A Networked Monetary Union: Accounting for Comovement in the Euro Area*

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Abstract

Production networks shape the co-movement of business cycles across countries. This matters for monetary unions, where the costs of a common monetary policy depend not only on the degree of business-cycle synchronization, but also on its underlying sources. Against this background, we develop and estimate a New Keynesian model of a monetary union with a production network spanning its member states. Using time-series data for 10 euro-area countries, we quantify the role of cross-border input-output linkages in generating co-movement through counterfactual exercises. We find that production networks account for a substantial share of business-cycle synchronization, while common shocks play a smaller role. We then use the estimated model to assess the welfare implications of alternative monetary-policy arrangements.

Keywords: Monetary union, production networks, business cycle comovement, intermediate goods trade, euro area
JEL-Codes: E32, F41, F45

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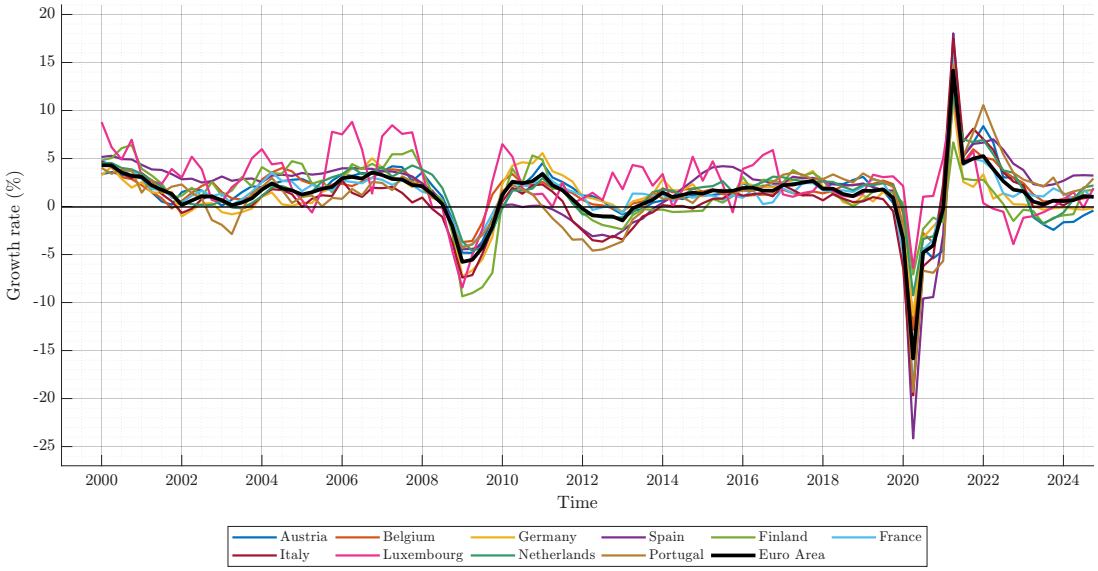
1 Introduction

Business cycles are highly synchronized across Euro Area (EA) countries. We illustrate this in Figure 1, which shows real GDP growth for individual member countries as well as for aggregate EA GDP. Growth rates co-move strongly, particularly during well-known shock episodes, but also in normal times. What drives this co-movement? We consider three distinct causes and aim to quantify their contributions to the co-movement of business cycles across EA countries: i) common monetary policy, ii) common shocks, and iii) spillovers through intra-EA trade. Since intra-EA trade consists overwhelmingly of intermediate goods, we develop a new model of a networked monetary union in which countries are linked through cross-border sourcing of intermediate inputs. This allows us to capture network propagation in the spirit of Foerster et al. (2011); however, rather than focusing on the transmission of sectoral shocks through domestic input-output linkages, we study how country-level shocks propagate through union-wide production networks.

This is of particular interest for the long-standing debate on optimum currency areas, dating back to Mundell (1961). This debate has focused heavily on the correlation of business cycles across (potential) members of a currency area. The standard argument is that a high degree of co-movement makes it less costly to forgo monetary independence and exchange-rate flexibility, since a common monetary policy is then more likely to suit all members. But such co-movement may arise for different reasons. If it reflects common shocks, it strengthens the case for a monetary union. If instead it is generated by the propagation of country-specific shocks through existing production networks, the welfare implications are less clear. Would countries then be better off retaining flexible exchange rates, or do network linkages make monetary integration desirable despite asymmetric shocks? To address this question, we use our model to perform a normative analysis of counterfactual policy scenarios and quantify the welfare losses from union membership.

The model we develop is a New Keynesian model of a monetary union and builds on earlier work on monetary unions, notably Gali and Monacelli (2008). Its key feature is that it incorporates a cross-country production network, following work on production networks in closed-economy settings (Rubbo, 2023). We estimate the model using time-series data for 10 EA countries, allowing productivity and demand shocks to originate both within the euro area and in the rest of the world. Both types of shocks have common and country-specific components and are transmitted across countries through the production network, both upstream and downstream. When quantifying their contributions to cross-country co-movement, we find a sizable role for the network. In its absence, there would be hardly any co-movement. Common shocks also matter, but to a lesser extent. Finally, we assess the welfare implications of alternative monetary policies.

Figure 1: Output growth in the euro area



Notes: This graph shows the year-over-year growth rate of real GDP across all euro area founding member countries from 2000Q1 to 2024Q3. Euro area real GDP is calculated as sum of country-level real GDP, before taking growth rates.

Our model consists of 10 Euro Area member countries and a largely exogenous country representing the rest of the world. Each EA country features a representative household and produces a country-specific good that can be either consumed or used as an intermediate input by households and firms in any country. This allows us to capture the large role of intermediates in intra-EA trade. Households in each EA country supply labor elastically to the domestic production sector and consume a composite of a good imported from the rest of the world and a bundle that, in turn, consists of goods produced by all EA countries. We permit non-unit elasticities at both stages of aggregation and different steady-state consumption shares across goods for each country, allowing us to calibrate the model to country-specific spending patterns observed in the data.

Within each country, the final good is assembled from the output of a continuum of monopolistically competitive firms that use labor and an intermediate input bundle consisting of the final goods produced by all other countries. While all firms within a given country use the same production technology, we allow the labor share and the share of intermediate inputs from a given country to differ across countries to reflect underlying differences in countries' industrial structures. Similar to the consumption bundle, we also allow for non-unit elasticities between inputs from different countries. A Calvo pricing friction leads to price stickiness, whose effects are amplified by the presence of the production network.

To close the model, we assume perfect risk sharing among all households within the EA and that the joint monetary policy follows a Taylor rule that reacts to EA-wide variables. Finally, we allow for conventional monetary policy shocks, union-wide and country-specific shocks to total factor productivity (TFP), and union-wide and country-specific demand shocks from the rest of the world.

We calibrate the model's bilateral consumption and intermediate shares as well as country-specific labor shares and country sizes directly using input-output tables and national accounts data. In the next step, we estimate the exogenous processes using full-information Bayesian estimation on time-series data for GDP and inflation across 10 EA countries. We find that TFP shocks have quite similar standard deviations across countries and that common and country-specific shocks are equally large. The size of demand shocks from the rest of the world, on the other hand, differs heavily across countries, with only an outsized role for the common component.

Given our estimates of the exogenous processes, we first examine the role of trade in intermediates in the transmission of country-specific shocks. We find that the presence of the network generally decreases co-movement in GDP between the shocked country and the rest of the union on impact after a TFP shock, but increases positive spillovers in the medium and long run. For demand shocks from the rest of the world, which generally cause negative spillovers when not accounting for the network, we find that the sign of the spillover crucially depends on the position in the network that the two countries have relative to each other: If the shocked country primarily acts as a supplier to the other country, spillovers are generally negative. On the other hand, if the shocked country is predominantly a buyer of the other country's goods, spillovers are positive.

We then ask how much of the pairwise cross-country correlations between GDP growth and inflation that the estimated model predicts is due to production linkages, and how much is due to common shocks. To this end, we simulate the model using the estimated shock series and shut down one or both components. Strikingly, the co-movement in GDP growth is barely affected by removing common shocks, but disappears entirely once we remove the production network. For inflation, the result is almost flipped: the network alone cannot generate meaningful co-movement, whereas common shocks without a network still lead to sizable correlations.

Finally, we examine how accounting for the network changes the perceived importance of common shocks. To this end, we repeat the estimation after shutting down the use of foreign intermediate inputs. We then compute the share of the historical variance of GDP growth attributable to union-wide shocks in both model versions. We find that the model attributes a much lower share of that variance to common shocks when accounting for the production network. Put differently, the model that includes the latter is able to explain the strong co-movement shown in Figure 1 with a much smaller reliance on common shocks.

Related literature. Johnson (2014) studies business-cycle comovement via intermediate-input trade. Huo et al. (2025) examines cross-country business cycle comovement. Canova et al. (2007) documents a common business cycle across G7 countries. Burstein et al. (2008) finds that countries with more intermediate goods trade have more correlated business cycles. Di Giovanni and Levchenko (2010) emphasizes the importance of intermediate production links for cross-country business cycle correlation. Di Giovanni et al. (2018) uses French micro data to show that trade links increase business cycle correlation. Di Giovanni and Hale (2022) studies the effect of input trade on stock returns. Auer et al. (2019) demonstrates that international input-output linkages synchronize producer price indices across countries. Devereux et al. (2023) analyzes the effects of country-specific fiscal shocks in a sticky wages model with intermediate goods trade. Huo et al. (2019) investigates the relative importance of country-specific versus correlated shocks to GDP comovement in a sticky-wage framework. Baqaee and Farhi (2024) develops a model with countries, sectors, and arbitrary distortions such as trade costs and sticky prices. Finally, Rubbo (2022) studies a sectoral model with fragmented markets calibrated to US sectors.

Foerster et al. (2011) estimates the importance of aggregate versus sectoral shocks with input-output links. Atalay (2017) extends this by incorporating non-unit elasticity in their analysis.

Flynn et al. (2022) studies fiscal multipliers in the presence of input-output networks. Similarly, Bouakez et al. (2018) analyzes sectoral fiscal multipliers considering IO linkages.

Gopinath et al. (2020) investigates dominant currency pricing in open economies with intermediate inputs. Itskhoki and Mukhin (2021) examines frictional international financial markets in the presence of intermediate goods trade. Goldberg and Hellerstein (2008) highlights how intermediate imports affect exchange rate pass-through to prices. Qiu et al. (2025) studies optimal monetary policy in a small open economy with a production network.

Farhi et al. (2014) shows that fiscal policies such as VAT-labor tax shifts and tariff-subsidy combinations can substitute for exchange rate devaluations. The NBP Working Paper titled Fiscal Devaluation and Economic Activity in the EU provides empirical evidence on fiscal devaluation effects in the European Union.

Schmitt-Grohé and Uribe (2011) argues that fixed nominal exchange rates are costly, but tax policies can reproduce the effects of devaluation. Staiger and Sykes (2010) shows that exchange rate manipulation is not equivalent to export subsidies. Farhi et al. (2014) again emphasizes that fiscal tools can substitute for exchange rate devaluation.

Mundell (1961) lays out the theory of optimal currency areas. Evers (2006) discusses fiscal transfers between countries to address asymmetric shocks. Bofinger and Mayer (2007) argues that countries in a monetary union need fiscal policies to manage country-specific shocks. Dellas and Tavlas (2009) provides a review of optimal currency union theory. Adao

et al. (2009) finds that exchange rate regimes are irrelevant once monetary and fiscal policies are fully optimized. Benigno (2004) studies optimal monetary policy in a currency union. Gali and Monacelli (2008) analyzes fiscal and monetary policy coordination in currency unions. Erceg and Lindé (2013) compares tax-based versus expenditure-based fiscal consolidation in a currency union. Beyer et al. (2023) discusses how fiscal policy can combat inflation in the Euro area. Galí and Monacelli (2016) studies how wage flexibility might reduce welfare in currency unions. Finally, Petroulakis (2017) evaluates the role of taxes and trade costs in currency union adjustment to shocks.

2 Model

We study the role of intermediate goods trade in an open economy New Keynesian model with a production network structure: N countries produce in a roundabout production structure output goods that are either consumed as final goods or used as intermediate inputs in other countries. The model allows for technology, external demand and monetary policy shocks and discriminates between idiosyncratic and common shocks. The model features non-unit elasticities in final and intermediate goods bundles as well as Calvo-style nominal rigidities.

2.1 Households

A representative household in country i consumes a bundle of domestic and imported final consumption goods and supplies labor to the domestic production sector. The household maximizes expected lifetime utility

$$\max_{\widetilde{C}_{t,i},\, L_{t,i},\, B_{t+1,i}} E_0 \sum_{t=0}^{\infty} \delta^t \left\{ \log(\widetilde{C}_{t,i}) - \frac{L_{t,i}^{1+\varphi}}{1+\varphi} \right\} \tag{1}$$

subject to the budget constraint

$$\widetilde{P}_{t,i}^{C} \widetilde{C}_{t,i} + E_t\{Q_{t,t+1}^{i} B_{t+1,i}\} \leq B_{t,i} + W_{t,i} L_{t,i} + T_{t,i} \tag{2}$$

where $\widetilde{C}_{t,i}$ is the final consumption bundle, $L_{t,i}$ is labor supply, $\widetilde{P}_{t,i}^{C}$ is the consumption price index in country i, $W_{t,i}$ is the nominal wage, and $T_{t,i}$ are lump-sum transfers. $B_{t,i}$ denotes holdings of a portfolio purchased in period $t-1$ and carried into period t, and $Q_{t,t+1}^{i}$ is the one-period stochastic discount factor. We assume complete asset markets, such that households can trade a full set of state-contingent claims.

Final consumption is described by a consumption bundle that aggregates consumption goods produced inside the network model and final consumption goods imported from

the Rest of the World (RoW henceforth):

$$\widetilde{C}_{t,i} = \left((1-\gamma_i^{RoW,C})^{\frac{1}{\eta^C}} (C_{t,i})^{\frac{\eta^C-1}{\eta^C}} + (\gamma_i^{RoW,C})^{\frac{1}{\eta^C}} (IM^C_{t,i,RoW})^{\frac{\eta^C-1}{\eta^C}} \right)^{\frac{\eta^C}{\eta^C-1}} \tag{3}$$

where $IM^C_{t,i,RoW}$ denotes imports from the RoW, $\gamma_i^{RoW,C}$ is the expenditure share on RoW imports, and η^C is the elasticity of substitution between RoW imports and the bundle of goods from the N model countries.[1] The inner bundle $C_{t,i}$ aggregates final consumption goods across all N model countries:

$$C_{t,i} = \left(\sum_j \beta_{i,j}^{\frac{1}{\eta^C}} C_{t,i,j}^{\frac{\eta^C-1}{\eta^C}} \right)^{\frac{\eta^C}{\eta^C-1}} \tag{4}$$

where $C_{t,i,j}$ is country i's consumption of goods produced in country j, $\beta_{i,j}$ is the corresponding expenditure share with $\sum_j \beta_{i,j} = 1$, and η^C is again the elasticity of substitution across countries within the consumption bundle.[2]

Price indices. Let $\mathcal{E}_{t,i}$ denote the nominal exchange rate that transforms country i's currency into the base currency, such that $P_{t,j}\frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}}$ converts prices from country j's currency into country i's currency. The RoW enters the model solely through trade in final goods and is not part of the production network; its price level $P_{t,RoW}$ and exchange rate $\mathcal{E}_{t,RoW}$ are taken as exogenous. The consumption price index of country i for goods produced within the N model countries is

$$P^C_{t,i} = \left(\sum_j \beta_{i,j} \left(P_{t,j}\frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}} \right)^{1-\eta^C} \right)^{\frac{1}{1-\eta^C}} \tag{5}$$

where $P_{t,j}$ is the producer price in country j and $\beta_{i,j}$ is the expenditure share on goods from country j with $\sum_j \beta_{i,j} = 1$. The import price index, covering goods from all foreign model countries, is

$$P^F_{t,i} = \left(\sum_{j\neq i} \beta^F_{i,j} \left(P_{t,j}\frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}} \right)^{1-\eta^C} \right)^{\frac{1}{1-\eta^C}} \tag{6}$$

where $\beta^F_{i,j} = \beta_{i,j}/(1-\beta_{i,i})$ for $j \neq i$ are bilateral import shares normalized to sum to one. The terms of trade are defined as the price of foreign model-country goods relative to domestic producer prices,

$$S_{t,i} = \frac{P^F_{t,i}}{P_{t,i}} \tag{7}$$

[1] To simplify notation, variables with a tilde refer to the outer consumption aggregate. In particular, $\widetilde{C}_{t,i}$ denotes the total final consumption bundle and $\widetilde{P}^C_{t,i}$ its associated price index.

[2] For tractability, the elasticity of substitution is assumed to be identical at both levels of the consumption nest. In particular, η^C governs both substitution across final goods produced by the N model countries and substitution between the resulting composite and final goods imported from the Rest of the World.

so that a decrease in $S_{t,i}$ reflects a deterioration in country i's terms of trade. The final consumption price index, additionally accounting for RoW imports, is

$$\widetilde{P}^C_{t,i} = \left((1 - \gamma_i^{RoW,C})(P^C_{t,i})^{1-\eta^C} + \gamma_i^{RoW,C} \left(P_{t,RoW} \frac{\mathcal{E}_{t,RoW}}{\mathcal{E}_{t,i}} \right)^{1-\eta^C} \right)^{\frac{1}{1-\eta^C}} \tag{8}$$

where $\gamma_i^{RoW,C}$ is country i's expenditure share on RoW consumption imports.

Optimality conditions. We define the nominal interest rate as $R_{t,i} \equiv \frac{1}{\mathrm{E}_t(Q^i_{t,t+1})}$. The household Euler equation is

$$1 = \delta R_{t,i} \, \mathrm{E}_t \left(\frac{\widetilde{P}^C_{t,i} \widetilde{C}_{t,i}}{\widetilde{P}^C_{t+1,i} \widetilde{C}_{t+1,i}} \right) \tag{9}$$

and the labor supply condition is

$$L^{\varphi}_{t,i} \widetilde{C}_{t,i} = \frac{W_{t,i}}{\widetilde{P}^C_{t,i}}. \tag{10}$$

Expenditure minimization over the outer consumption layer yields optimal demand for the bundle of goods from the N model countries

$$C_{t,i} = (1 - \gamma_i^{RoW,C}) \left(\frac{P^C_{t,i}}{\widetilde{P}^C_{t,i}} \right)^{-\eta^C} \widetilde{C}_{t,i} \tag{11}$$

and expenditure minimization over the inner layer yields bilateral import demand

$$C_{t,i,j} = \beta_{i,j} \left(\frac{P_{t,j} \frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}}}{P^C_{t,i}} \right)^{-\eta^C} C_{t,i}. \tag{12}$$

Risk sharing. We assume perfect risk sharing such that there exists an identical pricing kernel/stochastic discount factor across all countries, $Q^i_t = Q_t \forall i = 1, ..N$, that prices the set of state-contingent claims. From the optimality condition in eq. 9, it must hold that

$$\left(\frac{\widetilde{P}^C_{t,i} \widetilde{C}_{t,i}}{\widetilde{P}^C_{t,j} \widetilde{C}_{t,j}} \right) = \mathrm{E}_t \left(\frac{\widetilde{P}^C_{t+1,i} \widetilde{C}_{t+1,i}}{\widetilde{P}^C_{t+1,j} \widetilde{C}_{t+1,j}} \right) = c_{ij} \quad \forall i \neq j. \tag{13}$$

In other words, the relative nominal total consumption sizes of country i to country j stay constant over time. It follows that each country's share in total nominal consumption across the network countries is also time invariant.

2.2 Firms

In each country i, there is a continuum of monopolistically competitive firms $k \in [0, 1]$ that produce differentiated varieties using labor and a composite intermediate input bundle.

All firms within a country face the same factor prices and hence share a common marginal cost, which allows us to aggregate to the country level. Domestic output is a CES aggregate over all firm varieties

$$Y_{t,i} = \left(\int_0^1 Y_{t,i,k}^{\frac{\epsilon-1}{\epsilon}} dk \right)^{\frac{\epsilon}{\epsilon-1}} \tag{14}$$

with associated producer price index

$$P_{t,i} = \left(\int_0^1 P_{t,i,k}^{1-\epsilon} dk \right)^{\frac{1}{1-\epsilon}} \tag{15}$$

where ϵ is the elasticity of substitution across varieties. Firm-specific demand is then given by

$$Y_{t,i,k} = \left(\frac{P_{t,i,k}}{P_{t,i}} \right)^{-\epsilon} Y_{t,i}. \tag{16}$$

Production technology. Each firm produces according to a constant-returns-to-scale technology

$$Y_{t,i,k} = A_{t,i} L_{t,i,k}^{\alpha_i} X_{t,i,k}^{1-\alpha_i} \tag{17}$$

where $A_{t,i}$ is country-specific total factor productivity, $L_{t,i,k}$ is labor input, $X_{t,i,k}$ is a composite intermediate input bundle, and α_i is the labor share in production. The intermediate bundle aggregates inputs sourced from all N model countries via a CES aggregator

$$X_{t,i,k} = \left(\sum_j \omega_{i,j}^{\frac{1}{\eta^I}} X_{t,i,j,k}^{\frac{\eta^I-1}{\eta^I}} \right)^{\frac{\eta^I}{\eta^I-1}} \tag{18}$$

where $X_{t,i,j,k}$ is the intermediate input sourced from country j by firm k in country i, $\omega_{i,j}$ is the share of intermediates from country j in country i's intermediate bundle with $\sum_j \omega_{i,j} = 1$, and η^I is the elasticity of substitution across intermediate inputs. Since all firms face identical factor prices, marginal cost is common across firms and given by

$$MC_{t,i} = \frac{1}{\alpha_i^{\alpha_i}(1-\alpha_i)^{1-\alpha_i}} \frac{1}{A_{t,i}} W_{t,i}^{\alpha_i} (P_{t,i}^X)^{1-\alpha_i} \tag{19}$$

Price indices. The intermediate input price index is

$$P_{t,i}^X = \left(\sum_j \omega_{i,j} \left(P_{t,j} \frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}} \right)^{1-\eta^I} \right)^{\frac{1}{1-\eta^I}} \tag{20}$$

where $P_{t,j} \frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}}$ converts country j's producer price into country i's currency.

Optimality conditions. Cost minimization over labor and the intermediate bundle yields, after aggregating across firms,

$$W_{t,i}L_{t,i} = \alpha_i \, MC_{t,i}Y_{t,i} \tag{21}$$

$$P^X_{t,i}X_{t,i} = (1-\alpha_i) \, MC_{t,i}Y_{t,i}. \tag{22}$$

Cost minimization over the composition of the intermediate bundle yields bilateral intermediate demand

$$X_{t,i,j} = \omega_{i,j} \left(\frac{P_{t,j}\frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}}}{P^X_{t,i}} \right)^{-\eta^I} X_{t,i}. \tag{23}$$

Firms are subject to Calvo pricing, with country-specific probability λ_i of not resetting prices each period. A firm that resets its price in period t maximizes the expected stream of future profits conditional on not being able to reset in subsequent periods

$$\max_{P^\star_{t,i}} \mathrm{E}_t \left\{ \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} \left(P^\star_{t,i} Y_{s,i,k} - (1-\bar{\tau}) \, MC_{s,i} Y_{s,i,k} \right) \right\} \tag{24}$$

subject to the firm-specific demand constraint, where $Q_{t,s} = \delta^{s-t} \left(\frac{\widetilde{P}^C_{t,i}\widetilde{C}_{t,i}}{\widetilde{P}^C_{s,i}\widetilde{C}_{s,i}} \right)$ is the stochastic discount factor for nominal payoffs and $\bar{\tau} = \frac{1}{\epsilon}$ is a constant subsidy that offsets the steady-state monopolistic distortion. The resulting optimal reset price is

$$P^\star_{t,i} = \frac{\mathrm{E}_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} (P_{s,i})^\epsilon Y_{s,i} MC_{s,i}}{\mathrm{E}_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} (P_{s,i})^\epsilon Y_{s,i}} \tag{25}$$

and the producer price index evolves according to

$$P^{1-\epsilon}_{t,i} = \lambda_i P^{1-\epsilon}_{t-1,i} + (1-\lambda_i)(P^\star_{t,i})^{1-\epsilon}. \tag{26}$$

2.3 Monetary policy, external demand, and market clearing

Monetary policy follows a standard Taylor rule where the nominal interest rate $R_{t,i}$ reacts in response to aggregate economic conditions,

$$R_{t,i} = f(\pi_{t,i}, y_{t,i}, \ldots), \tag{27}$$

where $\pi_{t,i}$ and $y_{t,i}$ denote inflation and output, respectively.

Market clearing for country i requires that all domestically produced output is absorbed either as final consumption by households across all countries, as intermediate inputs in production across all countries or being exported to the Rest of the World,

$$Y_{t,i} = \sum_j C_{t,ji} + \sum_j X_{t,ji} + EX^{RoW}_{t,i}, \tag{28}$$

where $C_{t,ji}$ denotes consumption of goods produced in country i by households in country j, and $X_{t,ji}$ denotes the use of goods produced in country i as intermediate inputs in country j.

Exports to the Rest of the World (RoW) are modeled via an ad hoc demand function,

$$EX_{t,i}^{RoW} = \overline{EX}_i \cdot D_{t,i} \cdot \frac{\mathcal{E}_{t,RoW}}{P_{t,i}\,\mathcal{E}_{t,i}}, \tag{29}$$

where $\overline{EX}_i$ denotes the steady-state level of exports, determined by balanced trade as $\overline{EX}_i = \frac{\gamma_i^{RoW,C}}{1-\gamma_i^{RoW,C}} \nu_i \bar{C}$, and $D_{t,i}$ is an exogenous external demand shifter.[3]

2.4 Monetary union

Since our focus lies on understanding dynamics in a monetary union, we introduce a common central bank, instead of individual country-specific central banks, which sets the nominal interest rate R_t in reaction to union inflation π_t and union output dynamics y_t. In addition, we introduce fixed exchange rates such that $\mathcal{E}_{t,i} = \mathcal{E}_{t,j} \quad \forall i, j \in N$ model countries.

2.5 Exogenous processes

We consider common and country-specific exogenous processes, where the latter are indexed by i. All shocks follow log-linear AR(1) processes.

Technology. Aggregate and country-specific productivity evolve according to

$$a_t = \rho_a^{com} a_{t-1} + \varepsilon_t^a, \tag{30}$$

$$a_{t,i} = a_t + \rho_a^{idio} a_{t-1,i} + \varepsilon_{t,i}^a, \tag{31}$$

so that the common component enters the country-specific process contemporaneously.

External demand. Along the same pattern, aggregate and country-specific external demand follow

$$d_t = \rho_d^{com} d_{t-1} + \varepsilon_t^d, \tag{32}$$

$$d_{t,i} = d_t + \rho_d^{idio} d_{t-1,i} + \varepsilon_{t,i}^d. \tag{33}$$

Monetary policy. The monetary policy shock evolves as

$$\xi_t^{mp} = \rho_{mp} \xi_{t-1}^{mp} + \varepsilon_t^{mp}, \tag{34}$$

and enters the Taylor rule additively,

$$R_t = f(\pi_t, y_t, \ldots) + \xi_t^{mp}. \tag{35}$$

[3] For the derivation of the export demand function, see Appendix A.

2.6 Steady state and definitions

We consider an efficient steady state with all prices normalized to one and log-linearize the model around this steady state. Small letters denote log-deviations from steady state, $x = \log(X) - \log(\bar{X})$, bold letters denote column vectors $\boldsymbol{x} = [x_1, \ldots, x_N]'$, I is the identity matrix, I_x is a diagonal matrix with vector x on the diagonal, and $\mathbf{1}$ is a column vector of ones. We provide the log-linearized version of our model in appendix A.

Steady-state shares. We define several steady state shares that are used throughout the analysis and in the calibration. The intermediate input shares are collected in the input-output matrix Ω, such that an element in the matrix is given by $\Omega_{ij} = (1-\alpha_i)\omega_{ij} = \frac{X_{ij}}{Y_i}$. We define $v_i = C_i/C$ as country i's share of total union consumption, calibrated directly from the data. We define sales shares $\zeta_i = Y_i/C$, also known as Domar weights, as

$$\boldsymbol{\zeta} = L' \left(\boldsymbol{\beta}' + I_{\frac{\gamma^{RoW,C}}{1-\gamma^{RoW,C}}} \right) \boldsymbol{v} \tag{36}$$

where $L' = (I - \Omega')^{-1}$ is the Leontief inverse, Ω' has elements $(1-\alpha_j)\omega_{j,i}$, and balanced trade with the RoW in steady state implies a RoW export share of

$$\zeta_i^{RoW} = \frac{\gamma_i^{RoW,C}}{1-\gamma_i^{RoW,C}} v_i. \tag{37}$$

We further define the steady state share of network consumption from country i imported from country j as $\beta_{ij} = \frac{C_{ij}}{C_i}$ and the share of intermediate inputs imported from country j in the total intermediate input bundle in country i as $\frac{X_{ij}}{X_i} = \omega_{ij}$ such that $\frac{X_{ij}}{Y_i} = (1-\alpha_i)\omega_{ij}$. The model is log-linearized around its steady state, and the resulting system of linear rational expectations equations is solved using the QZ decomposition method of Klein (2000).

3 Parametrization

We parametrize our model tailored to the euro area, and report values in Table 1. We include ten euro area countries, namely Austria (AT), Belgium (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Luxembourg (LU), Italy (IT), the Netherlands (NL), and Portugal (PT), corresponding to the original founding members of the euro area excluding Ireland.

3.1 Model parameters

We calibrate the euro area production structure using data from Eurostat's Full International and Global Accounts for Research in Input-Output Analysis (FIGARO) database.[4]

[4]Information on the FIGARO database can be found here.

Table 1: Model parametrization.

Parameter	Description	Value
HOUSEHOLD SIDE		
δ	Discount factor	0.96
φ	Inverse-Frisch labor elasticity	2
η^C	Elasticity of substitution in final consumption	3.0
$\gamma_i^{RoW,C}$	RoW import share in final consumption	see Table 5 in App. B
$\beta_{i,j}$	Bilateral shares in final consumption	see Table 4 in App. B
v_i	Consumption shares in union consumption	see Table 5 in App. B
PRODUCTION SIDE		
η^I	Elasticity of substitution in intermediate inputs	0.1
λ_i	Calvo price stickiness	0.75
$\omega_{i,j}$	Bilateral shares in intermediate inputs	see Table 3 in App. B
α_i	Labor share in production	see Table 5 in App. B
MONETARY POLICY		
ϕ_π	Taylor rule coefficient on inflation	1.5

Notes: We provide the entire network related parametrization in Appendix B.

To avoid the distortions of the Covid-19 pandemic, we choose 2019 as our base year.

For the intermediate input shares $\omega_{i,j}$ and labor shares α_i, we use the FIGARO industry-by-industry input-output matrix. Following standard practice, we exclude value added components such as taxes and subsidies, retaining only intermediate transactions between industries. For each country i, we compute $\omega_{i,j}$ as the share of intermediates sourced from country j in total intermediate inputs. The home share $\omega_{i,i}$ is thus the share of domestically produced intermediates in total intermediate use. Labor shares α_i are computed as the ratio of compensation of employees to total costs, defined as compensation of employees plus total intermediate inputs.

The bilateral consumption shares $\beta_{i,j}$ and RoW import shares $\gamma_i^{RoW,C}$ are also calibrated from the FIGARO database using household final consumption expenditure. For each country i, $\beta_{i,j}$ is the share of goods from country j in total imports of final consumption goods from the N model countries, with the home share $\beta_{i,i}$ capturing domestically produced consumption. The RoW import share $\gamma_i^{RoW,C}$ is computed as the share of consumption expenditure on goods from outside the N model countries in total final consumption.

Consumption shares v_i are calibrated using household final consumption expenditure from the OECD National Accounts database for 2019.[5] We define v_i as country i's share of total union household consumption expenditure.

[5]OECD National Accounts data are available at https://stats.oecd.org.

3.2 Estimation

We estimate the shock processes in our model using Bayesian methods and quarterly data on real GDP growth and consumer price inflation for all ten countries in the model. The sample starts with the launch of the euro area in 1999Q1 and ends in 2019Q4, thereby excluding the Covid-19 pandemic. The estimation targets the shock persistence parameters and shock standard deviations.

We use the Kalman filter to evaluate the likelihood implied by the state-space representation of the solved model. We then employ a standard random-walk Metropolis-Hastings algorithm to generate draws from the posterior distribution, following an extensive mode-finding procedure. In line with standard practice in the DSGE literature, as in Smets and Wouters (2007) and Bayer et al. (2024), we use inverse-gamma priors for the shock standard deviations, with mean 0.10 and standard deviation 2.00, and beta priors for the persistence parameters, with mean 0.50 and standard deviation 0.20. The prior distributions, together with the posterior means and the 10th and 90th percentiles, are summarized in Table 2.

For the common technology and common external demand processes, we fix the persistence parameters, ρ_a^{com} and ρ_d^{com}, at 0.5.

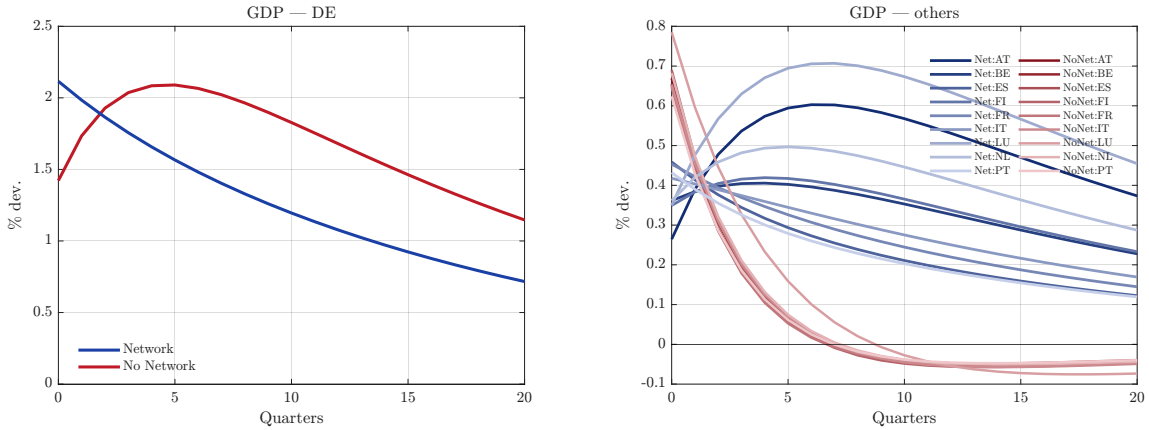
Table 2: Prior distributions and posterior estimates. The columns report the prior distribution, its mean and standard deviation, the posterior mean, and the 10th and 90th percentiles of the posterior distribution.

Parameter	**Prior distribution**			**Posterior distribution**		
	Distribution	**Mean**	**Std**	**Post. Mean**	**10%**	**90%**
MONETARY POLICY						
$\sigma_{\varepsilon^{mp}}$	Inv. Gamma	0.10	2.00	0.011	0.009	0.012
ρ_{mp}	Beta	0.30	0.20	0.721	0.688	0.755
TECHNOLOGY – COMMON						
$\sigma_{\varepsilon^{a}}$	Inv. Gamma	0.10	2.00	0.010	0.008	0.011
TECHNOLOGY – IDIOSYNCRATIC						
$\sigma_{\varepsilon^{a}_{AT}}$	Inv. Gamma	0.10	2.00	0.010	0.009	0.012
$\sigma_{\varepsilon^{a}_{BE}}$	Inv. Gamma	0.10	2.00	0.011	0.009	0.012
$\sigma_{\varepsilon^{a}_{DE}}$	Inv. Gamma	0.10	2.00	0.010	0.009	0.011
$\sigma_{\varepsilon^{a}_{ES}}$	Inv. Gamma	0.10	2.00	0.011	0.010	0.013
$\sigma_{\varepsilon^{a}_{FI}}$	Inv. Gamma	0.10	2.00	0.011	0.010	0.012
$\sigma_{\varepsilon^{a}_{FR}}$	Inv. Gamma	0.10	2.00	0.010	0.009	0.011
$\sigma_{\varepsilon^{a}_{IT}}$	Inv. Gamma	0.10	2.00	0.010	0.009	0.011
$\sigma_{\varepsilon^{a}_{LU}}$	Inv. Gamma	0.10	2.00	0.013	0.011	0.015
$\sigma_{\varepsilon^{a}_{NL}}$	Inv. Gamma	0.10	2.00	0.011	0.010	0.013
$\sigma_{\varepsilon^{a}_{PT}}$	Inv. Gamma	0.10	2.00	0.013	0.011	0.015
ρ^{idio}_{a}	Beta	0.30	0.20	0.951	0.929	0.975
EXTERNAL DEMAND – COMMON						
$\sigma_{\varepsilon^{d}}$	Inv. Gamma	0.10	2.00	0.157	0.109	0.205
EXTERNAL DEMAND – IDIOSYNCRATIC						
$\sigma_{\varepsilon^{d}_{AT}}$	Inv. Gamma	0.10	2.00	0.329	0.280	0.376
$\sigma_{\varepsilon^{d}_{BE}}$	Inv. Gamma	0.10	2.00	0.597	0.512	0.683
$\sigma_{\varepsilon^{d}_{DE}}$	Inv. Gamma	0.10	2.00	0.206	0.169	0.242
$\sigma_{\varepsilon^{d}_{ES}}$	Inv. Gamma	0.10	2.00	0.393	0.336	0.448
$\sigma_{\varepsilon^{d}_{FI}}$	Inv. Gamma	0.10	2.00	0.271	0.231	0.312
$\sigma_{\varepsilon^{d}_{FR}}$	Inv. Gamma	0.10	2.00	0.207	0.170	0.243
$\sigma_{\varepsilon^{d}_{IT}}$	Inv. Gamma	0.10	2.00	0.292	0.247	0.338
$\sigma_{\varepsilon^{d}_{LU}}$	Inv. Gamma	0.10	2.00	2.794	2.413	3.196
$\sigma_{\varepsilon^{d}_{NL}}$	Inv. Gamma	0.10	2.00	0.580	0.501	0.655
$\sigma_{\varepsilon^{d}_{PT}}$	Inv. Gamma	0.10	2.00	0.866	0.745	0.987
ρ^{idio}_{d}	Beta	0.50	0.20	0.948	0.935	0.963

4 The role of the network

4.1 Impulse response functions

Figure 2: Impulse responses for GDP to an idiosyncratic TFP shock in Germany.



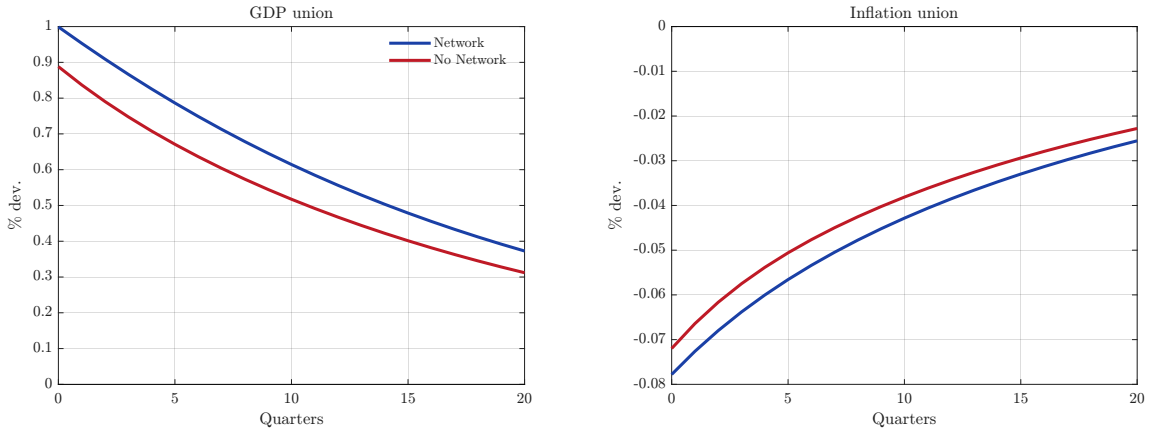
Notes: The figure reports impulse responses to an estimated idiosyncratic TFP shock in Germany. The left panel shows the response of Germany, while the right panel reports the responses of the remaining union countries. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages. Red lines refer to a counterfactual model in which the estimated shock processes are kept unchanged, but production network linkages are switched off.

Technology shocks. We start by examining the impulse responses to an idiosyncratic TFP shock in one union member country. We focus on Germany because it is the largest economy in the union and an important supplier of intermediate goods to other member countries. Figure 2 reports the responses in the benchmark production network model (blue) and in a counterfactual in which countries use only domestic intermediate inputs, so that cross-country production network linkages are shut down (red).

In both variants, the shock raises German GDP and generates positive spillovers on impact, but the subsequent dynamics differ sharply. In the network model, spillovers to other member countries peak at up to 0.7 percent and remain positive throughout the 20-quarter horizon, compared with a peak response in the shocked country of slightly above 2 percent. Without production networks, the spillovers fade quickly and turn negative after a few quarters.

These differences are primarily driven by the responses of the price of intermediate input bundles. With production networks in place, the TFP shock propagates downstream, lowering the price of intermediate inputs for customer firms; see Figure D.9 in Appendix D.1. This, in turn, translates into a more pronounced fall in marginal costs in the other countries, as well as a less pronounced deterioration in their terms of trade relative to the model without networks; see Figures D.2 and D.3 in Appendix D.1. These effects

Figure 3: Aggregate union impulse responses to an idiosyncratic TFP shock in Germany.



Notes: The figure reports impulse responses to an idiosyncratic TFP shock in Germany. The left panel shows the response of union GDP whereas the right panel shows the response of union inflation. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure. Union-wide GDP is the consumption share weighted sum of individual country GDP levels: $gdp_t^{union} = \sum_i \nu_i \text{gdp}_{ti}$. The construction of union inflation follows correspondingly.

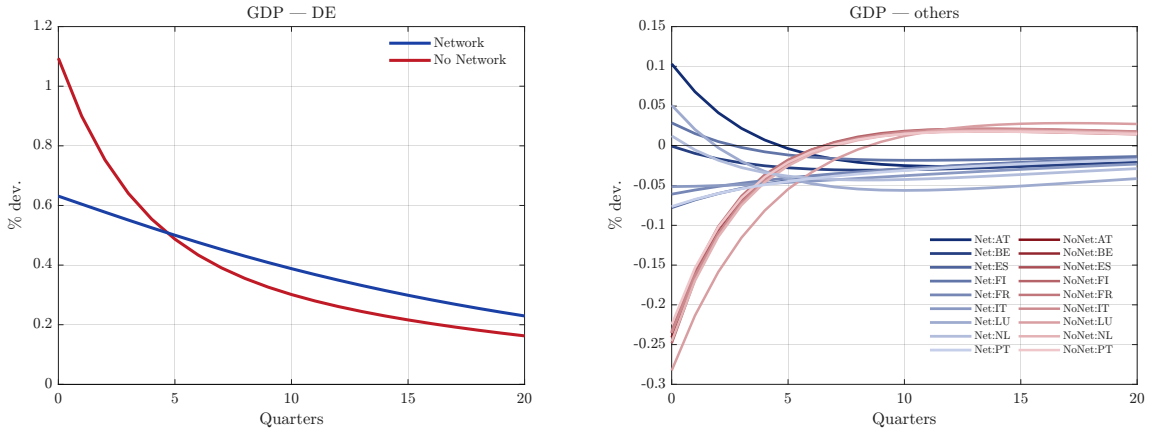
generate pronounced and persistent spillovers, raising GDP across all euro area countries.

The magnitude of the spillovers in the model with input-output structure also differ substantially across member countries, depending on the position of the country in the production network structure—this contrasts sharply with the model without network structure, where the foreign responses are closely aligned but at odds with the propagation we typically find in the data.

These differences in the dynamics and magnitude of spillovers across the two model variants translate into different aggregate union-wide GDP effects (see Figure 3). Here, we define union-wide GDP as the GDP-share weighted average of individual member GDP levels. Union GDP rises by close to 1 percent in the benchmark against slightly below 0.9 percent without networks; union disinflation is correspondingly stronger. The amplification comes from the same channel that drives the persistent country-level spillovers: cheaper German intermediates lower marginal costs across the union, so that the productivity gains translate to a fall in marginal costs beyond the German economy.

In contrast, the transmission of a common TFP shock is much more similar across the two specifications. As Figures D.7 and D.8 show, both the cross-country responses and the union-wide aggregates broadly line up, suggesting that the production network matters primarily for the cross-country transmission of idiosyncratic shocks rather than for the response to symmetric shocks.

Figure 4: Impulse responses for GDP to an idiosyncratic RoW demand shock in Germany.



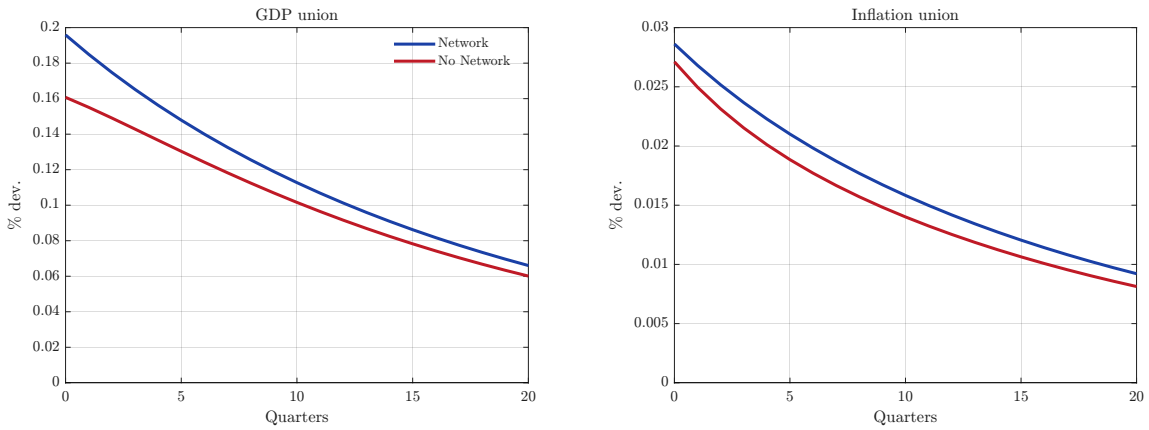
Notes: The figure reports impulse responses to an idiosyncratic RoW demand shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

RoW demand shocks. We next examine the response to a sudden increase in Rest-of-the-World (RoW) demand for goods produced by a single union member, again using Germany as our example. Given the roundabout production structure, the shock enters as a final-goods demand impulse but propagates predominantly upstream, through increased demand by Germany for intermediate goods produced by its suppliers in order to satisfy the rise in external final demand.

Figure 4 reports the country-level GDP responses. German GDP rises on impact in both specifications, with a larger initial response in the model without production networks but greater persistence in the network model. The size and sign of spillovers to other countries depend on each country's position in the network relative to Germany. In the network model, GDP rises on impact in several countries; without network linkages, the impact response is uniformly negative. The transmission channels differ across specifications. Absent production networks, negative spillovers are driven initially by the common monetary-policy tightening, then partly reverse as relative final-goods prices shift spillovers mildly positive after several quarters. In the network model, positive spillovers reflect upstream propagation through intermediate-input demand. These spillovers weaken over time and, for some countries, turn mildly negative as the demand expansion raises the general price level and marginal costs and monetary policy contracts aggregate demand.

When aggregated across union members, these responses imply stronger union-wide dynamics, as shown in Figure 5. Although the impact response of German GDP is smaller in the network model, union GDP rises by more on impact and remains above the model without network structure throughout the horizon, implying that positive spillovers to

Figure 5: Aggregate union impulse responses to an idiosyncratic RoW demand shock in Germany.



Notes: The figure reports impulse responses to an idiosyncratic RoW demand shock in Germany. The left panel shows the response of union GDP whereas the right panel shows the response of union inflation. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

supplier economies more than offset the weaker domestic response. Union inflation is likewise higher at all horizons. Production-network linkages therefore transmit the country-specific external-demand impulse beyond the directly affected economy and amplify its aggregate effects at the union level.

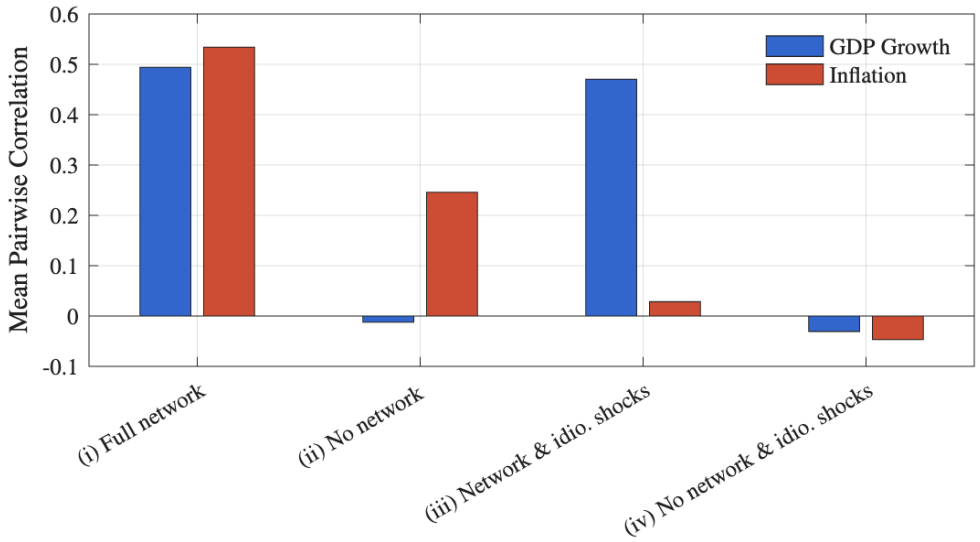
4.2 Counterfactual exercises

To quantify the contribution of the input–output structure to business cycle comovement within the monetary union, we conduct a set of counterfactual exercises. We recover the structural shocks from the estimated model using the Kalman smoother and use them to simulate the model, from which we compute pairwise cross-country correlations. We consider four model specifications: (i) the baseline model with production network linkages and both common and idiosyncratic shocks; (ii) a version in which the production network structure is shut down; (iii) a version in which common shocks are eliminated; and (iv) a version in which both the production network structure and common shocks are removed. For each specification, we recompute the average pairwise cross-country correlations. The results are reported in Figure 6.

In the baseline specification with production network linkages and both common and idiosyncratic shocks, the model generates average cross-country correlations of approximately 0.5 for GDP growth and 0.55 for inflation. Since the smoothed shocks are those that best fit the data, the implied correlation structure closely matches the empirical one.

If we feed the common and idiosyncratic shocks into a model without network struc-

Figure 6: Average pairwise cross-country correlations under alternative model structures



Notes: The figure shows the mean pairwise cross-country correlation of GDP growth and inflation, obtained by simulating the model using smoothed shocks from the Kalman smoother under four alternative specifications. *(i) Full Network*: baseline model with production network linkages and both common and idiosyncratic shocks. *(ii) No Network*: production network linkages are shut down, with both shock types retained. *(iii) Network & Idiosyncratic Shocks*: full network structure with common shocks shut down. *(iv) No Network & Idiosyncratic Shocks*: both the network structure and common shocks are shut down, leaving only idiosyncratic shocks.

ture (ii), the cross-country correlation for GDP growth turns negative, while the correlation for inflation roughly halves. Strikingly, when common shocks are eliminated but the production network structure is retained (iii), the model continues to generate cross-country correlations for GDP growth that are close to both the data and the baseline specification. In contrast, feeding only the idiosyncratic shocks into a model without production network linkages leads to a sharp decline in correlations, turning slightly negative for GDP growth and inflation. Removing both common shocks and the network structure further reinforces this result, producing negative correlations throughout.

These findings show that the production network is essential for the transmission channel of idiosyncratic shocks across countries and thereby plays a central role in generating business cycle synchronization within the monetary union.

4.3 Historical Decomposition

To complement the counterfactual exercises above, we use the historical shock decomposition implied by the estimated model to assess the role of common shocks in accounting for observed GDP growth dynamics and cross-country comovement. We compare two es-

timated specifications: the baseline model with production networks and an alternative specification in which the production network structure is switched off prior to estimation. The no-network model is estimated under the same prior distributions as the baseline specification; the corresponding posterior estimates are reported in Appendix XX. For each specification, we compute the historical decomposition under the structural relationship implied by each model of the observable GDP growth series.

In particular, for a given observable y, the historical decomposition assigns to each structural shock k a sequence of contributions $\{c_t^k\}_{t=1}^T$, where c_t^k denotes the contribution of shock k to the deviation of y from its steady state at date t. By construction, summing over all K shock contributions, together with the contribution of initial conditions, recovers the smoothed observable series. Applied jointly to GDP growth across countries, the decomposition therefore accounts not only for the evolution of each country-specific GDP growth series, but also for the cross-country comovement embedded in these observed series.

We aggregate the K structural shocks into a common group $\mathcal{C}$ and an idiosyncratic group $\mathcal{I}$, with group-level contributions

$$c_t^{\mathcal{C}} = \sum_{k \in \mathcal{C}} c_t^k, \qquad c_t^{\mathcal{I}} = \sum_{k \in \mathcal{I}} c_t^k. \tag{38}$$

We then summarize the relative role of common shocks over the estimation sample $\mathcal{T}$ by the share

$$s_{\mathcal{C}}^{\text{var}} = \frac{\sum_{t \in \mathcal{T}} \left(c_t^{\mathcal{C}}\right)^2}{\sum_{t \in \mathcal{T}} \left(c_t^{\mathcal{C}}\right)^2 + \sum_{t \in \mathcal{T}} \left(c_t^{\mathcal{I}}\right)^2}. \tag{39}$$

This statistic measures the fraction of the squared historical shock contribution to GDP growth that is attributed to common shocks rather than idiosyncratic shocks. Hence, comparing $s_{\mathcal{C}}^{\text{var}}$ across the two specifications shows how much each model relies on common shocks to reconstruct the observed GDP growth series and, through them, the observed cross-country comovement. Figure 7 reports the resulting shares for each country and for the union aggregate.

For most countries, the common-shock share is lower in the model with production networks than in the model without them. The exceptions are Portugal and Finland, where the share increases slightly. The decline is particularly pronounced for Austria, where the common-shock share falls by about 15 percentage points. Furthermore, if we look at the implied historical decomposition for union GDP growth, the difference is even more visible. The share of common shocks declines substantially by around 20 % under the network specification. Overall, the exercise shows that production networks reduce the extent to which the model must rely on common shocks to match the observed GDP growth series and their cross-country comovement.

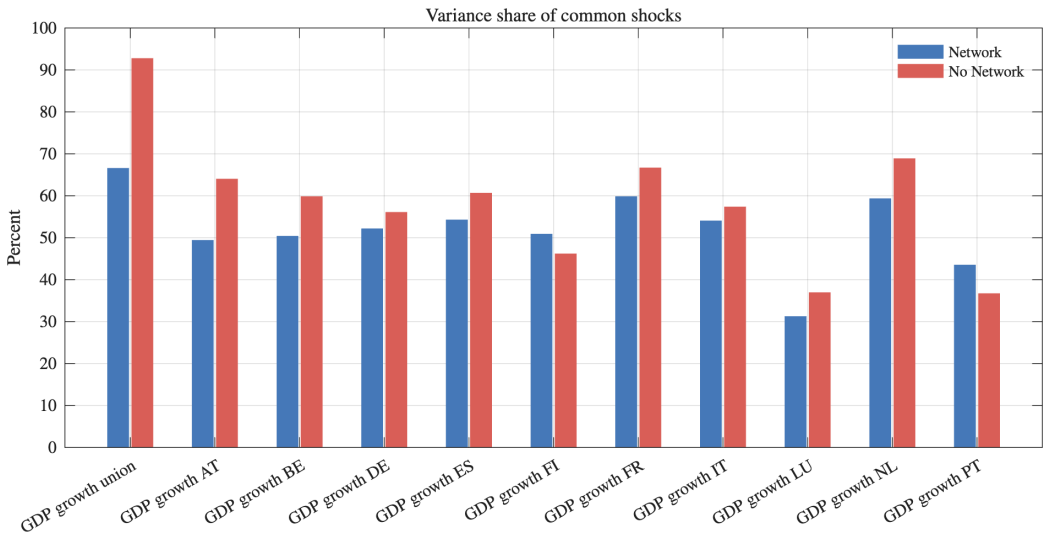


Figure 7: Variance share of common shocks in the historical decomposition of GDP growth, under the network and no-network specifications.

5 Conclusion

In this paper, we show that cross-border production networks are a key driver of business cycle synchronization within the euro area. We develop and estimate an open-economy New Keynesian model with intermediate-input trade among member countries, calibrated to the euro area production network. Our analysis demonstrates that production linkages fundamentally shape the transmission of shocks across countries. In particular, idiosyncratic shocks generate substantial cross-country co-movement when economies are connected through intermediate trade, whereas the same shocks lead to weak or even negative co-movement in the absence of production networks. Counterfactual exercises further show that models without intermediate input trade attribute a much larger role to common shocks in explaining euro area business cycles. These findings have important implications for the optimal currency area literature, as they suggest that the costs and benefits of monetary union depend also crucially on the production network structure through which shocks propagate across member economies.

References

Adao, Bernardino, Correia, Isabel, and Teles, Pedro. On the relevance of exchange rate regimes for stabilization policy. *Journal of Economic Theory*, 144(4):1468–1488, 2009.

Atalay, Enghin. How important are sectoral shocks? *American Economic Journal: Macroeconomics*, 9(4):254–280, 2017.

Auer, Raphael A, Levchenko, Andrei A, and Sauré, Philip. International inflation spillovers through input linkages. *Review of Economics and Statistics*, 101(3):507–521, 2019.

Baqaee, David Rezza and Farhi, Emmanuel. Networks, barriers, and trade. *Econometrica*, 92(2):505–541, 2024.

Bayer, Christian, Born, Benjamin, and Luetticke, Ralph. Shocks, frictions, and inequality in us business cycles. *American Economic Review*, 114(5):1211–1247, 2024.

Benigno, Pierpaolo. Optimal monetary policy in a currency area. *Journal of international economics*, 63(2):293–320, 2004.

Beyer, Robert, Duttagupta, Rupa, Fotiou, Alexandra, Honjo, Keiko, Horton, Mark, Jakab, Zoltan, Lindé, Jesper, Nguyen, Huong Vina, Portillo, Rafael, Suphaphiphat, Nujin, et al. Shared problem, shared solution: Benefits from fiscal-monetary interactions in the euro area. 2023.

Bofinger, Peter and Mayer, Eric. Monetary and fiscal policy interaction in the euro area with different assumptions on the phillips curve. *Open Economies Review*, 18:291–305, 2007.

Bouakez, Hafedh, Rachedi, Omar, Emiliano, Santoro, et al. *Sectoral heterogeneity, production networks, and the effects of government spending*. CIREQ, Centre interuniversitaire de recherche en économie quantitative, 2018.

Burstein, Ariel, Kurz, Christopher, and Tesar, Linda. Trade, production sharing, and the international transmission of business cycles. *Journal of Monetary Economics*, 55(4):775–795, 2008.

Canova, Fabio, Ciccarelli, Matteo, and Ortega, Eva. Similarities and convergence in g-7 cycles. *Journal of Monetary economics*, 54(3):850–878, 2007.

Dellas, Harris and Tavlas, George S. An optimum-currency-area odyssey. *Journal of International Money and Finance*, 28(7):1117–1137, 2009.

Devereux, Michael B, Gente, Karine, and Yu, Changhua. Production networks and international fiscal spillovers. *The Economic Journal*, 133(653):1871–1900, 2023.

Di Giovanni, Julian and Hale, Galina. Stock market spillovers via the global production network: Transmission of us monetary policy. *The Journal of Finance*, 77(6):3373–3421, 2022.

Di Giovanni, Julian and Levchenko, Andrei A. Putting the parts together: trade, vertical linkages, and business cycle comovement. *American Economic Journal: Macroeconomics*, 2 (2):95–124, 2010.

Di Giovanni, Julian, Levchenko, Andrei A, and Mejean, Isabelle. The micro origins of international business-cycle comovement. *American Economic Review*, 108(1):82–108, 2018.

Erceg, Christopher J and Lindé, Jesper. Fiscal consolidation in a currency union: Spending cuts vs. tax hikes. *Journal of Economic Dynamics and Control*, 37(2):422–445, 2013.

Evers, Michael P. Federal fiscal transfers in monetary unions: A noem approach. *International Tax and Public Finance*, 13:463–488, 2006.

Farhi, Emmanuel, Gopinath, Gita, and Itskhoki, Oleg. Fiscal devaluations. *Review of Economic Studies*, 81(2):725–760, 2014.

Flynn, Joel P, Patterson, Christina, and Sturm, John. Fiscal policy in a networked economy. Technical report, National Bureau of Economic Research, 2022.

Foerster, Andrew T., Sarte, Pierre-Daniel G., and Watson, Mark W. Sectoral vs aggregate shocks: A structural factor analysis. *Journal of Political Economy*, 119(1):1–38, 2011.

Gali, Jordi and Monacelli, Tommaso. Optimal monetary and fiscal policy in a currency union. *Journal of international economics*, 76(1):116–132, 2008.

Galí, Jordi and Monacelli, Tommaso. Understanding the gains from wage flexibility: the exchange rate connection. *American Economic Review*, 106(12):3829–3868, 2016.

Goldberg, Pinelopi Koujianou and Hellerstein, Rebecca. A structural approach to explaining incomplete exchange-rate pass-through and pricing-to-market. *American Economic Review*, 98(2):423–429, 2008.

Gopinath, Gita, Boz, Emine, Casas, Camila, Díez, Federico J, Gourinchas, Pierre-Olivier, and Plagborg-Møller, Mikkel. Dominant currency paradigm. *American Economic Review*, 110(3):677–719, 2020.

Huo, Zhen, Levchenko, Andrei A, and Pandalai-Nayar, Nitya. International comovement in the global production network. Technical report, National Bureau of Economic Research, 2019.

Huo, Zhen, Levchenko, Andrei A, and Pandalai-Nayar, Nitya. International comovement in the global production network. *Review of Economic Studies*, 92(1):365–403, 2025.

Itskhoki, Oleg and Mukhin, Dmitry. Mussa puzzle redux. Technical report, National Bureau of Economic Research, 2021.

Johnson, Robert C. Trade in intermediate inputs and business cycle comovement. *American Economic Journal: Macroeconomics*, 6(4):39–83, 2014.

Klein, Paul. Using the generalized schur form to solve a multivariate linear rational expectations model. *Journal of economic dynamics and control*, 24(10):1405–1423, 2000.

Mundell, Robert A. A theory of optimum currency areas. *The American economic review*, 51 (4):657–665, 1961.

Petroulakis, Filippos. Internal devaluation in currency unions: the role of trade costs and taxes. 2017.

Qiu, Zhesheng, Wang, Yicheng, Xu, Le, and Zanetti, Francesco. Monetary policy in open economies with production networks. 2025.

Rubbo, Elisa. Monetary non-neutrality in the cross-section. *Unpublished manuscript, Harvard Univ., Cambridge, MA*, 2022.

Rubbo, Elisa. Networks, phillips curves, and monetary policy. *Econometrica*, 91(4):1417–1455, 2023.

Schmitt-Grohé, Stephanie and Uribe, Martin. Pegs and pain. Technical report, National Bureau of Economic Research, 2011.

Smets, Frank and Wouters, Rafael. Shocks and frictions in us business cycles: A bayesian dsge approach. *American economic review*, 97(3):586–606, 2007.

Staiger, Robert W and Sykes, Alan O. 'currency manipulation'and world trade. *World Trade Review*, 9(4):583–627, 2010.

Wu, Jing Cynthia and Xia, Fan Dora. Negative interest rate policy and the yield curve. *Journal of Applied Econometrics*, 35(6):653–672, 2020.

Appendix

A Model derivation and log-linearization

For compactness, define

$$\mathcal{P}_{t,ij} \equiv P_{t,j}\frac{\mathcal{E}_{t,j}}{\mathcal{E}_{t,i}}, \qquad \mathcal{P}^R_{t,i} \equiv P_{t,RoW}\frac{\mathcal{E}_{t,RoW}}{\mathcal{E}_{t,i}}. \tag{A.1}$$

For a CES aggregator

$$Z = \left(\sum_m a_m^{1/\eta} z_m^{(\eta-1)/\eta}\right)^{\eta/(\eta-1)}, \qquad \sum_m a_m = 1, \tag{A.2}$$

expenditure minimization gives

$$z_m = a_m \left(\frac{p_m}{P^Z}\right)^{-\eta} Z, \tag{A.3}$$

$$P^Z = \left(\sum_m a_m p_m^{1-\eta}\right)^{1/(1-\eta)}. \tag{A.4}$$

A.1 Households

The Lagrangian for household i is

$$\mathcal{L}_i = E_0 \sum_{t=0}^{\infty} \delta^t \Bigg[\log \widetilde{C}_{t,i} - \frac{L_{t,i}^{1+\varphi}}{1+\varphi} \tag{A.5}$$

$$+ \mu_{t,i}\left(B_{t,i} + W_{t,i}L_{t,i} + T_{t,i} - \widetilde{P}^C_{t,i}\widetilde{C}_{t,i} - E_t\{Q^i_{t,t+1}B_{t+1,i}\}\right)\Bigg]. \tag{A.6}$$

The first-order conditions are

$$\frac{1}{\widetilde{C}_{t,i}} = \mu_{t,i}\widetilde{P}^C_{t,i}, \tag{A.7}$$

$$L^{\varphi}_{t,i} = \mu_{t,i}W_{t,i}, \tag{A.8}$$

$$Q^i_{t,t+1} = \delta\frac{\mu_{t+1,i}}{\mu_{t,i}}. \tag{A.9}$$

Equations (A.7) and (A.8) imply

$$L^{\varphi}_{t,i}\widetilde{C}_{t,i} = \frac{W_{t,i}}{\widetilde{P}^C_{t,i}}. \tag{A.10}$$

Equations (A.7) and (A.9) imply

$$Q^i_{t,t+1} = \delta\frac{\widetilde{P}^C_{t,i}\widetilde{C}_{t,i}}{\widetilde{P}^C_{t+1,i}\widetilde{C}_{t+1,i}}. \tag{A.11}$$

For a risk-free nominal bond,

$$R_{t,i}^{-1} = E_t Q_{t,t+1}^i, \tag{A.12}$$

and hence

$$1 = \delta R_{t,i} E_t \left[\frac{\widetilde{P}_{t,i}^C \widetilde{C}_{t,i}}{\widetilde{P}_{t+1,i}^C \widetilde{C}_{t+1,i}} \right]. \tag{A.13}$$

If $Q_{t,t+1}^i = Q_{t,t+1}^j$ state by state, then

$$\frac{\widetilde{P}_{t,i}^C \widetilde{C}_{t,i}}{\widetilde{P}_{t,j}^C \widetilde{C}_{t,j}} = c_{ij}. \tag{A.14}$$

A.2 Consumption demands and price indices

Applying (A.3)–(A.4) to the outer consumption nest gives

$$\widetilde{P}_{t,i}^C = \left[(1 - \gamma_i^{RoW,C}) (P_{t,i}^C)^{1-\eta^C} + \gamma_i^{RoW,C} (\mathcal{P}_{t,i}^R)^{1-\eta^C} \right]^{1/(1-\eta^C)}, \tag{A.15}$$

$$C_{t,i} = (1 - \gamma_i^{RoW,C}) \left(\frac{P_{t,i}^C}{\widetilde{P}_{t,i}^C} \right)^{-\eta^C} \widetilde{C}_{t,i}, \tag{A.16}$$

$$IM_{t,i,RoW}^C = \gamma_i^{RoW,C} \left(\frac{\mathcal{P}_{t,i}^R}{\widetilde{P}_{t,i}^C} \right)^{-\eta^C} \widetilde{C}_{t,i}. \tag{A.17}$$

Applying (A.3)–(A.4) to the network-consumption nest gives

$$P_{t,i}^C = \left(\sum_{j=1}^N \beta_{ij} \mathcal{P}_{t,ij}^{1-\eta^C} \right)^{1/(1-\eta^C)}, \tag{A.18}$$

$$C_{t,i,j} = \beta_{ij} \left(\frac{\mathcal{P}_{t,ij}}{P_{t,i}^C} \right)^{-\eta^C} C_{t,i}. \tag{A.19}$$

The foreign model-country import price index is

$$P_{t,i}^F = \left(\sum_{j \neq i} \beta_{ij}^F \mathcal{P}_{t,ij}^{1-\eta^C} \right)^{1/(1-\eta^C)}, \qquad \beta_{ij}^F = \frac{\beta_{ij}}{1 - \beta_{ii}}, \quad j \neq i, \tag{A.20}$$

and

$$S_{t,i} = \frac{P_{t,i}^F}{P_{t,i}}. \tag{A.21}$$

A.3 Firms

The final-good aggregator implies

$$P_{t,i} = \left(\int_0^1 P_{t,i,k}^{1-\epsilon} dk \right)^{1/(1-\epsilon)}, \tag{A.22}$$

$$Y_{t,i,k} = \left(\frac{P_{t,i,k}}{P_{t,i}} \right)^{-\epsilon} Y_{t,i}. \tag{A.23}$$

For a producer in country i,

$$Y_{t,i,k} = A_{t,i} L_{t,i,k}^{\alpha_i} X_{t,i,k}^{1-\alpha_i}. \tag{A.24}$$

Cost minimization over $L_{t,i,k}$ and $X_{t,i,k}$ gives

$$W_{t,i} = MC_{t,i}\alpha_i \frac{Y_{t,i,k}}{L_{t,i,k}}, \tag{A.25}$$

$$P_{t,i}^X = MC_{t,i}(1-\alpha_i)\frac{Y_{t,i,k}}{X_{t,i,k}}. \tag{A.26}$$

Thus

$$W_{t,i} L_{t,i,k} = \alpha_i MC_{t,i} Y_{t,i,k}, \tag{A.27}$$

$$P_{t,i}^X X_{t,i,k} = (1-\alpha_i) MC_{t,i} Y_{t,i,k}, \tag{A.28}$$

and

$$MC_{t,i} = \frac{1}{\alpha_i^{\alpha_i}(1-\alpha_i)^{1-\alpha_i}} \frac{1}{A_{t,i}} W_{t,i}^{\alpha_i} (P_{t,i}^X)^{1-\alpha_i}. \tag{A.29}$$

Aggregating across firms to first order around zero steady-state inflation gives

$$W_{t,i} L_{t,i} = \alpha_i MC_{t,i} Y_{t,i}, \tag{A.30}$$

$$P_{t,i}^X X_{t,i} = (1-\alpha_i) MC_{t,i} Y_{t,i}. \tag{A.31}$$

Applying (A.3)–(A.4) to the intermediate-input nest gives

$$P_{t,i}^X = \left(\sum_{j=1}^{N} \omega_{ij} \mathcal{P}_{t,ij}^{1-\eta^I} \right)^{1/(1-\eta^I)}, \tag{A.32}$$

$$X_{t,i,j} = \omega_{ij} \left(\frac{\mathcal{P}_{t,ij}}{P_{t,i}^X} \right)^{-\eta^I} X_{t,i}. \tag{A.33}$$

A.4 Calvo pricing

A firm resetting in period t solves

$$\max_{P_{t,i}^\star} E_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} \left[P_{t,i}^\star Y_{s,i,k} - (1-\bar{\tau}) MC_{s,i} Y_{s,i,k} \right] \tag{A.34}$$

subject to

$$Y_{s,i,k} = \left(\frac{P_{t,i}^\star}{P_{s,i}} \right)^{-\epsilon} Y_{s,i}, \qquad Q_{t,s} = \delta^{s-t} \frac{\widetilde{P}_{t,i}^C \widetilde{C}_{t,i}}{\widetilde{P}_{s,i}^C \widetilde{C}_{s,i}}. \tag{A.35}$$

The first-order condition is

$$0 = E_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} P_{s,i}^{\epsilon} Y_{s,i} \Big[(1-\epsilon)(P_{t,i}^\star)^{-\epsilon} \tag{A.36}$$

$$+ \epsilon(1-\bar{\tau}) MC_{s,i} (P_{t,i}^\star)^{-\epsilon-1} \Big]. \tag{A.37}$$

Therefore

$$P^{\star}_{t,i} = \frac{\epsilon}{\epsilon - 1}(1 - \bar{\tau}) \frac{E_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} P^{\epsilon}_{s,i} Y_{s,i} MC_{s,i}}{E_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} P^{\epsilon}_{s,i} Y_{s,i}}. \tag{A.38}$$

With $\bar{\tau} = 1/\epsilon$,

$$P^{\star}_{t,i} = \frac{E_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} P^{\epsilon}_{s,i} Y_{s,i} MC_{s,i}}{E_t \sum_{s=t}^{\infty} Q_{t,s} \lambda_i^{s-t} P^{\epsilon}_{s,i} Y_{s,i}}. \tag{A.39}$$

The aggregate price index evolves as

$$P^{1-\epsilon}_{t,i} = \lambda_i P^{1-\epsilon}_{t-1,i} + (1 - \lambda_i)(P^{\star}_{t,i})^{1-\epsilon}. \tag{A.40}$$

The first-order Phillips curve is

$$\pi_{t,i} = \delta E_t \pi_{t+1,i} + \kappa_i (mc_{t,i} - p_{t,i}), \qquad \kappa_i = \frac{(1 - \lambda_i)(1 - \delta\lambda_i)}{\lambda_i}. \tag{A.41}$$

A.5 Market clearing and steady-state shares

Goods-market clearing is

$$Y_{t,i} = \sum_{j=1}^{N} C_{t,j,i} + \sum_{j=1}^{N} X_{t,j,i} + EX^{RoW}_{t,i}. \tag{A.42}$$

External demand is

$$EX^{RoW}_{t,i} = \overline{EX}_i D_{t,i} \frac{\mathcal{E}_{t,RoW}}{P_{t,i} \mathcal{E}_{t,i}}. \tag{A.43}$$

The term $P_{t,RoW}$ is normalized to one, or equivalently absorbed into the external demand shifter $D_{t,i}$. The steady-state level $\overline{EX}_i$ is chosen such that trade with the RoW is balanced in steady state. In nominal terms, balanced trade requires

$$P_i \mathcal{E}_i \overline{EX}_i = P_{RoW} \mathcal{E}_{RoW} IM^{C}_{i,RoW}. \tag{A.44}$$

With $D_i = 1$ and steady-state prices and exchange rates normalized to one,

$$EX^{RoW}_{i} = \overline{EX}_i, \qquad \overline{EX}_i = IM^{C}_{i,RoW}. \tag{A.45}$$

From (A.16)–(A.17),

$$C_i = (1 - \gamma_i^{RoW,C}) \widetilde{C}_i, \qquad IM^{C}_{i,RoW} = \gamma_i^{RoW,C} \widetilde{C}_i. \tag{A.46}$$

Using $\widetilde{C}_i = C_i/(1 - \gamma_i^{RoW,C})$ gives

$$IM^{C}_{i,RoW} = \frac{\gamma_i^{RoW,C}}{1 - \gamma_i^{RoW,C}} C_i. \tag{A.47}$$

Hence,

$$\overline{EX}_i = \frac{\gamma_i^{RoW,C}}{1 - \gamma_i^{RoW,C}} C_i. \tag{A.48}$$

Let

$$C = \sum_{i=1}^{N} C_i, \qquad v_i = \frac{C_i}{C}, \qquad \zeta_i = \frac{Y_i}{C}, \qquad \zeta_i^{RoW} = \frac{\overline{EX}_i}{C}. \tag{A.49}$$

Then

$$\zeta_i^{RoW} = \frac{\gamma_i^{RoW,C}}{1-\gamma_i^{RoW,C}} v_i. \tag{A.50}$$

Steady-state demands imply

$$C_{i,j} = \beta_{ij} C_i, \qquad X_{i,j} = \omega_{ij} X_i, \qquad X_i = (1-\alpha_i) Y_i. \tag{A.51}$$

Define

$$\Omega_{ij} \equiv \frac{X_{i,j}}{Y_i} = (1-\alpha_i)\omega_{ij}. \tag{A.52}$$

Dividing market clearing by C gives

$$\zeta_i = \sum_{j=1}^{N} \frac{C_{j,i}}{C} + \sum_{j=1}^{N} \frac{X_{j,i}}{C} + \frac{\overline{EX}_i}{C} \tag{A.53}$$

$$= \sum_{j=1}^{N} \beta_{ji} v_j + \sum_{j=1}^{N} \Omega_{ji} \zeta_j + \zeta_i^{RoW}. \tag{A.54}$$

Hence

$$\boldsymbol{\zeta} = \boldsymbol{\beta}' \boldsymbol{v} + \boldsymbol{\Omega}' \boldsymbol{\zeta} + I_{\boldsymbol{\gamma}^{RoW,C}/(\mathbf{1}-\boldsymbol{\gamma}^{RoW,C})} \boldsymbol{v}, \tag{A.55}$$

and

$$\boldsymbol{\zeta} = (I - \boldsymbol{\Omega}')^{-1} \left(\boldsymbol{\beta}' + I_{\boldsymbol{\gamma}^{RoW,C}/(\mathbf{1}-\boldsymbol{\gamma}^{RoW,C})} \right) \boldsymbol{v}. \tag{A.56}$$

If data deliver shares in total final consumption, $\widetilde{v}_i = \widetilde{C}_i / \sum_m \widetilde{C}_m$, then

$$v_i = \frac{(1-\gamma_i^{RoW,C})\widetilde{v}_i}{\sum_{m=1}^{N}(1-\gamma_m^{RoW,C})\widetilde{v}_m}. \tag{A.57}$$

A.6 Log-linearized equations

Let $\hat{q}_{t,ij} = \hat{p}_{t,j} + \hat{e}_{t,j} - \hat{e}_{t,i}$ and $\hat{q}_{t,i}^{RoW} = \hat{p}_{t,RoW} + \hat{e}_{t,RoW} - \hat{e}_{t,i}$. The price indices are

$$\hat{p}_{t,i}^{C} = \sum_{j=1}^{N} \beta_{ij} \hat{q}_{t,ij}, \tag{A.58}$$

$$\hat{p}_{t,i}^{F} = \sum_{j \neq i} \beta_{ij}^{F} \hat{q}_{t,ij}, \tag{A.59}$$

$$\hat{s}_{t,i} = \hat{p}_{t,i}^{F} - \hat{p}_{t,i}, \tag{A.60}$$

$$\widehat{\widetilde{p}}_{t,i}^{C} = (1-\gamma_i^{RoW,C})\hat{p}_{t,i}^{C} + \gamma_i^{RoW,C} \hat{q}_{t,i}^{RoW}, \tag{A.61}$$

$$\hat{p}_{t,i}^{X} = \sum_{j=1}^{N} \omega_{ij} \hat{q}_{t,ij}. \tag{A.62}$$

The demand equations are

$$\hat{c}_{t,i} = \hat{\tilde{c}}_{t,i} - \eta^C(\hat{p}^C_{t,i} - \hat{\tilde{p}}^C_{t,i}), \tag{A.63}$$

$$\widehat{im}^C_{t,i,RoW} = \hat{\tilde{c}}_{t,i} - \eta^C(\hat{q}^{RoW}_{t,i} - \hat{\tilde{p}}^C_{t,i}), \tag{A.64}$$

$$\hat{c}_{t,i,j} = \hat{c}_{t,i} - \eta^C(\hat{q}_{t,ij} - \hat{p}^C_{t,i}), \tag{A.65}$$

$$\hat{x}_{t,i,j} = \hat{x}_{t,i} - \eta^I(\hat{q}_{t,ij} - \hat{p}^X_{t,i}). \tag{A.66}$$

Household optimality gives

$$\hat{\tilde{c}}_{t,i} = E_t\hat{\tilde{c}}_{t+1,i} - \left(\hat{r}_{t,i} - E_t\hat{\tilde{\pi}}^C_{t+1,i}\right), \tag{A.67}$$

$$\varphi\hat{l}_{t,i} + \hat{\tilde{c}}_{t,i} = \hat{w}_{t,i} - \hat{\tilde{p}}^C_{t,i}, \tag{A.68}$$

$$\hat{\tilde{p}}^C_{t,i} + \hat{\tilde{c}}_{t,i} = \hat{\tilde{p}}^C_{t,j} + \hat{\tilde{c}}_{t,j}, \qquad i \neq j, \tag{A.69}$$

where $\hat{\tilde{\pi}}^C_{t+1,i} = \hat{\tilde{p}}^C_{t+1,i} - \hat{\tilde{p}}^C_{t,i}$. The firm-side equations are

$$\widehat{mc}_{t,i} = -\hat{a}_{t,i} + \alpha_i\hat{w}_{t,i} + (1-\alpha_i)\hat{p}^X_{t,i}, \tag{A.70}$$

$$\hat{w}_{t,i} + \hat{l}_{t,i} = \widehat{mc}_{t,i} + \hat{y}_{t,i}, \tag{A.71}$$

$$\hat{p}^X_{t,i} + \hat{x}_{t,i} = \widehat{mc}_{t,i} + \hat{y}_{t,i}, \tag{A.72}$$

$$\hat{y}_{t,i} = \hat{a}_{t,i} + \alpha_i\hat{l}_{t,i} + (1-\alpha_i)\hat{x}_{t,i}, \tag{A.73}$$

$$\hat{\pi}_{t,i} = \delta E_t\hat{\pi}_{t+1,i} + \kappa_i(\widehat{mc}_{t,i} - \hat{p}_{t,i}), \tag{A.74}$$

$$\hat{\pi}_{t,i} = \hat{p}_{t,i} - \hat{p}_{t-1,i}. \tag{A.75}$$

Goods-market clearing is

$$\hat{y}_{t,i} = \sum_{j=1}^{N}\frac{\beta_{ji}v_j}{\zeta_i}\hat{c}_{t,j,i} + \sum_{j=1}^{N}\frac{\Omega_{ji}\zeta_j}{\zeta_i}\hat{x}_{t,j,i} + \frac{\zeta^{RoW}_i}{\zeta_i}\widehat{ex}^{RoW}_{t,i}. \tag{A.76}$$

External demand is

$$\widehat{ex}^{RoW}_{t,i} = \hat{d}_{t,i} + \hat{e}_{t,RoW} - \hat{p}_{t,i} - \hat{e}_{t,i}. \tag{A.77}$$

In the monetary union, $\hat{r}_{t,i} = \hat{r}_t$ and $\hat{e}_{t,i} = 0$ for all model countries i.

B Parametrization

Table 3: Intermediate Input Shares

		Exporting Country									
		at	*be*	*de*	*es*	*fi*	*fr*	*it*	*lu*	*nl*	*pt*
Importing Country	*at*	**0.6718**	0.0102	0.2171	0.0113	0.0065	0.0174	0.0415	0.0036	0.0180	0.0026
	be	0.0059	**0.6497**	0.0852	0.0183	0.0036	0.0884	0.0231	0.0170	0.1046	0.0041
	de	0.0299	0.0215	**0.8031**	0.0200	0.0063	0.0402	0.0270	0.0093	0.0395	0.0032
	es	0.0040	0.0096	0.0591	**0.7779**	0.0026	0.0718	0.0313	0.0062	0.0184	0.0191
	fi	0.0098	0.0229	0.1053	0.0177	**0.7264**	0.0366	0.0269	0.0043	0.0446	0.0055
	fr	0.0053	0.0319	0.0781	0.0362	0.0028	**0.7685**	0.0381	0.0082	0.0245	0.0066
	it	0.0127	0.0135	0.0593	0.0222	0.0028	0.0389	**0.8151**	0.0151	0.0182	0.0023
	lu	0.0049	0.0820	0.1512	0.0256	0.0011	0.0825	0.0603	**0.5573**	0.0316	0.0035
	nl	0.0078	0.0750	0.1349	0.0253	0.0077	0.0528	0.0217	0.0081	**0.6626**	0.0041
	pt	0.0027	0.0115	0.0534	0.1449	0.0017	0.0421	0.0219	0.0025	0.0188	**0.7005**

Notes: Bilateral import shares of intermediate inputs. Diagonal entries (domestic shares) in bold. Rows sum to one up to rounding.

Table 4: Final Consumption Shares

		Exporting Country									
		at	*be*	*de*	*es*	*fi*	*fr*	*it*	*lu*	*nl*	*pt*
Importing Country	*at*	**0.8451**	0.0029	0.0960	0.0081	0.0020	0.0077	0.0278	0.0008	0.0075	0.0021
	be	0.0025	**0.8509**	0.0354	0.0088	0.0010	0.0406	0.0120	0.0137	0.0335	0.0017
	de	0.0130	0.0071	**0.8980**	0.0119	0.0016	0.0176	0.0183	0.0050	0.0252	0.0025
	es	0.0018	0.0052	0.0327	**0.8809**	0.0008	0.0349	0.0180	0.0021	0.0111	0.0126
	fi	0.0037	0.0064	0.0574	0.0146	**0.8647**	0.0142	0.0110	0.0052	0.0197	0.0030
	fr	0.0018	0.0129	0.0355	0.0273	0.0011	**0.8754**	0.0241	0.0036	0.0124	0.0058
	it	0.0051	0.0059	0.0407	0.0178	0.0009	0.0225	**0.8960**	0.0006	0.0084	0.0020
	lu	0.0021	0.0361	0.0793	0.0143	0.0004	0.0599	0.0228	**0.7721**	0.0111	0.0020
	nl	0.0028	0.0241	0.0554	0.0092	0.0018	0.0153	0.0113	0.0019	**0.8752**	0.0031
	pt	0.0010	0.0046	0.0254	0.0722	0.0004	0.0234	0.0104	0.0014	0.0075	**0.8539**

Notes: Bilateral import shares in final consumption. Diagonal entries (domestic shares) in bold.

Table 5: Country-Level Parameters

	α	v	γ^{RoW}
at	0.3411	0.0329	0.0817
be	0.2986	0.0412	0.0653
de	0.3689	0.3065	0.0723
es	0.3482	0.1194	0.0732
fi	0.3276	0.0200	0.0965
fr	0.3698	0.2133	0.0734
it	0.2899	0.1805	0.0636
lu	0.1646	0.0033	0.1103
nl	0.3137	0.0604	0.0838
pt	0.3388	0.0225	0.0500

Notes: α denotes the labor share parameter, v the GDP share, and γ^{RoW} the share of consumption sourced from the rest of the world.

C Estimation

C.1 Data

For the estimation we use the following country-level data series:

Real GDP. The real GDP growth series stems from Eurostat (table namq_10_gdp, series B1GQ) and contains chain-linked volumes in Million euro. For the estimation, we divide by the total popoluation (Eurostat table namq_10_pe, series POP_NC).

Inflation. We use the harmonized index of consumer prices (annual rate of change) (all-times HICP) from Eurostat (table prc_hicp_manr). We aggregate the monthly series by taking the last observation from the quarter to arrive at a quarterly frequency.

Interest Rate. We use the EONIA interest rate as our baseline interest rate. In order to capture the Zero Lower Bound period, we rely on the shadow rate measure as in Wu and Xia (2020).[6]

We use calendar- and seasonally adjusted series whenever available at the country level. For Italy, France, and Portugal, seasonally adjusted series are constructed using

[6]We download the series from the private website of Cynthia Wu: https://sites.google.com/view/jingcynthiawu/shadow-rates.

Dynare's MATLAB `x13` function.

C.2 Measurement equations

Let $GDP_{i,t}$ denote real gross domestic product, $POP_{i,t}$ total population, and $CPI_{i,t}$ the consumer price index in country i at time t.

The three observables used in the estimation are constructed as follows.

Per capita real GDP growth. Per capita real GDP growth in country i is measured as

$$\Delta y_{i,t}^{obs} = \log\left(\frac{GDP_{i,t}}{POP_{i,t}}\right) - \log\left(\frac{GDP_{i,t-1}}{POP_{i,t-1}}\right). \tag{C.1}$$

Inflation. Quarterly inflation in country i is measured from the quarterly HICP series as

$$\pi_{i,t}^{obs} = \log(CPI_{i,t}) - \log(CPI_{i,t-1}). \tag{C.2}$$

Interest rate. Let R_t^{data} denote the quarterly average of the EONIA shadow rate, expressed as an annualized net rate in percent. We transform this series into the log quarterly gross rate according to

$$i_t^{obs} = \log\left(1 + \frac{R_t^{data}}{4 \cdot 100}\right). \tag{C.3}$$

All observables are demeaned over the estimation sample. The corresponding measurement equations are therefore given by

$$\Delta y_{i,t}^{obs} = \hat{y}_{i,t} - \hat{y}_{i,t-1}, \tag{C.4}$$

$$\pi_{i,t}^{obs} = \hat{\pi}_{i,t}, \tag{C.5}$$

$$i_t^{obs} = \hat{R}_t. \tag{C.6}$$

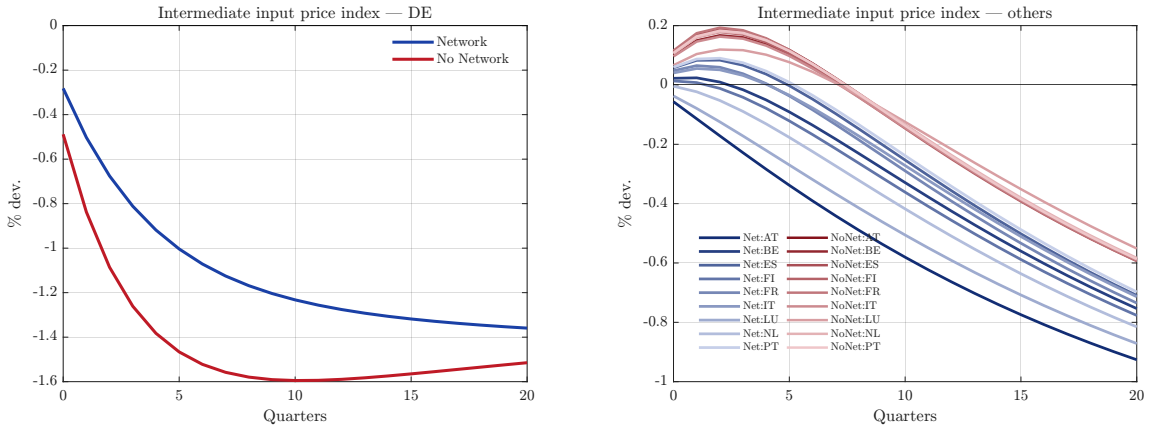
Thus, output growth is linked to the change in model-implied per capita output, inflation is linked directly to model inflation, and the interest rate observable is linked to the model's nominal interest rate in log-deviation form.

D Additional results

D.1 Impulse response functions

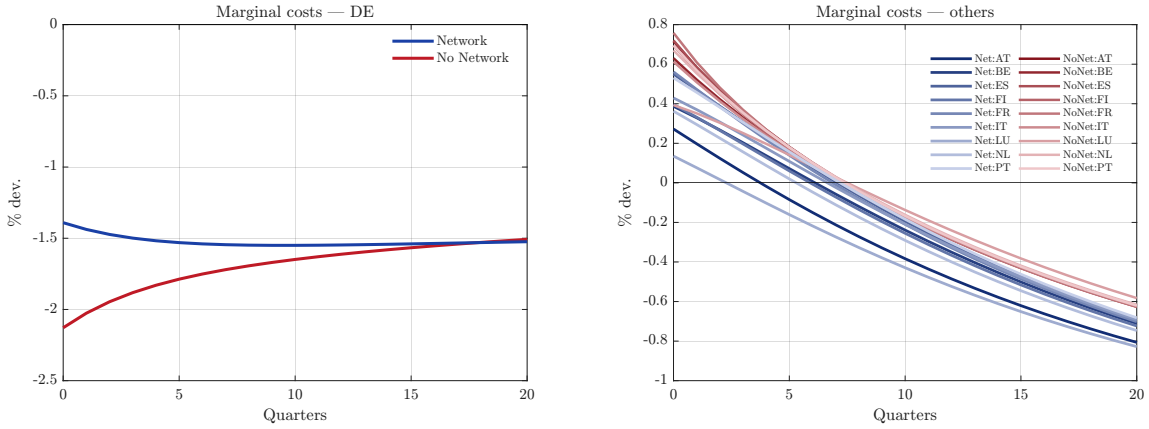
D.1.1 Technology shocks

Figure D.1: Impulse responses for price index of intermediate inputs to an idiosyncratic TFP shock in Germany.



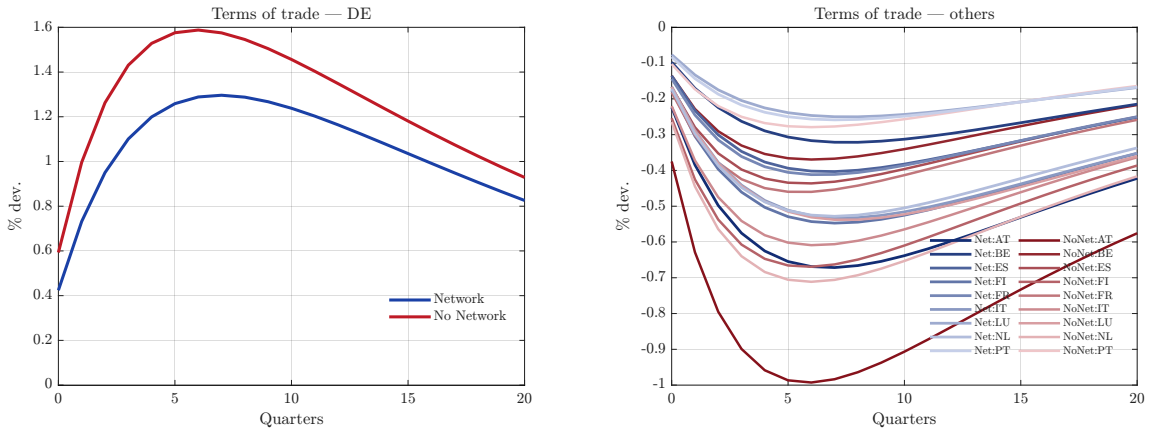
Notes: The figure reports impulse responses to an idiosyncratic TFP shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.2: Impulse responses for marginal costs to an idiosyncratic TFP shock in Germany.



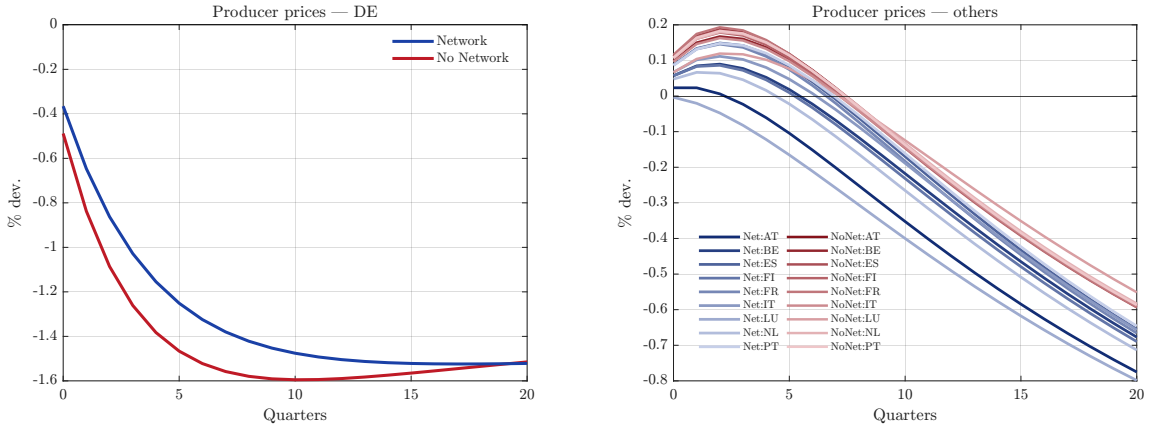
Notes: The figure reports impulse responses to an idiosyncratic TFP shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.3: Impulse responses for terms of trade to an idiosyncratic TFP shock in Germany.



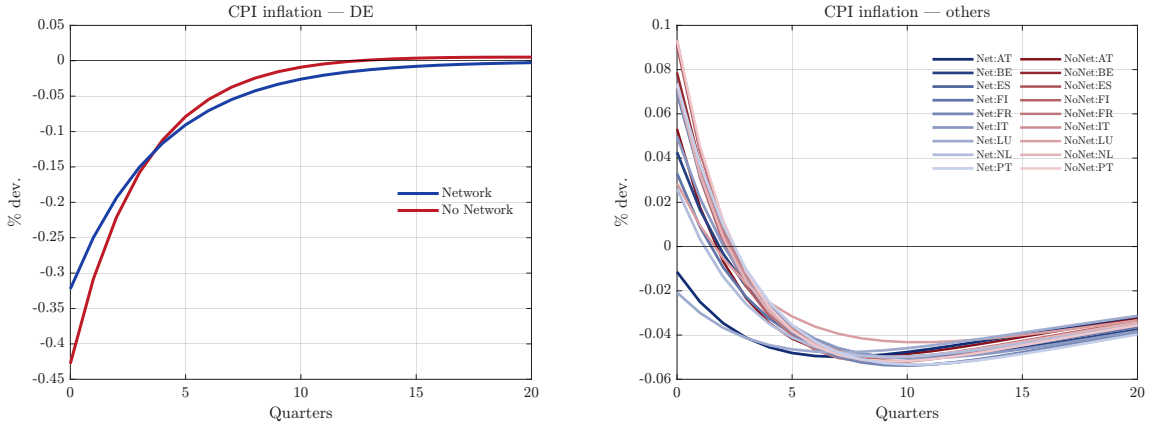
Notes: The figure reports impulse responses to an idiosyncratic TFP shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.4: Impulse responses for producer prices to an idiosyncratic TFP shock in Germany.



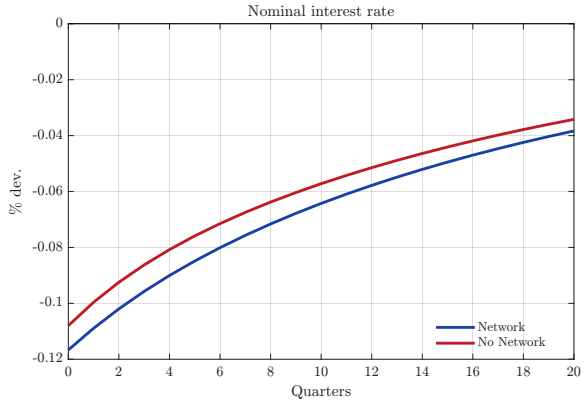
Notes: The figure reports impulse responses to an idiosyncratic TFP shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.5: Impulse responses for CPI inflation to an idiosyncratic TFP shock in Germany.



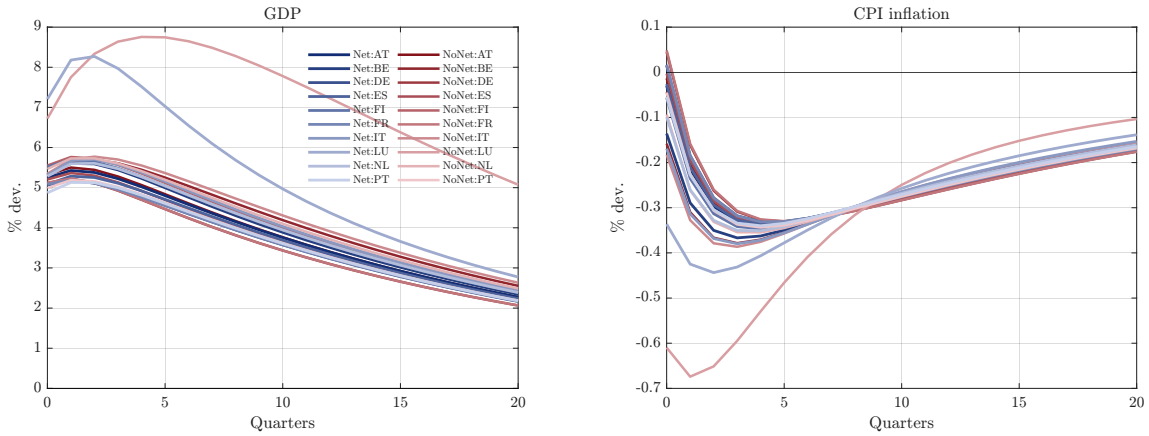
Notes: The figure reports impulse responses to an idiosyncratic TFP shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.6: Impulse responses for nominal interest rates to an idiosyncratic TFP shock in Germany.



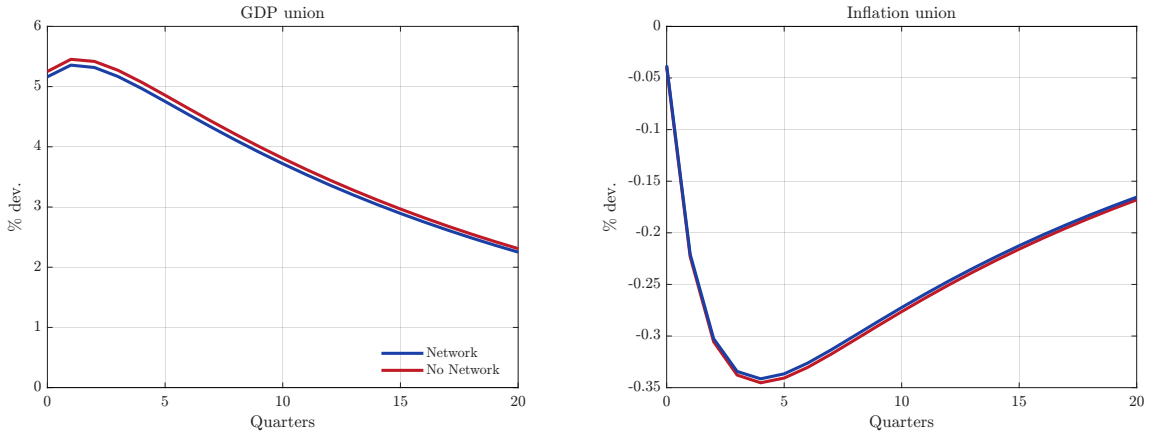
Notes: The figure reports impulse responses to an idiosyncratic TFP shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.7: Impulse responses for GDP and CPI inflation to a common TFP shock.



Notes: The figure reports impulse responses to a common TFP shock. The left panel shows the response of GDP and the right panel the response of inflation across all countries, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

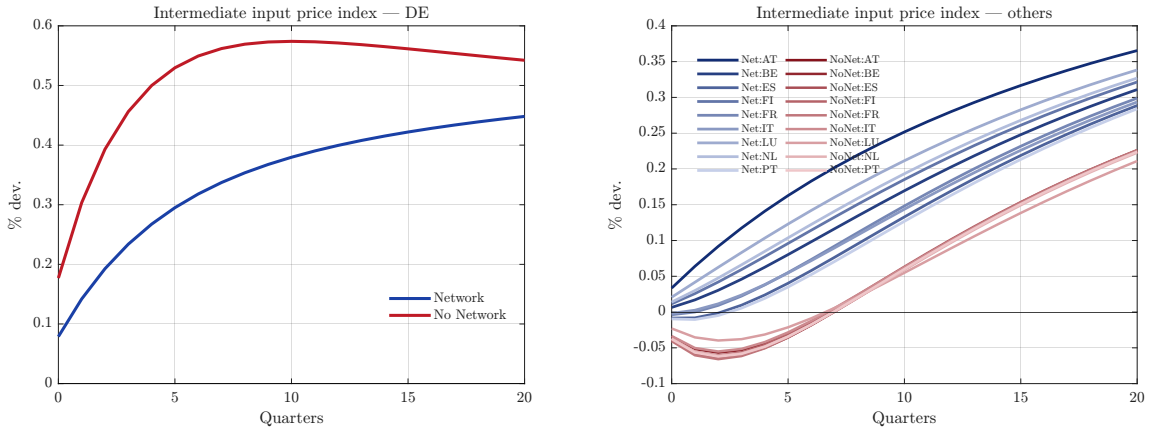
Figure D.8: Union impulse responses of GDP and inflation to a common TFP shock.



Notes: The figure reports impulse responses to an estimated aggregate TFP shock. The left panel shows the response of union GDP whereas the right panel shows the response of union inflation. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

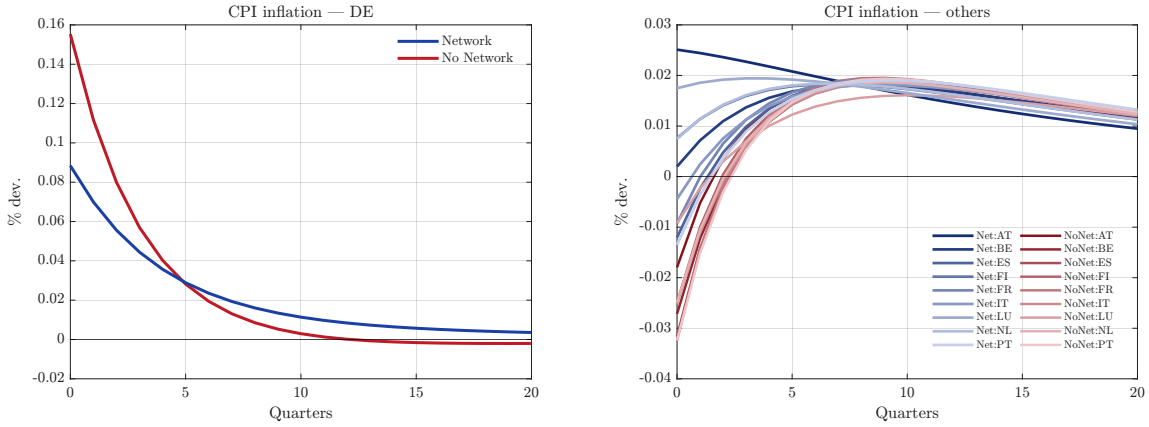
D.1.2 RoW demand shocks

Figure D.9: Impulse responses for price index of intermediate inputs to an idiosyncratic RoW demand shock in Germany.



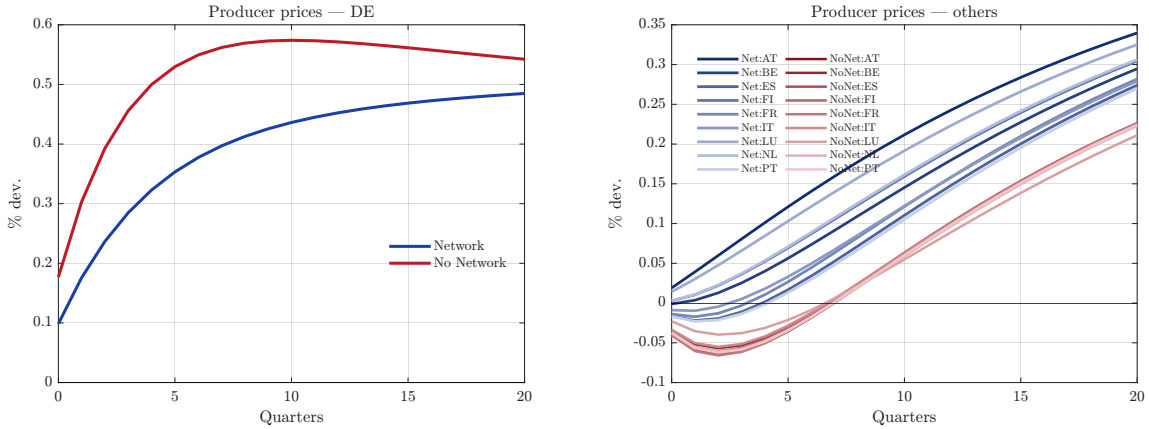
Notes: The figure reports impulse responses to an idiosyncratic RoW demand shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.10: Impulse responses for CPI inflation to an idiosyncratic RoW shock in Germany.



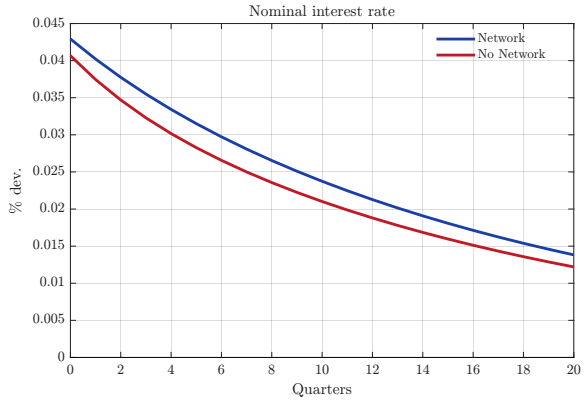
Notes: The figure reports impulse responses to an idiosyncratic RoW demand shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.11: Impulse responses for producer prices to an idiosyncratic RoW shock in Germany.



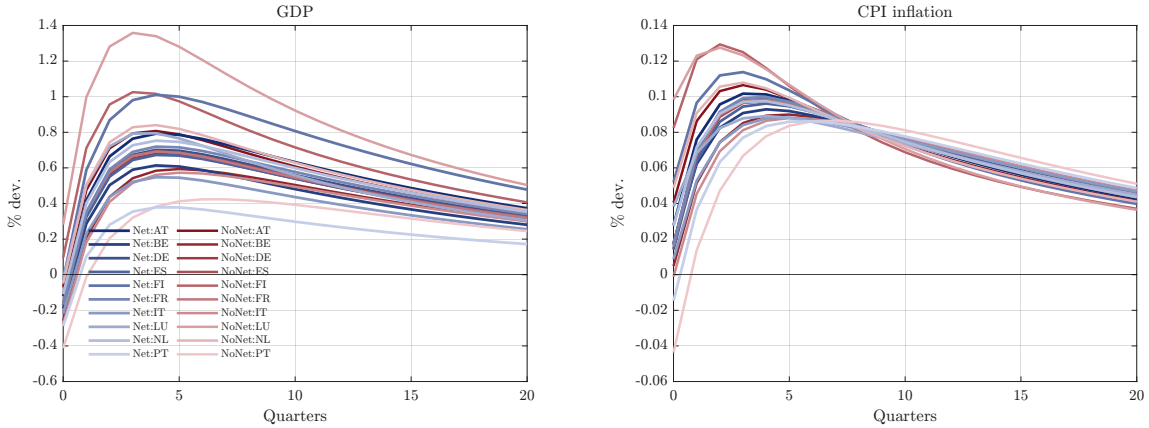
Notes: The figure reports impulse responses to an idiosyncratic RoW demand shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.12: Impulse responses for nominal interest rates to an idiosyncratic RoW shock in Germany.



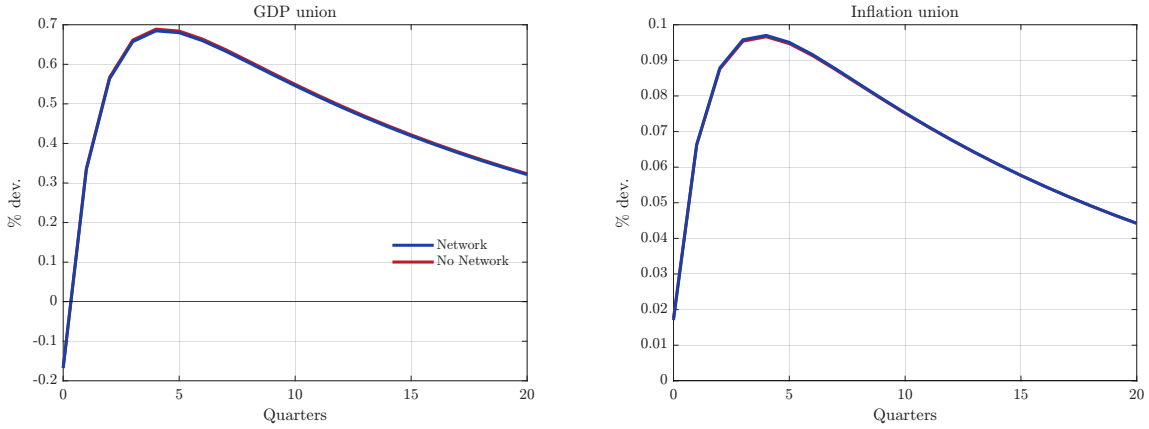
Notes: The figure reports impulse responses to an idiosyncratic RoW demand shock in Germany. The left panel shows the response of Germany, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.13: Impulse responses for GDP and CPI inflation to a common RoW demand shock.



Notes: The figure reports impulse responses to a common RoW demand shock. The left panel shows the response of GDP and the right panel the response of inflation across all countries, and the right panel shows the response of the rest of the union. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.

Figure D.14: Union impulse responses of GDP and inflation to a common RoW demand shock.



Notes: The figure reports impulse responses to an estimated common RoW demand shock. The left panel shows the response of union GDP whereas the right panel shows the response of union inflation. Responses are scaled to an estimated one-standard-deviation shock. Blue lines refer to the model with production network linkages; red lines refer to the model without production network structure.