Fiscal capacity investments in a monetary union*

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Abstract

We study the macroeconomic stabilization properties and welfare implications of a centralized fiscal capacity in a New Keynesian model for a two-country monetary union. When fiscal capacity investments respond endogenously and counter-cyclically to the business cycle, they enhance welfare and promote business cycle synchronization across member states. Exogenous fiscal capacity investments that are set up to provide other a public good can also provide macroeconomic stabilisation, provided they boost productivity and avoid exacerbating macroeconomic imbalances. If they fail to sufficiently enhance productivity, such investments risk aggravating macroeconomic variability. Our findings underscore the importance of the quality of public investments financed by a fiscal capacity under monetary union.

JEL Classification: fiscal capacity, public investment, monetary union, endogenous regime switching

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Non Technical Summary

A longstanding debate questions whether the European Monetary Union requires a form of fiscal union or a central fiscal capacity to function better. A central fiscal capacity could contribute to policy efficiency by providing macroeconomic stabilization in the event of negative shocks and reducing differences within the monetary union. The provision of European public goods has been proposed as a promising avenue in this regard, as it could deliver both public goods and macroeconomic stabilization.

This paper contributes to this debate by analyzing the macroeconomic stabilization properties of a central fiscal capacity that provides public capital in a New Keynesian model for a two-country monetary union. In our model, the EU fiscal authority has two possibilities. First, the fiscal capacity can react (directly) to economic shocks (akin to the Next Generation EU program that started during the COVID-crisis to provide support to the hardest hit countries). Second, it can react in an idiosyncratic manner with the aim to provide public capital to overcome specific challenges (such as a common defense program or investments to mitigate climate change) rather than responding to the state of the business cycle. In the first case (endogenous), the objective of the fiscal capacity is to provide economic stabilization. In the second case (exogenous), the objective is different, but the common fiscal capacity might provide stabilization as a desirable by-product.

Our main findings show that the endogenous fiscal capacity can help dampen the contractionary effects on output of adverse supply shocks by raising investment in public capital and thereby supporting productivity growth and aggregate demand. The boost in demand tends to amplify the inflationary effects of the supply shock, yet the productivity-enhancing effects of the fiscal capacity investments lead to a more muted inflation response in the medium- to long run. Model simulations show that a sufficiently counter-cyclical response of fiscal capacity investment helps substantially bring down output variability across the monetary union, raises slightly inflation variability, and results in a higher level of output and a lower level of inflation on average. Moreover, by closing macroeconomic imbalances

within the monetary union, counter-cyclical fiscal capacity investments also render business cycles more synchronized across member states, which supports monetary policy in achieving macroeconomic stability for the monetary union as a whole. As a result, we find that counter-cyclical fiscal capacity investments raise welfare, especially if public capital is more productive.

The endogenous response of the fiscal capacity is modeled as an endogenous Markov-Switching process depending on the relative position of the two countries vis-à-vis the business cycle. There are two regimes, one in which the relative gap is positive and another one where it is negative. Hence, with this approach fiscal capacity investments are used as a counter-cyclical macroeconomic stabilization tool to smooth out differences in economic performances across countries.

Exogenous fiscal capacity investments are found to have more heterogeneous effects on macroeconomic variability. As they are primarily undertaken to provide some public good, rather than macroeconomic stabilization, they might enhance utility but not increase the productive public capital stock. However, these investments can result in a higher level of output and a lower level of inflation on average, and also raise welfare, if they contribute to enhancing productivity. Moreover, the welfare gains are largest when fiscal capacity investments are used to build up common public capital, rather than public capital that is specific to an individual member state, as these investments do not contribute strongly to macroeconomic imbalances across countries.

All in all, we find that monetary unions benefit the most from a centralized fiscal capacity when such a capacity is used, either counter-cyclically or more exogenously, to finance productivity-enhancing public capital, that is common across member states, and in times when the economy faces large adverse supply shocks.

1 Introduction

A relatively recent variation of the longstanding debate whether the European Monetary Union requires a form of fiscal union or a central fiscal capacity to function well has been the debate on European public goods. The idea is that central provisioning of public goods in response to challenges such climate change, digitalization and security help to ensure that sufficient investments are made and contribute to macroeconomic stabilization. For example, Buti and Messori (2022) advocate that a central fiscal capacity can contribute to policy efficiency by focusing on stabilization in the event of negative demand shocks and boosting potential output in the event of negative supply shocks, and conclude that the provision of European public goods appears to be the most promising avenue in this regard.

We contribute to this debate by analyzing the macroeconomic stabilization properties of a central fiscal capacity that provides public capital in a New Keynesian model for a two-country monetary union. Our analysis considers two types of reactions of the EU fiscal authority. First, the fiscal capacity can react to economic shocks (akin the Next Generation EU program that started during the COVID-crisis to provide support to the hardest hit countries). Second, the fiscal capacity can be set up idiosyncratically with the aim to provide public capital to overcome other challenges, e.g. a large common defense program or investments to mitigate climate change, rather than in response to the state of the business cycle. In the first case, which we call *endogenous*, the objective of the fiscal capacity is to provide economic stabilization. In the second case, which we call *exogenous*, the objective is different, but the common fiscal capacity might provide stabilization as a desirable by-product.

From a more technical perspective, we contribute to the literature by introducing an endogenous Markov-Switching mechanism depending on the relative position of members states vis-à-vis the business cycle to model the stabilization properties of the endogenous fiscal capacity. Specifically, we define two regimes, one in which member states' relative output gap is positive and another in which it is negative. This approach allows us to model

fiscal capacity investments as a counter-cyclical macroeconomic stabilization tool to smooth out differences in economic performances across countries.

However, we do not try to define European public goods or attempt to estimate the size of the associated investment envelope. We also abstract from any discussion about practical issues such as political agreement, project selection and policy implementation, although these are of course crucial in the setup of a common fiscal capacity. While we are aware that past EU agreements on which public expenditures should be centralized have mainly relied on political considerations, rather than economic efficiency (Mourlon-Druol, 2024), we hope to contribute to the debate about desirable stabilization features of a common fiscal capacity.

We find that the endogenous fiscal capacity can help dampen the contractionary effects on output of adverse supply shocks by raising investment in public capital and thereby supporting productivity growth and aggregate demand. The boost in demand tends to amplify the inflationary effects of the supply shock, yet the productivity-enhancing effects of the fiscal capacity investments lead to a more muted inflation response in the medium- to long run. Model simulations suggest that a sufficiently counter-cyclical response of fiscal capacity investment helps to substantially bring down output variability across the monetary union, raises slightly inflation variability, and results in a higher level of output and a lower level of inflation on average. Moreover, by closing macroeconomic imbalances within the monetary union, counter-cyclical fiscal capacity investments also render business cycles more synchronized across member states, which supports monetary policy in achieving macroeconomic stability for the monetary union as a whole. As a result, we find that counter-cyclical fiscal capacity investments raise welfare, especially if public capital is more productive. However, if the investments are less counter-cyclical because of lags or because the fiscal capacity has to cut investments if its debt becomes too high, the welfare gains will be lower. Also, if the capacity focuses not only on cyclical differences among countries but also on the union-wide output gap, welfare gains will be comparatively smaller. The explanation for the latter result

is that using fiscal policy to manage business cycle fluctuations is less efficient than using monetary policies, at least when monetary policy is unconstrained by the effective lower bound.

Exogenous fiscal capacity investments are found to have more heterogeneous effects on macroeconomic variability than endogenous fiscal capacity investments that depend on their nature, such as whether these investments benefit member states equally or differently. As they are primarily undertaken to provide some public good, rather than macroeconomic stabilization, they might enhance utility but not increase the productive public capital stock. However, these investments can result in a higher level of output and a lower level of inflation on average, and also raise welfare, if they contribute to enhancing productivity. Moreover, the welfare gains are largest when fiscal capacity investments are used to build up common public capital, rather than public capital that is specific to an individual member state, as these investments do not contribute strongly to macroeconomic imbalances across countries.

All in all, we find that monetary unions benefit the most from a centralized fiscal capacity when such a capacity is used, either counter-cyclically or more exogenously, to finance productivity-enhancing public capital, that is common across member states, and in times when the economy faces large adverse supply shocks.

The remainder of the paper starts with a review of the related literature, then the model description and finishes with the results for the endogenous and exogenous fiscal capacities.

1.1 Related literature

Our paper relates to the economic literature on public goods and the policy debate on European public goods. The defining features of a pure public good are the non-excludability and non-rivalry of its benefits (Samuelson, 1954). A typical example are efforts to mitigate climate change: preventing climate change is beneficial for everyone on earth and the benefit for one individual remains equally large irrespective how many other people enjoy it. The characteristics of non-excludability and non-rivalry reward free-riding, and ensure that

independent provision decisions do not achieve Pareto-optimal levels.

For national public goods, cooperation to ensure the provision of public goods can be enforced through the nation state. For the provision of global or regional public goods, cooperation across nation states is required. In addition to the degree of non-rivalry and non-excludability, Buchholz and Sandler (2021) propose to add two additional characteristics for global or regional public goods. The first is the spillover range of benefits, which determines if the public good is national, regional or global. The second is the aggregator technology, which determines what level of cooperation across countries is necessary to enjoy the benefits of the public good and which can take many different forms. Regional defense that is provided by the total of the military capabilities of the participating countries is an example of summation aggregator technology, where the provision of the public good is determined by the sum of the contributions. Another example of an aggregator technology is weakest link, where the smallest contribution sets the overall level, for example in the protection of international communication networks.

In the policy debate on European public goods, there is no agreement among different authors on the exact definition of European public goods. For example, Fuest and Pisani-Ferry (2019) consider a rather wide definition ('policies and initiatives whose value to the citizens are higher when conducted at EU rather than at national level'), which leads to an extensive list of policy areas, including research and development in large and risky projects, climate change mitigation, migration policy, the protection of refugees etc. In a contribution to the European Parliament, Wyplosz (2024) comes to a much more restrictive list, consisting of research and development, a carbon tax (but not other elements of climate policy) and cybersecurity. Another approach starts from the overall additional investment needs. A prominent example is the Draghi report (Draghi, 2024), according to which the investment share in Europe will have to rise by around 5 percentage points of GDP to digitalize, decarbonize the economy and increase its defense capacity, some part of which will need to be covered by additional public investment. To benefit from economies of scale

and reduce the undersupply of public goods, the Draghi report advocates joint funding of investment at the EU level. But also others have advocated joint European financing for European public goods, in particular defence (Lagarde, 2025). Arnold et al. (2025) propose an EU Climate and Energy Security Facility to help meet Europe's climate goals, which should ensure the provision of key European public goods, in particular cross-border grid infrastructure.

An important consideration for the financing of public goods and the associated macroeconomic stabilization properties is whether the public investment has a positive impact on private productivity. In the US, military spending has large and persistent effects on output by shifting the composition of public spending towards R&D, which boosts innovation and private investment in the medium-term (Antolin-Diaz and Surico, 2025). Some of the expenditures that are proposed to be undertaken at the European level may have positive productivity effects that could indeed increase future growth and government revenues. However, some of the expenditures to mitigate climate change, such as those that shift the energy mix, may not provide a productivity impulse or even reduce growth for some time (Blanchard and Ubide, 2024).

Our contribution to the literature is that we show how a fiscal capacity dedicated to the provision of a common public good can provide macroeconomic stabilization in a monetary union. We do this in a small model of a two-country monetary union to be able to identify key channels. Irrespective of whether the goal of the fiscal capacity is economic stabilization or provide some public good, it requires the build-up of public capital in one or more member states within the monetary union. Similarly, the public good can have an aggregator technology that requires investment in one or multiple countries. We investigate the macroeconomic stabilization properties of all such combinations and under different assumptions about the productivity-enhancing effects of public investments.

Our paper also connects to the literature that focus on fiscal policy in monetary unions, and in particular papers that model a fiscal capacity in a structural model. Farhi and

Werning (2017) show that contingent transfers within a fiscal union, that work as a means of risk sharing, provide larger benefits if the shocks affecting the members of the currency union are more asymmetric and more persistent, and if the countries in the union are less open. Bianchi et al. (2023) model the stabilizing effect of a central fiscal capacity in a Two-Agent New Keynesian model of a monetary union with a high-debt country and a low-debt country. In an earlier paper, we showed in a two-country model setting that a joint fiscal capacity with conditional participation, which provides fiscal space to a country hit by an asymmetric shock, to be beneficial for both the net paying and receiving member state (Bonam et al., 2022). Schang and Vinci (2024) also analyze a central fiscal capacity in a two-country DGSE model, which in their case directly promotes public investment rather than through the national government budget. They include an exploratory treatment of a European public good that is modeled as joint national investments in a European stock of productive capital. Bozou Ninou and Creel (2025) investigate the effectiveness of a fiscal stimulus in a monetary union by modeling many different facets in a DSGE model, including the wealth effects of loans versus grants.

2 Model

The model economy describes that of a monetary union that consists of two countries, Home and Foreign. The two countries trade with each other in final goods and private bonds. Each country is populated by households, firms and a fiscal authority, while monetary policy is conducted at the supranational level. There exists a supranational fiscal capacity that may invest in the capital stock of both member states, either in equal or country-specific amounts. In this section, we mainly focus on the description of this fiscal capacity and the rules that govern its investment behavior. The rest of the model has, for the most part, standard New Keynesian features, i.e. wage and price stickiness, investment adjustment costs, and habits in consumption, that will be described in less detail, yet also includes a sovereign risk channel

that links government debt repayment risks to private investment returns. Furthermore, since the two countries are symmetric (unless stated otherwise), we focus mostly on the Home economy. Foreign variables are denoted with an asterisk superscript. A more comprehensive model description is provided in Appendix A.

2.1 Fiscal capacity

2.1.1 Public goods and fiscal capacity investments

The main aim of the fiscal capacity in our model is to finance investments that are used to accumulate two types of public goods: (i) 'common public capital', denoted by $\mathcal{K}_{mu,t}$, that benefits both countries, and (ii) 'country-specific public capital', i.e. $k_{mu,t}$ in Home and $k^*_{mu,t}$ in Foreign, whose (direct) benefits are limited to one country. One can think of common public capital as representing a type of capital required in both countries for the provision of a good which both countries can use, for example a transportation or communication network. Country-specific public capital, on the other hand, primarily benefits a particular country, such as investments under the NGEU program—that aim to stabilize macroeconomic conditions—or military R&D spending in one country—even if the resulting enhanced defense capabilities benefit the entire monetary union.

Common public capital evolves according to the following law of motion:

$$\mathcal{K}_{mu,t} = (1 - \delta_{mu})\, \mathcal{K}_{mu,t-1} + i_{mu,t}, \tag{1}$$

with $\delta_{mu} \in [0, 1]$ the depreciation rate of public capital. Common investment, $i_{mu,t}$, is a composite of Home and Foreign investment goods, i.e. $i_{f,t}$ and $i^*_{f,t}$:

$$i_{mu,t} = \left[(1 - \mu_{mu})^{\frac{1}{\eta_{mu}}}\, i_{f,t}^{\frac{\eta_{mu}-1}{\eta_{mu}}} + \mu_{mu}^{\frac{1}{\eta_{mu}}}\, i^{*\frac{\eta_{mu}-1}{\eta_{mu}}}_{f,t}\right]^{\frac{\eta_{mu}}{\eta_{mu}-1}}, \tag{2}$$

with $\eta_{mu} \geq 0$ the elasticity of substitution between Home and Foreign investment goods and

$\mu_{mu} \in [0,1]$ the share of investment goods purchased by the fiscal capacity from Foreign. Optimal demand schedules for $i_{f,t}$ and $i^*_{f,t}$ are given by

$$i_{f,t} = (1-\mu_{mu}) \left(\frac{P_{H,t}}{P_{mu,t}} \right)^{-\eta_{mu}} i_{mu,t}, \tag{3}$$

$$i^*_{f,t} = \mu_{mu} \left(\frac{P^*_{F,t}}{P_{mu,t}} \right)^{-\eta_{mu}} i_{mu,t}, \tag{4}$$

where $P_{H,t}$ and $P^*_{F,t}$ are the Home and Foreign producer price indices, and $P_{mu,t}$ the union-wide price level (defined below). As in Schang and Vinci (2024), we set common investments constant to some exogenous level, $\overline{i_{mu}}$.

Country-specific public capital faces the same rate of depreciation as that of common public capital and evolves according to

$$k_{mu,t} = (1-\delta_{mu})\, k_{mu,t-1} + \mathcal{A}_t, \tag{5}$$

$$k^*_{mu,t} = (1-\delta_{mu})\, k^*_{mu,t-1} + \mathcal{A}^*_t. \tag{6}$$

Country-specific investments, $\mathcal{A}_t$ and $\mathcal{A}^*_t$, can be interpreted as top-offs that policymakers may find necessary whenever injection of common public investment is deemed insufficient to raise the national level of productivity relative to that of the partner state.

The fiscal capacity can take two different approaches to decide on its level of (common or country-specific) investment. Under the first approach, which we refer to as *endogenous fiscal capacity investment*, the fiscal capacity determines the amount of country-specific investment, $\mathcal{A}_t$ and $\mathcal{A}^*_t$, by the relative output gaps of the two member states. In particular, let x_t denote the Home relative output gap as measured by the difference between the Foreign and Home output gap, i.e. $x_t = \log\left(\frac{gdp^*_t}{gdp^*}\right) - \log\left(\frac{gdp_t}{gdp}\right)$, with gdp^*_t and gdp_t the level of Foreign and Home real GDP, respectively, and where variables without a t subscript denote steady-state

values. Fiscal capacity investment is then determined as follows:

$$\mathcal{A}_t = \mathcal{A} + f_{mu,t}\mathcal{I}_t, \tag{7}$$

$$\mathcal{A}^*_t = \mathcal{A}^* + f_{mu,t}\left(1 - \mathcal{I}_t\right), \tag{8}$$

where $\mathcal{I}_t = \{1, 0\}$ is a dummy that equals 1 if $x_t > 0$ and 0 otherwise, and where effective investment by the fiscal capacity, $f_{mu,t}$, is given by

$$f_{mu,t} = \phi\left[\mathcal{I}_t\left(x_t \frac{gdp_{mu,t}}{s}\right) + \left(1 - \mathcal{I}_t\right)\left(x^*_t \frac{gdp_{mu,t}}{1-s}\right)\right], \tag{9}$$

with $x^*_t = -x_t$ and $s \in [0, 1]$ the relative population size of Home with respect to Foreign. In words, Equations (5) through (9) imply that whenever the Home output gap falls below that of Foreign, such that $x_t > 0$ and $\mathcal{I}_t = 1$, effective investment by the fiscal capacity is set equal to a fraction $\phi \geq 0$ of this relative output gap (measured in per capita terms) and is then used to build up public capital in Home only. Hence, with this approach fiscal capacity investments are used as a counter-cyclical macroeconomic stabilization tool to smooth out differences in economic performance across countries. The strength of the counter-cyclical response of this tool is governed by the parameter ϕ.

We implement this approach of endogenous fiscal capacity investments using endogenous regime-switching techniques. Specifically, we define two regimes, one in which x_t is **p**ositive and another in which x_t is **n**egative, and use the logistic function $p_{PN,t} = \left[1 + \exp\left(-\gamma x_t\right)\right]^{-1}$ to determine the probability $p_{PN,t}$ of switching from regime P to N, where we set γ to some large number (similarly, we use a logistic function to determine the probability of switching from N to P).[1]

Under the second approach, which we refer to as *exogenous fiscal capacity investment*, investment is set exogenously. Under this approach, there are four variants. In the first variant (labeled A), the fiscal capacity invests an equal amount, $z_{mu,t}$, to build up country-

[1] We use Junior Maih's RISE Toolbox to solve the model with endogenous regime switching.

specific capital in both countries:

$$\mathcal{A}_t = \mathcal{A} + z_{mu,t}, \tag{10}$$

$$\mathcal{A}^*_t = \mathcal{A}^* + z_{mu,t}, \tag{11}$$

where the common additional investment $z_{mu,t}$ evolves according to an AR(1) process. In the second variant (B), country-specific capital is raised by country-specific levels of investment, i.e. $z_{f,t}$ and $z^*_{f,t}$, which again evolve according to AR(1) processes:

$$\mathcal{A}_t = \mathcal{A} + z_{f,t}, \tag{12}$$

$$\mathcal{A}^*_t = \mathcal{A}^* + z^*_{f,t}. \tag{13}$$

In the third and fourth variants, the fiscal capacity builds up common capital. It can do so by raising the steady-state level of common investment, $i_{mu,t}$, through an increase in $z_{mu,t}$, which is the third variant (C):

$$i_{mu,t} = \overline{i_{mu}} + z_{mu,t}, \tag{14}$$

or by raising national investments, $i_{f,t}$ or $i^*_{f,t}$, through increases in $z_{f,t}$ or $z^*_{f,t}$, which is the fourth variant (D):

$$i_{f,t} = (1 - \mu_{mu}) \left(\frac{P_{H,t}}{P_{mu,t}} \right)^{-\eta_{mu}} i_{mu} + z_{f,t}, \tag{15}$$

$$i^*_{f,t} = \mu_{mu} \left(\frac{P^*_{F,t}}{P^*_{mu,t}} \right)^{-\eta_{mu}} i_{mu} + z^*_{f,t}. \tag{16}$$

This second approach of exogenous fiscal capacity investment can be used to analyze the implications of different types of a-cyclical stimulus provided by the fiscal capacity, such as a large defense spending package.

Table 1 presents an overview of these two approaches that determine the investment behavior of the fiscal capacity and the four variants of the second approach.

Table 1: Approaches that determine investment behavior of the fiscal capacity

Approach	Description
1. Endogenous fiscal capacity investment	Endogenous change in $\mathcal{A}_t$ and $\mathcal{A}_t^*$, depending on relative economic performance
2. Exogenous fiscal capacity investment	
A. Country-specific capital, common investment	Exogenous change in $\mathcal{A}_t$ and $\mathcal{A}_t^*$ by $z_{mu,t}$
B. Country-specific capital, country-specific investment	Exogenous change in $\mathcal{A}_t$ and $\mathcal{A}_t^*$, by $z_{f,t}$ in Home and $z_{f,t}^*$ in Foreign
C. Common capital, common investment	Exogenous change in $i_{mu,t}$ by $z_{mu,t}$
D. Common capital, country-specific investment	Exogenous change in $i_{f,t}$ and $i_{f,t}^*$, by $z_{f,t}$ in Home and $z_{f,t}^*$ in Foreign

2.1.2 Budget constraint of the fiscal capacity

Investments by the fiscal capacity are financed through a combination of 'common bonds', $B_{mu,t}$, which are purchased by Home and Foreign households, and own resources, which are generated by levying a common consumption tax, $\tau_{c,t}^{mu}$, and a common lump-sum tax, τ_t^{mu}, on all households. The period budget constraint of the fiscal capacity therefore reads:

$$\begin{aligned} Q_{mu,t}\left(B_{mu,t}-\varrho_{mu}B_{mu,t-1}\right) = B_{mu,t-1} + P_{H,t}i_{f,t} + P_{F,t}^*i_{f,t}^* + P_{H,t}\mathcal{A}_t + P_{F,t}^*\mathcal{A}_t^* \\ - \tau_t^{mu}\left[sP_t + (1-s)\,P_t^*\right] - \tau_{c,t}^{mu}\left[sP_tc_t + (1-s)\,P_t^*c_t^*\right], \end{aligned} \tag{17}$$

where $\varrho_{mu} \in [0,1]$ governs the average duration of common bonds, $Q_{m,t}$ is the bond price, c_t and c_t^* denote consumption by Home and Foreign households, and P_t and P_t^* are the Home and Foreign consumer price indices. Lump-sum taxes are adjusted to stabilize common debt according to $\tau_t^{mu} = \tau^{mu} + \gamma_b^{\tau,mu}\left(b_{mu,t-1} - b_{mu}\right)$, with $b_{mu,t} \equiv \frac{B_{mu,t}}{P_{mu,t}}$ real debt.

2.2 Production

Home final goods, $y_{H,t}$, are a composite of Home intermediate goods, $y_{H,t}(i)$, and traded internationally to produce the household's consumption basket, which consists of both Home and Foreign final goods. Intermediate goods firm $i \in [0,1]$ employs labor, $n_t(i)$, and private

capital, $k_t(i)$, to produce $y_{H,t}(i)$ according to the following production function:

$$y_{H,t}(i) = z_{A,t} n_t(i)^{\alpha} k_{t-1}(i)^{1-\alpha} \left(\mathcal{K}_{mu,t-1}^{\upsilon} k_{mu,t-1}^{1-\upsilon}\right)^{\alpha_{mu}} k_{g,t-1}^{\alpha_g}, \tag{18}$$

where $z_{A,t}$ denotes the domestic aggregate level of productivity that evolves according to a stationary AR(1) process, and where $\alpha \in (0,1)$ governs the output elasticity with respect to labor.

Firm productivity may be enhanced through a combination of public capital financed by the fiscal capacity—which is either common across countries, $\mathcal{K}_{mu,t}$, or country specific, $k_{mu,t}$—and public capital financed by the national fiscal authority, $k_{g,t}$. The parameter $\upsilon \in [0,1]$ governs the relative importance of common and country-specific public capital financed by the fiscal capacity, while $\alpha_{mu} \geq 0$ determines their joint productivity-enhancing effect. Similarly, $\alpha_g \geq 0$ determines the productivity of national public capital. For future reference, we measure total factor productivity, TFP_t, by the contribution to output from factors other than labor and private capital:

$$TFP_t = z_{A,t} \left(\mathcal{K}_{mu,t-1}^{\upsilon} k_{mu,t-1}^{1-\upsilon}\right)^{\alpha_{mu}} k_{g,t-1}^{\alpha_g}. \tag{19}$$

The objective of the firm is to choose how much labor and private capital to hire, and what price to set, $P_{H,t}(i)$, in order to maximize current and expected future profits:

$$E_t \sum_{k=0}^{\infty} \mathcal{D}_{t,t+k} \left(\frac{P_{H,t+k}(i)}{P_{t+k}} y_{H,t+k}(i) - \frac{W_{t+k}}{P_{t+k}} n_{t+k}(i) - \frac{R_{k,t+k}}{P_{t+k}} k_{t+k-1}(i) - \frac{AC_{P,t+k}(i)}{P_{t+k}} \right), \tag{20}$$

subject to the production function (18) and a quadratic price adjustment cost function, given by $AC_{P,t}$, and taking the nominal wage, W_t, the nominal capital rental rate, $R_{k,t}$, and the household's stochastic discount factor, $\mathcal{D}_t$, as given. The firm's corresponding first-order conditions are derived in Appendix A.

2.3 Households

Households choose how much to consume, c_t, how many hours to work, n_t, how much to invest in private capital, i_t, and how much bonds to hold, in order to maximize expected lifetime utility, given by

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{\left(c_{t+k} - h c_{t+k-1}\right)^{1-\sigma}}{1-\sigma} - \chi \frac{n_{t+k}^{1+\varphi}}{1+\varphi} \right), \tag{21}$$

where χ is used to pin down steady-state hours worked. The parameters $\beta \in (0,1)$, $h \geq 0$, $\sigma > 0$ and $\varphi > 0$ denote the discount factor, the degree of habit formation, the inverse elasticity of intertemporal substitution and the inverse Frisch elasticity of labor supply, respectively.

Households have access to three types of nominal bonds: (i) domestically traded government bonds, $B_{G,t}$; (ii) internationally traded private bonds, issued by Foreign households, $B_{F,t}$, and other Home households, $B_{H,t}$; and (iii) common bonds issued by the fiscal capacity, $B_{mu,t}^{H}$. Home and Foreign private bonds have a duration of one period and yield a gross nominal return of R_t and R_t^*, respectively. Households face a financial transaction cost, $\Gamma_{f,t}^* \left(\frac{B_{F,t}}{P_t^*} \right)$, whenever they adjust their holdings of Foreign private bonds and which is paid to the Foreign government. Bonds issued by the government and fiscal capacity, on the other hand, may be of longer duration, with the average duration determined by ϱ_G and ϱ_{mu}, and are traded at prices $Q_{G,t}$ and $Q_{mu,t}$, respectively.

Following Corsetti et al. (2013) and Kaufmann et al. (2023), we assume that, in each period, there is a probability that the government does not repay a fraction, $\overline{\vartheta} \in [0,1]$, of its outstanding debt. The ex-ante expected haircut is given by $\vartheta_t = p_{S,t}\overline{\vartheta} + (1 - p_{S,t})\, 0$, where the default probability, $p_{S,t} \in [0,1]$, is a function of the government debt to GDP ratio. We also allow for sovereign risk to pass through to private credit conditions in the form of a reduction in the return on private capital, given by $\rho_{RP}\left(RP_{t-1} - 1\right)$, where $\rho_{RP} \in [0,1]$ measures the degree of sovereign risk pass through and $RP_t = \frac{1}{1 - E_t \vartheta_{t+1}}$ is the sovereign risk

premium. To rule out the possibility that sovereign default reduces the default probability, i.e. by lowering the amount of outstanding debt, any losses from default, $\Gamma_{G,t} \equiv \vartheta_t \frac{B_{G,t-1}}{P_t}$, are rebated to the household.

In addition to paying lump-sum and consumption taxes to the fiscal capacity, households also pay several taxes to the home government: income taxes, $\tau_{w,t}$, capital taxes, $\tau_{k,t}$, consumption taxes, $\tau_{c,t}$, and lump-sum taxes, τ_t. Finally, households face adjustment costs when resetting their nominal wages, $AC_{W,t}$, and when changing their level of investment.

The period budget constraint faced by households is given by

$$\begin{aligned} & P_t c_t + P_t i_t + P_t \left[\tau_t + \tau_t^{mu} + \left(\tau_{c,t} + \tau_{c,t}^{mu}\right) c_t\right] \\ & \quad + Q_{G,t} \left(B_{G,t} - \varrho_G B_{G,t-1}\right) + B_{H,t} + B_{F,t} + Q_{mu,t} \left(B_{mu,t}^H - \varrho_{mu} B_{mu,t-1}^H\right) \\ & = \left[\left(1 - \tau_{k,t}\right) r_{k,t} - \rho_{RP} \left(RP_{t-1} - 1\right)\right] R_{k,t} k_{t-1} + \left(1 - \tau_{w,t} - AC_{W,t}\right) W_t n_t \\ & + \left(1 - \vartheta_t\right) B_{G,t-1} + R_{t-1} B_{H,t-1} + R_{t-1}^* B_{F,t-1} + B_{mu,t-1} + P_t \left(\Gamma_t + \Gamma_{G,t} - \frac{1-s}{s} \Gamma_{f,t}^*\right), \end{aligned} \tag{22}$$

where Γ_t denotes firm profits that are distributed to households as lump-sum dividends. The objective of the household is to maximize lifetime utility (21), subject to the period budget constraint (22) and an appropriate transversality condition. The corresponding first-order conditions are presented in Appendix A.

2.4 Fiscal and monetary policy

The fiscal authority issues bonds and levies lump-sum and distortionary taxes to cover its debt servicing costs and finance an exogenous stream of government consumption, g_t, and investment, $i_{g,t}$. Lump-sum taxes are adjusted to stabilize public debt, while remaining taxes are held constant. The period budget constraint of the fiscal authority is given by

$$Q_{G,t} \left(B_{G,t} - \varrho_G B_{G,t-1}\right) + \mathcal{T}_t = \left(1 - \vartheta_t\right) B_{G,t-1} + P_{H,t} \left(g_t + i_{g,t}\right) + P_t \Gamma_{G,t}, \tag{23}$$

where total tax revenue, $\mathcal{T}_t$, is given by $\mathcal{T}_t = P_t(\tau_t + \tau_{c,t}c_t) + \tau_{w,t}W_t n_t + \tau_{k,t}R_{k,t}k_{t-1}$, while lump-sum taxes are set according to $\tau_t = \tau + \gamma_b^\tau(b_{G,t-1} - b_G)$, with $b_{G,t} \equiv \frac{B_{G,t}}{P_t}$.

Monetary policy is conducted by the common central bank which sets the policy rate, $R_{cb,t}$, to stabilize union-wide inflation, $\frac{P_{mu,t}}{P_{mu,t-1}} = \pi_{mu,t}$ where $P_{mu,t} = s \cdot P_t + (1-s) \cdot P_t^*$, and union-wide output growth, $\frac{gdp_{mu,t}}{gdp_{mu,t-1}}$, where $gdp_{mu,t} = s \cdot \frac{P_t}{P_{mu,t}} gdp_t + (1-s) \cdot \frac{P_t^*}{P_{mu,t}} gdp_t^*$:

$$\frac{R_{cb,t}}{R_{cb}} = \left(\frac{R_{cb,t-1}}{R_{cb}}\right)^{\rho_R} \left[\left(\frac{\pi_{mu,t}}{\pi_{mu}}\right)^{\phi_\pi} \left(\frac{gdp_{mu,t}}{gdp_{mu,t-1}}\right)^{\phi_y}\right]^{1-\rho_R}. \tag{24}$$

The parameters $\phi_\pi > 1$ and $\phi_y \geq 0$ measure the aggressiveness with which the central bank targets inflation and output, respectively, while $\rho_R \in [0,1]$ governs the degree of interest rate smoothing.

2.5 Market clearing

Goods market clearing in Home implies

$$\begin{aligned} y_{H,t} = (1-\mu)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta}(c_t + i_t) + g_t + i_{g,t} + \left(\frac{1-s}{s}\right)\mu^*\left(\frac{P_{H,t}^*}{P_t^*}\right)^{-\eta}(c_t^* + i_t^*) \\ + \frac{1}{s}(\mathcal{A}_t + i_{f,t}) + P_{H,t}^{-1}(AC_{P,t} + AC_{W,t}W_t n_t), \end{aligned} \tag{25}$$

where $\eta > 1$ measures the trade elasticity of substitution between Home and Foreign final goods, and $\mu \in (0,1)$ is a measure of trade openness. Note that investments by the fiscal capacity in Home, $\mathcal{A}_t$ and $i_{f,t}$, are both *country-specific* investments and therefore work to increase Home aggregate demand directly, but not Foreign aggregate demand. The difference between these two investments is that $i_{f,t}$ is used to build up common public capital, $\mathcal{K}_{mu,t}$, that benefits Home and Foreign productivity equally by (1) and (2), whereas $\mathcal{A}_t$ is used to accumulate public capital in Home only, by the law of motion shown in (5).

Bonds market clearing implies

$$s \cdot B^{H}_{mu,t} + (1-s) \cdot B^{F*}_{mu,t} = B_{mu,t}, \tag{26}$$

$$s \cdot B_{H,t} + (1-s) \cdot B^{*}_{H,t} = 0, \tag{27}$$

$$s \cdot B_{F,t} + (1-s) \cdot B^{*}_{F,t} = 0, \tag{28}$$

where $B^{F*}_{mu,t}$ are common bonds held by Foreign households. Finally, the resource constraint of the Home country reflects the balance between net national savings and net capital outflows:

$$\begin{aligned} & P_{H,t}y_{H,t} - (P_t c_t + P_t i_t + P_{H,t} g_t + P_{H,t} i_{g,t}) - [AC_{W,t} W_t n_t + AC_{P,t} + \rho_{RP} \left(RP_{t-1} - 1\right) P_t k_{t-1}] \\ & = Q_{mu,t} \left(B^{H}_{mu,t} - \varrho_{mu} B^{H}_{mu,t-1} \right) - B^{H}_{mu,t-1} + B_{H,t} - R_{t-1} B_{H,t-1} + B_{F,t} - R^{*}_{t-1} B_{F,t-1} \\ & + P_t \left(\Gamma_{f,t} - \frac{1-s}{s} \Gamma^{*}_{f,t} \right) + P_t \left(\tau^{mu}_{c,t} c_t + \tau_{mu,t} \right), \end{aligned} \tag{29}$$

where $\Gamma^{*}_{f,t}\left(\frac{B^{*}_{H,t}}{P_t}\right)$ are the financial transaction costs paid by Foreign households when they adjust their real holdings of Home private bonds.

2.6 Calibration

We calibrate the model parameters based on a quarterly frequency for t. Where applicable, we assume that Home faces the same values for the structural parameters as Foreign. This symmetry assumption allows us to more easily identify the channels through which the fiscal capacity affects the economy and welfare. It also allows us to use a relatively common calibration for most parameters. With regards the steady state, we further assume symmetric initial conditions, such that prices are the same across countries. Tables 2 through 4 in Appendix A provide a summary of our baseline calibration.

A key parameter of interest is ϕ, which governs the counter-cyclical response of fiscal

capacity investments under the first approach in which these investments are determined endogenously. To study the macroeconomic implications of this type of investment, we shall experiment with a wide range of values for ϕ and compare these cases against a baseline with $\phi = 0$. Furthermore, we set α_{mu}, which determines the productivity-enhancing effect of public capital, to 0.05. Again, as a robustness check, we will experiment with alternative values, including zero in which case public investment by the fiscal capacity is reduced to public consumption. The parameter υ, which determines the relative weight of common public capital compared to that of country-specific public capital in the firm's production function is set agnostically to 0.5. Common bonds are assumed to have an average duration of 28 quarters, such that $\varrho_{mu} = 1 - \frac{1}{28}$.

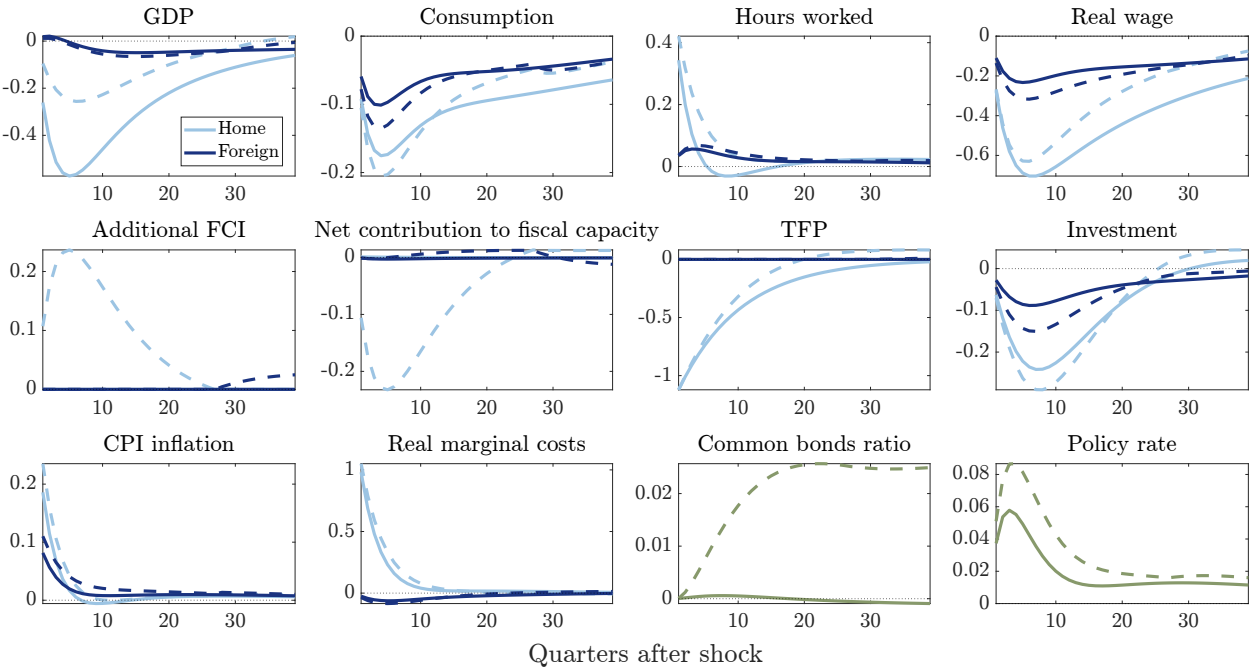
To solve for the steady state, we need to make assumptions about some variables related to the fiscal capacity. Specifically, we assume that all investments by the fiscal capacity are set to 1% of union-wide GDP in steady state, i.e. $\frac{i_{mu}}{gdp_{mu}} = \frac{\mathcal{A}}{gdp_{mu}} = \frac{\mathcal{A}^*}{gdp_{mu}} = 0.01$. Common bonds are assumed to be (almost) in zero net supply, i.e. $B_{mu} \approx 0$.

3 Results

3.1 Fiscal capacity investment as a stabilization tool

We start by examining the macroeconomic and welfare implications of the fiscal capacity when its investments behave according to the rule under the first approach, i.e. the fiscal capacity raises investment to build up capital only in the country whose economy underperforms that of the partner state. Therefore, fiscal capacity investments are endogenous and used to stabilize relative economic conditions within the monetary union. One can think of the Recovery and Resilience Facility of Next Generation EU (NGEU) as an example of this type of supranational public investment, as it was a direct response to a large adverse shock (i.e. the pandemic crisis), although the commonly issued bonds are transfered to national authorities to fund national projects rather than fund supranational investments.

Figure 1: Responses to an adverse Home productivity shock, with and without endogenous fiscal capacity investments



Notes: Solid lines refer to the case without fiscal capacity investments, i.e. with $\phi = 0$; dashed lines refer to the case with endogenous fiscal capacity investments, with $\phi = 0.5$. FCI = fiscal capacity investments. Units are expressed in percentage deviation from steady state.

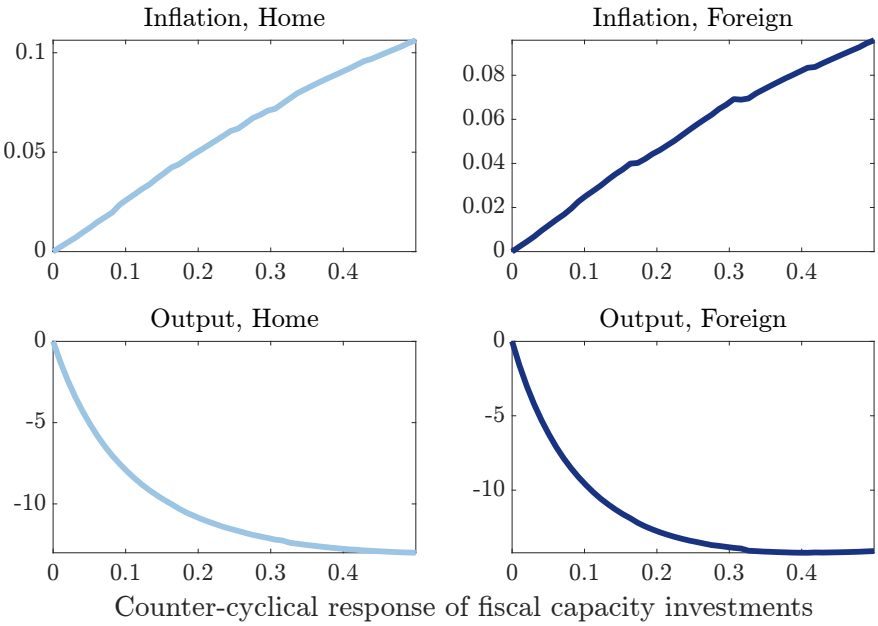
To illustrate the macroeconomic stabilization properties of such endogenous fiscal capacity investments, we first present the impulse response functions to an adverse productivity shock in Home, see Figure 1.[2] The solid lines show the responses under the baseline scenario without fiscal capacity investments, in which we set the counter-cyclical response of these investments to relative economic conditions to $\phi = 0$. The adverse productivity shock results in a sharp contraction in Home GDP that is accompanied by a decline in consumption and an increase in inflation. A negative wealth effect causes hours worked to rise, which leads to a fall in the real wage. The government debt to GDP ratio rises persistently above its steady-state level, due to a combination of weak economic growth and a tightening of monetary policy that aims to stabilize inflation. As the rise in the interest rate leads to a crowding-out of consumption in both countries, Foreign GDP falls steadily below its steady state.

[2]Since the countries are symmetric, the IRFs would look the same under an adverse productivity shock in Foreign, but with the Home/Foreign labels switched.

The dashed lines show the responses under the alternative scenario, in which the counter-cyclical response of fiscal capacity investments is set to $\phi = 0.5$. In response to the positive gap between Foreign and Home GDP, the fiscal capacity runs up investments in Home, which helps dampen the fall in Home TFP and, correspondingly, Home GDP. These investments also raise aggregate demand for Home goods, which further supports economic activity. Home consumption recovers more quickly, while a boost to labor demand causes employment to rise by more and wages to fall by less. Furthermore, the fiscal capacity investments amplify the inflation response in the short run, due to the increase in aggregate demand, which dominates the dampening effects of the rise in TFP on marginal costs and inflation in the medium- to long term. Hence, while the fiscal capacity helps stabilize real economic conditions, it also adds to inflation volatility, albeit modestly. The additional boost in demand from the fiscal capacity partly spills over to Foreign through the trade channel, which results in a stronger rise in Foreign inflation compared to the baseline. Correspondingly, the common central bank engages in a tighter monetary policy that causes Foreign consumption to contract by more, hours worked to rise and real wages to fall by more. Hence, through this interest rate channel, Foreign also experiences a slight increase in inflation variability compared to the baseline. At some point, economic conditions in Home have improved by so much compared to those in Foreign that the fiscal capacity redirects its investments from Home to Foreign and net contributions from the two countries to the fiscal capacity flip sign.

In this scenario, in which Home is hit by a country-specific adverse shock, we find that counter-cyclical investments in Home by the fiscal capacity are a powerful tool to stabilize the real economy, yet also generate some additional inflation volatility in Home which may spill over to Foreign. To further assess the balance between these counteracting implications of fiscal capacity investments, we simulate the model for 1,000 periods, while assuming that, in each period, both Home and Foreign are hit by random (positive and negative) productivity shocks. We perform this exercise multiple times, each time varying the strength of the counter-cyclical response of fiscal capacity investments to relative economic conditions along

Figure 2: Standard deviation in inflation and output, in percentage point deviation from baseline without endogenous fiscal capacity investments



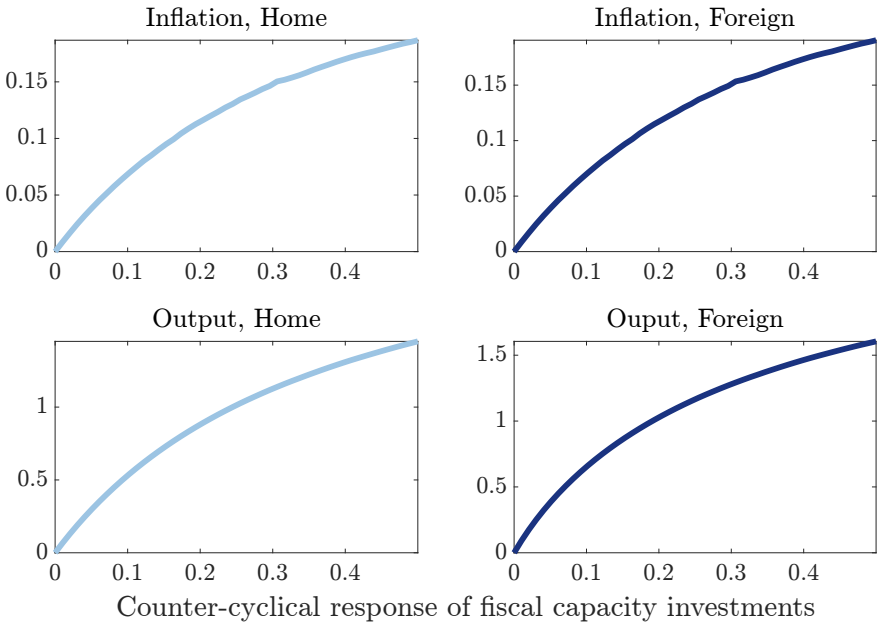
Notes: Simulation assumes that both Home and Foreign are hit by random productivity shocks over 1,000 periods.

the range $\phi = \{0, 0.5\}$. Figure 2 confirms that counter-cyclical fiscal capacity investments help stabilize real economic conditions, while raising inflation variability in both Home and Foreign.

Figure 3, shows that, on average over the simulation period, inflation and output are higher in both countries, the greater is the counter-cyclical response of fiscal capacity investments, in line with the stimulative and inflationary effects of these investments shown in Figure 1. Moreover, as fiscal capacity investments help close the gap between Home and Foreign real GDP, enhancing their counter-cyclicality also causes Home and Foreign business cycles to be more synchronized, as is shown by Figure 4. Although the ability of Home and Foreign households to borrow and lend from one another already results in a strong co-movement between Home and Foreign consumption, this co-movement is even greater when fiscal capacity investments are highly responsive to macroeconomic imbalances within the monetary union.

Together, these results imply that the fiscal capacity can enhance union-wide welfare, not

Figure 3: Average inflation and output, in percentage point deviation from baseline without endogenous fiscal capacity investments

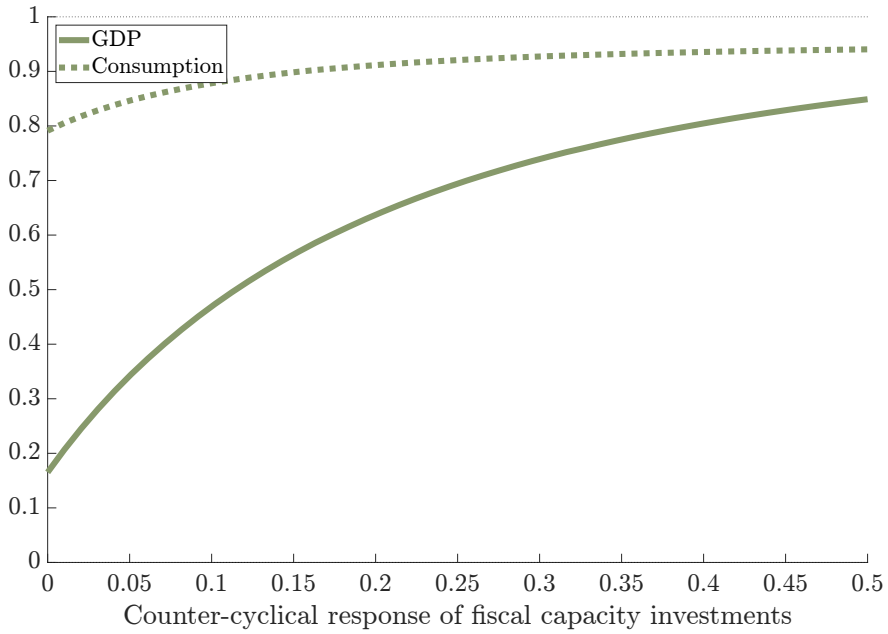


Notes: Simulation assumes that both Home and Foreign are hit by random productivity shocks over 1,000 periods.

only by improving macroeconomic conditions, but also by reducing the potentially adverse effects of monetary policy in times when economic conditions across member states strongly diverge, in which case the common monetary policy stance may be less optimal for some and more optimal for other member states. As a result, when simulating the model under a second-order approximation, again conditional on the monetary union facing random productivity shocks in both countries, we find that strengthening the counter-cyclical response of fiscal capacity investments enhances welfare for the monetary union as a whole, as we show in Figure 5.

To get a sense of the sensitivity of our baseline results on the welfare implications of counter-cyclical fiscal capacity investments, we present in Figure 6 the welfare gain of moving from an economy in which $\phi = 0$ to one where $\phi = 0.5$ under alternative calibrations of a number of key parameters. A reduction in the probability that firms cannot reset their price, from $\theta_p = 0.75$ to $\theta_p = 0.05$, implies a much stronger inflation response to an adverse productivity shock in one member state, which in turn leads to a more aggressive

Figure 4: Correlation between Home and Foreign variables



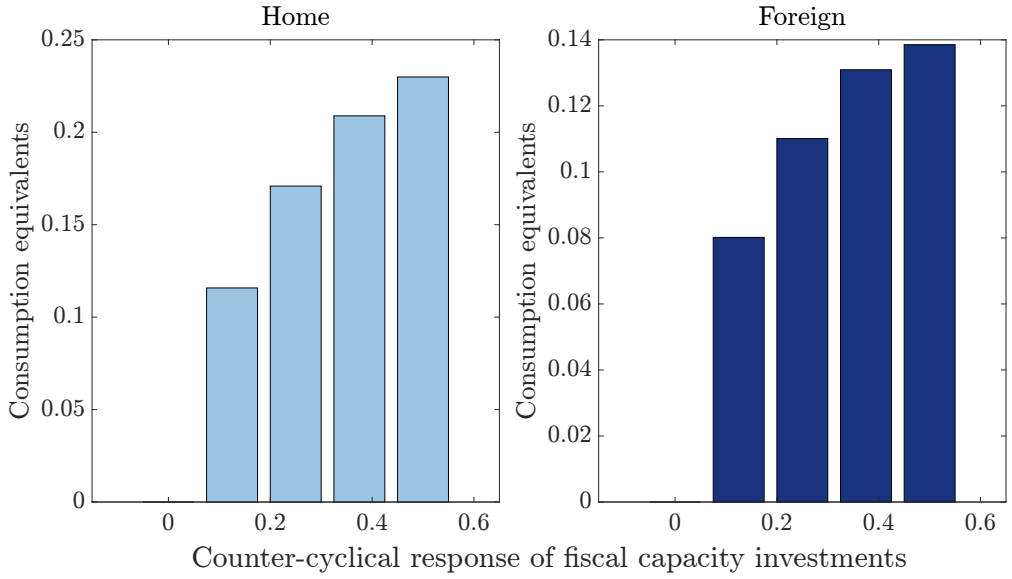
Notes: Simulation assumes that both Home and Foreign are hit by random productivity shocks over 1,000 periods.

tightening in monetary policy that worsens the crowding-out effects on consumption in both member states. Hence, there is more scope for the fiscal capacity to stabilize the economy, as evidenced by the greater welfare gain of fiscal capacity investments compared to the baseline.

Next, one may wonder whether countries are not better off using national, rather than supranational, public investments to support their economies in the face of adverse supply shocks. To test this, we assume that, in the baseline without fiscal capacity investments, national public investments respond counter-cyclically to the national output gap. We compare welfare against an alternative with fiscal capacity investments and with national public investments kept constant. We find that the welfare gain of employing fiscal capacity investments are not only still positive, but slightly larger than the baseline. This may be due to the fact that national public investments are not geared towards reducing macroeconomic imbalances and may even aggravate these imbalances, providing further scope for fiscal capacity investments to improve union-wide economic conditions.

In real life, it may take time for a fiscal capacity to quickly adjust its investments in response to shocks, e.g. due to frictions that hamper the ability to raise funds or gather

Figure 5: Welfare gain compared to baseline without endogenous fiscal capacity investments

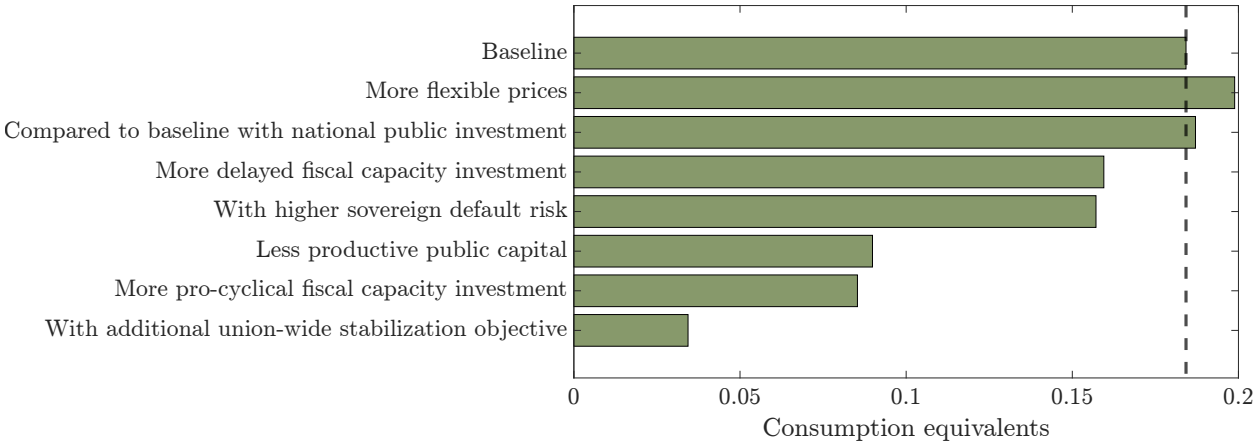


Notes: Simulation assumes that both Home and Foreign are hit by random productivity shocks over 1,000 periods.

the required resources (e.g. workforces and capital) to get the work done. Indeed, we find that greater delays in the realization of fiscal capacity investments—modeled as a rise in the persistence of fiscal capacity investments—result in lower, yet still positive, welfare gains. The reduction in welfare gain arises, not only because investments arise too late, when the economy has already started its recovery, but also because the investments are deployed for too long, rendering them less counter-cyclical or even pro-cyclical.

We study the implications of sovereign risk for the welfare gains from fiscal capacity investments by considering a greater elasticity of the default probability, $p_{S,t}$, with respect to the government debt ratio. Due to the assumption of sovereign risk pass-through, a higher degree of sovereign risk implies a lower return on private capital on average. Consequently, while the welfare gains from fiscal capacity investments are still positive, a stronger pass-through of sovereign risk to private capital returns results in these welfare gains being lower than in the baseline as fiscal capacity investments result in weaker crowding-in effects on private investment. This result underscores the importance of a financially strong private sector and an attractive investment environment, which benefits, among other things, from sound public finances.

Figure 6: Union-wide welfare gain of endogenous fiscal capacity investments compared to case without such investments, across different scenarios



Notes: Simulation assumes that both Home and Foreign are hit by random productivity shocks over 1,000 periods. The 'Baseline' scenario refers to the scenario in which model parameters assume their baseline calibration.

A reduction in the productivity gains arising from fiscal capacity investments, governed by α_{mu}, which we lower from 0.05 to 0.025, significantly reduces the ability of these investments to stabilize economic conditions, which in turn lowers their corresponding impact on welfare. Similarly, if we assume that fiscal capacity investments are also rolled back when the fiscal capacity faces a high level of outstanding debt, fiscal capacity investments turn more pro-cyclical and thereby loose some of their macroeconomic stabilization effects and ability to enhance welfare.

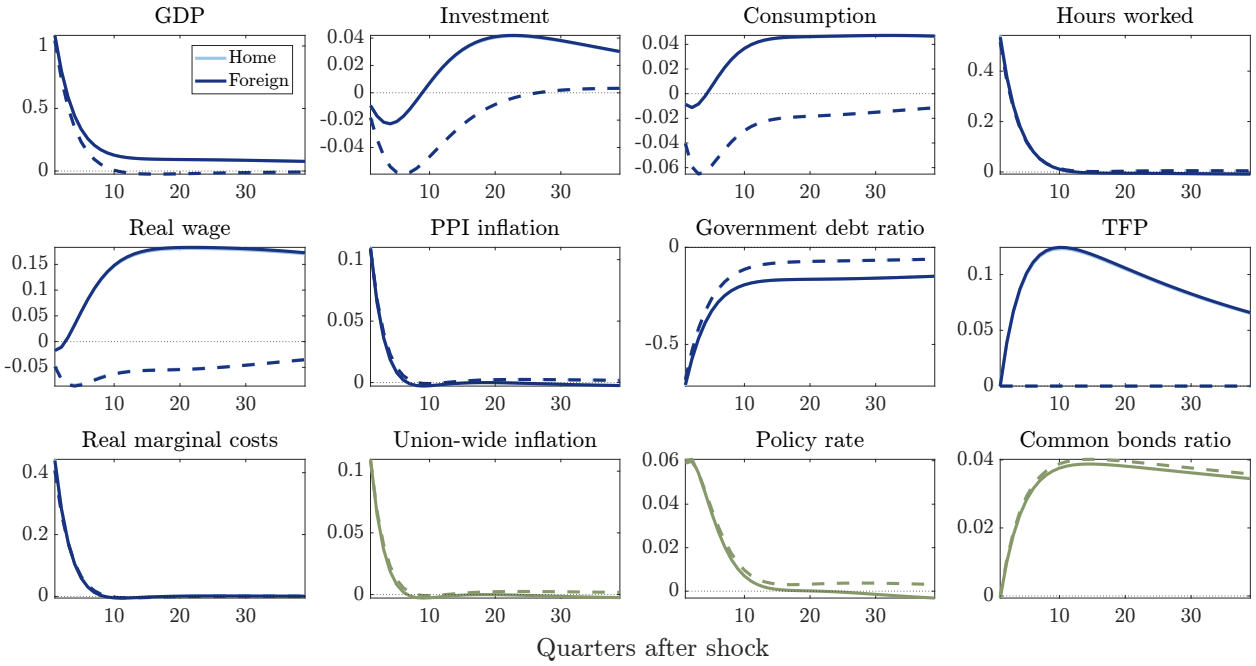
Finally, in addition to responding to the relative output gaps of Home and Foreign, we consider the case in which fiscal capacity investments also respond to union-wide macroeconomic conditions. In this case, the welfare gains are substantially smaller than in the baseline without this additional union-wide stabilization objective. Again, the stabilization gains from fiscal capacity investments arise from their ability to reduce macroeconomic imbalances within the union and enhance the business cycle synchronization between countries that allows for a more appropriate monetary policy stance for each member state. Union-wide stabilization does not address macroeconomic imbalances and may even weaken the effort of fiscal capacity investments to reduce them, which is why, in this case, the welfare gains from fiscal capacity investments are smaller.

In sum, investments by a centralized fiscal capacity used to build up a country-specific capital stock, and rendering these investments sufficiently counter-cyclical, can deliver significant welfare gains for the monetary union as a whole through various channels and under a range of alternative conditions. Counter-cyclical fiscal capacity investments act as a buffer against adverse shocks and help to significantly reduce macroeconomic variability. Enhancing the counter-cyclicality of fiscal capacity investments raises inflation variability, but generally not by enough to turn the corresponding welfare gains negative. Furthermore, by helping to close the output gaps between member states, these investments also lead to more synchronized business cycles across the monetary union, which helps improve the stabilization properties of monetary policy when the central bank faces country-specific shocks. Fiscal capacity investments are particularly complementary to monetary policy if prices are more flexible, when these investments have a greater effect on productivity and are less subject to implementation delays. If the fiscal capacity pursues a more pro-cyclical debt stabilization policy, or adopts additional union-wide stabilization objectives, the welfare gains from counter-cyclical fiscal capacity investments are smaller, but still positive.

3.2 Fiscal capacity investment as a boost to the economy

We now study the macroeconomic effects and welfare implications of *exogenous* fiscal capacity investments, that is investments that do not vary systematically with the business cycle, yet are pursued for other reasons, e.g. elevated geopolitical risks that prompt a need to increase military spending. These type of investments could be of a common nature, meaning that each member state is infused with an equally-sized investment by the fiscal capacity, or of a country-specific nature, in which case the investment is higher or lower in some member states than in the rest of the monetary union. Furthermore, the investments can be used to build up a common capital stock, $\mathcal{K}_{mu,t}$, that affects the level of productivity equally across member states, or to accumulate country-specific capital, $k_{mu,t}$ or $k^*_{mu,t}$. It turns out that the macroeconomic effects of fiscal capacity investments do not depend much on whether these

Figure 7: Responses to a common fiscal capacity investment shock



Notes: Solid (dashed) lines refer to the case where fiscal capacity investments are productive (unproductive) and their output elasticity is set to $\alpha_{mu} = 0.05$ ($\alpha_{mu} = 0$). Fiscal capacity investments are used to build up country-specific capital. Units are expressed in percentage deviation from steady state.

investments build up common or country-specific capital, which is why we shall focus on just one of these cases, specifically on the case where the investments raise country-specific capital.

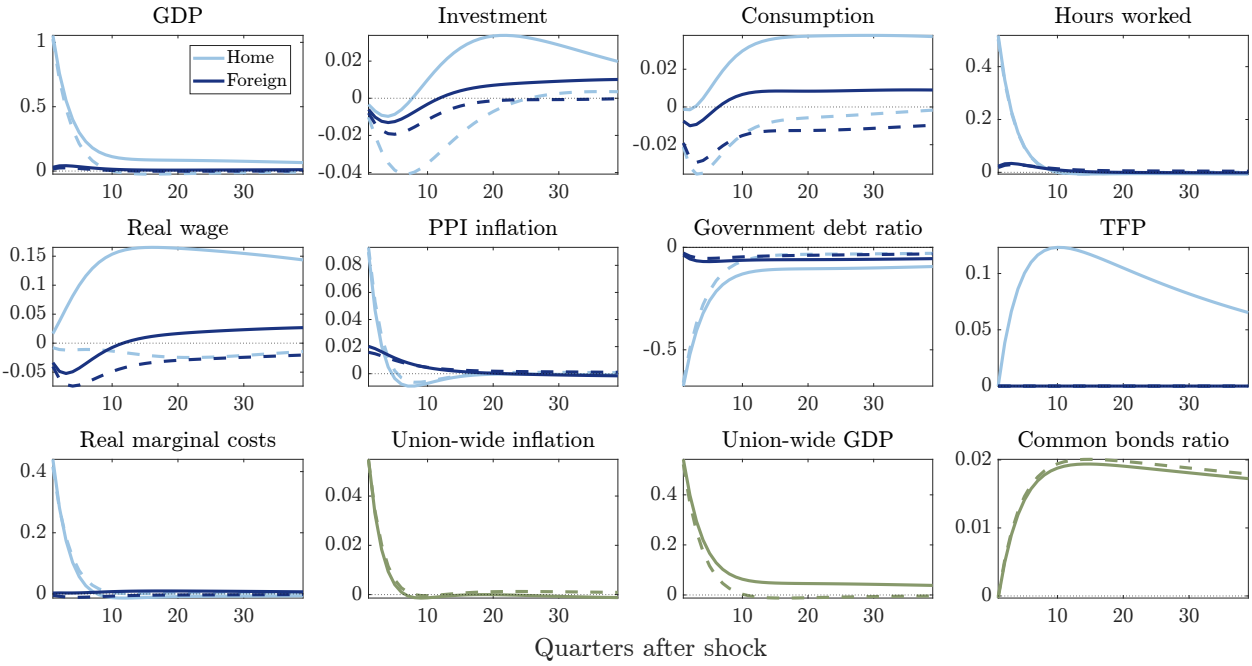
Figure 7 shows the responses to a fiscal capacity investment shock of 1% of union-wide GDP that is common across member states and raises country-specific capital. The solid lines show the baseline responses in which these investments are productive and α_{mu} is set to 0.05, whereas the dashed lines show the responses that correspond to these investments being unproductive, with α_{mu} set to 0. Because the two member states are symmetric, and because each member state receives the same amount of investment from the fiscal capacity, their responses to the shock are the same and the IRFs associated with each country overlay each other (which is why you do not observe the light-blue lines that correspond to the responses of the Home variables).

The fiscal capacity investment shock is expansionary and drives up aggregate demand. The resulting rise in labor demand leads to an increase in hours worked and real wages, which

raises union-wide inflation and prompts a tightening in monetary policy by the central bank. Consumption and private investment both fall, on impact, due to the rise in the interest rate. However, if the fiscal capacity investment is sufficiently productive, it will help raise total factor productivity which raises the marginal product of capital and incentives firms to raise their own investments. Furthermore, to the extent that total factor productivity rises, firms will eventually reduce their prices which implies a fall in union-wide inflation in the medium term. Consequently, the central bank reverts to a looser monetary policy stance and lowers the interest rate which stimulates consumption and, at the same time, helps to bring down government debt. On the other hand, if fiscal capacity investments are unproductive, they still raise aggregate demand and drive up union-wide inflation, yet will not induce a medium-term fall in producer prices, implying that the crowding-out effect on consumption and private investment will be more persistent. In that case, the stronger negative wealth effect raises labor supply and reduces real wages, while the monetary contraction also causes government debt to fall below its steady state by less. In sum, a common fiscal capacity investment shock can be a boon to the real economy and crowd in consumption and private investment, whilst improving fiscal conditions, but only if these investments are sufficiently effective in enhancing productivity.

Figure 8 shows the responses to a fiscal capacity investment shock that is country-specific, again scaled to be of size 1% of union-wide GDP, yet this time also scaled by the population size of Home, as we focus on the case in which the Home country receives the investment—the results are symmetric when the investment would instead go to the Foreign country. In Home, the responses are very similar to those following the common fiscal capacity investment shock shown in Figure 7: aggregate demand rises, which leads to a short-term rise in union-wide inflation, a tightening of monetary policy, and a crowding-out effect on consumption and private investment that is reversed once the fiscal capacity investment yields a sufficient rise in Home productivity. Foreign, on the other hand, experiences a much more muted boost to its economy as the country also experiences a crowding-out effect, yet does not benefit directly

Figure 8: Responses to a country-specific fiscal capacity investment shock in Home



Notes: Solid (dashed) lines refer to the case where fiscal capacity investments are productive (unproductive) and their output elasticity is set to $\alpha_{mu} = 0.05$ ($\alpha_{mu} = 0$). Fiscal capacity investments are used to build up country-specific capital. A country-specific fiscal capacity investment shock in Foreign would yield symmetrical results. Units are expressed in percentage deviation from steady state.

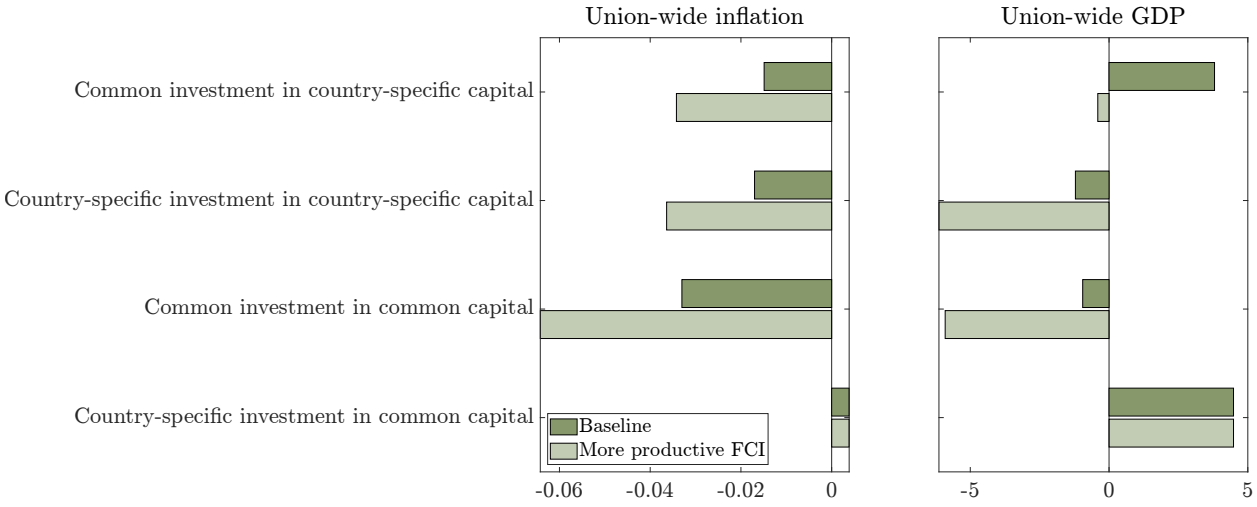
from the productivity-enhancing effects of the fiscal capacity investment. The consequent fall in Foreign consumption and output leads to a decline in real wages. Hence, country-specific fiscal capacity investments are likely to widen macroeconomic imbalances within the monetary union.

In addition to examining the impact of a one-time exogenous shock to investments by the fiscal capacity, we also consider the case in which these investments occur frequently and randomly over time in both member states, in conjunction with random productivity shocks across the monetary union. While random, we impose that productivity shocks are always negative, while fiscal capacity investment shocks are always positive, to reduce the risk of fiscal capacity investments being pro-cyclical (which would otherwise make the results more difficult to interpret). Furthermore, we calibrate the size of the investment shocks such that, under the baseline calibration, they generate a rise in fiscal capacity investment on impact of 1% of either union-wide output or national output, depending on whether the investment

is common across countries or directed to a specific country.

Figure 9 shows that, compared to a scenario in which member states only face negative productivity shocks, a counterfactual scenario in which countries also face random positive bouts of investments by the fiscal capacity is characterized by lower union-wide inflation variability. Intuitively, fiscal capacity investments help offset the inflationary effects of adverse productivity shocks, thereby smoothing inflation dynamics over time. The impact on union-wide output variability depends on whether the investment is common across countries or country specific, and on the productivity-enhancing effect of the fiscal capacity investment. When the latter is sufficiently large, fiscal capacity investments can lower output variability, except in the case when they are country specific and used to raise common capital. In that case, total investment is kept unchanged, which follows from Equation (2), in which $i_{mu,t}$ is kept constant, while country-specific investments, $i_{f,t}$ and $i^*_{f,t}$, are allowed to vary over time. Consequently, these type of investments only work to raise aggregate demand, yet do not raise productivity, and so they result in both greater inflation and output volatility. Figure 10 shows a similar result for average union-wide inflation and output: compared to the baseline, fiscal capacity investments can reduce average inflation and raise average output, and more so the more productive are these investments. Finally, Figure 11 plots the union-wide welfare gain of moving from a baseline scenario without exogenous fiscal capacity investments to one of the other scenarios and shows that random exogenous fiscal capacity investments are generally welfare enhancing, as long as they are sufficiently productivity enhancing. Note that the greatest welfare gains are achieved when fiscal capacity investments are common across countries and used to build up common public capital, as in this scenario the macroeconomic dispersion across member states induced by the investment shocks is minimized.

Figure 9: Standard deviation in union-wide inflation and output, in percentage point deviation from scenario without exogenous fiscal capacity investments



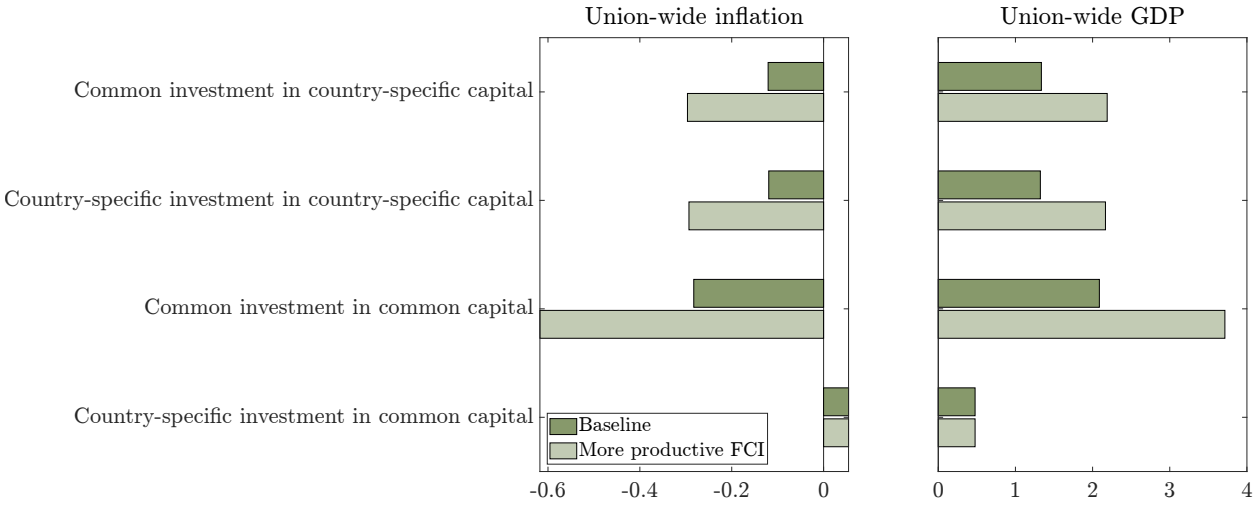
Notes: In all scenarios, both Home and Foreign are hit by random negative productivity shocks over 1,000 periods. In each of the four alternative scenarios, fiscal capacity investment (FCI) shocks are added to the simulation. These investment shocks occur randomly over time, are restricted to always be positive and are calibrated to generate an increase in fiscal capacity investment on impact of 1% of either union-wide output or national output, depending on whether the investment is common or country specific. In the baseline, we set $\alpha_{mu} = 0.05$, while in the case with more productive FCI, we set $\alpha_{mu} = 0.12$.

4 Conclusion

In a structural model of a two-country monetary union, we investigate the macroeconomic stabilization properties of a fiscal capacity that provides a public good. This fiscal capacity can take different forms, which matter for its stabilization properties, as does the type of economic shock. The fiscal capacity can undertake investments in response to an asymmetric shock in one country (endogenous fiscal capacity) or for other purposes (exogenous fiscal capacity). An exogenous fiscal capacity can undertake investments in one or both of the countries of the monetary union, which build-up public capital in one or both countries of the union.

We find that an endogenous fiscal capacity can help dampen the contractionary effects on output of adverse supply shocks by raising investment in public capital and thereby supporting productivity growth and aggregate demand. The boost in demand tends to amplify the inflationary effects of the supply shock, yet the productivity-enhancing effects of the fiscal capacity investments lead to a more muted inflation response in the medium- to long

Figure 10: Average union-wide inflation and output, in percentage point deviation from scenario without exogenous fiscal capacity investments



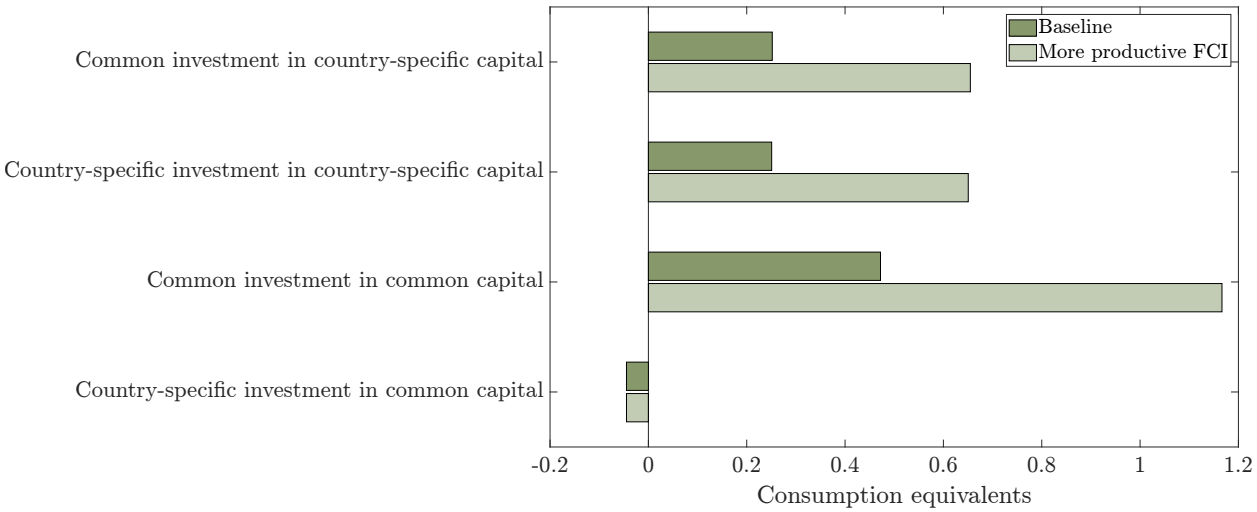
Notes: In all scenarios, both Home and Foreign are hit by random negative productivity shocks over 1,000 periods. In each of the four alternative scenarios, fiscal capacity investment (FCI) shocks are added to the simulation. These investment shocks occur randomly over time, are restricted to always be positive and are calibrated to generate an increase in fiscal capacity investment on impact of 1% of either union-wide output or national output, depending on whether the investment is common or country specific. In the baseline, we set $\alpha_{mu} = 0.05$, while in the case with more productive FCI, we set $\alpha_{mu} = 0.12$.

run. Model simulations show that a sufficiently counter-cyclical response of fiscal capacity investment helps to substantially bring down output variability across the monetary union, raises slightly inflation variability, and results in a higher level of output and a lower level of inflation on average. Moreover, by closing macroeconomic imbalances within the monetary union, counter-cyclical fiscal capacity investments also render business cycles more synchronized across member states, which supports monetary policy in achieving macroeconomic stability for the monetary union as a whole. As a result, we find that counter-cyclical fiscal capacity investments raise welfare, especially if public capital is more productive.[3]

Exogenous fiscal capacity investments are found to have more heterogeneous effects on macroeconomic variability than endogenous fiscal capacity investments that depend on their nature, such as whether these investments benefit member states equally or differently. As these investments are taken primarily to provide some public good, rather than to stabilize the economy, they might enhance utility but not increase the productive public capital stock. However, these investments can result in a higher level of output and a lower level of inflation

[3]When the monetary union is confronted with demand shocks, rather than supply shocks, the welfare gains from the endogenous fiscal capacity are much smaller, yet still positive.

Figure 11: Union-wide welfare gain of exogenous fiscal capacity investments compared to case without such investments



Notes: In all scenarios, both Home and Foreign are hit by random negative productivity shocks over 1,000 periods. In each of the four alternative scenarios, fiscal capacity investment (FCI) shocks are added to the simulation. These investment shocks occur randomly over time, are restricted to always be positive and are calibrated to generate an increase in fiscal capacity investment on impact of 1% of either union-wide output or national output, depending on whether the investment is common or country specific. In the baseline, we set $\alpha_{mu} = 0.05$, while in the case with more productive FCI, we set $\alpha_{mu} = 0.12$. Units are measured in consumption equivalents.

on average, and also raise welfare, if they contribute to enhancing productivity. Moreover, the welfare gains are largest when fiscal capacity investments are used to build up common public capital, rather than public capital that is specific to an individual member state, as these investments do not contribute strongly to macroeconomic imbalances across countries.

All in all, we find that monetary unions benefit the most from a centralized fiscal capacity when such a capacity is used, either counter-cyclically or more exogenously, to finance productivity-enhancing public capital, that is common across member states, and in times when the economy faces large adverse supply shocks.

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A Detailed model description

This section describes in more detail the household and production sectors of the model discussed in Section 2. We shall focus on the Home economy as the Foreign block is symmetric. Foreign variables are denoted with an asterisk superscript.

A.1 Households

Each household $i \in [0,1]$ consumes both Home and Foreign final goods, $c_{H,t}(i)$ and $c_{F,t}(i)$, which are assembled into the final consumption basket, $c_t(i)$, according to the following aggregator:

$$c_t(i) = \left[(1-\mu)^{\frac{1}{\eta}} c_{H,t}(i)^{\frac{\eta-1}{\eta}} + \mu^{\frac{1}{\eta}} c_{F,t}(i)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{30}$$

with $\mu \in [0,1]$ the import share in consumption and $\eta > 1$ the trade elasticity. Maximizing (30) subject to a standard expenditure constraint yields the optimal demand schedules for final goods:

$$c_{H,t}(i) = (1-\mu)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} c_t(i), \tag{31}$$

$$c_{F,t}(i) = \mu\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} c_t(i), \tag{32}$$

where $P_{H,t}$ and $P_{F,t}$ denote the Home and Foreign producer price indices (PPI), while the Home consumer price index (CPI) is given by

$$P_t = \left[(1-\mu) P_{H,t}^{1-\eta} + \mu P_{F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{33}$$

We assume the law of one price holds, which implies $P_{H,t} = P_{H,t}^*$ and $P_{F,t} = P_{F,t}^*$. The real exchange rate q_t is defined as

$$q_t \equiv \frac{P_t^*}{P_t}. \tag{34}$$

The objective of the household is to maximize its expected lifetime utility:

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{\left(c_{t+k}(i) - h c_{t+k-1}(i)\right)^{1-\sigma}}{1-\sigma} - \chi \frac{n_{t+k}(i)^{1+\varphi}}{1+\varphi} \right), \tag{35}$$

subject to its budget constraint:

$$\begin{aligned}
&P_t c_t(i) + P_t i_t(i) + P_t \left[\tau_t + \tau_t^{mu} + \left(\tau_{c,t} + \tau_{c,t}^{mu} \right) c_t(i) \right] \\
&+ Q_{G,t} \left(B_{G,t}(i) - \varrho_G B_{G,t-1}(i) \right) + B_{H,t}(i) + B_{F,t}(i) + Q_{mu,t} \left(B_{mu,t}(i) - \varrho_{mu} B_{mu,t-1}(i) \right) \\
&= \left[(1-\tau_{k,t}) r_{k,t} - \rho_{RP} \left(R P_{t-1} - 1 \right) \right] R_{k,t} k_{t-1}(i) + \left(1 - \tau_{w,t} - AC_{W,t}(i) \right) W_t(i) n_t(i) \\
&+ (1-\vartheta_t) B_{G,t-1}(i) + R_{t-1} B_{H,t-1}(i) + R_{t-1}^* B_{F,t-1}(i) + B_{mu,t-1}(i) + P_t \left(\Gamma_t + \Gamma_{G,t} - \frac{1-s}{s} \Gamma_{f,t}^*(i) \right),
\end{aligned} \tag{36}$$

where the financial transaction costs are given by

$$\Gamma_{f,t}^*(i) = \frac{\kappa_D}{2} \left(b_{F,t} - \bar{b}_F \right)^2, \tag{37}$$

with $b_{F,t} \equiv \frac{B_{F,t}}{P_t^*}$. Wage adjustment costs, $AC_{W,t}$, are given by

$$AC_{W,t} = \frac{\kappa_W}{2} \left(\frac{W_t(i)}{W_{t-1}(i)} - 1 \right)^2, \tag{38}$$

with $\kappa_W \geq 0$. Optimal demand for labor variety $n_t(i)$ is given by

$$n_t(i) = \left(\frac{W_t(i)}{W_t} \right)^{-\epsilon_w} n_t, \tag{39}$$

with $\epsilon_w > 1$ the elasticity of substitution between labor varieties.

Private capital evolves according to the following law of motion:

$$k_t = (1-\delta) k_{t-1} + \left[1 - \frac{\kappa_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t, \tag{40}$$

with $\delta \in [0,1]$ the depreciation rate of capital and where $\kappa_i \geq 0$ measures the size of investment adjustment costs.

Let $\pi_t \equiv \frac{P_t}{P_{t-1}}$ be gross inflation, $w_t \equiv \frac{W_t}{P_t}$ the real wage, $r_{k,t} \equiv \frac{R_{k,t}}{P_t}$ the real rental rate, $\pi_{W,t} \equiv \frac{W_t}{W_{t-1}}$ nominal wage growth, and λ_t and ϑ_t the Lagrange multipliers on the household's budget constraint and capital law of motion, respectively. Furthermore, define $b_{G,t} \equiv \frac{B_{G,t}}{P_t}$, $b_{H,t} \equiv \frac{B_{H,t}}{P_t}$, and $b_{mu,t} \equiv \frac{B_{mu,t}}{P_t}$. The first-order conditions of the household are then given by

$$c_t: \quad \lambda_t = \frac{1}{1+\tau_{c,t}+\tau_{c,t}^{mu}} \left\{ (c_t - hc_{t-1})^{-\sigma} - h\beta E_t \left[(c_{t+1} - hc_t)^{-\sigma} \right] \right\}, \tag{41}$$

$$b_{G,t}: \quad 1 = \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{(1-\vartheta_{t+1}) + \varrho_G Q_{G,t+1}}{\pi_{t+1} Q_{G,t}} \right], \tag{42}$$

$$b_{H,t}: \quad 1 = \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t} \frac{R_t}{\pi_{t+1}} \right), \tag{43}$$

$$b_{F,t}: \quad 1 = \beta E_t \left(\frac{\lambda_{t+1}}{\lambda_t} \frac{R_t^*}{\pi_{t+1}^*} \frac{q_{t+1}}{q_t} \right) - \kappa_D \left(b_{F,t} - b_F \right), \tag{44}$$

$$b_{mu,t}: \quad 1 = \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{1 + \varrho_{mu} Q_{mu,t+1}}{\pi_{t+1} Q_{mu,t}} \right], \tag{45}$$

$$k_t: \quad 1 = \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \frac{(1-\tau_{k,t+1}) r_{k,t+1} - \rho_{RP}(RP_t - 1) + \mathcal{Q}_{t+1}(1-\delta)}{\mathcal{Q}_t} \right\}, \tag{46}$$

$$\begin{aligned} i_t: \quad 1 = {} & \mathcal{Q}_t \left\{ 1 - \kappa_i \left(\frac{i_t}{i_{t-1}} - 1 \right) \frac{i_t}{i_{t-1}} - \frac{\kappa_i}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right\} \\ & + \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \mathcal{Q}_{t+1} \kappa_i \left(\frac{i_{t+1}}{i_t} - 1 \right) \left(\frac{i_{t+1}}{i_t} \right)^2 \right], \end{aligned} \tag{47}$$

$$\begin{aligned} W_t(i): \quad 0 = {} & (1-\epsilon_w)(1-\tau_{w,t}) + \frac{\epsilon_w}{w_t} \frac{\chi n_t^{\varphi}}{\lambda_t} - \kappa_W (\pi_{W,t} - 1) \pi_{W,t} \\ & - (1-\epsilon_w) \frac{\kappa_W}{2} (\pi_{W,t} - 1)^2 + \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \kappa_W (\pi_{W,t+1} - 1) \pi_{W,t+1}^2 \pi_{t+1}^{-1} \frac{n_{t+1}}{n_t} \right], \end{aligned} \tag{48}$$

where $\mathcal{Q}_t \equiv \frac{\vartheta_t}{\lambda_t}$ denotes Tobin's Q.

A.2 Production

The Home final consumption good, $y_{H,t}$, is a composite of intermediate good varieties, $y_{H,t}(i)$, given by

$$y_{H,t} = \left(\int_0^1 y_{H,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{49}$$

where $\varepsilon > 1$ denotes the elasticity of substitution between varieties from the same country. The optimal demand for good variety i is given by

$$y_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}} \right)^{-\varepsilon} y_{H,t}. \tag{50}$$

The intermediate good firm produces $y_{H,t}(i)$ using the following production function:

$$y_{H,t}(i) = z_{A,t} n_t(i)^{\alpha} k_{t-1}(i)^{1-\alpha} \left(\mathcal{K}_{mu,t-1}^{v} k_{mu,t-1}^{1-v} \right)^{\alpha_{mu}} k_{g,t-1}^{\alpha_g}. \tag{51}$$

The objective of the intermediate good firm is to maximize expected discounted profits:

$$E_t \sum_{k=0}^{\infty} \mathcal{D}_{t,t+k} \left(\frac{P_{H,t+k}(i)}{P_{t+k}} y_{H,t+k}(i) - \frac{W_{t+k}}{P_{t+k}} n_{t+k}(i) - \frac{R_{k,t+k}}{P_{t+k}} k_{t+k-1}(i) - \frac{AC_{P,t+k}(i)}{P_{t+k}} \right),$$

where $\mathcal{D}_{t,t+k} \equiv \beta^k \frac{\lambda_{t+k}}{\lambda_t}$ denotes the household's stochastic discount factor and price adjustment costs are given by

$$AC_{P,t}(i) = \frac{\kappa_P}{2} \left(\frac{P_{H,t}(i)}{P_{H,t-1}(i)} - 1 \right)^2 P_{H,t} y_{H,t}, \tag{52}$$

with $\kappa_P \geq 0$, subject to the production function. Let $\pi_{H,t} \equiv \frac{P_{H,t}}{P_{H,t-1}}$ denote gross PPI inflation and mc_t real marginal costs. The first-order conditions of the firm are then given by

$$n_t(i): \qquad w_t = \alpha mc_t \frac{y_{H,t}}{n_t}, \tag{53}$$

$$k_{t-1}(i): \qquad r_{k,t} = (1-\alpha)\, mc_t \frac{y_{H,t}}{k_{t-1}}, \tag{54}$$

$$P_{H,t}(i): \qquad (\pi_{H,t}-1)\,\pi_{H,t} = \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{y_{H,t+1}}{y_{H,t}}\frac{1}{\pi_{t+1}}(\pi_{H,t+1}-1)\,\pi_{H,t+1}^2\right] \tag{55}$$
$$+\frac{\varepsilon}{\kappa_P}\left(\frac{mc_t}{p_{H,t}}-\frac{\varepsilon-1}{\varepsilon}\right).$$

B Calibration

Table 2: Baseline calibration of structural parameters

Parameter	Description	Calibration
β	Discount factor	0.995
h	Degree of consumption habit	0.5
σ	Inverse of elasticity of intertemporal substitution	2
φ	Inverse of Frisch elasticity of labor supply	2
κ_D	Elasticity of risk premium with respect to external assets	0.001
$\delta, \delta_{mu}, \delta_g$	Depreciation rate of private and public capital	0.025
κ_i	Private investment adjustment cost parameter	5
ϵ_w	Elasticity of substitution between labor varieties	5
α	Output elasticity with respect to labor	2/3
ϵ_p	Elasticity of substitution between intermediate goods	6
θ_p	Probability of non-price adjustment	0.75
κ_P	Price adjustment cost parameter	$\frac{\theta_p(\epsilon_p-1)}{(1-\theta_p)(1-\theta_p\beta)}$
θ_w	Probability of non-wage adjustment	0.75
κ_W	Wage adjustment cost parameter	$\frac{(\epsilon_w-1)\alpha\cdot\theta_w(1+\epsilon_w\varphi)}{(1-\theta_w)(1-\theta_w\beta)}\frac{\epsilon_p-1}{\epsilon_p}$
s	Relative population size of Home	0.5
η, η_{mu}	Trade elasticity	3
μ_{mu}	Import share of Foreign investment goods by fiscal capacity	0.5
ω	Trade openness	0.5
ρ_A	AR(1) coefficient of productivity shocks	0.9
α_{mu}	Output elasticity with respect to public capital	0.05
υ	Weight common public capital in production function	0.5
ϑ	Ex-post haircut on government bonds	0.063
η_1, η_2	Logistic function determining probability of sovereign default	$\{-7.2, 1.2\}$
ρ_{RP}	Degree of sovereign risk pass through	0.6

Table 3: Baseline calibration of policy parameters

Parameter	Description	Calibration
$\text{dur}_G, \text{dur}_{mu}$	Average duration public and common bonds (in quarters)	28
ϱ_G, ϱ_{mu}	Coupon payment decay rate	$\frac{\text{dur}_G-1}{\text{dur}_G}, \frac{\text{dur}_{mu}-1}{\text{dur}_{mu}}$
ρ_R	Interest rate smoothing	0.8
ϕ_π	Monetary policy response to inflation	1.5
ϕ_y	Monetary policy response to output	0.125
γ_b^τ	Tax response to outstanding debt of national fiscal authority	0.5
$\gamma_b^{\tau,mu}$	Tax response to outstanding debt of fiscal capacity	0.25

Table 4: Steady-state assumptions

Variable	**Description**	**Calibration**
$\overline{gdp}$	Home GDP	1
$\overline{n}$	Home hours worked	1/3
$\overline{B_G}, \overline{B_G^*}$	Government debt to GDP ratio (annualized)	0.6
$\overline{\tau_c}, \overline{\tau_c^*}$	Consumption tax	0.2
$\overline{\tau_w}, \overline{\tau_w^*}$	Income tax	0.3
$\overline{\tau_k}, \overline{\tau_k^*}$	Capital tax	0.3
$\overline{\frac{g}{gdp}}, \overline{\frac{g^*}{gdp^*}}$	Government consumption to GDP ratio	0.2
$\overline{\frac{i_g}{gdp}}, \overline{\frac{i_g^*}{gdp^*}}$	Government investment to GDP ratio	0.04
$\overline{\frac{\mathcal{A}}{gdp_{mu}}}, \overline{\frac{\mathcal{A}^*}{gdp_{mu}}}$	Country-specific investment by the fiscal capacity	0.01
$\overline{\frac{i_{mu}}{gdp_{mu}}}$	Common investment by the fiscal capacity	0.01
$\overline{B_{mu}}$	Common bonds to union-wide GDP ratio	0
$\overline{B_F}, \overline{B_H^*}$	Private bonds held externally	0.6