitution (CES) aggregate of private consumption c as well as government services g

$$\tilde{c}_{t+j(l)} = \left[\phi c_{t+j}(l)^{\frac{\varphi-1}{\varphi}} + (1-\phi) g_{t+j}^{\frac{\varphi-1}{\varphi}}\right]^{\frac{\varphi}{\varphi-1}} \tag{2}$$

where ϕ denotes the relative weight of private consumption and φ measures the elasticity of substitution. Households are subject to the per period budget constraint

$$\begin{aligned} &B_{t+1}(l) + B^I_{t+1}(l) + P_t c_t(l) + P_t i_t(l) \\ &\qquad = R_{t-1} B_t(l)(1-v_t) + R^m_{t-1} B^I_t(l) e(B^I_{t-1}, Y_{t-1}) x_{t-1} + I^{Bonds}_t \\ &\qquad + W_t(1-\tau^h_t) h_t(l) - T^{Union}_t + P^A_t \left(r^k_t (1-\tau^k) k_t(l) + \pi^{Firm}_t \right) \end{aligned} \tag{3}$$

B_t represent one period nominal domestic government bonds, purchased at time $(t-1)$, that earn the nominal interest rate r_t, such that $R_{t-1} = (1 + r_{t-1})$ is the gross interest rate. Their return is subject to a risk premium due to default risk, captured by v_t. B^I_t are nominal international bonds, which earn the area wide interest rate R^m_t set by the monetary authority, plus an intermediation fee proportional to the change in net foreign assets, captured by $e(B^I_t, Y_t) = \exp(-\kappa_b(B^I_t - B^I)/Y_t)$ where Y_t is output. The latter is rebated back to households, as captured by the term I^{Bonds}_t. x_t represents a demand shifter for safe liquid assets and follows an AR(1) process in logarithm specified in section (3.10). r^k_t represents the real rental rate of capital k_t, τ^j_t are taxes on capital, consumption and labour income $j \in \{k, c, h\}$, whilst π^{Firm}_t are real profits redistributed to households by firms. W_t is the nominal wage and T^{Union}_t is a nominal lump-sum fee from unions.

The capital stock grows with investment, net of depreciation and subject to quadratic investment adjustment costs parameterized with κ, according to the law of motion

$$k_{t+1} = i_t + (1-\delta) k_t - \frac{\kappa}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 i_t \tag{4}$$

The first order conditions in real terms of the household with the lagrange multipliers λ_t and

$\lambda_t\mu_t$ associated with (3) and (4) can be summarized as

$$\lambda_t = \left\{(\tilde{c}_t - \chi\tilde{c}_{t-1})^{-\frac{1}{\sigma}} - \beta\chi(\tilde{c}_{t+1} - \chi\tilde{c}_t)^{-\frac{1}{\sigma}}\right\}\phi\left(\frac{\tilde{c}_t}{c_t}\right)^{\frac{1}{\varphi}} \tag{5}$$

$$\lambda_t = \beta E_t \frac{R_t(1-v_{t+1})}{\Pi_{t+1}}\lambda_{t+1} \tag{6}$$

$$\lambda_t = \beta E_t \frac{R_t^m}{\Pi_{t+1}}\lambda_{t+1} e(B_t^I, Y_t) x_t \tag{7}$$

$$\mu_t = \beta E_t \frac{\lambda_{t+1}}{\lambda_t}\left[r_{t+1}^k(1-\tau_{t+1}^k) + \mu_{t+1}(1-\delta)\right] \tag{8}$$

$$\begin{aligned} 1 &= \mu_t\left\{1 - \frac{\kappa}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 - \kappa\left(\frac{i_t}{i_{t-1}} - 1\right)\frac{i_t}{i_{t-1}}\right\} \\ &+ \beta E_t\left\{\mu_{t+1}\frac{\lambda_{t+1}}{\lambda_t}\kappa\left(\frac{i_{t+1}}{i_t} - 1\right)\left(\frac{i_{t+1}}{i_t}\right)^2\right\} \end{aligned} \tag{9}$$

As households consume both domestic and foreign goods, international demand can be defined as

$$c_t = \left[\phi_A^{\frac{1}{\eta}}(c_t^{AA})^{\frac{\eta-1}{\eta}} + (1-\phi_A)^{\frac{1}{\eta}}(c_t^{AB})^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{10}$$

$$i_t = \left[\phi_A^{\frac{1}{\eta}}(i_t^{AA})^{\frac{\eta-1}{\eta}} + (1-\phi_A)^{\frac{1}{\eta}}(i_t^{AB})^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{11}$$

where c_t^{AB} (c_t^{AA}) denotes region A's households' consumption of region B's (A's) products. ϕ_A represents the home biases of region A (ϕ_B for region B). Consumption as well as investment expenditure from the perspective of region A are captured by the sum of home and foreign goods expenditure, with domestic consumer price-index (CPI) P_t and producer price indices (PPIs) P_t^A and P_t^B.

$$P_t c_t = P_t^A c_t^{AA} + P_t^B c_t^{AB} \tag{12}$$

$$P_t i_t = P_t^A i_t^{AA} + P_t^B i_t^{AB} \tag{13}$$

Cost minimization of (12) subject to (10), and analogously of (13) subject to (11) for investment gives the optimal allocation of home and foreign goods as a function of the terms of trade $\frac{P_t^B}{P_t^A}$

and the degree of home bias

$$c_t^{AA} = \frac{\phi_A}{1-\phi_A}\left(\frac{P_t^B}{P_t^A}\right)^{\eta} c_t^{AB} \tag{14}$$

$$i_t^{AA} = \frac{\phi_A}{1-\phi_A}\left(\frac{P_t^B}{P_t^A}\right)^{\eta} i_t^{AB} \tag{15}$$

Lastly, we define the terms of trade as the ratio of producer price indices $\mathcal{T}_t := \frac{P_t^B}{P_t^A}$ and the real exchange rate as the ratio of consumer price indices $\mathcal{E}_t := \frac{P_t^*}{P_t}$. The evolution of prices over time gives the (gross) CPI inflation $\Pi_t := \frac{P_t}{P_{t-1}}$ and (gross) PPI inflation $\Pi_t^A := \frac{P_t^A}{P_{t-1}^A}$[6].

3.2 Labour Unions

Unions collect differentiated labour types from workers and sell these types to firms after setting nominal wages W_{lt}. They maximise returns in perfect competition, subject to the CES aggregation technology:

$$h_t = \left(\int_0^1 h_t(l)^{\frac{\epsilon-1}{\epsilon}} dl\right)^{\frac{\epsilon}{\epsilon-1}} \tag{16}$$

with the elasticity of labour substitution ϵ. The demand for labour type l is $h_t(l) = \left(\frac{W_t(l)}{W_t}\right)^{-\epsilon} h_t$. We assume that unions set wages to maximise households' utility subject to labour demand, and wage adjustment costs à la Rotemberg (1982), which are covered by charging every member a lump sum fee. The intertemporal problem for each labour type l is then:

$$\max_{\{h_t(l),W_t(l)\}} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \lambda_t \left[\frac{W_t(l)}{P_t} h_t(l)(1-\tau_t^h) - \frac{\chi^w}{2}\left(\frac{W_t(l)}{W_{t-1}(l)} - 1\right)^2 \frac{W_t}{P_t} \right] - \psi \frac{h_t(l)^{1+\nu}}{1+\nu} \right\} \tag{17}$$

$$s.t. \qquad h_t(l) = \left(\frac{W_t(l)}{W_t}\right)^{-\epsilon} h_t \tag{18}$$

where χ^ω governs the strength of wage rigidity. Taking first order conditions with respect to hours and nominal wages and applying symmetry of labour types $W_t(l) = W_t$ in equilibrium

[6]Where $\Pi_t^* := \frac{P_t^*}{P_{t-1}^*}$ is gross CPI inflation of B and $\Pi_t^B := \frac{P_t^B}{P_{t-1}^B}$ gross PPI inflation of B.

yields a standard wage Phillips curve

$$\chi^w \left(\Pi_t^W - 1\right) \Pi_t^W = (1-\epsilon) h_t (1-\tau_t^h) + \beta \left[\frac{\lambda_{t+1}}{\lambda_t} \chi^w \left(\Pi_{t+1}^W - 1\right) \left(\Pi_{t+1}^W\right)^2 \frac{1}{\Pi_{t+1}} \right] + \epsilon \psi \frac{h_t^{1+\nu}}{w_t} \frac{1}{\lambda_t} \frac{P_t}{P_t^A} \tag{19}$$

where $\Pi_t^W = \frac{W_t}{W_{t-1}}$ denotes wage inflation, while the real wage is defined as $w_t = \frac{W_t}{P_t^A}$.

3.3 The final good sector

The final good, y_t, is produced in perfect competition employing domestic intermediate goods, and can be turned into the consumption or investment good for both the public and private sector

$$\max_{y_t(i)} P_t^A y_t - \int_0^1 P_t^A(i) y_t(i) di \tag{20}$$

$$s.t. \quad y_t = \left(\int_0^1 y_t(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} \tag{21}$$

taking first order conditions yields the demand function for intermediate goods

$$y_t(i) = \left(\frac{P_t^A(i)}{P_t^A} \right)^{-\theta} y_t \tag{22}$$

and the price index $P_t^A = \left(\int_0^\omega P_t^A(i)^{1-\theta} \right)^{\frac{1}{1-\theta}}$.

3.4 The intermediate good sector

Costs Minimization. Each firm i, $i \in (0,1)$ in the intermediate good sector operates under monopolistic competition. It employs capital services and labour, minimizing real costs $\min\limits_{k_t(i),h_t(i)} \quad w_t h_t(i) + r_t^k k_t(i)$ subject to the technology:

$$y_t(i) = a_t \left(k_t^g\right)^\xi \left(k_t(i)\right)^\alpha \left(h_t(i)\right)^{1-\alpha} \tag{23}$$

where $a_t \left(k_t^g\right)^\xi$ is total factor productivity (TFP), comprised of an exogenous component a_t following a process specified in section (3.10) and and endogenous component $\left(k_t^g\right)^\xi$ stemming from public capital, with elasticity ξ. The latter thus affects TFP dynamics, which can vary over the medium term beyond the effects of exogenous shocks. $\alpha \in (0,1)$ is the capital share in production. The first order conditions give the usual expressions for factor prices $w_t = (1-\alpha)mc_t\frac{y_t(i)}{h_t(i)}$ and $r_t^k = \alpha mc_t\frac{y_t(i)}{k_t(i)}$ with real marginal costs

$$mc_t = \frac{1}{\alpha^\alpha(1-\alpha)^{1-\alpha}}\frac{1}{a_t\,(k_t^g)^\xi}w_t^{1-\alpha}(r_t^k)^\alpha \tag{24}$$

Price Setting Intermediate good firm i maximizes its profit $\Pi_t^{Firm}(i)$ given its marginal cost and quadratic price adjustment costs à la Rotemberg (1982)

$$\max_{P_t^A(i)} \quad E_t\left[\sum_{j=0}^{\infty}\Phi_{t,t+j}\left(P_{t+j}^A(i)y_{t+j}(i) - P_{t+j}^A mc_{t+j}y_{t+j}(i) - P_{t+j}^A\frac{\phi_p}{2}\left(\frac{P_t^A(i)}{P_{t-1}^A(i)}-1\right)^2 y_{t+j}\right)\right] \tag{25}$$

where $\Phi_{t,t+j} \approx \beta^j\frac{\Lambda_{t+j}}{\Lambda_t} = \beta^j\frac{\lambda_{t+j}}{\lambda_t}\frac{1}{\Pi_{t+1}}$ is the household's discount factor. Taking the first order condition subject to the demand function for intermediate goods (22), and then applying the symmetric equilibrium $P_t^A(i) = P_t^A\ \forall i$, we find region A's producer price Phillips curve expressed in real terms as

$$\phi_p\left(\Pi_t^A - 1\right)\Pi_t^A = \phi_p\beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\left(\Pi_{t+1}^A - 1\right)\frac{(\Pi_{t+1}^A)^2}{\Pi_{t+1}}\frac{y_{t+1}}{y_t}\right] + (1-\theta) + \theta\left[mc_t\right] \tag{26}$$

3.5 The monetary authority

The monetary authority sets a Taylor rule of the following form:

$$\left(\frac{R_t^m}{\bar{R}^m}\right) = \left(\frac{R_{t-1}^m}{\bar{R}^m}\right)^{\rho_R}\left(\frac{\Pi_t^{EA}}{\bar{\Pi}^{EA}}\right)^{\rho_\Pi}\left(\frac{gdp_t^{EA}}{\overline{gdp^{EA}}}\right)^{\rho_y} \tag{27}$$

Where $\overline{gdp^{EA}}$, $\bar{R}$, $\bar{\Pi}$ are target values and ρ_Π, ρ_y, ρ_R are policy parameters. This formulation implies that the current nominal interest rate is determined by the deviation of inflation and output from their targets. $\overline{\text{gdp}}^{EA}$ represents potential output, which is set to the steady state value of area wide gdp.[7]

[7] gdp_t is defined in Section 3.9, and area wide variables are $P_t^{EA} = \omega P_{A,t} + (1-\omega)P_{B,t}$, $\Pi_t^{EA} = \frac{P_t^{EA}}{P_{t-1}^{EA}}$ and $gdp_t^{EA} = \omega gdp_t^A\frac{P_t^A}{P_t^{EA}} + (1-\omega)gdp_t^B\frac{P_t^B}{P_t^{EA}}$.

3.6 Fiscal block

In this economy, the government consumes a portion of private output to provide public services g_t, and invest in public infrastructure i^g, by raising distortionary taxes on capital and labour, issuing and accumulating debt. In addition, the government receives net financing F_t from the central fiscal capacity, where fr_t represents a fraction earmarked for public investment, and not available for discretionary fiscal policy.[8] The government's spending and cost of debt must be equal to the taxes collected and the issuance of new debt. The Government's budget constraint reads

$$P_t^A g_t + P_t^A i_t^g + R_{t-1} D_t (1 - v_t) + T_t^{def} = D_{t+1} + P_t^A \tau^k r_t^k k_t + P_t^A \tau_t^h w_t h_t + (1 - fr_t) F_t \tag{28}$$

Government capital accumulates according to:

$$k_{t+1}^g = \tilde{i}_t^g + (1-\delta) k_t^g - \frac{\kappa_{i_g}}{2} \left(\frac{\tilde{i}_t^g}{\tilde{i}_{t-1}^g} - 1 \right)^2 \tilde{i}_t^g \tag{29}$$

where $\tilde{i}_t^g = i_t^g + fr_t f_t$ is total real government investment including the earmarked funds and κ_{i_g} regulates investment adjustment costs in the public sector.

Risk premium on partial default risk. The sovereign spread $SP_t = R_t - R_m$ is affected by partial default v_t, which is modeled reduced-form to take into account the empirical relationship between general government debt-to-GDP and sovereign risk premia:

$$v_t = \alpha_{ss} + \alpha_d \left(\frac{d_t}{gdp_t} \frac{P_t}{P_t^A} - \frac{d}{gdp} \right) \tag{30}$$

Corsetti et al. (2013) highlight that assuming partial default on debt can lead to counter-intuitive results. Namely, high default rates can actually lower the risk premium because households anticipate the lower debt burden after the (partial) default. They address this concern by assuming that the government still bears such costs, and the corresponding resources are rebated

[8] Where real CFC financing is defined in terms of EA PPI $f_t = \frac{F_t}{P_t^{EA}}$

to households. This is captured by the term $T_t^{def} = D_t v_t$ in (28). We follow their approach, but strengthen the channel by assuming that T_t^{def} is wasted rather than rebated. This modelling assumption is meant to increase the real cost of sovereign spreads in the the economy.

The rate of interest on government debt is pinned down by the no-arbitrage relation that can be derived from first order conditions of the household

$$E_t \frac{R_t(1 - v_{t+1})}{\Pi_{t+1}} = E_t \frac{R_t^m}{\Pi_{t+1}} e(B_t^I, Y_t) x_t \tag{31}$$

where higher default risk implies higher rates on government debt, ceteris paribus.

3.7 The Central Fiscal Capacity

We introduce a supranational fiscal capacity, providing resources to national governments. The central fiscal capacity is modelled with the aim to fulfill two key goals: (i) macroeconomic stabilisation, including debt sustainability, and (ii) reduction of public investment procyclicality. The facility is modelled as a share ω_t^* of euro area output, such that net benefits for region A (in *per capita* terms) are defined as $f_t^{stabilisation} = \omega_t^* \frac{gdp_t^{EA}}{\omega}$ where gdp_t^{EA} is euro area output.[9]

$$\omega_t^* = -\phi_1 \underbrace{\left[\log\left(\frac{gdp_t}{gdp}\right) - \log\left(\frac{gdp_t^B}{gdp^B}\right)\right]}_{\text{relative output gap}}$$

Financing for region A depends on the relative decline in GDP compared to region B, and the size of the stabilisation function is regulated by ϕ_1. This implies zero net financing in steady state, thus ruling out permanent transfers in steady state. In the baseline, overall financing is determined exclusively through the stabilisation function such that financing $f_t = f_t^{stabilisation}$.[10] The CFC also comprises a debt sustainability mechanism for the high-debt region, and $\Omega_t = exp\left(\frac{f_t \frac{P_t^{EA}}{P_t^A} - f}{y_t}\right)^{\gamma_f}$ governs the effort with which region A needs to reduce its deficit through tax increases and reduction of spending. This specification implies that $\Omega_t > 1$ in case the government receives positive funding ($f_t > 0$), leading to deficit reduction, with the strength of fiscal adjustment increasing with the relative size of the financing. This specification is meant to

[9] Where $gdp_t^{EA} = \omega gdp_t^A \frac{P_t^A}{P_t^{EA}} + (1 - \omega) gdp_t^B \frac{P_t^B}{P_t^{EA}}$

[10] This assumption will be relaxed in the extensions.

parsimoniously capture the EU fiscal framework, which imposes fiscal adjustment requirements on countries with debt exceeding 60% of GDP.[11] For this reason, the fiscal adjustment requirement modelled through Ω_t is only applied to the high-debt region, which we assume has debt beyond the debt sustainability criteria in steady state. Moreover, this specification implies an implicit benefit for region B, which is calibrated to have 60% debt to gdp. The CFC framework thus entails implicit rewards for complying with fiscal sustainability requirements *ex ante*, i.e. before shocks materialise.

This deficit stabilisation mechanism operates through the government policy rules for taxes and government services:

$$\left(\frac{\tau_t^w}{\tau^w}\right) = \left(\frac{\tau_{t-1}^w}{\tau^w}\right)^{\rho_w} \left(\frac{gdp_t}{gdp}\right)^{\gamma_{w,y}} \left(\frac{d_t}{d}\right)^{\gamma_{w,d}} \Omega_t \tag{32}$$

$$\left(\frac{g_t}{g}\right) = \left(\frac{g_{t-1}}{g}\right)^{\rho_g} \left(\frac{gdp_t}{gdp}\right)^{\gamma_{g,y}} \left(\frac{d_t}{d}\right)^{\gamma_{g,d}} \Omega_t^{-1} \tag{33}$$

The other components of the government policy rules' specification are closely aligned with the literature. Both tax rates (32) and government services (33) are set proportionally to the output gap to allow for empirically observed co-movement, and both rules respond to the debt gap to ensure non-explosive debt paths. In a similar spirit, discretionary government investment (34) is proportional to the output and debt gap

$$\left(\frac{i_t^g}{i^g}\right) = \left(\frac{i_{t-1}^g}{i^g}\right)^{\rho_{i^g}} \left(\frac{gdp_t}{gdp}\right)^{\gamma_{i^g,y}} \left(\frac{d_t}{d}\right)^{\gamma_{i^g,d}} \tag{34}$$

The earmarking rule that effects total public investment $\tilde{i}_t^g$ is defined as

$$fr_t = \phi_2 e^{\frac{f_t \frac{P_t^{EA}}{P_t^A} - f}{y_t}}$$

Here, ϕ_2 governs the fraction of transfer that is earmarked for public investment. Importantly, the exponential term implies a higher fraction earmarked for investment if the region is a net

[11] Debt reduction requirements in the EU fiscal framework hinge on the Stability and Growth Pact and the Fiscal Compact (See Articles 121 and 126 of the Treaty on the Functioning of the European Union (TFEU), and the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union (TSCG)). Such general principles were maintained in the reformed fiscal governance framework, which entered into force in 2024.

recipient ($f_t \geq 0$) and a lower fraction if the region is a net donor ($f_t < 0$), thus preventing excessive cuts in public investment for donor regions.

3.8 International Linkages

Relative prices between countries evolve according to

$$\mathcal{T}_t = \mathcal{T}_{t-1} \frac{\Pi_t^B}{\Pi_t^A} \tag{35}$$

$$\mathcal{E}_t = \left[\frac{\phi_B (\mathcal{T}_t)^{1-\eta} + (1-\phi_B)}{\phi_A + (1-\phi_A)(\mathcal{T}_t)^{1-\eta}} \right]^{\frac{1}{1-\eta}} \tag{36}$$

Net exports nx_t for region A are total exports minus total imports

$$nx_t = \frac{1-\omega}{\omega} \frac{P_t^A}{P_t} (c^{BA} + i^{BA}) - \frac{P_t^B}{P_t} (c^{AB} + i^{AB}) \tag{37}$$

with symmetric net exports for region B

$$nx_t = -\frac{1-\omega}{\omega} \mathcal{E}_t nx_t^* \tag{38}$$

We can then specify the current account and the evolution of net foreign assets B_t^I (NFA) as last periods NFA with interest, net exports and net financial transfers through the CFC

$$b_{t+1}^I = \frac{R_t^m}{\Pi_t} b_t^I + nx_t + \frac{P_t^{EA}}{P_t} f_t \tag{39}$$

Note, that CFC financing f_t become part of the current account and add to the claims against the other region. Symmetry of the international asset market demands net foreign asset market clearing $b_{t+1}^I = -\frac{1-\omega}{\omega} \mathcal{E}_t b_{t+1}^{I*}$ and foreign funding of the CFC $f_t^{stabilisation} = -\frac{1-\omega}{\omega} f_t^{stabilisation,*}$.

3.9 Resource Constraint

Lastly, aggregate resources in real terms satisfy

$$y_t = c_t^{AA} + i_t^{AA} + \frac{1-\omega}{\omega}(c_t^{BA} + i_t^{BA}) + g_t + \tilde{i}_t^g + v_t \frac{d_t}{\Pi_t} \frac{P_t}{P_t^A} + \frac{\phi_p}{2}\left(\Pi_t^A - 1\right)^2 y_t + \frac{\chi_w}{2}\left(\Pi_t^W - 1\right)^2 w_t \frac{P_t^A}{P_t} \tag{40}$$

where our definition of GDP excludes adjustment costs

$$gdp_t = y_t - v_t \frac{d_t}{\Pi_t} \frac{P_t}{P_t^A} - \frac{\phi_p}{2}\left(\Pi_t^A - 1\right)^2 y_t - \frac{\chi_w}{2}\left(\Pi_t^W - 1\right)^2 w_t \frac{P_t^A}{P_t} \tag{41}$$

3.10 Shocks

There are two shock types $z \in \{a, x\}$ in the model which evolve according to

$$\log(z_t) = \rho_z \log(z_{t-1}) + \epsilon_{z,t} \tag{42}$$

where $\epsilon_{z,t} \sim N(0, \sigma_z^2)$ is an iid gaussian shock with variance σ_z^2.

4 Calibration

Parameters effecting the steady state are shown in Table (2), and were selected in to be broadly in line with the literature.

Macroeconomic aggregates. We calibrate the model to the euro area economy, comprised of a high-debt (A) region with 90% debt-to-gdp and a low-debt (B) region with 60% debt-to-gdp.[12] For each region we match key macroeconomic aggregates, as shown in Table (1). In particular, we match public and private investment ratios, private consumption, and government services for each region. Given the parsimonious nature of the labour market in our model, we match the labour share and labour hours for the euro area as a whole. The public debt ratios are set to 60 and 90 percent of GDP, respectively, in line with two region DSGE literature for the euro area

[12] Following Kaufmann et al. (2023), we consider countries that joined the euro area early on. The low-debt region thus comprises Austria, Belgium, Germany, Finland, France, Luxembourg and Netherlands, while the high-debt region includes Greece, Ireland, Italy, Portugal and Spain.

that target debt ratios (see e.g. Kaufmann et al. (2023)). Moreover, these values are consistent with debt sustainability criteria entailed by the European framework.[13]

	A		B		
	Model	Data	Model	Data	Data EA
Public Investment	3.0	3.0	3.0	3.0	
Private Investment	17.2	17.2	18.3	18.3	
Government Services	18.5	18.5	21.6	21.6	
Private Consumption	61.0	59.2	57.1	53.0	
Net Exports (data: incl. RoW)	00.0	1.3	00.0	3.4	
Import share	15.0		10.0		
labour share	55.7		55.7		55.7
labour hours	18.3		18.3		18.3
Public Debt ratio	90.0		60.0		SGP/EGR

Table 1: Euro area low- and high-debt region data vs model steady state values (percentages of output). Because we keep the labour market parsimonious we target a weighted euro area average for labour share and hours in the model. Public debt ratio is annualized.

Preferences. We calibrate the model to a quarterly frequency using a discount factor β of 0.9975, an intertemporal elasticity of substitution for consumption of 0.5 which implies a constant relative risk aversion of 2. We set a value of 0.7 for the internal habits χ and a standard value of 1 for the inverse Frisch elasticity of labour supply. The scaling factor for the disutility of labour ψ is 100 (124) for region A (B) matching labour hours. We set the parameter regulating the preference for private consumption in the CES aggregator ϕ to 0.85 and the substitution elasticity φ to 0.29 following Kaufmann et al. (2023). The home bias for region A is 0.81 matching an import share of 15% of GDP, also in line with Kaufmann et al. (2023). Notably, since our model does not include a rest of the world (RoW) sector, we do not match empirical net exports and set the home bias for region B to 0.87, which implies zero net trade for both regions in steady state. The trade elasticity is set to 3 as in Bonam et al. (2022).

Price and wage frictions. For Rotemberg adjustment costs, we follow the approaches proposed by Ascari & Rossi (2012) and Born & Pfeifer (2020) calculating them as follows:

$$\phi_p = \frac{(\theta - 1)\theta^p}{(1-\theta^p)(1-\beta\theta^p)} \tag{43}$$

$$\chi^w = \frac{(\epsilon - 1)\frac{\theta-1}{\theta}(1-\alpha)\theta^w}{(1-\theta^w)(1-\beta\theta^w)}(1+\epsilon\eta), \tag{44}$$

[13] For example, the legislative text of the preventive arm regulation, which entered into force in 2024 following the conclusion of the economic governance review process, stipulates more stringent debt reduction requirements as long as the general government debt to GDP ratio exceeds 90%, which are reduced once the general government debt to GDP ratio remains between 60% and 90%.

where $\theta^p = 0.75$ represent the Calvo probability of not being able to reset prices and $\theta^w = 0.75$ for wages. As the elasticity of substitution for the final good is set to 5, the implied price adjustment cost parameter of 48. Similarly, for the wage Phillips curve, we set the elasticity of labour types to 5 with a wage adjustment cost of 159.

Production. The share of private capital and production α is 0.30, matching the labour share. The depreciation for private and public capital is set to 3% for both regions. We pick a conservative value for the elasticity of public capital of 0.1, in line with the benchmark value used by Baxter & King (1993) and later by Leeper et al. (2010) as well as Kaufmann et al. (2023), among others. As discussed by Leeper et al. (2010), while this parameter is critical to determine the role played of public capital in TFP, empirical estimates provide a mixed picture. In Appendix (A) we explore the implications of assuming a different value of ξ compared to our baseline analysis. Lastly, the strength of private and public investment adjustment costs, regulated by κ, is set to 5, in line with the literature.

Government Risk Premia. The weights for the government risk premium approximate the relation between general government debt-to-GDP and sovereign risk premia, as measured by 5-year sovereign CDS spreads. We take the empirical results of Attinasi et al. (2017), who estimated a cubic relationship of CDS spreads and debt to GDP, and take a linear approximation around 60% and 90% of the debt ratio for region A and B. This implies that the two regions pay different risk premia in steady state and the high-debt region faces a steeper increase in in spreads for a given rise in debt than the low debt region. The parameter on the international financial intermediation fee is set to 0.025 to ensure stationarity of the open economy[14].

Policy rules. Table (3) shows parameters governing the policy rules. The Taylor rule parameters for monetary policy are standard. For the dynamic government policy rules regulating government services, public investment and labour taxes we follow Kaufmann et al. (2023), who in turn rely on the posterior mode values from a Bayesian estimation on euro area data by Coenen et al. (2013) of an extended version of the New Area Wide Model (NAWM) (Christoffel

[14]See Uribe & Schmitt-Grohé (2017) for a discussion on inducing stationarity in open economy macro models.

et al., 2008). Since the NAWM does not provide estimates for region-specific government policy rules, we assume identical coefficients for both regions. The debt feedback coefficients of all rules imply a stabilisation of the debt level, which ensures stationarity of the model. Conversely, all expenditure items respond pro-cyclically to GDP, while labour taxes respond countercyclically. In steady state, capital taxes are set to match the private investment ratios, while labour taxes balance the budget.

Description	Parameter	Value (A/joint)	(B)
Preferences			
Discount factor	β	0.9975	
Elasticity of substitution in consumption	σ	0.5	
Habit formation	χ	0.7	
Inverse of Frisch elasticity	ν	1	
Scaling parameter for labour hours	ψ	100	124
Preference for private/public good	ϕ	0.85	
Substitution private/public good	φ	0.29	
Home bias A	ϕ_A	0.81	
Home bias B	ϕ_B	0.87	
Trade elasticity	η	3.00	
Price and Wage Frictions			
Elasticity in final good	θ	5	
Price adjustment parameter	ϕ_p	48	
Elasticity in labour types	ϵ^w	5	
Wage adjustment cost	χ_w	159	
Investment			
Private investment adjustment costs	κ	5	
Public investment adjustment costs	κ_g	5	
Technology			
Private capital share in production	α	0.30	
Elasticity of output to public capital	ξ	0.1	
Private capital depreciation rate	δ	0.03	
Public capital depreciation rate	δ_G	0.03	
Bond Premia			
Constant on Risk Premium	α_{rss}	0.0035	0.000825
Weight on debt ratio in Risk Premium	α_{rdy}	0.017	0.00285
International Bond Premium	κ_b	0.025	
International			
Size	ω	0.4	0.6

Table 2: Quarterly calibration parameters. If applicable, separate parameter values for B are shown in column *(B)*.

TFP Shocks. Following Bonam et al. (2022), we assume that economic dynamics outside the steady state are driven by region-specific TFP shocks. In order to calibrate their volatility, we employ a GMM estimation procedure to match the relative volatility of output gdp, consumption c and investment i for both regions. This yields a standard deviation of 0.0061 (0.0042) of region A (B). Table (4) shows the model implied volatilities and their observed counterparts. Correlations between GDP and consumption are untargeted moments. We set the persistence of both shocks to 0.9.

Description	Parameter	Value (A/joint)	(B)
Monetary Policy			
Policy persistence	ρ_R	0.85	
Policy response to inflation	ρ_Π	1.5	
Policy response to output gap	ρ_y	0.125	
Taxes			
tax rate on labour	τ_h	0.32	0.38
tax rate on capital	τ_k	0.23	0.18
Fiscal response			
Response of labour tax to debt	$\gamma_{d,w}$	0.08	
Response of labour tax to output gap	$\gamma_{y,w}$	-0.02	
Response of govt consumption to debt gap	$\gamma_{d,g}$	-0.02	
Response of govt consumption to output gap	$\gamma_{y,g}$	0.06	
Response of govt investment to debt gap	$\gamma_{d,i}$	-0.18	
Response of govt investment to output gap	$\gamma_{y,i}$	0.55	
Shocks			
St. dev TFP shock	σ_a	0.0061	0.0042
Persistence of the TFP shock	ρ_a	0.9	
CFC			
Risk sharing	ϕ_1	0.06	
Investment earmark	ϕ_2	0.10	
Debt stability	γ_f	0.18	

Table 3: Policy rules and shocks. If applicable, separate parameter values for B are shown in column *(B)*.

Moment	A		B	
	Data	Model	Data	Model
Standard Deviation				
Output (gdp)	2.45	2.40	1.83	1.46
Private consumption (c)	2.73	1.78	1.75	0.97
Private investment (i)	6.89	5.53	3.33	3.95
Correlation				
Output and private consumption (gdp,c)	0.96	0.97	0.84	0.95

Table 4: Business cycle moments. Data moments calculated from Eurostat data (2000-2022), expressed in logarithms and and detrended with an HP filter. Standard deviations are calculated from variables in percent deviation. Correlations are untargeted. The model is calibrated without the CFC. For moments with the CFC see table (5) in the Appendix.

Central Fiscal Capacity. To discipline the parameters for the central fiscal capacity we calibrate the stabilisation parameter (ϕ_1) to values that jointly maximize weighted euro area welfare. We achieve this by maximizing unconditional weighted euro area welfare $W^{EA} := \omega U_0 + (1-\omega)U_0^B$ where U is unconditional welfare of region A as defined in (1). This yields a value of 0.06 for ϕ_1 , as shown in Figure (1), which implies a positive degree of stabilisation between the regions. This value implies that region A would receive total financing amounting to 0.06% of euro area GDP per quarter in response to a 1 percent relative output gap. We find that both regions gain from the stabilisation function, and welfare gains are concave, peaking at different levels of ϕ_1. At the euro area optimum, welfare gains in terms of consumption equivalent (CE) are 0.01%, which represents the value of consumption households would have to receive forever in an economy without the CFC to be indifferent with respect to an economy with the CFC[15]. To put the number into perspective, removing the entire business cycle fluctuation in our model without the CFC corresponds to a consumption equivalent gain of 0.02%.[16] Thus, in the context of this model, an active CFC significantly reduces the welfare cost of business cycles, effectively cutting it in half.

As for the debt sustainability mechanism in the CFC, we set γ_f to 0.18, imposing a moderate degree of deficit reduction. To anchor this value, we first compute the difference between the high-debt region level of debt to GDP and the reference value of 60% embedded in the European framework in steady state. Then we calibrate the CFC parameter to target a specific cumulative reduction of the debt ratio over the transition in response to a TFP shock, with the stabilisation function active ($\phi_1 > 0$). The reduction target is set to the ratio of the excess debt to the debt ratio level, both in steady state. For the high-debt region A this results in a debt reduction requirement of 33% over the transition, compared to a scenario where $\phi_1 > 0$ while $\gamma_f = 0$.[17] We choose this approach as it allows us to capture the quantitative debt target embedded in the European framework, as well as the initial conditions of the high-debt region. Notably, the further away the region is from the debt target in steady state, the more stringent the debt reduction requirement becomes. The isolated dynamic effects of this mechanism are explored in section 5.2.

As for the public investment earmarking parameter, we take an agnostic approach, due to the exogenous un-modelled investment needs discussed in policy arenas. We consider a range of parameters $\in [0.1, 0.2]$, and pick 0.1 in our baseline, while illustrating the implications of different values in section 5.2. The total business cycle effect of the CFC mechanisms is a reduction in volatility across both regions. In particular GDP volatility is reduced by 13.3% (9.6%) for region A (B) as discussed in more detail in Appendix (B).

[15] When comparing two regimes, the consumption equivalent is the change in consumption a household would need to receive (or give up) in one regime to be indifferent between the two regimes.

[16] It is worth noting that our results are well aligned with this class of models and the literature on this topic, stemming from the seminal contribution of Lucas (1987), who quantified the welfare loss of business cycles fluctuations at 0.008% of consumption in the United States. Several subsequent studies contributed alternative estimates, but a consensus emerged on the fact that the welfare gains from full business cycle stabilisation in this class of models are quantitatively small (Imrohoroglu, 2016). For this reason, we evaluate the welfare gains stemming from the central fiscal capacity relatively to the cost of business cycles as a whole.

[17] Debt reduction requirement: $\frac{Debt^A - DebtTarget^{EA}}{Debt^A} = \frac{90\% - 60\%}{90\%} = 33\%$.

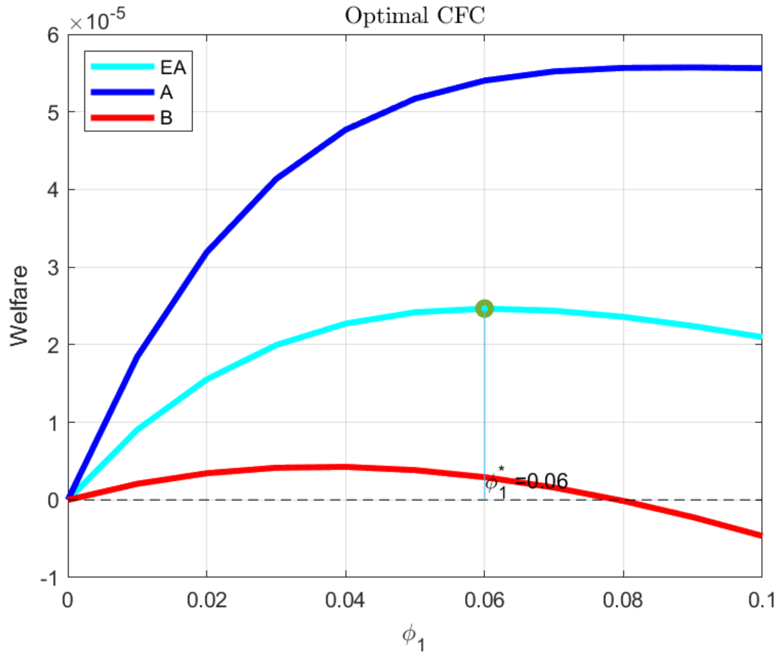

Figure 1: Welfare over different degrees of stabilisation (ϕ_1). Blue is high-debt (A) region, red is low-debt (B) region and cyan is euro area weighted average.

5 Results

In this section we study the effects of the introduction of the central fiscal capacity in the model economy. We analyse the impact both negative supply and demand shocks to the high-debt region, and delve into the mechanics at play. In subsection (5.1) we first study the transmission of a negative supply shock, affecting the high-debt region through a reduction in TFP. To understand the contribution of the CFC mechanisms, we then zoom into the isolated contributions of the deficit and investment channels in subsection (5.2). Subsection (5.3) discusses a demand shock. The similarity of the demand shock suggests that the specification of the CFC mechanisms would result in similar mechanics in the face of alternative shocks. For this reason the focus of the exposition lies on the supply shock, while for the demand shock we concentrate on the key differences only.

5.1 Supply Shock

We analyse impulse responses to a negative TFP shock affecting the high-debt region and the effect of the CFC on such dynamics. Figure (2) includes impulse responses for the baseline TFP shock with inactive (solid lines) and active (dashed lines) CFC.

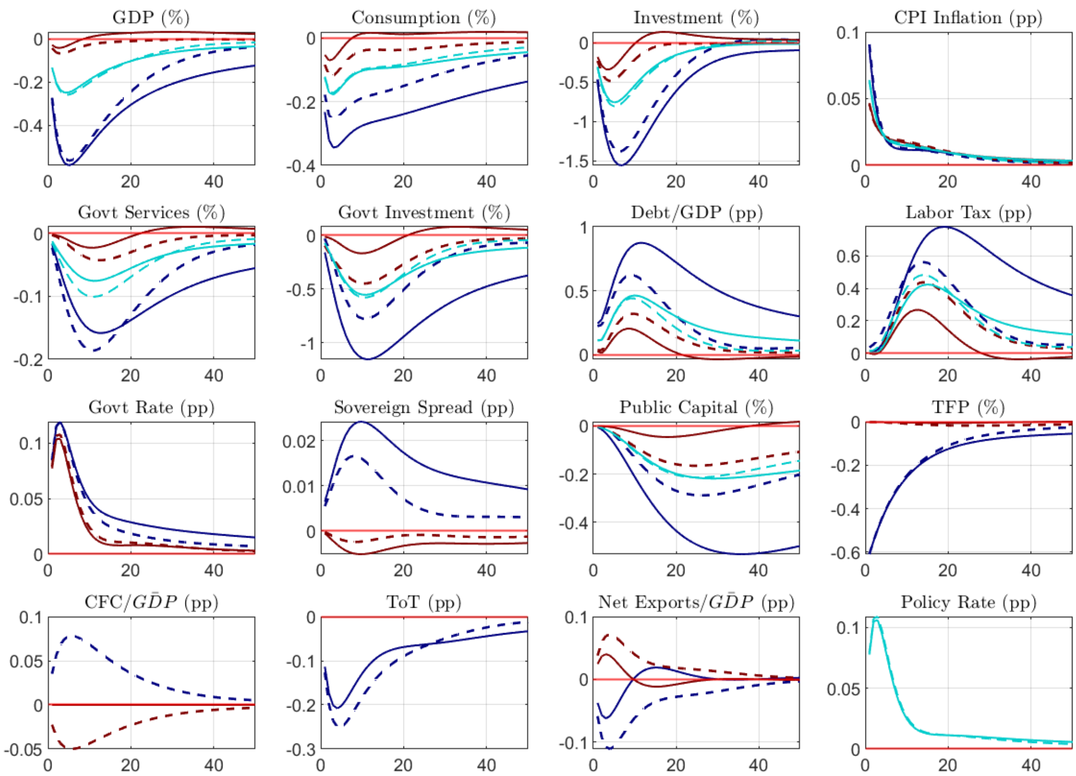

Figure 2: IRF for TFP shock to A. No CFC (solid) vs CFC (dashed). Blue is high-debt (A) region, red is low-debt (B) region and cyan is euro area weighted average. TFP is the combination of exogenous a_t and endogenous public capital k_t^g productivity.

Inactive CFC. The solid line in Figure (2) shows the impulse response functions (IRF) to a negative supply shock to the high-debt region (A), with an inactive CFC.[18] The first row shows a persistent decline in economic aggregates with a gradual return to steady state over the medium term while inflation spikes on impact. Government policy rules (second row) react procyclically while incurring a positive deficit that increases the debt ratio. The monetary authority responds to inflation by raising rates, while the sovereign spread for the high-debt region increases as a consequence of the larger debt burden. The persistent drop in public capital slows the recovery

[18] $\phi_1 = \phi_2 = \gamma_f = 0$

through the endogenous TFP channel.[19] Terms of trade fall, making imports from region B more attractive such that net exports decline for region A. While the shock hits region A only, there are some spillover effects for region B which are felt predominantly in the short run. These are driven by the trade channel, the monetary policy channel and the risk premia channel.

Active CFC. The dashed IRFs correspond to the model with the CFC mechanisms switched on. Due to the relatively stronger decline in GDP of region A, the high-debt region receives positive CFC financing, which is funded through contributions from region B. The direct effect of the CFC financing is a relaxation of the government budget constraint. As a consequence, the government debt ratio increases by less, while fiscal policies become less procyclical. A low debt ratio implies more fiscal space and a reduction of the sovereign spreads. The relatively higher government investment mitigates the persistent drop in public capital and allows for a faster recovery of productivity in the medium run. A lower tax burden on households' labour income allows for higher spending on private consumption and investment, where spending on investment is aided by a higher return to capital through increased productivity in the medium run. Overall the effects result in a faster recovery of output, which becomes even more pronounced in the medium run.

The impact on inflation is positive but minuscule in the short run while returning slightly quicker to target. Thus the CFC does not significantly exacerbate the policy trade-off between output and inflation stabilisation for monetary policy. This, in part, stems from an improvement of the terms of trade for region A. The terms of trade improvement is firstly driven by increased demand for domestic goods through the government sector, but also through increased private consumption and investment that is biased towards home goods. At the same time, worsened terms of trades for B lead to lower relative imports and to a decline in region A's net exports. An additional channel for the decline in next exports stems more directly from the CFC transfer which enters the specification of the current-account. Ultimately, region A uses the funds received to purchase goods from region B, lowering the net exports term.[20] Overall, these results

[19] To recall, TFP in the model is a composite of an exogenous component, driven by a shock process, and an endogenous component driven by public capital.

[20] This mechanism is related to what is known as the "transfer problem" in the literature, as discussed in Samuelson (1952) and Jones (1970), amongst others.

indicate that some of the CFC financing is *de facto* rebated back to region B through the trade channel. At the euro area level, an active CFC in the medium run leads to a faster recovery in GDP, public investment and private consumption, while taming public debt.

5.2 Fiscal Adjustment and Investment Earmarking Implications

(a) Debt Sustainability **(b)** Investment Earmarking

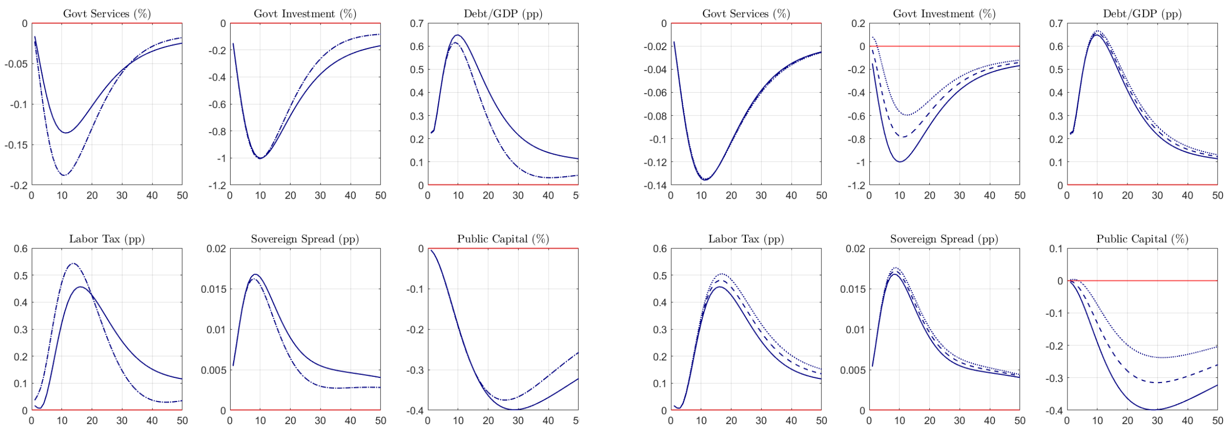

Figure 3: CFC mechanisms. IRF for TFP shock to A. Figure (3a) shows the CFC with the stabilisation mechanism active only $\{\phi_1 > 0, \phi_2 = 0, \gamma_f = 0\}$(solid) vs CFC with the stabilisation and debt sustainability mechanism active (dashed). Figure (3b) shows the CFC with the stabilisation mechanism active only (solid) vs CFC with the stabilisation and varying degrees of investment earmarking mechanism active (dashed).

To understand the contribution of the fiscal adjustment requirements and the investment earmarking mechanisms of the CFC, we analyse the isolated contribution of each element following a negative TFP shocks to to region A. The solid lines in Figure (3a) capture the response stemming from a CFC with only stabilisation mechanisms active $\{\phi_1 > 0, \phi_2 = 0, \gamma_f = 0\}$ while the dashed lines show the responses stemming from a CFC with the stabilisation and debt stabilisation mechanism active $\{\phi_1 > 0, \phi_2 = 0, \gamma_f > 0\}$. The debt sustainability mechanism is aimed at reducing the deficit through a reduction in government services and an increase in taxes. In figure (3a) we see precisely this reduction of government services and increase of taxes in the *short run*. The reduction of the deficit directly affects the debt ratio, which is reduced due to lower deficit accumulation, resulting in a reduction of the sovereign spread. The attained fiscal space allows for an increase in government investment and therefore mitigates the decline in public capital. Interestingly, the gained fiscal space actually allows for a slight *increase* of government services as well as a *reduction* of taxes in the *medium run*. Hence, although the mechanism is designed to reduce the deficit by closing the gap between expenditures and taxes, the ultimate goal of debt sustainability bears fruit in the medium run and allows for an increase and spending while lowering taxes.

Figure (3b) shows the response to a TFP shock to region A isolating the role played by investment earmarking. The solid lines give the response from the CFC with the stabilisation mechanism active only $\{\phi_1 > 0, \phi_2 = 0, \gamma_f = 0\}$ while the dashed lines show the response from the CFC with the stabilisation and investment earmarking mechanisms active $\{\phi_1 > 0, \phi_2 > 0, \gamma_f = 0\}$, where $\phi_2 = [0.1, 0.2]$. The investment earmark imposes restrictions on a portion of CFC financing, which can be used exclusively for government investment, and our calibration considers either 10% or 20%. Because the earmarked fraction goes directly into investment, it is not available for the consolidation of government debt. This mechanism is shown in Figure (3b), where higher degrees of earmarking lead to increased government investment and public capital, leading to a small but positive increase in GDP over the medium run. At the same time, a higher debt ratio implies a slightly higher sovereign spread, while the reduction in fiscal space reduces funds available for government services and triggers an increase and taxes to support debt stabilisation.

Overall, the two CFC mechanisms have opposite effects on government debt and sovereign spreads, thus partially cancelling each other out when combined, while unequivocally supporting government investment and thus productivity in the medium run and contributing to the outcomes depicted in Figure (2).

5.3 Demand Shock

While we assume that business cycles are driven by TFP shocks, we also consider the dynamic response of the economy to a demand shock, to investigate the mechanics of the CFC in this setting. We set the volatility of the demand shock to the values estimated in Kaufmann et al. (2023), which imply a standard deviation of 0.003 for region A, together with a persistence ρ_x of

0.93. Figure (4) shows the response to a negative demand shock, which is modelled as an increase in the demand for safe assets. Qualitatively, the effects for region A are similar to the effects of a TFP shock, except for inflation which drops on impact, triggering an expansionary monetary policy response and an increase in net exports. In terms of magnitudes, the flight to safe assets raises the debt ratio by a considerably higher margin resulting in a higher sovereign spread. This leads to an overall increase in the interest burden for region A despite accommodating monetary policy. Moreover, because of reduced demand for consumption and investment in region A, there are positive spillovers to region B, as lower producer prices make imports from A more attractive and both consumption and investment react positively.

The effect of the CFC on the dynamics is qualitatively similar to the supply shock scenario. However, since trade channel effects are reversed, the improvement of the terms of trade mitigates the trade adjustment: there is less outflow of goods and services to region B. At the same time, the upward pressure on inflation in the short-run slightly mitigates the dis-inflationary period for region A in the short run. As a consequence, the CFC stimulus supports monetary policy in the short-run.

6 Extensions

6.1 European Bonds

An important aspect of the debate on the introduction of a CFC relates to its funding mechanism. Our benchmark framework models CFC financing through direct government contribution from the member states. In this section, we explore funding through euro area bonds at interest factor $R_t^{EA} = R_t^m$. Let d_t^{EA} be the real stock of supranational debt. The evolution of EA debt follows the law of motion

$$d_t^{EA} = \frac{R_t^{EA}}{\Pi_t^{EA}} d_{t-1}^{EA} + u_t^{EA} \tag{45}$$

where u_t^{EA} is new real issuance of EA debt. Real issuance u_t^{EA} follows:

$$\left(1 + \frac{u_t^{EA}}{gdp_t^{EA}}\right) = \left(1 + \frac{u^{EA}}{gdp^{EA}}\right) \left(\frac{gdp_t^{EA}}{gdp^{EA}}\right)^{\phi_{u,y}} \left(1 + \frac{d_t^{EA}}{gdp_t^{EA}} - \frac{d^{EA}}{gdp^{EA}}\right)^{\phi_{u,y}} \tag{46}$$

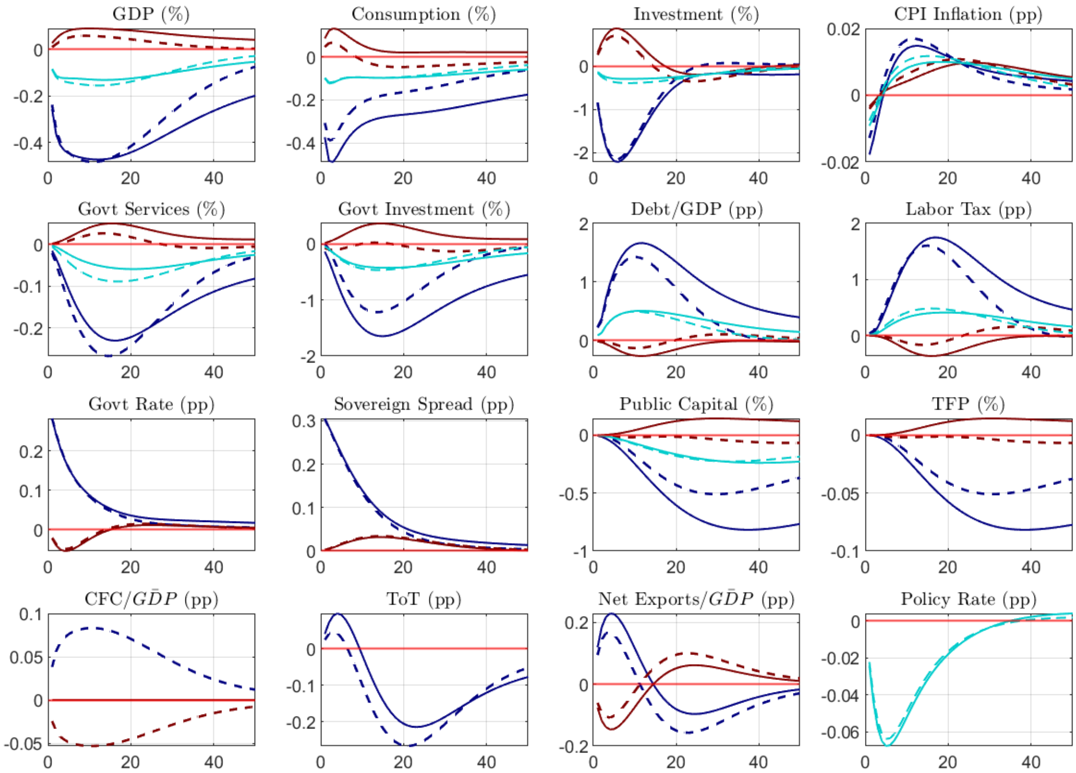

Figure 4: IRF for demand shock to A. No CFC (solid) vs CFC (dashed). Blue is high-debt (A) region, red is low-debt (B) region and cyan is euro area weighted average.

making issuance respond to the output and debt gap. We assume that each region receives issued funds proportionally to their size (or contributes if $u^{EA} < 0$)

$$f_t = u_t^{EA} + f_t^{stabilisation} \tag{47}$$

$$f_t^B = u_t^{EA} + f_t^{B,stabilisation} \tag{48}$$

Note that, as per our convention, aggregate variables are expressed in per capita terms for their respective region such that equations (47) and (48) imply that a fraction ω of bond issuance is received by region A and a fraction $(1-\omega)$ is received by region B.[21] The CFC financing of national governments remains unchanged. Outstanding EA debt will become part of the

[21] ωu_t^{EA} is the (non per capita) amount for region A, $(1-\omega)u_t^{UE}$ is the (non per capita) amount for region B, u_t^{EA} is the amount for EA region (which is the sum of region A and B $\omega + (1-\omega) = 1$.)

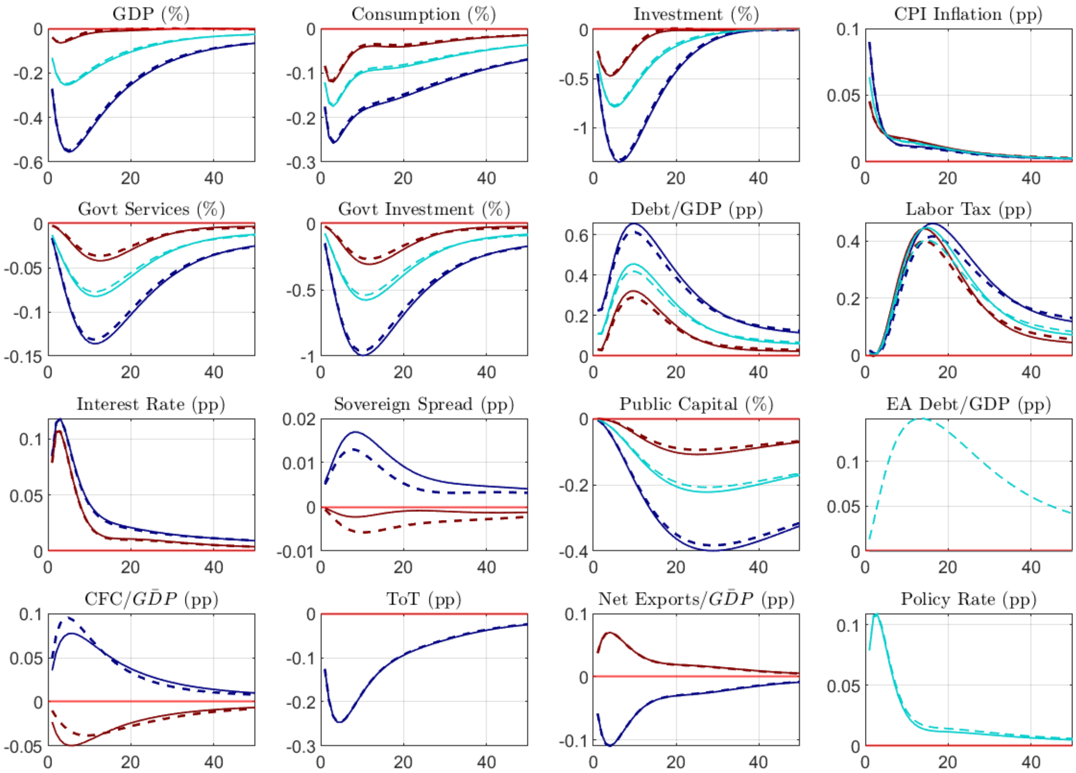

Figure 5: European Bond issuance. IRF for supply shock to A. The CFC stabilization rule is active in both scenarios, funded by direct contribution of B without EA bond issuance (solid) vs with EA bond issuance (dashed). Blue is high-debt (A) region, red is low-debt (B) region and cyan is euro area weighted average. EA debt refers to the supranational debt facility d^{EA}.

international bond supply such that the international bond market clearing becomes

$$d_t^{EA} = \omega \frac{P_t}{P_t^{EA}} b_t^I + (1-\omega)\frac{P_t^*}{P_t^{EA}} b_t^{I*} \tag{49}$$

The calibration only requires us to take a stance on the EA debt issuance. Firstly, we set steady state EA debt to zero, thus ruling out issuance in steady state. For stability reasons, issuance must stabilize debt in the long-run, which is achieved with a value of $\gamma_{u,d} = -0.1$ that dampens issuance as EA debt increases. $\gamma_{u,y}$ influences whether debt issuance is procyclical ($\gamma_{u,y} > 0$) or countercyclical ($\gamma_{u,y} < 0$). Countercyclical issuance implies a reduced burden on government budget constraints during recessions. We optimally pick $\gamma_{u,y} = -0.11$ to maximize EA welfare, taking the baseline CFC stabilization function as given. This sufficiently reduces the short-run burden on region B's government when region A is hit by a shock.

Figure (5) shows the response to a TFP shock to region A. All responses include an active CFC stabilization function, matching our baseline specification, but the dashed response is partially financed by European bonds. The countercyclical issuance of EA debt relaxes the supranational budget constraints (47 and 48) and thus the contribution of the donor region (B) in the short run. Funds have to be repaid eventually, leading to higher contribution to the CFC in the medium run. This amounts to an intertemporal substitution of the recovery financing.

6.2 European Public Goods

"Cyclical risk-sharing is hard to implement in Europe because political preferences are severely misaligned. But for shared goals such as health, defence and the climate transition, policy preferences are overlapping and the need for higher spending commitments is incontrovertible."

Draghi (2023)

While the findings of this paper, as well as a broad economic literature, support the introduction of a fiscal stabilisation capacity in the euro area, political appetite for increased stabilisation on the basis of fiscal transfers remains low in Europe (Draghi, 2023). At the same time, the debate on European Public Goods (EPGs) is gaining traction. EPGs represent strategic investments in areas such as the green transition, energy, innovation, and defense. Some policy-makers and academics argue that these offer EU-wide benefits and that it would be more efficient to manage their funding at EU level.[22] Moreover, a central fiscal capacity could be the tool necessary for their delivery, but no consensus on its precise design has emerged (Gentiloni, 2024), (Buti et al., 2022).

We draw from these discussions, and put forward a framework to embed EPGs in a DSGE model, proposing an alternative CFC. To achieve this, we rely on three key assumptions, which are detailed in Appendix (C). Firstly, we assume that public capital is a composite of national and European capital, introducing a channel linking European investment to productivity through the production function. Secondly, European capital stems from accumulated euro area investment, which is assumed to be acyclical, *i.e.* fixed over the business cycle, while investment goods

[22] See for example Draghi (2023), Buti et al. (2023) and Bakker et al. (2024).

come from both regions. This assumption is meant to capture the importance of maintaining investment in EPGs, despite macroeconomic conditions. Thirdly, we assume that the EPGs-CFC reallocates the share of European investment costs across the two regions, depending on the relative output gap, thus introducing a redistribution channel over the business cycle.

Optimal EPGs CFC. Following the same approach as in our baseline specification, we compute the optimal cost redistribution parameter by maximizing weighted euro area welfare. We achieve this by maximizing unconditional weighted euro area welfare $W^{EA} := \omega U_0 + (1-\omega)U_0^B$ where U is unconditional welfare of region A as defined in (1). This yields a value of 6 for ϕ^{cost}, which implies a positive degree of cost redistribution between the regions.

EPGs CFC Results. Figure 6 illustrate the dynamic impact of the alternative CFC in the EPG setting, following a negative TFP shock to region A. The solid line represent the case where the cost of EPGs is not redistributed over the business cycle ($\phi^{cost} = 0.0$), while the dotted line shows the effects of the alternative (optimal) CFC active. European bond issuance remains active in either scenario. Compared to the baseline, there is now an additional channel through the endogenous adjustment of EPG inputs: as the terms of trade respond to the shock, the supranational facility shifts investment procurement to the region that is relatively cheaper (more competitive).

The remaining dynamics are well aligned with our baseline specification, as the alternative CFC also stabilises output for region A, promotes public investment and productivity in the medium run, tames government debt and the risk premium. These findings support the view that a central fiscal capacity in Europe could be introduced with the purpose of ensuring the provision of European Public Goods, *de facto* providing stabilisation while also addressing common investment needs. This constitutes an important contribution of our work, as this is the first paper to conceptualise EPGs in a DSGE model, but also because we put forward a novel proposal for a central fiscal capacity design for EPGs. While fiscal stabilisation through a transfer system might not be politically palatable in the European context, a framework for sharing the responsibility of providing European Public Goods (EPGs) could garner broader support, as it would ultimately support the Union's objectives. Nevertheless, the identification of a comprehensive framework for EPGs necessitates further analysis. However, our work puts forward some initial avenues for exploration that can serve as a foundation for future research.

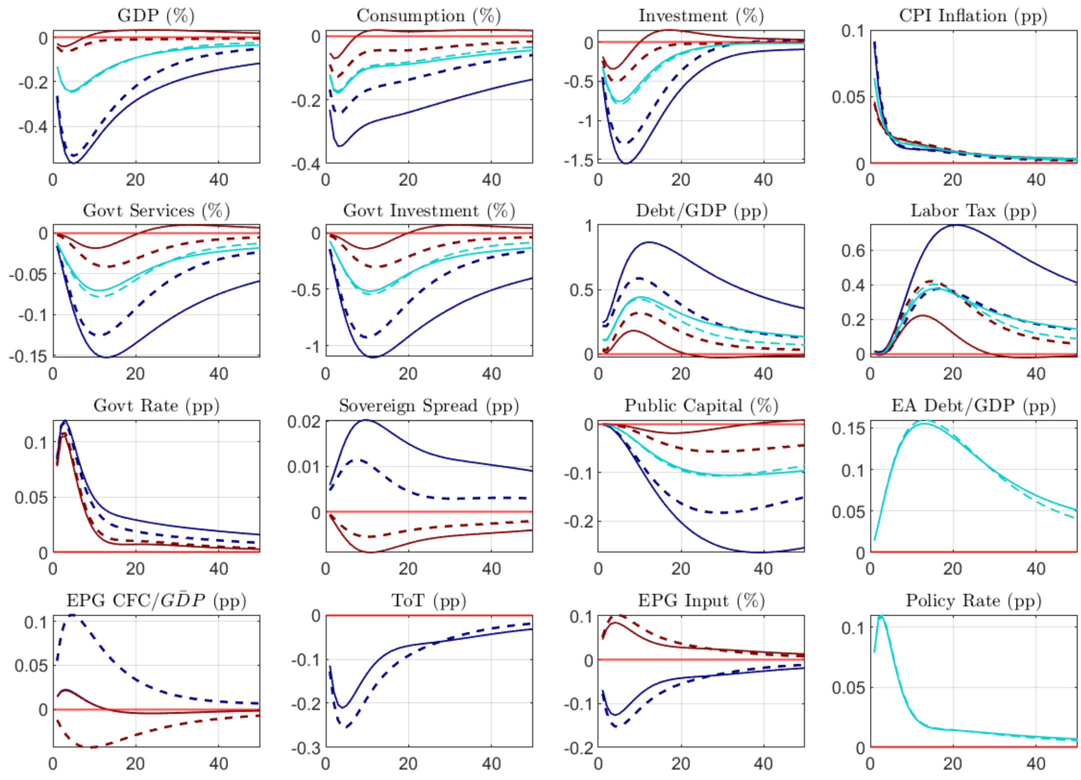

Figure 6: European Public Goods. IRF for supply shock to A. With inactive (solid) vs active (dashed) cost redistribution of European Public Goods (EPG). Blue is high-debt (A) region, red is low-debt (B) region and cyan is euro area weighted average. EPG Input refers to the investment inputs $i^{EA,A}$ and $i^{EA,B}$ for the supranational investment good.

7 Conclusion

This paper contributes to the literature and the policy debate on the introduction of a central fiscal capacity in Europe. We put forward a policy proposal for the establishment of a CFC in the euro area, aimed at promoting macroeconomic stabilisation, public debt sustainability and public investment. We develop a two-region DSGE model and find that an active CFC leads to improved stabilisation for both regions. Through model extensions we also find supporting evidence for CFC financing through common bond issuance as well as for the provision of European Public Goods. Overall, the findings of this paper highlight the potential for a CFC to strengthen the euro area's economic resilience and economic sustainability. We provide valuable insights into the potential benefits and challenges of implementing such a reform as policymakers continue to explore avenues for strengthening the euro area's economic architecture through a well-designed CFC.

Limitations of our approach open several avenues for future research: Firstly, the current framework does not incorporate long-run effects of investment activity. Formulating a CFC in an endogenous growth framework would allow to explore the channels through which a CFC could affect economic growth trajectories. Along similar lines, investigating optimal public investment warrants further research against the backdrop that it will crucially depend on its productivity, implementation cost and complementarity with private investment. Secondly, our results also emphasise political economy dimensions pertaining to structurally unequal regions that would be worth examining in more detail. Furthermore, the treatment of European Public Goods remains exploratory and leaves ample room for further study on active supranational policy designs. Lastly, investigating the implications of a CFC through a heterogeneous agents framework could shed light on the distribution of costs and benefits within regions.

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Appendix

A Robustness: Public Capital Productivity

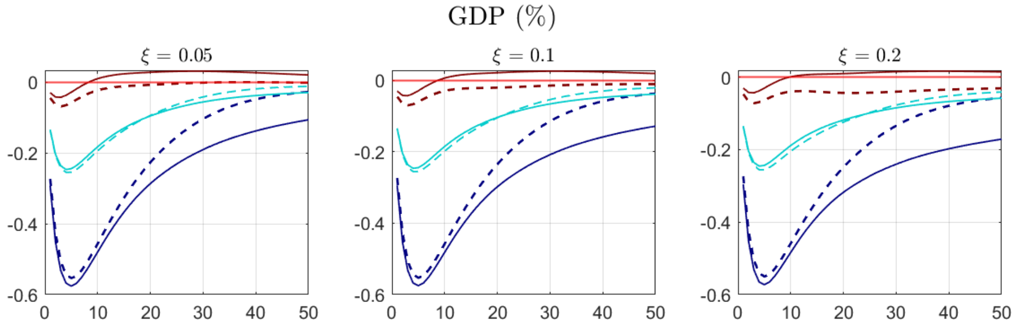

Figure 7: Different assumption on public capital productivity ($\xi = 0.05, \xi = 0.1, \xi = 0.2$). IRF for TFP shock to A. No CFC (solid) vs CFC (dashed). Blue is high-debt (A) region, red is low-debt (B) region and cyan is euro area weighted average.

In this exercise, we explore the implications of assuming a relatively higher (lower) productivity of public capital. We set $\xi = 0.2$ ($\xi = 0.05$) thus increasing (decreasing) the elasticity associated with public capital in the production function. Figure (7) shows the resulting dynamics to a TFP shock in the high-debt region. Higher public capital productivity results in a somewhat more persistent business cycle, *ceteris paribus.* This stems from the procyclical reduction in public investment, which now has a stronger amplifying effect on TFP, and by extension to overall output. This implies that a higher productivity of public capital is associated with a stronger pass-through between public capital and output. At the same time, this assumption strengthens the impact of an active CFC on the high-debt region in the medium-run, while yielding similar effects at the EA level. The story is reversed for lower values of the elasticity, but none of the considered values result in large quantitative deviations from the baseline.

B Business Cycle Moments with Active CFC.

Table (5) shows business cycle moments comparing the model with active versus inactive CFC. An active CFC leads to reduced volatility for GDP, consumption and private investment in both regions due to active stabilization. Reduction in volatility is more pronounced in region A (high-debt) and tends to be stronger for consumption compared to output, in part due to the

Moment	A			B		
	Inactive CFC	Active CFC	Change (%)	Inactive CFC	Active CFC	Change (%)
Standard Deviation						
Output (gdp)	2.40	2.08	(- 13.3%)	1.46	1.32	(- 9.6%)
Private consumption (c)	1.78	1.16	(- 34.8%)	0.97	0.85	(- 12.4%)
Private investment (i)	5.53	4.73	(- 14.5%)	3.95	3.53	(- 10.6%)
Correlation						
Output and private consumption (gdp,c)	0.97	0.93		0.95	0.90	

Table 5: Business cycle moments of model with and without (baseline) CFC. Standard deviations are calculated from variables in percent deviation.

trade channel.

C Model extension: European Public Goods (EPG)

In this section we further modify the baseline framework to explore an alternative CFC design. We enable EA level investment in European Public Goods (EPGs). These are meant to capture common investment needs, such as efforts to further the climate and digital transitions, promote innovation and boost defence, raising productivity for the entire block. To achieve this, we replace national public capital in the production function with composite public capital k_t^{pc}

$$y_t(i) = \underbrace{a_t\,(k_t^{pc})^{\xi}}_{\text{firm's TFP}}\; k_t(i)^{\alpha}\; h_t(i)^{1-\alpha} \tag{50}$$

We assume a flexible CES specification with elasticity η_{EPG} that aggregates national k^g and European public capital k^{EA} to allow for complementarity or substitutability of EPGs with national investment

$$k_t^{pc} = \left[\phi^{EPG}(k_t^{EA})^{\frac{\eta_{EPG}-1}{\eta_{EPG}}} + (1-\phi^{EPG})(k_t^{g})^{\frac{\eta_{EPG}-1}{\eta_{EPG}}}\right]^{\frac{\eta_{EPG}}{\eta_{EPG}-1}} \tag{51}$$

with weight ϕ^{EPG} on EPGs. Euro area public capital is accumulated by euro area investment $\bar{i}^{EA}$. We assume that EA investment is acyclical, *i.e.* fixed over the business cycle, while investment goods for EA public investment i_t^{EA} come from both regions

$$\bar{i}^{EA} = \left[\phi^{EA,A}(i_t^{EA,A})^{\frac{\eta_{EA}-1}{\eta_{EA}}} + (1-\phi^{EA,A})(i_t^{EA,B})^{\frac{\eta_{EA}-1}{\eta_{EA}}}\right]^{\frac{\eta_{EA}}{\eta_{EA}-1}} \tag{52}$$

EA capital is thus:

$$\bar{k}_t^{EA} = \frac{\bar{i}^{EA}}{\delta_G} \tag{53}$$

Relative demand for the investment goods satisfies

$$i_t^{EA,A} = \left(\frac{\phi^{EA,A}}{1-\phi^{EA,A}}\right)^{\eta_{EA}} \left(\frac{P_t^B}{P_t^A}\right)^{\eta_{EA}} i_t^{EA,B} \tag{54}$$

Notably, net exports now include trade with the supranational EA facility (this implies that the sum of net exports between A and B does not necessarily equal zero.)

$$nx_t = \frac{(1-\omega)}{\omega}\frac{P_t^A}{P_t}(c_t^{BA} + i_t^{BA}) + \frac{1}{\omega}\frac{P_t^A}{P_t} i_t^{EA,A} - \frac{P_t^B}{P_t}(c_t^{AB} + i_t^{AB}) \tag{55}$$

and region B

$$nx_t^B = \frac{\omega}{(1-\omega)}\frac{P_t^B}{P_t^*}(c_t^{AB} + i_t^{AB}) + \frac{1}{(1-\omega)}\frac{P_t^B}{P_t^*} i_t^{EA,B} - \frac{P_t^A}{P_t^*}(c_t^{BA} + i_t^{BA}) \tag{56}$$

which replace the original expressions for net exports.[23]

EPGs CFC. In this setting, we introduce an alternative CFC, meant to provide government financing f_t as sum of debt issuance and cost of EA EPGs:

$$f_t = u_t^{EA} - f_t^{share} \underbrace{\left(i_t^{EA,A}\frac{P_t^A}{P_t^{EA}} + i_t^{EA,B}\frac{P_t^B}{P_t^{EA}}\right)}_{\text{EPG investment costs}}$$

[23]Resource constraint becomes:

$$y_t = g_t + i_t^g + c_t^{AA} + i_t^{AA} + \frac{1}{\omega} i^{EA,A} + \frac{(1-\omega)}{\omega}(c_t^{BA} + i_t^{BA}) + v_t \frac{d_t}{\Pi_t}\frac{P_t}{P_t^A} + \frac{\phi_p}{2}\left(\Pi_t^A - 1\right)^2 y_t + \frac{\chi_w}{2}\left(\Pi_t^W - 1\right)^2 w_t \frac{P_t^A}{P_t}$$

Changes in equilibrium conditions:

- Production function (50) replaces (23)
- Equations for net exports (55),(56) replace (37),(38) to include investment exports to EA.

We assume that the share of cost depends again on the output gap, thus introducing a redistribution channel over the business cycle.

$$f_t^{share} = 1 + \phi^{cost}\left[\log\left(\frac{gdp_t^A}{gdp^A}\right) - \log\left(\frac{gdp_t^B}{gdp^B}\right)\right]$$

The calibration requires us to take a stance on the aggregation of euro area and national public capital as well as investment aggregation. The CES aggregators in principle allow for a rich calibration, but given the exploratory nature of this framework and the lack of an empirical counterpart, we choose parameters we take a conservative stance. We assume the same fraction for the national investment good as for the EA investment good which we set to 1.5% of the respective output. Weights on EA and national capital aggregation are set equally to $\phi^{EPG} = 0.5$. $\phi^{EA,A} = \omega$ implies production of EA investment goods in each region proportional to their respective size. The elasticities are set to $\eta^{EPG} = \phi^{EA} = 1.0$ collapsing the CES to Cobb-Douglas making EPGs and their inputs neither substitutes nor complements to national investment. Table (6) summarizes the parameterization.

Description	Parameter	Value	(B)
Steady State Targets			
EA public investment	i^{EA}/gdp^{EA}	0.015	
National public investment	i^g/gdp	0.015	
Structural			
Weight on EA capital	ϕ^{EPG}	0.5	
Weight on EA investment from region A	$\phi^{EA,A}$	ω	$(1-\omega)$
Elasticity of capital	η^{EPG}	1.0	
Elasticity of investment	η^{EA}	1.0	
Cost redistribution			
Weight on output gap in cost redistribution	ϕ^{cost}	6	

Table 6: Parameters for EPG extension. Column (B) gives values for region B if different from A.

As in the baseline, we calculate business cycle moments in the version with European Public Goods. Table (7) summarizes the moments with and without active cost redistribution.

Moment		A			B	
	Inactive CFC	Active CFC	Change (%)	Inactive CFC	Active CFC	Change (%)
Standard Deviation						
Output (gdp)	2.29 (2.33)	2.11	(- 7.86%)	1.41 (1.44)	1.32	(- 6.38%)
Private consumption (c)	1.78 (1.81)	1.37	(- 23.03%)	0.97 (0.99)	0.86	(- 11.34%)
Private investment (i)	5.41 (5.51)	4.89	(- 9.61%)	3.90 (3.99)	3.60	(- 7.69%)
Correlation						
Output and private consumption (gdp,c)	0.96 (0.96)	0.95		0.95 (0.95)	0.92	

Table 7: Business cycle moments of model with and without CFC in an economy with EPGs. Active with cost redistribution and European bonds. Inactive only with European bonds (without European Bonds). Standard deviations are calculated from variables in percent deviation.

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