Monetary Unions with Heterogeneous Fiscal Space[†]

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Abstract

We develop a multi-country Heterogeneous Agents New Keynesian (HANK) model of a monetary union with ex-ante heterogeneity in legacy public debt across member states. Following symmetric aggregate shocks, the systematic monetary policy reaction induces heterogeneous responses driven by national fiscal space. This generates a trade-off between union-wide macroeconomic stabilization and cross-country synchronization of economic activity for the central bank. We characterize a possibility frontier between union-wide inflation stability and cross-country synchronization, which is traced out by varying the degree of the central bank's hawkishness towards inflation. We study the role of deficit caps, fiscal and political unions, and augmented Taylor rules as instruments to navigate the stabilization-synchronization trade-off.

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Fiscal and monetary policies must go hand in hand, and if there is to be an optimum policy mix, they should have the same domains. (Kenen, 1969)

1 Introduction

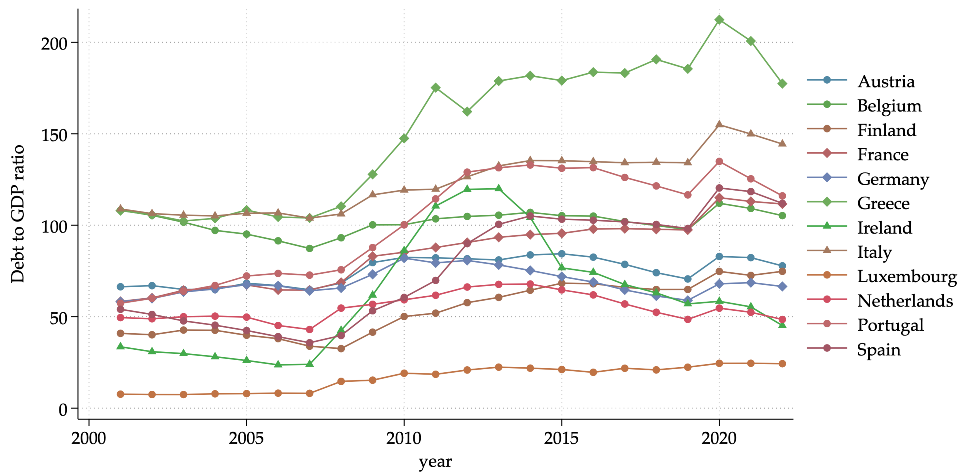
Following the pioneering work of Mundell (1961), McKinnon (1963), and Kenen (1969), the Optimum Currency Area (OCA) theory studies the complex cost-benefit calculus of forming and sustaining stable currency unions. The three pillars of an OCA are generally understood to be symmetry of responses and shocks, flexibility of labor markets, and integration of economic activity and policy. In this paper, we focus on one empirically salient aspect of asymmetry across member states of a monetary union – fiscal space, as proxied by public debt-to-GDP ratios – and ask whether this dimension of heterogeneity affects the stability and integrity of the union.[1] Our paper is applied to the context of the euro area, which represents a unique laboratory setting as it features a single supranational monetary authority but separate national fiscal authorities.

To fix ideas, we first present a stylized fact on the distribution of debt-to-GDP ratios across the euro area, with a special focus on its twelve members as of 2001. Figure 1 documents that national debt levels have been (i) ex-ante heterogeneous since the formation of the union and (ii) highly persistent and stable over time. This fact motivates our choice to use cross-country differences in steady-state levels of debt as an inherent, medium-run feature of our modelling environment. In other words, we will be operating within a framework where countries are identical in every aspect except for the levels of legacy public debt that differ ex-ante.

Stark differences in national fiscal stances beg the natural question of whether European countries belong to an optimal currency area to begin with (Eichengreen, 1991). An important view is that OCA criteria may be endogenous (Frankel and Rose, 1998, Rose, 2000). One can argue that even if potential members of a monetary union do not satisfy all OCA criteria today, the decision to set up the union will facilitate endogenous integration and synchronization in the future. Gradual elevation in bilateral trade and the rising correlation of national business cycles will satisfy the criteria ex post through mutually reinforcing channels. In this paper, we study the extent to which different levels of public debt across member states represent a challenge for European integration over the business cycle.

[1] We follow the International Monetary Fund (IMF) and define fiscal space as "room in a government´s budget that allows it to provide resources for a desired purpose without jeopardizing the sustainability of its financial position or the stability of the economy" (Heller, 2005). We are proxying fiscal space with national debt-to-GDP ratios, in line with the literature (Romer and Romer, 2019, Aizenman et al., 2019).

Figure 1: Fiscal Space in the Eurozone since 2001



Note: This figure plots the time-varying distribution of debt-to-GDP ratios in the euro area. Only countries that were members of the eurozone as of 2001 are included. Source: International Monetary Fund.

We address our research question using a multi-country Heterogeneous Agents New Keynesian (HANK) framework. In this setting, where Ricardian equivalence does not hold and marginal propensities to consume are high, the fiscal response to monetary shocks becomes a crucial channel of monetary transmission. Since governments are the sole issuers of the union-wide asset, a change in the interest rate impacts their budget constraints, leading to fiscal responses that affect households' disposable income (Kaplan et al., 2018). Hence, in the presence of trade frictions between members of a monetary union, and unlike in representative agent models, the fiscal reaction to monetary shocks is a key determinant of the overall national macroeconomic responses. We argue that in a setting in which legacy public debt varies across countries, this fiscal reaction function is *endogenously* bound to be country-specific, which induces heterogeneous exposure of national economies to the same monetary policy stance.

The main finding of our paper is that ex-ante differences in the levels of legacy public debt across members of a monetary union can cause an asymmetric response of national economies to union-wide shocks, and to monetary shocks in particular. The economic mechanism behind our finding is the following. In response to symmetric aggregate disturbances, the centralized monetary authority responds to inflation according to a standard Taylor-type rule. The monetary policy response, in turn, transmits differentially across the member states via national governments' budget constraints. In response to a monetary contraction, high-debt countries have limited fiscal ammunition to act countercyclically, which translates into a muted response of primary deficits. As a result, they experience a more severe economic recession. Low-debt countries, on the other hand, contract by less than the union-wide average. This implies that the monetary authority faces a trade-off between union-wide macroeconomic stabilization and synchronization of economic activity across its members. The more hawkish the central bank is, i.e. the more aggressively it responds to inflation, the starker the increase in the cross-country dispersion of economic activity. We represent this trade-off as a *stabilization-synchronization possibility frontier* which, to the best of our knowledge, is a novel dimension that monetary authorities within currency unions might want to pay attention to.[2]

While there seem to be well-defined dollar and euro common currency areas (Alesina et al., 2002), some would argue that a first-order question for the lasting success of currency unions in general, and the euro area in particular, is whether a monetary union can be sustained without fiscal and political coordination (De Grauwe, 2009). Because monetary and fiscal policies are usually deeply interlinked (Sargent and Wallace, 1981), being able to analyze the effect of the fiscal stance on the transmission of monetary policy is particularly challenging. Classic theory of fiscal federalism is concerned with the assignment of fiscal policies to various layers of government (Oates, 1999). Typically, stabilization policy – including discretionary fiscal policy and automatic stabilizers – is thought of as a task for the central government. Centralized government is also well-known to be important for risk sharing and smoothing the cross-sectional variance of local fluctuations (Asdrubali et al., 1996). In the context of the euro area, an absence of active fiscal and political unions begs a question of whether the status quo is desirable.

The above consideration motivates us to run the first policy experiment in our quantitative laboratory: a fiscal union. We introduce an authority that can issue bonds and distribute lump-sum transfers across countries and households in a homogeneous fashion. This approach is closely related to the frequently referenced "Eurobonds" proposal (Frankel, 2012). We find that the fiscal union is effective at stabilizing average real activity in the monetary union. This is because the introduction of the fiscal union essentially adds an additional source of counter-cyclical, stabilizing fiscal policy. However, the fiscal union has a much greater stabilizing effect on the low-debt countries than on the high-debt ones. The reason is that, in general equilibrium, the rise of the total amount of public debt in the single market pushes the interest rate up. As a result, the higher interest rate further shrinks fiscal capacity of the high-debt country that had tight fiscal space to begin with. Thus, while both country types are clearly better off with a fiscal union than without, the

[2]Our channel is loosely related to the trade-off between the size of political unions and coordination capacity: the greater the degree of economic heterogeneity across independent parties that are willing to establish a political union, the lower the equilibrium size of the union and the harder political cooperation becomes (Alesina et al., 2001).

stabilization-synchronization trade-off is still present.

In addition to the above, we also consider a political union - an arrangement implying cross-country redistribution and a full political compromise. We model a political union as an institution that runs a balanced budget every period and transfers resources across high- and low-debt countries' national fiscal authorities. We find that a political union is very effective at harmonizing economic fluctuations across countries. Endogenous desynchronization of the monetary union is prevented, thus solving the stability-synchronization problem. Our political union experiment can raise two non-trivial questions. First, a political compromise may be impossible if cross-country transfers are inherently non-reversible, meaning that the low-debt countries are generally always the "donors" and the high-debt countries are the "receivers". This is not the case in our model experiment. The direction of transfers varies over the business cycle so that neither country receives positive net transfers on average over time. Second, this analysis abstracts from important moral hazard considerations (Persson and Tabellini, 1996). The problem can be alleviated if cross-country re-distributive transfers are conditional on structural reforms, which we do not analyze explicitly.

A third policy experiment that we study in our model is the so-called *augmented* Taylor rule. It is possible that in the absence of fiscal coordination, the monetary authority could fix the stabilization-synchronization trade-off by itself. In the spirit of Cúrdia and Woodford (2010) and Boissay et al. (2021), we introduce a measure of cross-country consumption inequality explicitly into the central bank's policy rule. Along the transition path following exogenous aggregate shocks, the central bank that values cross-country synchronization generally allows for a greater inflation response. Thus, as inflation responds by more, desynchronization reacts by less. While theoretically operational, the extent to which a monetary authority could have its mandate and policy scope expanded with additional items is a complicated practical question.

The fourth and final policy instrument that we analyze in our model is the frequently debated cap on fiscal deficits. Hard limits on public deficits have been present ever since the 1992 Maastricht Treaty. In recent years, the European Union has been considering further reforms and improvements to its fiscal governance in general and deficit rules in particular. Relative to the frictionless benchmark, we find that deficit caps can *amplify* the disparity in economic responses across high- and low-debt countries. While deficit caps are successful at achieving enhanced debt sustainability, the cross-country distributional consequences of this policy are unequal. The intuition is simple: high-debt countries very quickly run into the binding deficit cap constraint precisely in the state of the world where they wish to engage in counter-cyclical fiscal stabilization. The constraint does not bind for the low-debt countries who remain unconstrained and go through a milder economic recession following the same monetary contraction. As a result, while fiscal diligence and coordination are undoubtedly important, the *instrument* of fiscal resilience matters.

Generally speaking, our framework can speak to the so-called Brussels-Frankfurt consensus view, according to which the European economy is more rigid than, for example, the US, and thus might benefit from limited governmental interventions in favor of free market discipline. Prescott (2004), among others, argued that differences in hours worked in Europe and in the United States are due to an excessive marginal tax burden of the former. In other words, Keynesian stabilization policies – particularly within a monetary union – can be distortive. Furthermore, if output shocks are due to demand movements, inflation targeting will not only stabilize the rate of inflation but also output movements. Instead, national fiscal policies plus structural reform are sufficient to deal with symmetric or asymmetric disturbances. However, in our framework the inflation targeting limit induces the *greatest* degree of desynchronization of national business cycles. The sufficient condition for this result is the empirically validated ex-ante heterogeneity in national fiscal space. As such, our model suggests that the Brussels-Frankfurt consensus view is limited in scope. Relatedly, our finding is much more subtle than the standard monetarist position which would state that *activist* monetary interventions create instability and imbalances. In our model, the monetary authority is not acting autonomously. Desynchronization arises because the central bank performs its mandate, i.e. reacts to inflationary shocks through its *systematic* policy arm. Thus, we conclude that for as long as member states adopt a common monetary area while differing in fiscal space – a natural assumption in the European context – deeper fiscal integration is necessary to preserve the monetary union over time.

There are three general limitations to our modelling approach and findings. First, our model does not allow for ex-ante entry and ex-post exit decisions for the member states. This restriction implicitly assumes that the monetary union has de-facto coercive power to prevent secession, much like in the case of the United States. Alternatively, one can assume that the costs of exit are infinitely large. In practice, this is a strong assumption and the high-debt countries may eventually be tempted to secede. Second, we abstract from all normative implications of our policy experiments. For the analysis of optimal policy in currency unions, including in international contexts, see Galí and Monacelli (2008) and Ferrero (2009), among others. Third and finally, we generally abstract from sovereign default risk considerations for tractability, while this channel is very important in practice (Corsetti et al., 2013, Costain et al., 2024).

Literature Our paper is related to three main strands of literature. First, we are contributing to the burgeoning literature on open-economy HANK settings (de Ferra et al., 2020, Druedahl et al., 2022, Bayer et al., 2024, Aggarwal et al., 2023, Oskolkov, 2023, Guo et al., 2024). In particular, we focus on the analysis of fiscal policies in general equilibrium environments where Ricardian equivalence fails (Hagedorn et al., 2019, Auclert and Rognlie, 2018). The above studies are almost entirely theoretical and/or quantitative. For the empirical treatment of heterogeneous responses to common monetary policy shocks, with a special emphasis on the euro area, see Burriel and Galesi (2018), Almgren et al. (2022), and Pica (2023).

Second, our paper relates to the literature on OCAs (Mundell, 1961, McKinnon, 1963, Kenen, 1969, Kenen and Meade, 2008). While abstracting from normative statements, we study how heterogeneity in member countries affects the ability of the monetary authority to stabilize economic activity – both in the aggregate and in the cross section. Our particular emphasis is on fiscal integration and stabilization policies (Farhi and Werning, 2016, 2017). Our modelling approach is closest to Farhi and Werning (2017) and Bellifemine et al. (2023a).

Finally, we are contributing to the rapidly growing literature that solves complex general equilibrium models with sequence space methods (Mankiw and Reis, 2006, Boppart et al., 2018, Auclert et al., 2021a). The sequence space domain has been applied to the study of heterogeneous households (Auclert et al., 2020, 2024), firms (González et al., 2023), banks (Bellifemine et al., 2023b), regions and countries (Auclert et al., 2021b, Bellifemine et al., 2023a), and optimal policy (Wolf and McKay, 2023, Bilal, 2023). The tractability of the sequence space method allows us to conduct various structural experiments – such as fiscal and political unions – with relative ease both along transitions following mean-revering MIT shocks and in long time-series simulations of the economy.

2 A Multi-Country HANK Model of Monetary Unions

In this section we first introduce our multi-country Heterogeneous Agent New Keynesian (HANK) model of a monetary union. Next, we cast our modeling framework in the sequence space and define two objects that are going to be useful in our analysis: the sequence space Jacobian matrices capturing intertemporal Marginal Propensities to Consume (iMPCs) and the share of non-tradable labor income.

2.1 Setup

Our theoretical framework builds on the currency area HANK model proposed in Bellifemine et al. (2023a), extended to study the role of fiscal policy. Time $t \geq 0$ is discrete. There is a continuum of countries indexed by $j \in [0,1]$ each having a potentially non-zero measure $\mu(j)$. There is no aggregate uncertainty and we consider perfect-foresight impulse responses to shocks around the steady state ("MIT shocks").

Households Each country j is inhabited by a continuum of households $i \in [0,1]$. As in the standard incomplete markets model, households are ex-ante identical but different ex-post because they face uninsured idiosyncratic shocks to their labor productivity e, which evolves over time according to a Markovian process. The preferences of household i living in country j are defined over an aggregate consumption good c_{jit} as well as aggregate labor supply ℓ_{jit}, which imply the following time-0 utility:

$$\mathbb{E}_0 \sum_{t \geq 0} \beta^t \{u(c_{jit}) - v(\ell_{jit})\}$$

Agents pay a proportional tax τ on their labor income, receive transfers T_{jt} from their national government, and can imperfectly insure themselves by saving in a nominal risk-free bond which is traded union-wide with real value b_{jit}. The bond is subject to a borrowing limit $\underline{b} \leq 0$. The households' budget constraint reads as follows:

$$c_{jit} + b_{jit+1} = (1-\tau)e_{jit}\frac{W_{jt}}{P_{jt}}\ell_{jit} + T_{jt} + (1+r_{jt})b_{jit}, \quad b_{jit+1} \geq \underline{b} \tag{1}$$

where W_{jt} and P_{jt} are, respectively, the aggregate wage and price index in country j, they will be defined momentarily.

Demand Composition There are two consumption goods in the economy: non-tradables and tradables. The two goods are combined into the aggregate consumption basket c_{jit} according to a constant-elasticity-of-substitution (CES) aggregator:

$$c_{jit} = \left[\omega^{1/\nu}\left(c_{jit}^{NT}\right)^{(\nu-1)/\nu} + (1-\omega)^{1/\nu}\left(c_{jit}^{T}\right)^{(\nu-1)/\nu}\right]^{\frac{\nu}{\nu-1}} \tag{2}$$

Where c_{jit}^{NT} and c_{jit}^{T}, respectively, denote consumption of the non-tradable and the tradable good, ω is a parameter governing households' preferences for non-tradables, and $\nu > 0$ is the elasticity of substitution between the two types of goods. The defining feature of non-tradable goods is that they must be consumed in the same country where they have been produced. Tradable goods are themselves defined as a composite of tradable variaties produced in each country j, as in Galí and Monacelli (2005, 2008):

$$c_{jit}^{T} = \left(\int_0^1 c_{jit}^{T}(j')^{\frac{\psi-1}{\psi}} d\mu(j') \right)^{\frac{\psi}{\psi-1}} \tag{3}$$

With ψ the elasticity of substitution between tradable goods produced in different countries. This implies the following demand for tradables produced in country j' from residents of country j:

$$c_{jt}^{T}(j') = \left(\frac{P_t^T(j')}{P_t^T} \right)^{-\psi} c_{jt}^{T} \tag{4}$$

where $P_t^T(j')$ represents the price of tradable goods produced in country j' and $P_t^T \equiv \left(\int_0^1 P_t^T(j')^{1-\psi} dj' \right)^{\frac{1}{1-\psi}}$ is the price index for tradable goods.[3] As is standard, households split their spending between the two types of goods as follows:

$$c_{jit}^{NT} = \omega \left(\frac{P_{jt}^{NT}}{P_{jt}} \right)^{-\nu} c_{jit} \quad \text{and} \quad c_{jit}^{T} = (1-\omega) \left(\frac{P_t^T}{P_{jt}} \right)^{-\nu} c_{jit} \tag{5}$$

Where P_{jt}^{NT} represents country j's price index for non-tradable goods, while P_{jt} is the aggregate price index in country j. Because in our model preferences are homothetic and do not depend on the household type i, both the price and the wage indices as well as the composition of the consumption basket will be identical across household types within one country. Finally, the price index corresponding to the preferences represented in (2) is given by:

$$P_{jt} = \left[\omega \left(P_{jt}^{NT} \right)^{1-\nu} + (1-\omega) \left(P_t^T \right)^{1-\nu} \right]^{\frac{1}{1-\nu}} \tag{6}$$

Sectoral labor allocation Similarly to demand, the supply side of each country j is comprised of two sectors: one producing country j's tradable variety and one producing the non-tradable good. We follow Berger et al. (2022) when modelling the supply of labor to the two sectors: individual households' aggregate labor supply ℓ_{jit} is a composite of a measure of labor supplied to the non-tradable sector ℓ_{jit}^{NT} and a measure ℓ_{jit}^{T} supplied

[3] Note that we abstract from trade costs between countries. This, together with the fact that preferences are homogeneous across countries implies that the price for the aggregate tradable basket P_t^T does not depend on country j.

to the tradable sector. In particular, the labor supply composite is given by the following CES aggregator:

$$\ell_{jit} = \left(\alpha^{-\frac{1}{\eta}}(\ell_{it}^{NT})^{\frac{\eta+1}{\eta}} + (1-\alpha)^{-\frac{1}{\eta}}(\ell_{it}^{T})^{\frac{\eta+1}{\eta}}\right)^{\frac{\eta}{\eta+1}} \tag{7}$$

Where η is the elasticity of labor substitution across sectors and is assumed to be constant across countries. Parameter α captures the propensity of country j to produce non-tradable goods and is also common across countries.[4] Given (7), households split their labor supply in the following fashion:

$$\ell_{jit}^{NT} = \alpha \left(\frac{W_{jt}^{NT}}{W_{jt}}\right)^{\eta} \ell_{jit}, \quad \text{and} \quad \ell_{jit}^{T} = (1-\alpha)\left(\frac{W_{jt}^{T}}{W_{jt}}\right)^{\eta} \ell_{jit} \tag{8}$$

Finally, the wage index corresponding to this labor supply structure is given by:

$$W_{jt} = \left[\alpha(W_{jt}^{NT})^{1+\eta} + (1-\alpha)(W_{jt}^{T})^{1+\eta}\right]^{\frac{1}{1+\eta}} \tag{9}$$

where W_{jt}^{T} is defined accordingly.

Final Good Producers Firms in both sectors produce using a linear production technology: $Y_{jt}^{s} = L_{jt}^{s}$, $s \in \{NT, T\}$. Moreover, in both sectors the market for final goods is perfectly competitive. As a result, final prices for the two goods equal the marginal cost, i.e., $P_{jt}^{s} = W_{jt}^{s}$.

Labor Markets Our economy features nominal rigidities in the form of sticky wages, while prices are allowed to adjust frictionlessly.[5] In line with the New Keynesian sticky-wage literature (Erceg et al., 2000, Schmitt-Grohé and Uribe, 2005, Auclert et al., 2024), we assume that the amount of hours worked is determined by labor unions. In particular, there is one set of unions per country and per sector. In each country j and sector s, there is a continuum of labor unions which set a nominal wage w_{jt}^{s}. Wage setting is subject to quadratic utility costs of adjustment in order to maximize the welfare of the average household in that country. Unions then allocate labor among households in a uniform

[4] The parameter α can be equivalently interpreted as governing the non-tradable labor endowment.

[5] This assumption is common in heterogeneous agent New Keynesian models, as sticky wages have the desirable property of making the model consistent with empirical evidence on the cyclicality of profits (Broer et al., 2019, Alves et al., 2020) and the income effect on labor supply (Auclert et al., 2023).

fashion, i.e., $\ell^s_{jit} = \ell^s_{jt}$.[6] This gives rise to a wage Phillips curve in every country and every sector. We derive a *national* Phillips curve by taking the weighted average of the two sectoral Phillips curves. See Appendix A.1 for technical details.

National governments There are national governments that administer affine tax and transfer schemes. The tax and transfer scheme consists of a country-specific lump-sum transfer T_{jt}, which is rebated equally to all households, together with a proportional tax rate $\tau \geq 0$ on households' nominal labor income, which is constant across countries. National governments are the sole issuer of liquid assets, which are nominal bonds with real value B_{jt}. Each government's budget constraint, expressed in real terms, is given by:

$$B_{jt+1} + \tau \frac{W_{jt}}{P_{jt}} L_{jt} = (1 + r_{jt}) B_{jt} + T_{jt} \tag{10}$$

In steady state, we target debt-to-GDP levels $\frac{\overline{B}_j}{\overline{W}_j \overline{L}_j / \overline{P}_j}$ to be different across countries. In other words, countries enter the beginning of time with ex-ante heterogeneous levels of *legacy* public debt. This important feature is the only source of between-country heterogeneity and is a key focus of this paper.

Out of steady state, the government follows a fiscal rule that specifies the reaction of overall deficits to contemporaneous deviations from steady-state quantities:

$$B_{jt+1} - B_{jt} = -\gamma^L (L_{jt} - \overline{L}_j) - \gamma^B (B_{jt} - \overline{B}_j) \tag{11}$$

With $\gamma^L > 0$, which represents a counter-cyclical stabilization motive for the fiscal authority, and $\gamma^B > 0$, which in turn guarantees long-run stability of public debt.[7] This type of specification is standard in the literature on fiscal rules (Leeper, 1991, Bohn, 1998, Galí and Perotti, 2003, Auclert and Rognlie, 2018). In our exercises, we let transfers adjust endogenously along the transition path in order to always satisfy the government's budget constraint and the fiscal rule. Debt levels are stable for all countries: any changes in deficits and debt levels are entirely transitory, implying otherwise stable fiscal policy and the willingness of investors to hold government debt, thus satisfying the non-explosive rational expectations solution (Hall, 2014). In addition, we assume that national political-economy constraints prevent countries from changing taxes along the transition path.

[6] The assumptions that the union maximizes the welfare of the average household, as well as the uniform labor allocation rule, can be relaxed to more general cases.

[7] The parameter γ^B is needed to ensure the stationarity of our model. It does not materially affect any of our results.

Asset market There is a single union-wide asset market for bonds that pay a nominal risk-free rate i_t. Accordingly, the asset market needs to clear at the union level:

$$\int_0^1 P_{jt} B_{jt} d\mu(j) = \int_0^1 P_{jt} \int_0^1 b_{ijt} di \, d\mu(j) \tag{12}$$

(12) requires that, in equilibrium, nominal asset holdings by households across the whole union equal the total nominal amount of bonds issued by national governments across the union. In other words, our model features financial integration across member countries. Note that because of *within country* market incompleteness our HANK framework does not require stationarity-inducing tools to guarantee that asset holdings go back to steady state following a shock. As discussed in Ghironi (2006), with incomplete markets the steady state growth rate of consumption depends on aggregate asset holdings, which are thus uniquely pinned down in steady state. In other words, the stationarity of our model is guaranteed by the fact that market incompleteness gives rise to an upward sloping asset supply schedule at the country level.[8]

Monetary policy There is one central bank that sets the nominal interest rate in the union-wide market for nominal bonds. In our baseline exercise, monetary policy follows a standard Taylor Rule:

$$i_t = \bar{r} + \phi \pi_t + \varepsilon_t^i \tag{13}$$

where $\pi_t \equiv \int_0^1 \pi_{jt} d\mu(j)$ denotes union-wide price inflation,[9] i_t is the nominal interest rate, $\bar{r}$ is the steady-state real interest rate, and ε_t^i is a non-systematic monetary policy shock.

Demand and cost-push shocks We model demand shocks ε_t^m as exogenous disturbances to the discount factor of households, and cost-push shocks ε_t^u as additive shifters in the wage Phillips curve. All shocks are *symmetric*, i.e. hitting all countries belonging to the monetary union homogeneously.

2.2 Equilibrium

Given initial regional distributions $\{G_{j0}(b,e)\}_j$ over bonds b and idiosyncratic labor productivity e, and given exogenous paths of monetary, demand, and cost-push shocks $\{\varepsilon_t^i,$

[8] Notice that this would not be true in a two agent New Keynesian (TANK) model. This is one of the reason why we adopt a fully fledged HANK framework as our baseline.

[9] In particular, $\pi_{jt} \equiv \frac{P_{jt} - P_{jt-1}}{P_{jt-1}}$.

$\varepsilon_t^m, \varepsilon_t^u\}_t$, an equilibrium is defined as a set of national sequences $\{B_{jt}, T_{jt}, c_{jt}, c_{jt}^{NT}, c_{jt}^T, L_{jt}, L_{jt}^{NT}, L_{jt}^T, P_{jt}, P_{jt}^{NT}, P_{jt}^T, \pi_{jt}, \pi_{jt}^{NT}, \pi_{jt}^T, r_{jt}\}_{jt}$, union-wide nominal interest rates $\{i_t\}_t$, individual allocation rules $\{c_{jt}(b,e), b_{jt+1}(b,e)\}_{jt}$, and joint distributions over assets and productivity levels $\{G_{jt}(b,e)\}_{jt}$, such that households, unions, and firms in all countries optimize, governments' budget constraints and fiscal rules are satisfied, the Taylor rule and the Fisher equation hold, and all markets clear:

$$L_{jt}^{NT} = c_{jt}^{NT} \quad \text{for all } j \tag{14}$$

$$L_{jt}^{T} = \int_0^1 c_{j't}^{T}(j) d\mu(j') \quad \text{for all } j \tag{15}$$

$$\int_0^1 P_{jt} B_{jt} d\mu(j) = \int_0^1 P_{jt} \int_0^1 b_{ijt} di \, d\mu(j) \tag{16}$$

Equation (14) is the market clearing condition for the non-tradable goods market. It requires that in every country local demand for non tradable goods equal local supply. Similary, (15) is the market clearing condition for tradable goods. It states that the total amount of tradables produced in a given country j must equal total union-wide demand for that particular variety of good. Finally, (16) is the market clearing condition for the union-wide asset market that we discussed above.

2.3 Sequence Space Representation

We cast our model in the sequence space domain and study transition dynamics of perfect-foresight responses to zero-probability "MIT shocks" (Mankiw and Reis, 2006, Boppart et al., 2018, Auclert et al., 2021a). Throughout the rest of our analysis, we express all sequences in log-deviations from steady state.[10] We can express idiosyncratic household-level real income as a function of aggregate country-level quantities only. In particular we have: $z_{ijt} e_{ijt} = \frac{W_{jt} L_{jt}}{P_{jt}} e_{jit}$. Substituting this expression into the household's budget constraint shows how the path of policy functions $\{c_{jt}(b,e), b_{jt+1}(b,e)\}_{t\geq 0}$ is entirely pinned down by the sequence of aggregate real non-interest income $\left\{\frac{W_{jt}}{P_{jt}} L_{jt}\right\}_{t\geq 0} \equiv \{Z_{jt}\}_{t\geq 0}$, together with the sequence of the real interest rate $\{r_{jt}\}_{t\geq 0}$ and lump-sum transfers $\{T_{jt}\}_{t\geq 0}$.We can then integrate over the states (b,e) to write aggregate consumption in country j at time

[10] In particular, for a generic variable X_{jt}, we denote by $d\boldsymbol{X}_j$ the full sequence of log-deviations of the variable X_{jt} from its steady-state value, i.e., $d\boldsymbol{X}_j \equiv \left(\frac{X_{j0} - X_j}{X_j}, \frac{X_{j1} - X_j}{X_j}, \dots\right)'$. For real interest rates r_{jt}, we adopt a slightly different notation and let $d\boldsymbol{r}_j \equiv (\frac{r_{j0} - r}{1+r}, \frac{r_{j1} - r}{1+r}, \dots)'$.

t as a function of the sequences of real income, rates, and transfers only:

$$\int c_{jt}(b,e)dG_{jt}(b,e) = \mathcal{C}_t\left(\left\{Z_{js}\right\}_{s\geq 0}, \left\{r_s\right\}_{s\geq 0}, \left\{T_{js}\right\}_{s\geq 0}\right) \tag{17}$$

Following Auclert et al. (2024), we denote the Jacobian of $\mathcal{C}_t(\cdot)$ with respect to aggregate real labor income $\boldsymbol{Z}_j \equiv (Z_{j0}, Z_{j1}, \dots)'$ by $\boldsymbol{M}$, which is a matrix whose element (t,s) is given by $\frac{\partial \ln \mathcal{C}_t(\cdot)}{\partial \ln Z_{js}}$. Similarly, we denote by $\boldsymbol{M}^r$ the matrix of elasticities of $\mathcal{C}_t(\cdot)$ with respect to the interest rate sequence $\boldsymbol{r} \equiv (r_0, r_1, \dots)'$, that is $(\boldsymbol{M}^r)_{t,s} \equiv \frac{\partial \ln \mathcal{C}_t(\cdot)}{\partial \ln(1+r_s)}$. This Jacobian is going to capture both the *intertemporal substitution* motives induced by changes in interest rates, as well as *wealth effects* on households' consumption due to non-zero positions in net foreign assets. Finally, $\boldsymbol{M}^t$ is the Jacobian with respect to lump-sum transfers, $\left(\boldsymbol{M}^t\right)_{t,s} \equiv \frac{\partial \ln \mathcal{C}_t(\cdot)}{\partial \ln T_{js}}$. Together, these Jacobians summarize all country-level transition dynamics.

Sufficient statistics for openness On top of the sequence-space Jacobians defined above, another object that is going to be at the core of our analysis is the non-tradable share of labor income, which we denote by ρ.

Definition 1 (ρ)**.** *We define ρ as country j's non-tradable share of the wage bill in the steady state. Formally:*

$$\rho = \frac{\overline{L}_j^{NT}\overline{W}_j^{NT}}{\overline{L}_j\overline{W}_j}$$

Since it represents the share of non-tradable labor income, ρ is naturally bounded between 0 and 1 and gauges the extent to which country j is exposed to fluctuations in the non-tradable sector, as opposed to fluctuations in the tradable one. The following Lemma highlights the role of ρ as a sufficient statistic to capture the partial equilibrium (i.e., holding wages fixed) transmission of consumption to real labor income:

Lemma 1. *Consider a zero-measure country j. Then, ρ is equal to the partial equilibrium elasticity of real labor income to consumption:*

$$\frac{\partial \log Z_{jt}}{\partial \log C_{jt}} = \rho$$

Proof. See Appendix A.2. □

Note that this result only relies on the homotheticity of the consumption and labor aggregators, and does not rest on the specific CES forms we imposed. Lemma 1 shows how accounting for the presence of non-tradable goods is crucial to connect the local consumption and income responses following an aggregate shock.[11]

3 Heterogeneous Transmission of Monetary Policy

In this section we analyze how ex-ante differences in legacy public debt affect the transmission of monetary policy across members of a monetary union. First, we describe analytically the channels that drive the heterogeneous effects of monetary policy in our framework. Next, we solve our model quantitatively in order to inspect the mechanism in greater detail. We emphasize how the redistribution between high and low public debt countries, induced by interest rate changes, matters for the heterogeneous transmission of monetary policy.

3.1 Analytical Decomposition

When countries differ in their levels of public debt, monetary policy affects governments' fiscal space differently through its impact on debt servicing costs. This can be seen by combining (10) with (11):

$$D_{jt} = \underbrace{-\gamma^L(L_{jt} - \bar{L}_j) - \gamma^B(B_{jt} - \bar{B}_j)}_{\text{Fiscal rule}} \quad - \quad \underbrace{r_{jt}B_{jt}}_{\text{Debt servic. costs}} \tag{18}$$

where $D_{jt} \equiv \tau \frac{W_{jt}}{P_{jt}} L_{jt} - T_{jt}$ denotes primary deficits. High levels of legacy public debt result in a larger exposure of the government's budget to monetary policy via debt servicing costs.[12] Thus, high-debt countries cannot engage in counter-cyclical fiscal policy as much as low-debt ones when the central bank raises the common interest rate. Following a contractionary monetary policy shock, primary deficits – and hence, transfers to households – respond differently across member states. A key result of this paper is that the presence of a non-tradable sector and of households with realistic marginal propensities to consume (MPCs) implies that the country-level response to a shock is shaped by a *National Keynesian Cross* (NKC) multiplier (Bellifemine et al., 2023a). Because of the heterogeneous responses of local public deficits and transfers, this multiplier gets activated differentially across the member states, resulting in the heterogeneous transmission of the monetary

[11] An alternative approach to achieving a similar result is to introduce home bias in households' preferences.

[12] Note that, because of the presence of uninsured idiosyncratic risk, in our framework it holds that $r < g$ in the calibrated steady state. Thus, governments run primary deficits in the stationary equilibrium.

policy impulse across the union.

To see this more clearly, let us focus for simplicity on a zero measure, atomistic country j.[13] Then, taking a first-order approximation of (17) around the balanced-trade steady state we can derive the following characterization of the consumption response in country j to a union-wide monetary policy shock:[14]

$$\begin{aligned} \widehat{\boldsymbol{c}}_j = & \underbrace{\boldsymbol{M}^r\widehat{\boldsymbol{r}}_j}_{\text{Direct effect}} + \underbrace{\boldsymbol{M}^t\widehat{\boldsymbol{t}}_j}_{\text{Fiscal reaction}} + \underbrace{\rho\boldsymbol{M}\widehat{\boldsymbol{c}}_j}_{\text{Multiplier}} \\ & + \underbrace{(1-\rho)\boldsymbol{M}\widehat{\boldsymbol{c}}^T}_{\text{Foreign demand}} + \underbrace{\boldsymbol{M}\widehat{\boldsymbol{w}}_j}_{\text{Real wage}} - \underbrace{\nu\boldsymbol{M}\left(\rho\widehat{\boldsymbol{w}}_j^{NT} - (1-\rho)\widehat{\boldsymbol{s}}_j\right)}_{\text{Expenditure switching}} \end{aligned} \tag{19}$$

Where $\widehat{\boldsymbol{s}}_j \equiv \widehat{\boldsymbol{p}}^T - \widehat{\boldsymbol{w}}_j^T$ denotes the relative price of imports over exports, i.e., the terms of trade. Equation (19) provides an intuitive decomposition of the total consumption response $\widehat{\boldsymbol{c}}_j$ to the real interest rate impulse $\widehat{\boldsymbol{r}}_j$. As usual, there is the *direct effect*, or the *intertemporal substitution channel* of monetary policy, which is the initial impulse shaping the consumption response.

The initial impulse, which is common for all countries, propagates heterogeneously across the union because of the second term in (19), which is at the core of this paper. It captures the role of the fiscal response, and in particular changes in lump-sum transfers $\widehat{\boldsymbol{t}}_j$, for the transmission of monetary policy. Because Ricardian equivalence fails in our framework, government transfers can affect aggregate demand and the entries in the matrix $\boldsymbol{M}^t$ are in general different from zero. Thus, the fiscal reaction channel acts to dampen the consumption response to monetary shocks whenever fiscal policy is countercyclical, i.e., $\gamma^L > 0$. Moreover, as Equation (18) shows, this dampening effect is decreasing in the level of legacy public debt, because of the debt servicing channel discussed above. Following a monetary contraction, debt servicing costs will crowd out fiscal space more in high public debt countries than in low public debt ones. Because of this, primary deficits in high-debt countries will behave less counter-cyclically and consumption will be more responsive. Thus, the heterogeneous fiscal response induced by differences in the levels of steady-state public debt generates heterogeneity in the transmission of monetary policy to real activity across member countries of the union, a central result in our paper.

Next, we have the aforementioned national multiplier term. The NKC multiplier captures indirect, second-round effects of the transmission mechanism. In particular, it cap-

[13]This simplifies the analysis as it shuts down feedback effects of the consumption response in country j on the union-wide response.

[14]See Appendix A.3 for details on the derivation.

tures the idea that the consumption response induced by the initial impulse generates a change in disposable income which in turn yields a further consumption response, and so on. Two objects shape the NKC multiplier term: the iMPC matrix $\boldsymbol{M}$, determining the pass-through from disposable income to consumption, and the share of non-tradable income ρ, which captures the exposure of country j to local economic conditions.

Finally, the last three terms in (19) are standard. They represent (i) the effect of the response of union-wide demand for tradables on local income and hence on the local consumption response, (ii) a real wage channel as in Auclert et al. (2021b), and (iii) an expenditure-switching term capturing the fact that changes in relative prices induce substitution for local households between non-tradable and tradable goods, and for foreign households among different varieties of tradable goods.

Note that because it generates different responses of real economic activity across member countries, public debt matters for the response of nominal variables as well. In particular, local price inflation is going to respond more to interest rate impulses precisely in the countries where consumption reacts by more. This can be seen from our derived Phillips Curve relationship below:[15]

$$\boldsymbol{\pi}_j = \rho \boldsymbol{K} \left[(\sigma + \rho\varphi)\widehat{\boldsymbol{c}}_j + \varphi \left((1-\rho)\widehat{\boldsymbol{c}}^T - \nu\rho\widehat{\boldsymbol{w}}_j^{NT} + \nu(1-\rho)\widehat{\boldsymbol{s}}_j \right) - \widehat{\boldsymbol{w}}_j \right] + (1-\rho)\boldsymbol{\pi}^T \quad (20)$$

In particular, countries where consumption is more responsive to monetary policy will also experience a larger inflation response, via households' labor supply in the non-tradable sector. Moreover, the dispersion in local inflation responses will be larger as the share of non-tradable labor income ρ increases, since union-wide tradable goods act to equalize inflation across member countries.

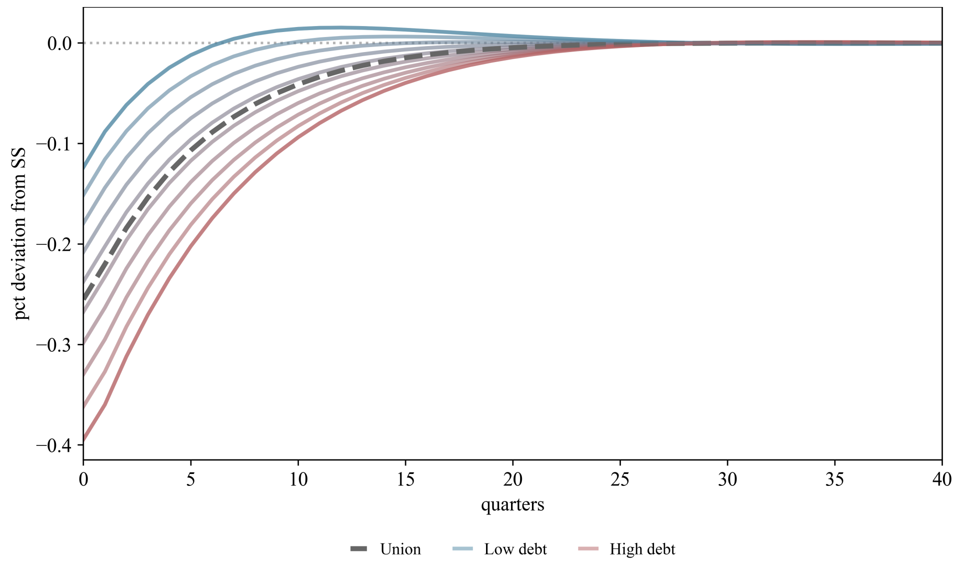
Overall, Equations (18) to (20) showcase the implications that differences in legacy public debt have for the transmission of monetary policy to both real and nominal economic variables across members of a monetary union.

3.2 Quantitative Illustration

Before proceeding with a precise calibration, we demonstrate how our model can generate heterogeneous country-level responses to a monetary policy impulse. To this end, we solve the model for a monetary union that consists of ten hypothetical countries, each with a different ex-ante level of steady-state debt. For illustrative purposes, we choose debt-to-GDP ratios that range from from 8% to 180%. These numbers loosely correspond to the highest and lowest levels of sovereign debt that are observed among euro area mem-

[15] Appendix A.1 provides details on the derivation of (20).

Figure 2: Heterogeneous Consumption Responses to Monetary Policy Shocks



Note: consumption responses to a shock that increases the interest rate i_t by 1 p.p. (annualized) on impact, with quarterly persistence of 0.85.

bers. Figure 2 demonstrates rich heterogeneity in the national aggregate consumption responses to a 1 p.p. annualized interest rate shock. The consumption response to this union-wide shock ranges from 7 to 27 basis points among member countries. The pecking order of responses lines up monotonically with the degree of national fiscal space: high-debt (low-debt) countries are more (less) responsive to the same shock. The following sections delve deeper into the mechanisms behind this result.

3.3 Calibration to Core and Periphery of the Euro Area

We calibrate our model to the quarterly frequency. Table 1 reports our parameterization choices. Importantly, we calibrate the fiscal rules based on the results in Galí and Perotti (2003) in the case of euro area countries.[16] For the remainder of the paper, we study the special case of a two-countries union, with the two members differing only in their steady-state debt-to-GDP ratios. Our approach loosely corresponds to the "core-periphery" divergence commonly referenced in the euro area context. [17] More precisely, the two coun-

[16] Our parameter γ^L is meant to capture both the discretionary and the automatic response of government deficits to employment fluctuations. We thus set it to 1, which corresponds to the sum of the estimates for discretionary and non-discretionary deficits in Galí and Perotti (2003).

[17] The core and periphery duality arises naturally in currency areas. The type of country that stands to gain more from relinquishing its own currency is a small open economy (SOE) that trades heavily with a larger partner, has a history of high inflation, and/or exhibits a high business cycle correlation with that same partner. Once the union is adopted, the SOE becomes the "periphery" and the larger partner becomes the "core" (Alesina and Barro, 2002).

Table 1: Model Parametrization

Parameter	Description	Value	Comment
β	Discount factor	0.98	Standard
σ	Inverse IES	1	Standard
φ	Frisch Elasticity	1	Chetty et al. (2011)
ω	Preference for non-trad. consumption	0.66	Hazell et al. (2022)
α	Preference for non-trad. labor supply	0.66	Hazell et al. (2022)
ν	Cons. elasticity of subs. btw sectors	1.5	Hazell et al. (2022)
ψ	Elasticity of subs. btw tradables	1.5	Equal to ν for exposition
η	Labor elasticity of subs. btw sectors	0.45	Berger et al. (2022)
ρ_e	Pers. of log-productivity process	0.92	Auclert et al. (2021b)
σ_e	Std. of log-productivity process	0.6	Auclert et al. (2021b)
$\underline{b}$	Borrowing limit	0	Standard
μ	Union market power	21	Schmitt-Grohé and Uribe (2005)
θ	Wage rigidity	210	Target 0.1 slope of wage NKPC
τ	Income tax rate	30%	Eurozone average
$\bar{B}_1/\bar{Y}_1$	Debt-to-GDP ratio in country 1	134%	Italy, 2019 (source: AMECO)
$\bar{B}_2/\bar{Y}_2$	Debt-to-GDP ratio in country 2	60%	Germany, 2019 (source: AMECO)
γ^L	Response of deficits to L	1	Galí and Perotti (2003)
γ^B	Response of deficits to debt	0.07	Galí and Perotti (2003)

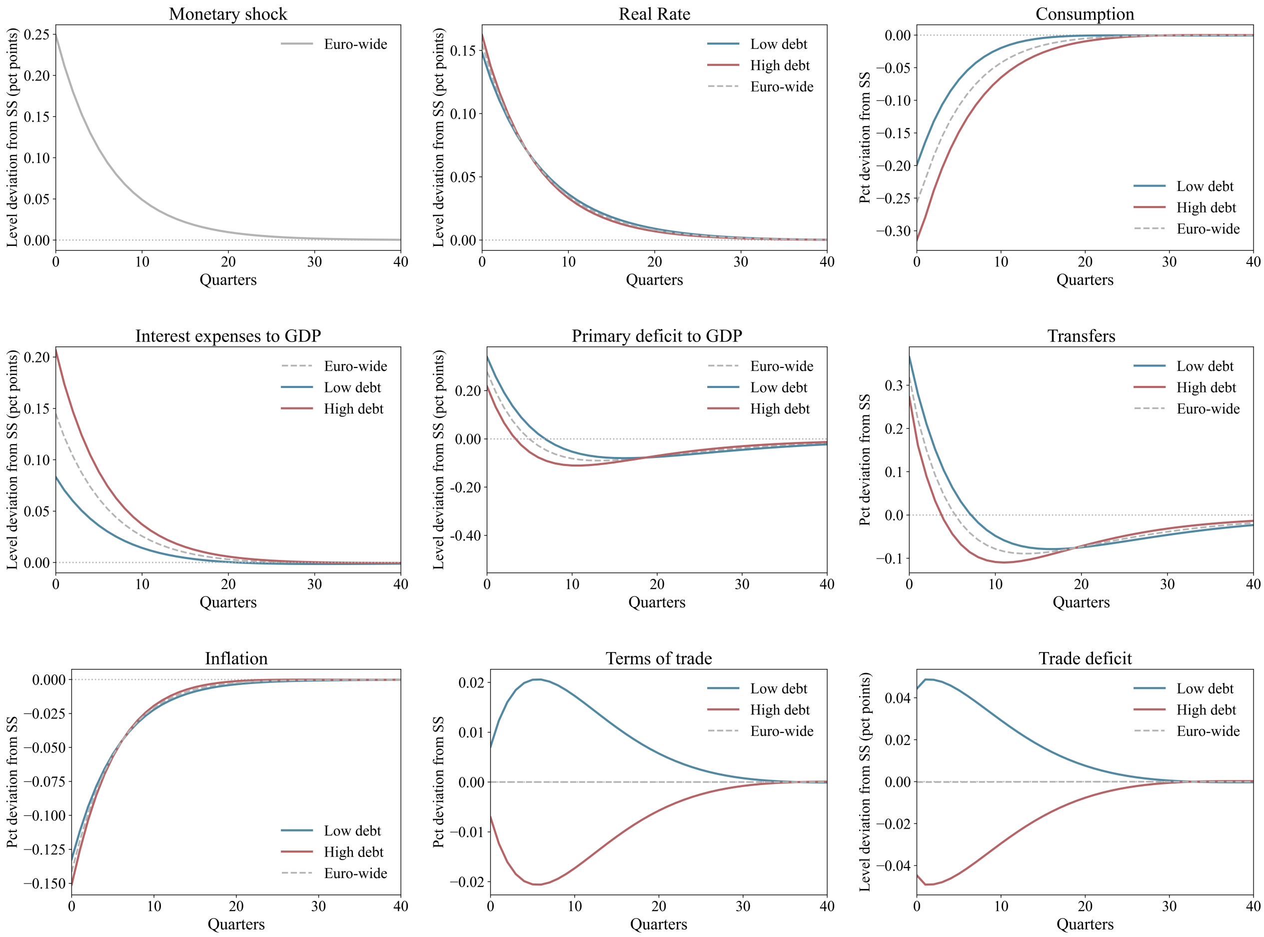
tries share exactly the same parameters, with the exception of the level of steady-state lump-sum transfers to households, which we vary in order to match our chosen debt-to-GDP calibration targets. For illustration purposes, we calibrate the two countries to the debt-to-GDP ratios of Italy and Germany as of 2019: 134% and 60%, respectively.

For the remaining parameters, we assign standard values and rely on the existing literature. The discount factor β is 0.98. The inverse intertemporal elasticity of substitution (IES) and the Frisch labor supply elasticity are both equal to unity following Kaplan et al. (2018). We parametrize the triad of substitution elasticities $\{\omega, \alpha, \nu\}$ following Hazell et al. (2022) and impose the restriction that $\psi = \nu$ for expository reasons. The elasticity of labor susbstitution across sectors is set at 0.45 following Berger et al. (2021). Parameters that govern the idiosyncratic log-productivity process $\{\rho_e, \sigma_e\}$ are set to standard values following Auclert et al. (2021b). We target a slope of the Phillips Curve of 0.1 as is standard in the literature (Kaplan et al., 2018) and set $\theta = 210$ accordingly. Finally, following Schmitt-Grohé and Uribe (2005), we assume that the union market power parameter μ is equal to 21.

3.4 Quantitative Inspection of the Mechanism

The discussion of equation (19) provided some important analytical insights on the main channels via which heterogeneity in the level of public debt can affect the transmission of

Figure 3: Heterogeneous Effects of ECB Monetary Policy Shocks



Note: responses to a shock that increases i_t by 1 p.p. (annualized) on impact, with quarterly persistence of 0.85. Debt servicing costs and primary deficits are

monetary policy across countries within a monetary union. We now study these effects quantitatively in the properly calibrated version of our model that we solve numerically. We consider a contractionary monetary policy shock that increases the nominal interest rate by 1% on impact with a quarterly persistence of 0.85, as depicted in the first panel of Figure 3.

Figure 3 reports the results. We observe that via the counter-cyclical fiscal rule, primary deficits and transfers increase in both countries following the shock. However, because of the debt servicing cost channel discussed above, the high-debt country is more exposed to interest rates changes and experiences a larger increase in interest expenses. Thus, it has less space to engage in counter-cyclical fiscal policy following the interest rate hike, with primary deficits and transfers responding by less. Since our framework features realistic within-country distributions of MPCs and a failure of Ricardian equivalence, this implies that consumption is more responsive in the high-debt country than in the low-debt one. Via the Phillips Curve relationship, inflation is then more responsive in the high-debt country as well. This greater deflation, in turn, makes real public debt balances in the high-debt country even larger. As a result, this puts further pressure on the government's budget as the real interest rate increases by more in the country whose public sector is more exposed to it.

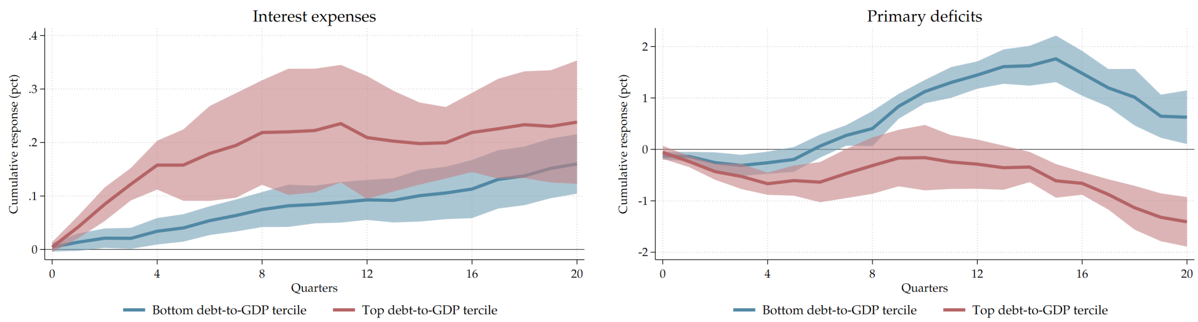
The heterogeneous consumption and inflation responses across the two countries also have implications for international competitiveness and trade flows. In particular, the high (low) debt country experiences a reduction (increase) in its terms of trade, thus making its exports more (less) competitive. As a result, final goods are going to flow from the high- to the low-debt country, and trade deficits in the low-debt country increase.

These results can also be interpreted in light of *between-countries* redistribution that monetary policy induces in our framework. This is similar to the between-households redistributive effects of monetary policy in standard closed-economy settings (Kaplan et al., 2018, Auclert, 2019). The high public-debt country is a net borrower overall (i.e., after consolidating the private and public sectors), with the low-debt country being a net saver. Thus, when interest rates increase, resources are redistributed away from the high-debt region and towards the low-debt one. As a result, consumption in the high-debt country needs to go down by more, while households in the low-debt country experience a consumption contraction that is more mild. This showcases how monetary policy in a heterogeneous monetary union can have large redistributive consequences. Moreover, these effects are going to be larger the more active monetary policy is in moving the interest rate. We further expand on the trade-offs associated with this cross-country redistribution channel in the next sections.

3.5 Testing the Mechanism in the Data

We now to turn to testing our theoretical mechanism in the data. In particular, our model predicts that the differential response to an increase in the interest rate is driven by (i) high public-debt countries experiencing a larger increase in debt servicing costs and, as a result, (ii) having to run tighter fiscal deficits at some point in time, in order to satisfy their intertemporal budget constraint. We test these two predictions by splitting the 20 eurozone countries into three groups based on debt-to-GDP terciles. Next, we run the following Jordà (2005)-style panel local projection separately for countries in the first and

Figure 4: Testing the Mechanism in the Data



Note: estimates for $\hat{\beta}^q_h$ from (21) in response to a contractionary monetary policy shock raising the EONIA rate by 1 percentage point. Shaded areas represent 90% confidence intervals. Standard errors are clustered at the country level.

third terciles[18]:

$$\Delta Y_{jt+h} = \alpha_{jh} + \beta^q_h \times i_t + \sum_{\ell=1}^{4} \Gamma^q_{\ell h} \boldsymbol{Z}_{t-\ell} + \sum_{\ell=1}^{4} \gamma^q_{\ell h} \Delta Y_{jt-\ell} + u_{jth} \tag{21}$$

Where Y_{jt} is our variable of interest – either the interest expenses to GDP ratio or the primary deficits to GDP ratio – in country j period t, $\Delta Y_{jt+h} \equiv \frac{Y_{jt+h}-Y_{jt-1}}{Y_{jt-1}}$ represents the cumulative change h quarters ahead,[19] α_{jh} is a country fixed effect, i_t is the EONIA interest rate, which we instrument with the ECB monetary policy shocks constructed in Almgren et al. (2022), $\boldsymbol{Z}_t$ is a vector of euro-wide variables which includes the EONIA rate, the eurozone industrial production index and the euro area CPI.[20] Finally, because we run the regression separately for different debt-to-GDP terciles, all coefficients are indexed by q, which denotes the debt-to-GDP tercile that country j belongs to. We weigh our regressions by population and cluster standard errors at the country level.

Figure 4 plots the estimates from (21). The left panel shows that, following a 1 percentage point increase in the nominal interest rate, eurozone countries that belong to the top tercile of the debt-to-GDP distribution experience a larger rise in debt servicing costs as a share of output. Interest expenses go up by more simply because high public-debt countries have a larger stock of debt to begin with, so they are more exposed to interest rate changes. This, combined with the fact that governments need to respect an intertemporal budget constraint, implies tha high-debt countries need to run smaller *primary* deficits at some point in time in order to make up for the larger debt servicing costs. This is depicted

[18]See Jordà and Taylor (2024) for an excellent review of the literature on local projections.

[19]Similarly, $\Delta Y_{jt-\ell} = \frac{Y_{jt-1}-Y_{jt-\ell}}{Y_{jt-\ell}}$ denotes lagged cumulative changes in Y.

[20]See Appendix A.4 for details on data construction.

clearly in the right panel of Figure 4. Following the interest rate hike, high public-debt countries slightly *decrease* their primary deficit, while low public-debt countries mildly *increase* it. Overall, these two empirical patterns are entirely consistent with the corresponding impulse responses from our model, which can be seen in the left and center panels in the middle row of Figure 3, thus lending further credibility to the model mechanisms.

4 Stabilization-Synchronization Trade-off

In this section, we explore how the central bank's concerns for inflation stability, captured by the Taylor coefficient ϕ, impact the ergodic volatility and synchronization of key economic aggregates across countries, specifically inflation and consumption. For illustration purposes, in this section we focus on demand shocks.[21] All shocks in our paper are union-wide symmetric.

4.1 Hawk vs Dove Central Bank

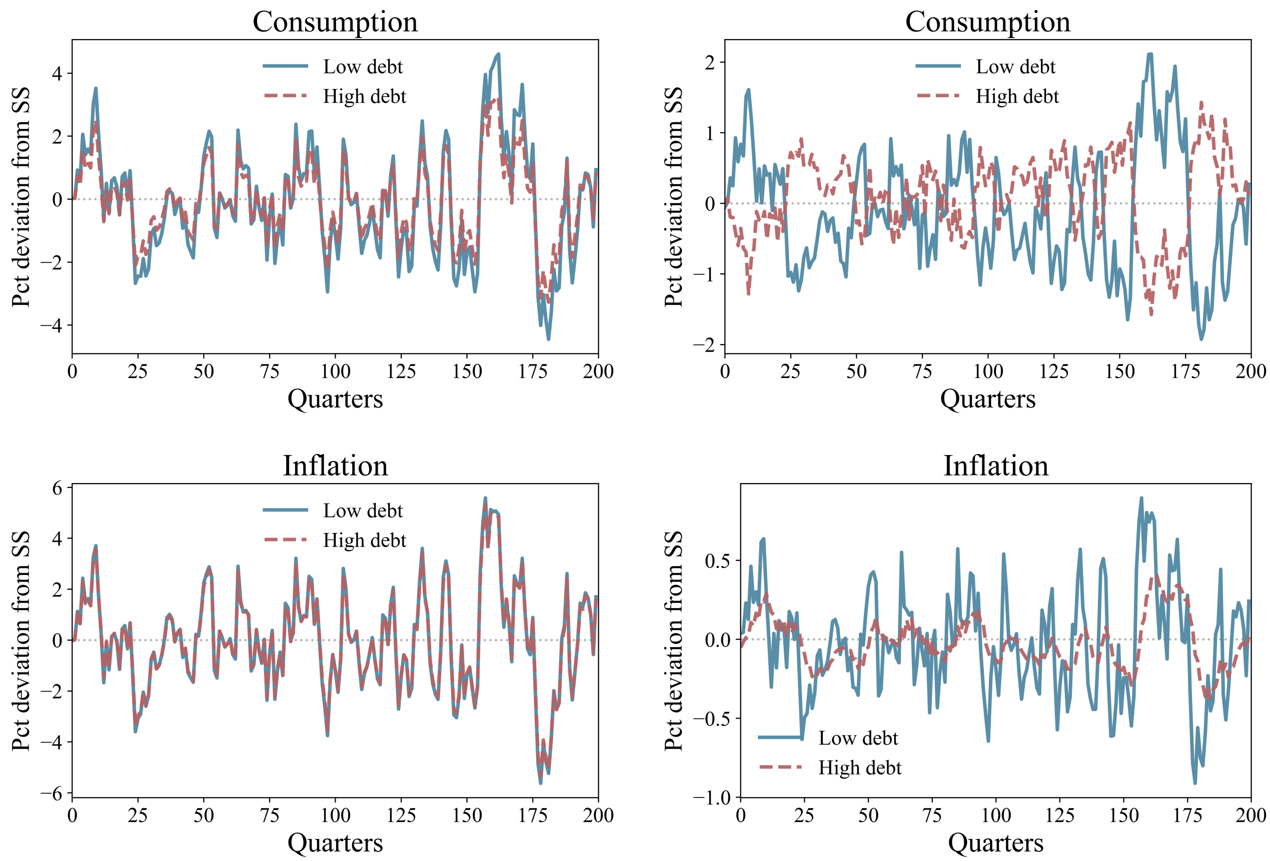
To illustrate the stabilization-synchronization trade-off that arises within our framework, we consider the ergodic behavior of consumption and inflation under a dovish central bank ($\phi = 1.01$) and a hawkish one ($\phi = 7$). This comparison is visually represented in Figure 5, which shows model simulations for consumption and inflation under different monetary stances. The Figure consists of four panels: the top-left and bottom-left panels depict consumption and inflation under the dovish stance; the top-right and bottom-right panels, instead, depict consumption and inflation dynamics under the hawkish stance. Every panel presents the time series for the high-debt and the low-debt country conditional on the monetary regime.

A dovish central bank, which does not respond aggressively to inflation, allows demand shocks to pass through to inflation without substantially moving its policy tool, the nominal interest rate. Consequently, the heterogeneous transmission of monetary policy, as described in the previous section, is less salient, resulting in inflation and consumption moving in tandem in both low- and high-debt countries. This is why the time-series dynamics are highly synchronized in the two left panels of Figure 5.

Conversely, when the central bank prioritizes inflation stabilization, the nominal interest rate becomes highly responsive to inflation via the Taylor rule. Due to the heterogeneous transmission of monetary policy across members of the monetary union, a central bank aiming to stabilize *average* inflation across the eurozone is going to de-synchronize

[21] In Appendix A.5 we reproduce our results for the case of supply shocks.

Figure 5: Ergodic Behavior of the Economy under Different Monetary Stances

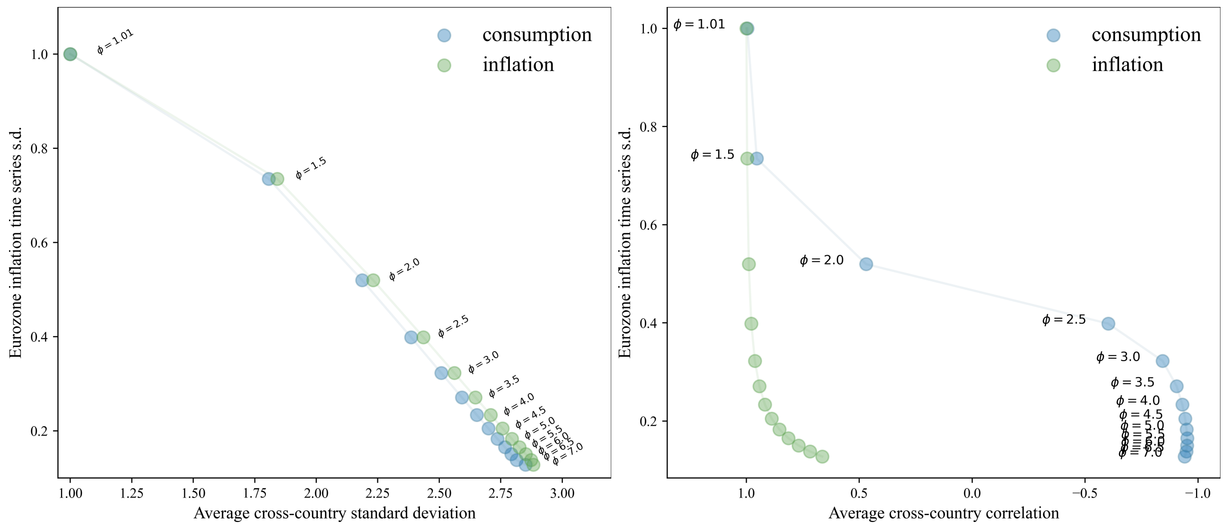


Dove, $\phi = 1.01$ | Hawk, $\phi = 7$

Note: simulations for consumption and inflation under different Taylor coefficients and aggregate demand shocks.

consumption patterns between countries as a byproduct of its price stabilization efforts. Specifically, when the stance of the central bank is hawkish enough, consumption in the high-debt country *decreases* in response to a *positive* demand shock. This is because the hike in interest rates to stabilize inflation induces a large increase in debt servicing costs in the high-debt country and a fiscal contraction. This phenomenon is depicted in the top-right and bottom-right panels of Figure 5. As the ECB's monetary stance becomes more aggressive, cross-country dispersion in consumption and inflation responses increases, while the correlation decreases. This dynamic gives rise to what we call a "stabilization-synchronization trade-off". As the monetary authority attempts to stabilize price fluctuations, economic activity across member countries gets de-synchronized.

Figure 6: Stabilization-Synchronization Possibility Frontier



Note: We normalize all standard deviation measures to unity for the smallest Taylor coefficient ($\phi = 1.01$). The correlation measures are not normalized.

4.2 Stabilization-Synchronization Possibility Frontier

To further crystallize the central banker's trade-off between stabilizing union-wide inflation and synchronizing business cycles across member states, we plot in Figure 6 what we call the stabilization-synchronization *possibility frontier*.[22] This frontier illustrates the attainable set of union-wide inflation time-series volatility (y-axis) and cross-country synchronization (x-axis), traced out as we vary the Taylor coefficient on inflation ϕ. The frontiers are plotted for four types of synchronization measures: average cross-country standard deviations and correlations, one each for consumption and inflation. The left panel of Figure 6 shows the relationship between the standard deviation (over time) of eurozone inflation and the cross-country standard deviation of consumption and inflation (averaged across time periods). Each point on the curve represents a different value of the Taylor coefficient ϕ, ranging from 1.01 (dovish) up to 7 (hawkish). The right panel depicts the same standard deviation for eurozone inflation against cross-country *correlations* of consumption and inflation. We normalize the standard deviation measures to unity for the most dovish Taylor coefficient ($\phi = 1.01$). Correlation measures are not normalized.

We find the stabilization-synchronization trade-off to be quantitatively large. Varying the Taylor coefficient to reduce average inflation volatility by 50% (starting from a dovish central bank with a Taylor coefficient of 1.01) results in a *two-fold* increase in the cross-country standard deviation of both consumption and inflation. Similarly, the same change

[22]The figure plots the frontiers for demand shocks. See Figure A.1 in Appendix A.5 for the frontier in the case of supply shocks.

in the Taylor coefficient halves the cross-country correlation in consumption, while having a muted effect on the cross-country inflation correlation.[23] For sufficiently large Taylor coefficients, the consumption correlation can even turn negative. This is because stabilizing inflation in response to demand shocks also involves stabilizing Euro-wide consumption. However, since countries respond differently to interest rate changes, in order for the *average* response to a positive demand shock to be zero, one country needs to experience a negative consumption response.[24]

In summary, these stabilization-synchronization possibility frontiers suggest a potentially significant trade-off faced by monetary policy between stabilizing average union-wide price levels and synchronizing business cycles across member countries. In the context of the euro area, this suggests that fiscal coordination and integration of some sort is potentially desirable, a point we now turn to in the next section.

5 Policy Experiments

In this section we analyze three policy proposals that have been put forth in the context of monetary unions generally and the euro area more specifically. We will pay special attention to how these proposals impact the trade-off between economic stabilization and cross-country synchronization faced by the central bank. We begin by studying deficit caps, which have been proposed and implemented in practice, for example, in the context of the EU "Stability and Growth Pact".[25] We then consider the case of fiscal unions and full-blown political unions. We characterize conditions under which they can help synchronize fluctuations across member states. Finally, we introduce cross-country consumption inequality concerns into an otherwise traditional Taylor rule and study the impact of synchronization-conscious central bank on the union's economy.

5.1 Deficit Caps

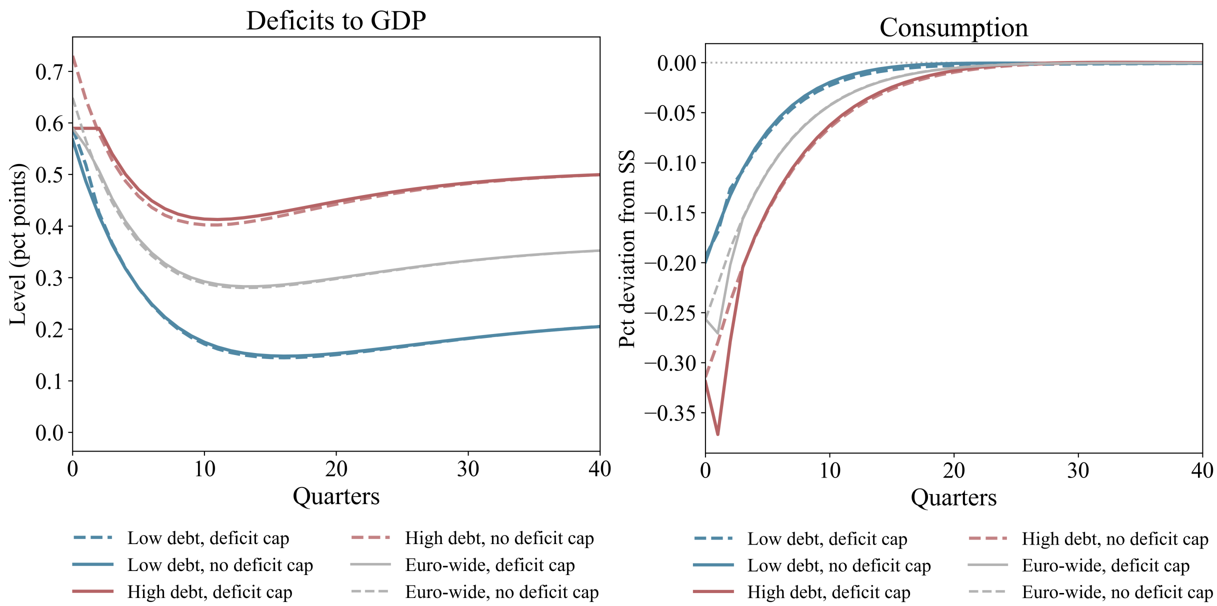
We begin by studying the consequences of introducing hard ceilings on deficit-to-GDP ratios. Public deficit caps have been present since the early days of the European Union, first introduced with the 1992 Maastricht Treaty and then further developed as part of the 1997 Stability and Growth Pact and the 2013 Fiscal Compact. In recent years, the EU has

[23]The small effect on inflation correlation is due to the presence of tradable goods, which imposes a lower bound on the correlation of inflation across countries.

[24]In Figures A.3 and A.4 of Appendix A.5 we provide an alternative visualization of the stabilization-synchronization trade-off. As ϕ increases, we generally see that cross-country correlations in consumption and inflation dynamics fall while cross-country standard deviations rise.

[25]See, among others, Galí and Perotti (2003) for a description of the Stability and Growth Pact.

Figure 7: The Role of Deficit Caps



Note: responses with and without a deficit cap to a shock that increases i_t by 1 p.p. (annualized) on impact, with quarterly persistence of 0.85.

been strongly considering a further reform to its fiscal rules.[26] In our model experiment, we implement the cap such that it does not bind for either country in the steady state but can bind along the transition path following exogenous shocks. We then look at the consumption response to the same contractionary monetary shock as we considered in Figure 3, in cases with and without the deficit cap.

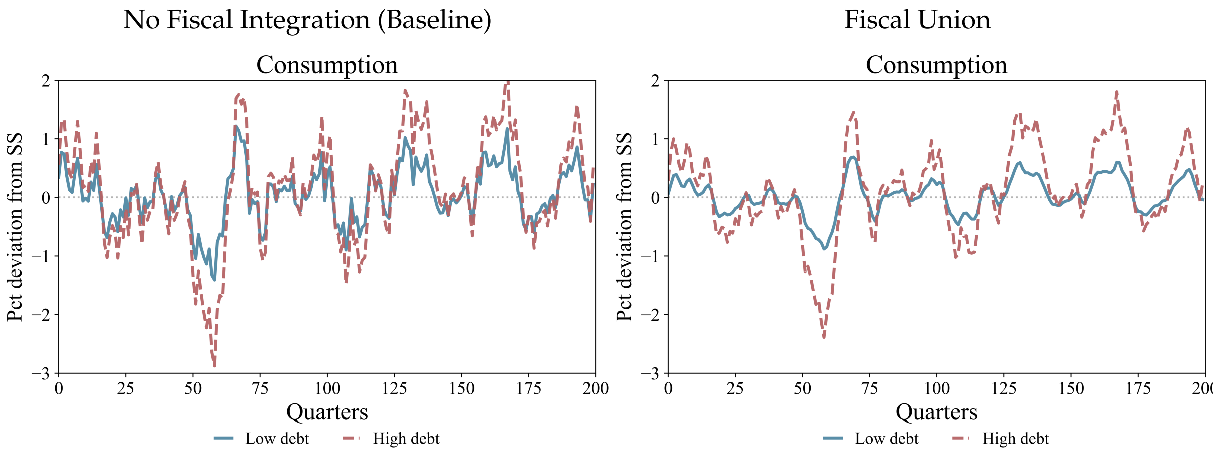
Figure 7 shows the results from this quantitative exercise. We observe that relative to the frictionless baseline, deficit caps *amplify* the dispersion in the consumption response across the two countries. This can be clearly seen from the right panel of the Figure. Aggregate consumption of the high-debt (low-debt) country falls by more (less). Thus, in spite of enhanced debt sustainability the union-wide introduction of the deficit cap has unequal, potentially unintended consequences on cross-country consumption inequality.

The intuition is rather simple. The high-debt country runs larger deficits to begin with, because of higher debt servicing costs.[27] Accordingly, following the monetary contraction, it is the high-debt country which is more likely to hit the deficit cap. Once the constraint begins to bind, differences in the counter-cyclicality of fiscal policies across the two countries become even bigger, resulting in larger disparity in the responses to the same shock. Thus, while being silent on the effectiveness of deficit caps in achieving convergence in

[26]See a February, 2024 press release from the Council of the EU here.

[27]Note that in the Stability and Growth Pact deficit caps apply to *overall* deficits, not primary deficits. This is in line with our exercise.

Figure 8: The Role of Fiscal Unions



Note: simulations are driven only by demand shocks.

the *level* of public debt across countries, our exercise suggests that they can be a driver of desynchronization during transitions following aggregate shocks. Broadly speaking, this observation suggests that the policy *instrument* chosen to enhance fiscal resilience matters.

5.2 Fiscal Unions

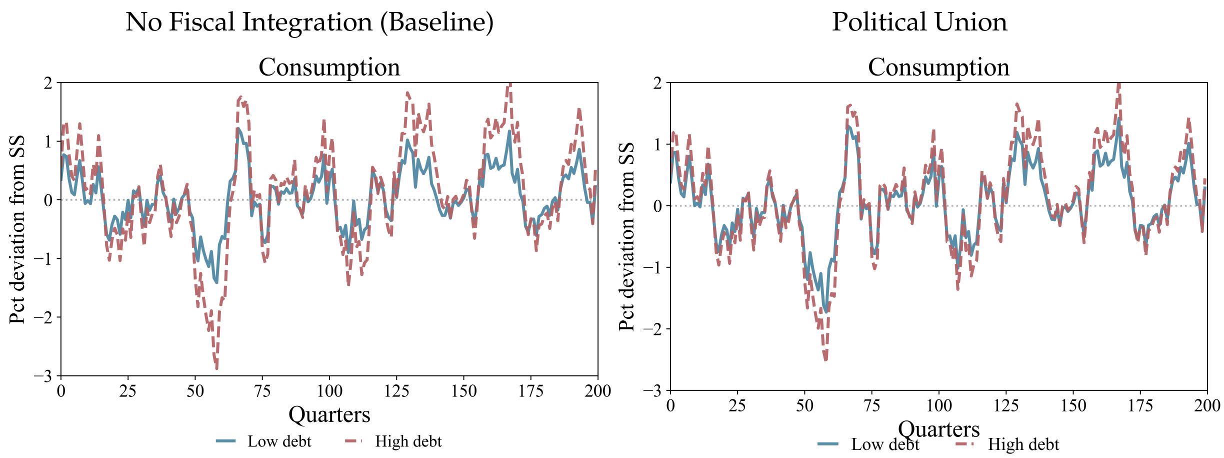
We now turn to fiscal unions. At the core of our stabilization-synchronization trade-off is the presence of a single monetary authority but multiple local fiscal authorities, each reacting differently to the initial shock. Thus, the introduction of a centralized fiscal union seems like a natural solution to this problem. We consider a *homogeneous* fiscal union, which we model as an authority that issues bonds in order to distribute lump-sum transfers homogeneously across countries and households.[28] This version of a fiscal union is very close to the "Eurobonds" solution that was proposed during the eurozone debt crisis (Frankel, 2012).

In Figure 8 we plot simulations of the time series of consumption in the two countries under varying levels of centralized fiscal integration. Because the introduction of the fiscal union effectively adds one extra layer of counter-cyclical fiscal policy, it is effective at stabilizing real activity on average in the euro area, as well as in each of the two countries.

Interestingly, we find that the fiscal union has a much larger stabilizing effect for the low-public debt country than for the high-debt one. In other words, the fiscal union *am-*

[28]We model the union as inactive in the steady state, with zero debt and transfers. The bond issuance and transfer programs are only active during out of steady state episodes, following the same fiscal rule as in (11). Note that we do not take a stance on the optimality of the fiscal union's policy rule and hence are abstracting away from normative considerations.

Figure 9: The Role of Political Unions



Note: simulations are driven only by demand shocks.

plifies the dispersion and desynchronization of fluctuations across the two countries. This is because of the general equilibrium effects that fiscal integration has on interest rates. During recessions, the presence of the federal fiscal authority increases the total amount of debt issued in the single asset market, thus putting upward pressure on interest rates. Higher interest rates then tighten the fiscal space for the government in the high-debt country, thus making national fiscal policy in that country less counter-cyclical.

On one hand, results from this experiment are consistent with the notion that countries that are members of a currency union benefit from aggregate risk sharing in the presence of incomplete markets, as is the case in our framework (Farhi and Werning, 2016, 2017). We do find that both countries are better off with a fiscal union than without it. However, we do not observe that the fiscal union solves the stabilization-synchronization problem. A caveat to this analysis is that we still consider only symmetric aggregate disturbances. The benefits of fiscal unions are generally *greater* the more asymmetric the shocks are (Farhi and Werning, 2017). Thus, our findings potentially point to a lower bound on the total benefits of fiscal unions.

5.3 Political Unions

Next, we introduce a political union which, more specifically, means a fiscal union with active cross-border redistribution. As we highlighted in Figure 3, in our framework any action of the central bank is inherently accompanied by a redistribution of resources between countries. It seems natural, hence, to study the role of a federal fiscal authority with the power to counteract the redistributive effects of monetary policy. We model the redistributive political union as running a balanced budget every period. As such, it does not issue any bonds and does not act countercyclically. It simply transfers resources across the two national fiscal authorities.

We assume that the political union transfers resources across borders with the goal of dampening the difference in the fiscal response across the two countries by a share δ. Thus, when $\delta = 0$ we are in the baseline case of no political unions, while $\delta = 1$ means that the fiscal response is fully equalized across countries. For our quantitative illustration we set $\delta = 0.35$, which implies partial redistribution. Just like in the case of the fiscal union, we assume that the political union is inactive in the steady state and only operates during transition dynamics.

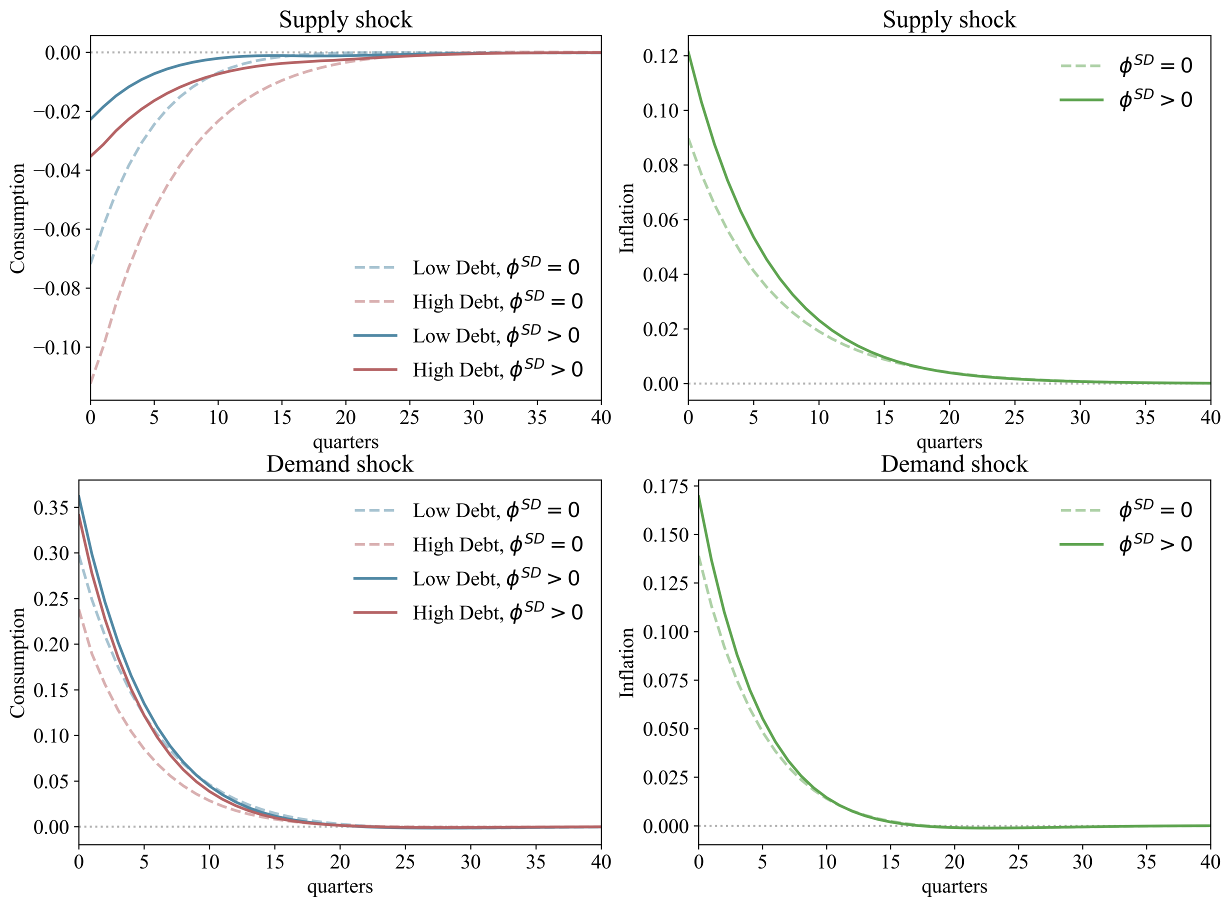
Figure 9 presents our results. Because the political union runs a balanced budget in every period, it is not able to stabilize aggregate, euro-wide fluctuations by design. However, it can be very effective at harmonizing economic activity across countries and therefore at tackling our stability-synchronization trade-off. This can be clearly seen from the right panel of the Figure: consumption dynamics in low- and high-debt countries are almost quantitatively identical. Thus, at face value, we can conclude that the political union can solve the trade-off and prevent desynchronization of the union.

The practical cost of a full-blown political union is potentially very high if transfers are non-reversible. In this case, while the political union may be desirable, it may still be challenging if not impossible to achieve in reality. However, this is not the case in our experiment. The defining feature of this political union is that the direction of cross-country transfers varies over the business cycle. In particular, as can be seen in Figure A.5 in Appendix A.5, transfers flow from the low-debt to the high-debt country during recessions, and the opposite happens during expansions. Neither country receives positive net transfers on average over time. Thus, our version of a political union could be potentially more feasible politically than other versions circulating in the policy debate. There are two additional, important caveats to this analysis. First, as mentioned previously, we abstract from the non-trivial issue of moral hazard considerations (Persson and Tabellini, 1996). Second, our model does not include sovereign default risk and equilibrium credit spreads (Corsetti et al., 2013, Costain et al., 2024). A complete treatment of political integration in monetary unions should take both of these channels into account.

5.4 Taylor Rules with Cross-Country Consumption Inequality

For our final policy instrument, we revert back to the baseline situation without any fiscal integration. We now consider a monetary authority that is inequality-conscious, i.e.

Figure 10: Augmented Taylor Rule with Synchronization Considerations



Note: consumption and inflation responses to cost-push and demand shock with persistence 0.85 under different synchronization concerns ϕ^{SD}.

it cares about cross-border consumption inequality explicitly. In our baseline model, the stability-synchronization trade-off arises because the central bank's sole duty is price stability. A natural solution would be to expand the central bank's reaction function – the Taylor rule – with a metric that captures cross-country synchronization concerns. Specifically, we modify our baseline Taylor rule (13) as follows:

$$i_t = \bar{r} + \max\left\{1, \phi - \phi^{SD}\sigma_t^c\right\} \pi_t + \varepsilon_t^i \tag{22}$$

where $\sigma_t^c \equiv \mathbb{V}ar_j \hat{c}_{jt}$ is the cross-sectional standard deviation of consumption deviations from steady state across member countries in period t. Thus, the more dispersed consumption fluctuations across countries are, the more dovish the central bank becomes "endogenously".

Figure 10 presents two examples from this exercise. We plot the consumption and inflation responses to a union-wide demand and supply shock under the expanded Taylor rule for a positive ϕ^{SD} and for the baseline ($\phi^{SD} = 0$). Under a supply shock, we see that when the central bank is inequality-conscious, euro-wide inflation (consumption) responds by more (less). Recall that changes in nominal interest rates transmit differentially across countries and generate cross-country dispersion in macro responses. The central bank that values cross-country synchronization is willing to allow higher inflation in response to the same cost-push shock. As a result, cross-border consumption inequality along the transition path goes down while inflation goes up by more. Similarly, under a positive demand shock, the monetary authority is willing to let inflation surge as the spread between the two consumption paths is lower with a less aggressive reaction. Thus, desynchronization of the monetary union can be avoided if the monetary authority - in the absence of fiscal or political coordination - cares about integration intensity explicitly.

We highlight two additional points with regards to our extended Taylor rule exercise. First, although our experiment is hypothetical in nature and departs from the practical central banking mandate of the ECB, unconventional Taylor rules have been studied extensively in the academic literature. For example, Cúrdia and Woodford (2010) and Boissay et al. (2021) analyze augmented Taylor rules that explicitly include credit spreads and financial-sector metrics, respectively. Second and finally, note that normative implications of our positive analysis are very unclear and would depend on the societal disdain for price fluctuations. See, among others, Ferrero (2009) for the joint analysis of optimal monetary and fiscal policy in a currency union.

6 Conclusion

To study the role of fiscal integration in monetary unions we have developed a multi-country HANK model of a currency union with a single source of cross-country heterogeneity: fiscal space. Ex-ante differences in fiscal space – as proxied by legacy debt levels – can generate endogenous desynchronization of economic activity in the union as local elasticities to aggregate shocks are not homogeneous and are driven by domestic fiscal capacity. The central monetary authority faces a trade-off between synchronization of economic activity across member countries and stabilization of union-wide inflation. Deficit caps and homogeneous fiscal unions do not relax this trade-off. A political union, on the other hand, can be effective at synchronizing economic activity but subject to important caveats such as sovereign default risk and moral hazard considerations, which we abstract from. Importantly, the political union exercise does not involve any systematic transfer from one country to another. In other words, net contributions to the union are zero on average, and no particular member of the union is forced to be a regular "donor" to the system. Finally, a central bank that follows an augmented Taylor rule with synchronization considerations can also successfully tackle the trade-off but subject to the practical questions regarding expanding the policy mandate.

Our paper highlights the subtlety of optimum currency area criteria. Potential member states of a monetary union that are very similar and synchronized ex ante may end up experiencing desynchronized business cycles ex post if they have heterogeneous fiscal capacity. Fiscal integration is hence crucial for a successful and lasting monetary union. However, the type of fiscal coordination framework matters. We show that even deficit caps, one of the more frequently-discussed policy instruments, fail at ensuring that desynchronization does not occur. Given the importance of differences in fiscal capacity for the heterogeneous pass-through of monetary policy, further exploring its effects on financial markets presents a fruitful area for future research. Another interesting area for future work involves political economy considerations associated with the establishment of common monetary and fiscal policies within a monetary union, especially in the context of member countries differing in their bargaining power.

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A Appendix

A.1 Labor Unions and Phillips Curves

In every country j there are two sets of labor unions, one per sector. In every sector s, there is a continuum of unions indexed by $\iota \in [0,1]$ that set their wage $w^s_{jt}(\iota)$ at any time t to maximize the following problem:

$$\max_{\{W^s_{jt+h}(\iota)\}_{h\geq 0}} \sum_{h\geq 0} \beta^{t+h}\left[u(c_{jt+j}) - v(\ell_{jt+h}) - \frac{\psi}{2}\left(\frac{w^s_{jt+h}(\iota)}{w^s_{jt+h-1}(\iota)} - 1\right)^2\right]$$
$$s.t. \quad \ell^s_{jt}(\iota) = \left(\frac{w^s_{jt}(\iota)}{w^s_{jt}}\right)^{-\epsilon}\ell^s_{jt}$$

Where c_{jt} and ℓ_{jt} are respectively aggregate consumption and aggregate labor supply in country j. So the union has preferences defined over the "average" or representative household of the country (this can of course be relaxed). The first order condition to the union's problem reads:

$$u'(c_{jt})\frac{\partial c_{jt}}{\partial w^s_{jt}(\iota)} - v'(\ell_{jt})\frac{\partial \ell_{jt}}{\partial w^s_{jt}(\iota)} - \psi\left(\frac{w^s_{jt}(\iota)}{w^s_{jt-1}(\iota)} - 1\right)\frac{1}{w^s_{jt-1}(\iota)} + \beta\psi\left(\frac{w^s_{jt+1}(\iota)}{w^s_{jt}(\iota)} - 1\right)\frac{w^s_{jt+1}(\iota)}{w^s_{jt}(\iota)}\frac{1}{w^s_{jt}(\iota)} = 0$$

Which can be rewritten as:

$$u'(c_{jt})w^s_{jt}(\iota)\frac{\partial c_{jt}}{\partial w^s_{jt}(\iota)} - v'(\ell_{jt})w^s_{jt}(\iota)\frac{\partial \ell_{jt}}{\partial w^s_{jt}(\iota)} - \psi\pi^s_{jt}(\iota)\left(1+\pi^s_{jt}(\iota)\right) + \beta\psi\pi^s_{jt+1}(\iota)\left(1+\pi^s_{jt+1}(\iota)\right) = 0$$

Now notice

$$\frac{\partial \ell_{jt}}{\partial w^s_{jt}(\iota)} = \frac{\partial \ell_{jt}}{\partial \ell^s_{jt}}\frac{\partial \ell^s_{jt}}{\partial \ell^s_{jt}(\iota)}\frac{\partial \ell^s_{jt}(\iota)}{\partial w^s_{jt}(\iota)}$$

From the households' perspective $\ell^s_{jt} = \int_0^1 \ell^s_{jt}(\iota)d\iota$ so $\frac{\partial \ell^s_{jt}}{\partial \ell^s_{jt}(\iota)} = 1$. Next, from $\ell^s_{jt}(\iota) = \left(\frac{w^s_{jt}(\iota)}{w^s_{jt}}\right)^{-\varepsilon}\ell^s_{jt}$, we have

$$\frac{\partial \ell^s_{jt}(\iota)}{\partial w^s_{jt}(\iota)} = -\epsilon\frac{\ell^s_{jt}(\iota)}{w^s_{jt}(\iota)}$$

and

$$\frac{\partial \ell_{jt}}{\partial \ell_{jt}^s} = \left(\frac{\ell_{jt}^s}{\alpha_j^s \ell_{jt}}\right)^{\frac{1}{\eta}} = \frac{w_{jt}^s}{w_{jt}}$$

Combining all of these together we have that

$$\frac{\partial \ell_{jt}}{\partial w_{jt}^s(\iota)} = -\epsilon \frac{\ell_{jt}^s(\iota)}{w_{jt}^s(\iota)} \frac{w_{jt}^s}{w_{jt}}$$

Now the other term, $\frac{\partial c_{jt}}{\partial w_{jt}^s(\iota)}$. Auclert and co argue that we can apply the envelope theorem and just say $\frac{\partial c_{jt}}{\partial w_{jt}^s(\iota)} = \frac{\partial Z_{jt}}{\partial w_{jt}^s(\iota)}$, i.e. evaluate it as if all extra income was spent. Then:

$$\frac{\partial c_{jt}}{\partial w_{jt}^s(\iota)} = \tau_{j\ell} \left(\frac{\partial w_{jt}}{\partial w_{jt}^s} \frac{\partial w_{jt}^s}{\partial w_{jt}^s(\iota)} \ell_{jt} + \frac{\partial \ell_{jt}}{\partial \ell_{jt}^s} \frac{\partial \ell_{jt}^s}{\partial \ell_{jt}^s(\iota)} \frac{\partial \ell_{jt}^s(\iota)}{\partial w_{jt}^s(\iota)} w_{jt} \right)$$

Note that

$$\frac{\partial w_{jt}}{\partial w_{jt}^s} = \alpha_j^s \left(\frac{w_{jt}^s}{w_{jt}}\right)^{\eta} = \frac{\ell_{jt}^s}{\ell_{jt}}$$

And

$$\frac{\partial w_{jt}^s}{\partial w_{jt}^s(\iota)} = \left(\frac{w_j^s(\iota)}{w_{jt}^s}\right)^{-\epsilon} = \frac{\ell_{jt}^s(\iota)}{\ell_{jt}^s}$$

Thus

$$\frac{\partial c_{jt}}{\partial w_{jt}} = \tau_{j\ell} \left(\frac{\ell_{jt}^s}{\ell_{jt}} \frac{\ell_{jt}^s(\iota)}{\ell_{jt}^s} \ell_{jt} - \epsilon \frac{\ell_{jt}^s(\iota)}{w_{jt}^s(\iota)} \frac{w_{jt}^s}{w_{jt}} w_{jt} \right)$$

So now we can combine all of the above together and plug it into the FOC:

$$\begin{aligned}
\pi_{jt}^s(\iota) + \pi_{jt}^s(\iota)^2 &= \beta \left(\pi_{jt+1}^s(\iota) + \pi_{jt+1}^s(\iota)^2 \right) \\
&+ \frac{1}{\psi} \left[\frac{u'(c_{jt})}{P_{jt}} \tau_{j\ell} \left(w_{jt}^s(\iota) \ell_{jt}^s(\iota) - \epsilon w_{jt}^s \ell_{jt}^s(\iota) \right) + \epsilon v'(\ell_{jt}) \ell_{jt}^s(\iota) \frac{w_{jt}^s}{w_{jt}} \right]
\end{aligned}$$

Imposing symmetry

$$\pi^s_{jt} + {\pi^s_{jt}}^2 = \beta\left(\pi^s_{jt+1} + {\pi^s_{jt+1}}^2\right) + \frac{\epsilon}{\psi}\ell^s_{jt}\left[v'(\ell_{jt})\frac{w^s_{jt}}{w_{jt}} - \mu u'(c_{jt})\tau_{j\ell}w^s_{jt}\right]$$

Where $\mu = \frac{\epsilon-1}{\epsilon}$. Evaluating the equation above at the 0 inflation SS:

$$v'(\ell_j)\ell_j = \mu u'(c_j)\tau_j w_j \ell_j \tag{A.1}$$

Which is not s dependent, meaning that the different unions' choices are consistent in SS. Now let's do a first order approximation around the zero inflation SS:

$$\pi^s_{jt} = \beta\pi^s_{jt+1} + \frac{\epsilon}{\psi}\ell_j v'(\ell_j)\rho^s_j\left[\varphi\hat{l}_{jt} + \sigma\hat{c}_{jt} - \hat{w}_{jt}\right]$$

Where hat variables represent log deviations from SS, $\rho^s_j = \frac{w^s_j\ell^s_j}{w_j\ell_j}$, $\varphi = \frac{v''(\ell_j)}{v'(\ell_j)}\ell_j$, $\sigma = -\frac{u''(c_j)}{u'(c_j)}c_j$. See commented lines for derivation.

We can iterate forward the equation above and write it in sequence space form as:

$$\boldsymbol{\pi}^s_j = \boldsymbol{K}^s_j\left[\varphi\widehat{\boldsymbol{\ell}}_j + \sigma\widehat{\boldsymbol{c}}_j - \widehat{\boldsymbol{w}}_j\right] \tag{A.2}$$

Where

$$\boldsymbol{K}^s_j \equiv \kappa^s_j\begin{bmatrix}1 & \beta & \beta^2 & \cdots\\ 0 & 1 & \beta & \cdots\\ 0 & 0 & 1 & \cdots\\ \vdots & \vdots & \vdots & \ddots\end{bmatrix}$$

And $\kappa^s_j \equiv \frac{\epsilon}{\psi}\ell_j v'(\ell_j)\rho^s_j$.

$$\begin{aligned}\boldsymbol{\pi}^w_j =& \rho_j\boldsymbol{\pi}^{NT}_j + (1-\rho_j)\boldsymbol{\pi}^T_j\\ &= \boldsymbol{K}_j\left[\varphi\widehat{\boldsymbol{\ell}}_j + \sigma\widehat{\boldsymbol{c}}_j - \widehat{\boldsymbol{w}}_j\right]\end{aligned}$$

where

$$\kappa_j \equiv \frac{\epsilon}{\psi}\ell_j v'(\ell_j)\left(\rho_j^2 + (1-\rho_j)^2\right)$$

On top of this we need the relation :

$$\boldsymbol{\pi}_j^s = (\boldsymbol{I} - \boldsymbol{L})\widehat{\boldsymbol{w}}_j^s \tag{A.3}$$

Where $\boldsymbol{L}$ is the lag matrix :

$$\boldsymbol{L} = \begin{bmatrix} 0 & 0 & 0 & \cdots \\ 1 & 0 & 0 & \cdots \\ 0 & 1 & 0 & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

A.2 Proof of Definition 1

Recall that $Z_{jt} \equiv (1-\tau)W_{jt}L_{jt}$. Taking logs and differentiating with respect to C_{jt} gives:

$$\frac{\partial \log Z_{jt}}{\partial \log C_{jt}} = \frac{\partial \log W_{jt}}{\partial \log C_{jt}} + \frac{\partial \log L_{jt}}{\partial \log C_{jt}} \tag{A.4}$$

Because Definition 1 focuses on the *partial equilibrium* elasticity of real labor income in country j to consumption in the same country we have

$$\frac{\partial \log W_{jt}}{\partial \log C_{jt}} = 0 \tag{A.5}$$

The log-linearized labor aggregator reads:[29]

$$d\log L_{jt} = \rho d \log L_{jt}^{NT} + (1-\rho)\log L_{jt}^{T} \tag{A.6}$$

Because Definition 1 considers a zero-measure country, we have

$$\frac{\partial \log L_{jt}^{T}}{\partial \log C_{jt}} = 0 \tag{A.7}$$

Moreover, under the assumption of an homothetic consumption aggregator in partial equilibrium it holds that:

$$\frac{\partial \log C_{jt}^{NT}}{\partial \log C_{jt}} = 1 \tag{A.8}$$

[29]Note that (A.6) holds under the more general assumption of an homothetic labor aggregator.

Finally, substituting (A.5), (A.7), (A.8), together with the market clearing condition for non-tradable goods (14) into (A.6) gives the result in the main text.

A.3 Derivation of the National Keynesian Cross

Log-linearizing (17) gives:

$$\widehat{\boldsymbol{c}}_j = \boldsymbol{M}^r \widehat{\boldsymbol{r}}_j + \boldsymbol{M}\widehat{\boldsymbol{\ell}}_j + \boldsymbol{M}\widehat{\boldsymbol{w}}_j + \boldsymbol{M}^t \widehat{\boldsymbol{t}}_j \tag{A.9}$$

Log-linearizing the labor aggregator gives:

$$\widehat{\boldsymbol{\ell}}_j = \rho \widehat{\boldsymbol{\ell}}_j^{NT} + (1-\rho)\widehat{\boldsymbol{\ell}}_j^{T} \tag{A.10}$$

Plugging in the market clearing conditions for the non-tradable and tradable good market:

$$\widehat{\boldsymbol{\ell}}_j = \rho\left(-\nu \widehat{\boldsymbol{w}}_j^{NT} + \widehat{\boldsymbol{c}}_j\right) + (1-\rho)\left(\widehat{\boldsymbol{c}}^{T} + \nu \widehat{\boldsymbol{s}}_j\right) \tag{A.11}$$

Plugging (A.11) in (A.9) and rearranging gives (19) in the main text.

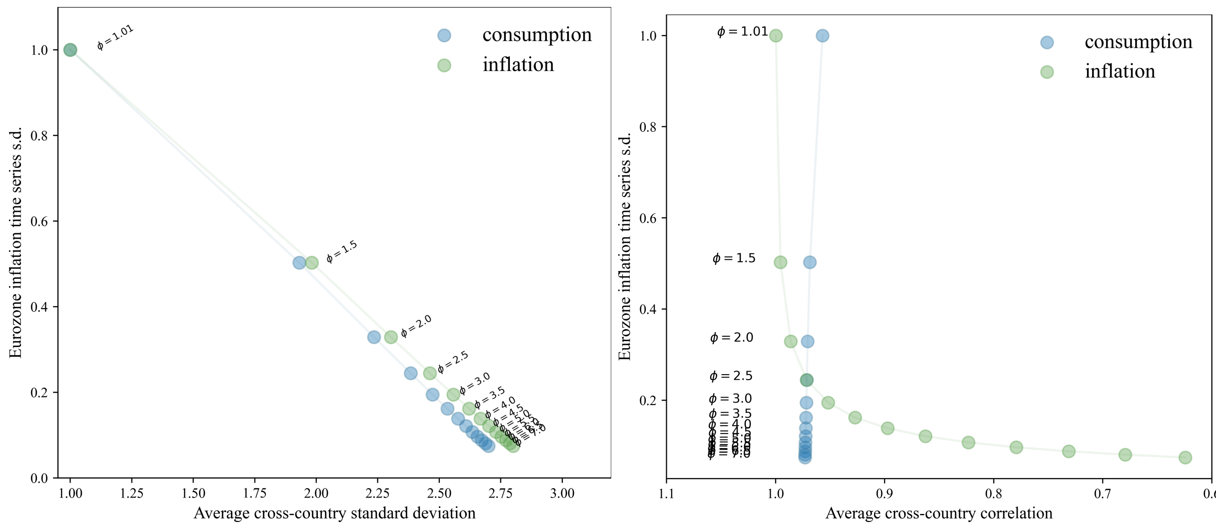
A.4 Data for Local Projections

We use two primary data sources to conduct our local projection analysis (21). First, we download quarterly data on (central) government primary deficits and debt servicing costs to GDP from Eurostat. To adjust for seasonality in government deficits and interest expenses we apply a four-quarter backward-looking moving average to both of these variables. Data on public debt-to-GDP ratios, the EONIA interest rate, the euro area industrial production index and CPI also come from Eurostat. Second, we use the instrument for ECB monetary policy shocks constructed by Almgren et al. (2022).

A.5 Additional Results

In this section we provide four additional results in order to supplement the main text. First, Figure A.1 shows the stabilization-synchronization possibility frontier in the case of supply shocks. Second, Figure A.2 presents stochastic simulations of the economy under different monetary regimes in the case of supply shocks. Third, Figures A.3 and A.4 present alternative visualizations of the stabilization-synchronization trade-off: cross-country correlations and standard deviations in consumption and inflation dynamics as a function of ϕ_π in the case of demand and supply shocks, respectively. Finally, Figure A.5 shows

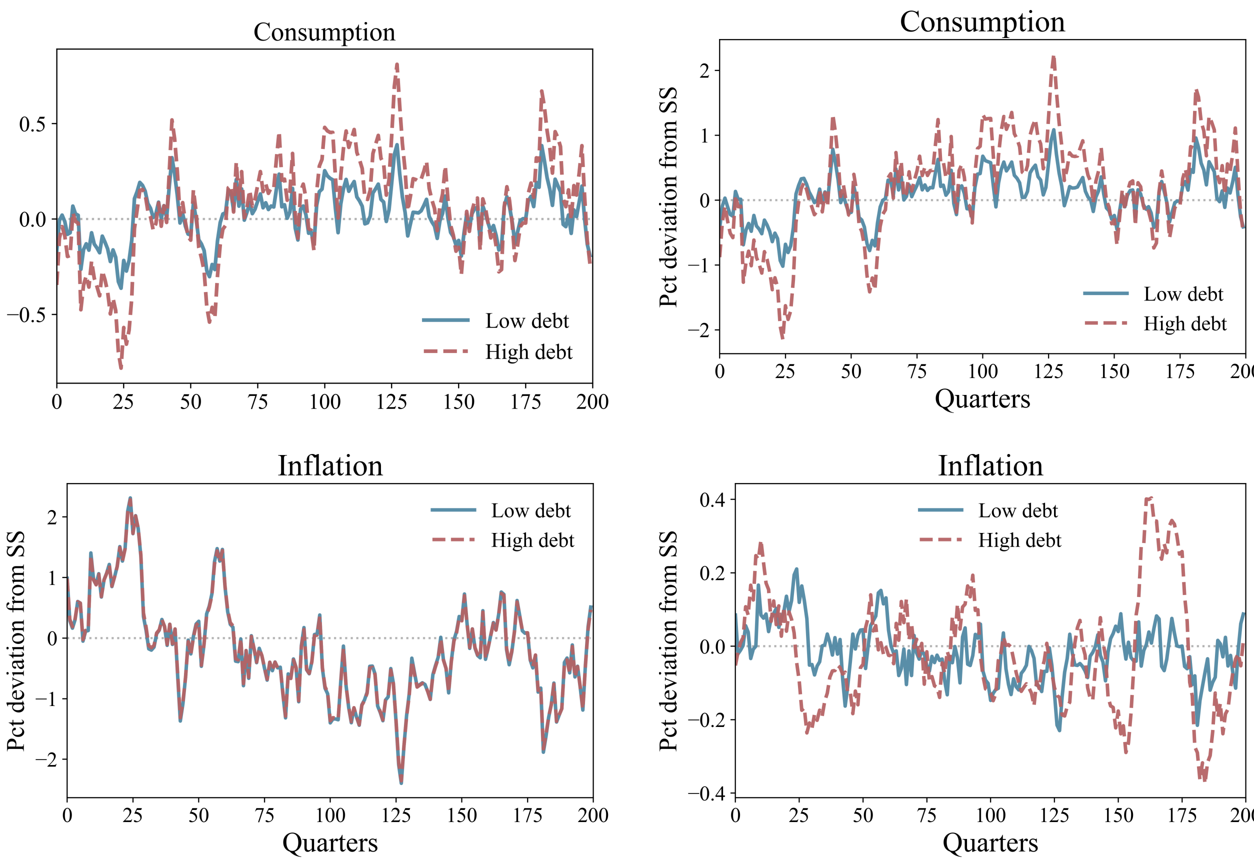
Figure A.1: Stabilization-Synchronization Possibility Frontier – Supply Shocks



Note: We normalize all standard deviation measures to unity for the smallest Taylor coefficient ($\phi = 1.01$). The correlation measures are not normalized.

net transfers from the low-debt to the high-debt country over time in the stochastic simulation.

Figure A.2: Ergodic Behavior of the Economy under Different Monetary Stances – Supply Shocks

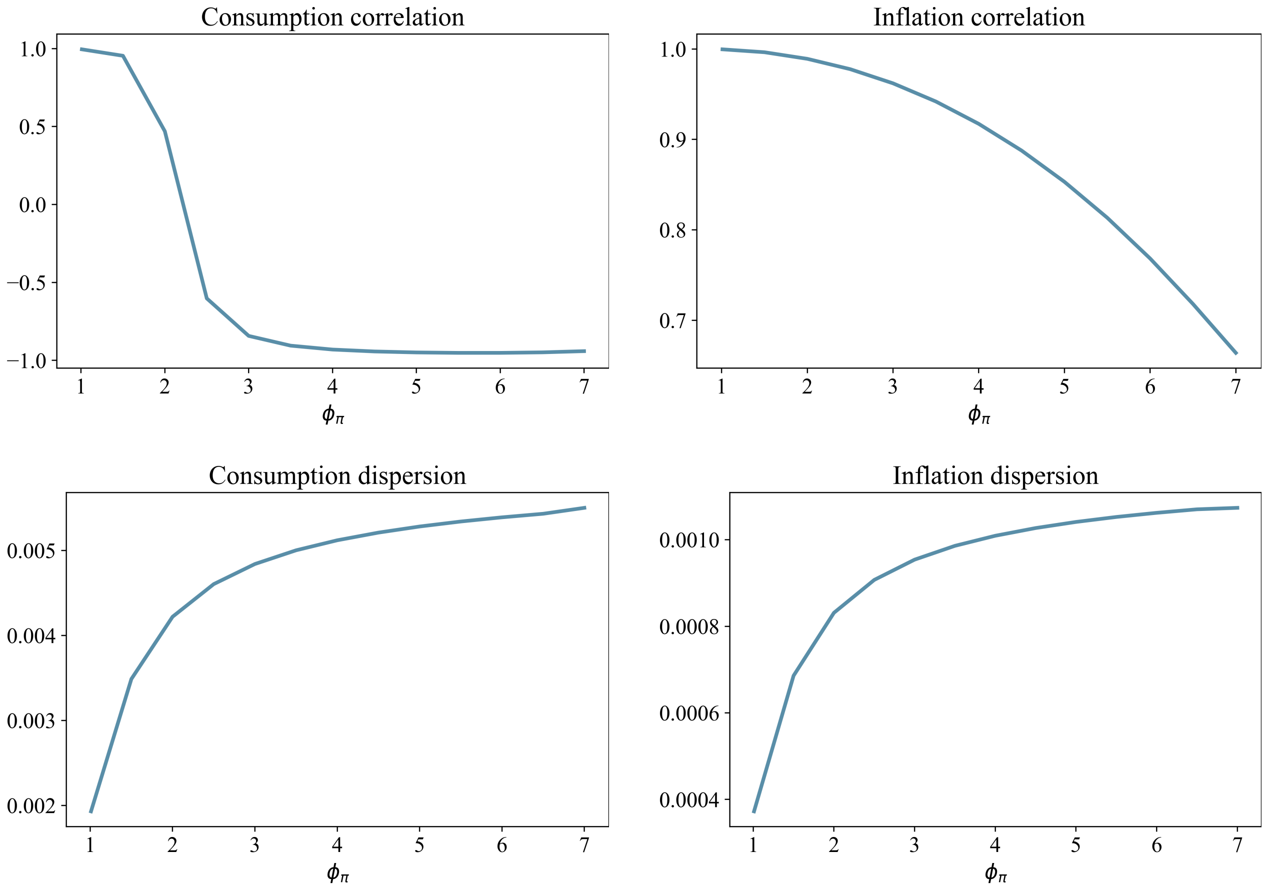


Dove, $\phi = 1.01$

Hawk, $\phi = 7$

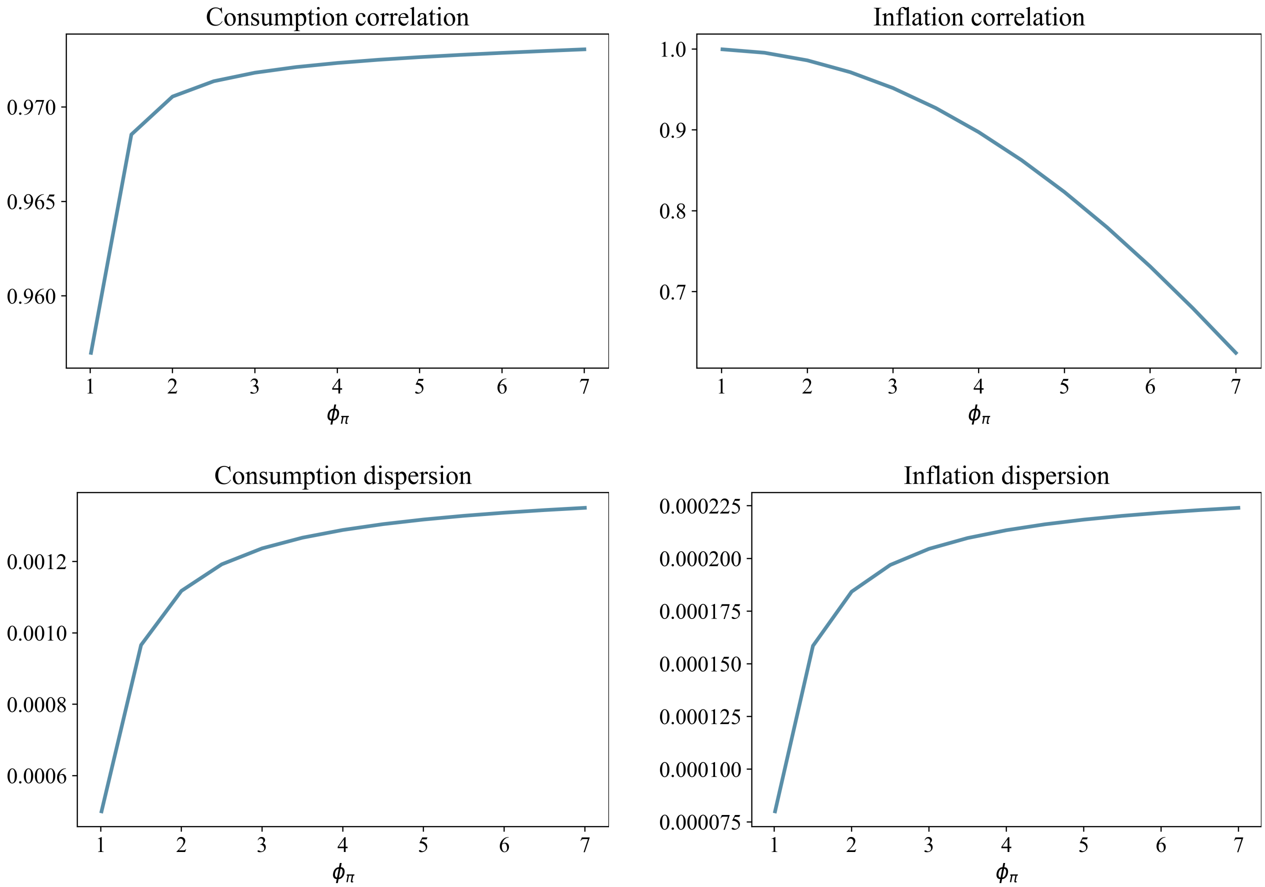
Note: simulations for consumption and inflation under different Taylor coefficients and supply shocks.

Figure A.3: Cross-country Synchronization – Demand Shocks



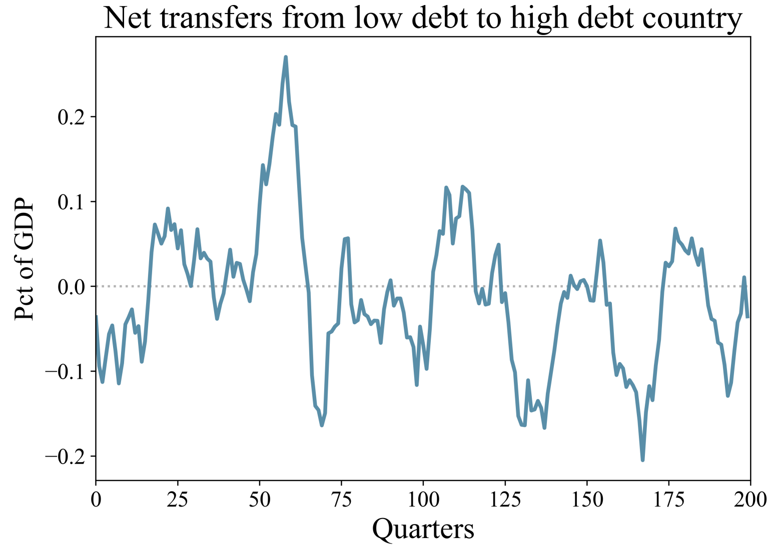
Note: cross-country standard deviations and correlations of consumption and inflation under different Taylor coefficients and demand shocks.

Figure A.4: Cross-country Synchronization – Supply Shocks



Note: cross-country standard deviations and correlations of consumption and inflation under different Taylor coefficients and supply shocks.

Figure A.5: Political Union – Transfers between Countries



Note: net cross-country transfers from the low-debt to the high-debt country under a political union and demand shocks. See Figure 9 for more details.