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## The macroeconomic effects of global supply chain reorientation

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The macroeconomic effects of global supply chain reorientation

No 2903

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## Abstract

Policymakers around the world are encouraging the local production of key inputs to reduce risks from excessive dependencies on foreign suppliers. We analyse the macroeconomic effects of supply chain reorientation through localisation policies, using a global dynamic general equilibrium model. We proxy non-tariff measures, such as the stricter enforcement of regulatory standards, which reduce import quantity but do not directly alter costs and prices. These measures have, so far, been a key component of attempts to reshore production and are an increasingly popular trade policy instrument in general. Focusing on the euro area, we find that localisation policies are inflationary, imply transition costs and generally have a negative long-run effect on aggregate domestic output. The size (and sign) of the impact depends on whether these policies are implemented unilaterally or induce a retaliation from trade partners, and also the extent to which they reduce domestic competition and productivity. We provide some recommendations for policymakers considering implementing a localisation agenda.

*Keywords:* General equilibrium; Reshoring; Strategic autonomy

*JEL Classification:* F13, F41; F45; F62

## Non-technical summary

The COVID-19 pandemic and heightened geopolitical tensions from events such as Brexit, the US/China trade dispute and the Russian invasion of Ukraine, have increased concerns over the smooth functioning and security of global supply chains. European policymakers, like many others around the world, have introduced legislation to spur the local production of key manufacturing inputs and reduce “excessive dependencies” on external suppliers. These initiatives seek to help Europe achieve *Open Strategic Autonomy*.

While arguments about comparative advantage, the potential forgone benefits of international specialisation and industry- and product-specific disruptions are familiar, there is less analysis on the macroeconomic effects of supply chain changes resulting from localisation policies. The large sensitivity of the global economy to the recent supply chain shocks suggests that the international trade reconfiguration implied by localisation policies could also have sizable impacts on key macroeconomic variables such as output, employment and inflation.

To analyse this issue, we simulate a (partial) reshoring of production back to Europe in a global dynamic general equilibrium framework. Our model covers three regions: the euro area, the United States and the rest of the world. These economies are linked through bilateral trade and participation in international financial markets, with region-specific calibration. We model the reshoring of production by (permanently) replacing a proportion of imported inputs used in the creation of export goods with locally produced inputs. Thus, localisation focuses on the goods in our model most closely related to global supply chains.

Our approach is a proxy for non-tariff measures, such as the stricter enforcement of regulatory standards, which reduce import quantity but do not directly alter costs and prices. A value added of our framework is that we can analyse not only the *long-run* effects of the reshoring, but also the *medium-term* adjustment process following a decision to reshore.

We start by analysing the effects of a basic scenario in which the euro area *unilaterally* reshores part of its production and there is no impact from reshoring on local competition and productivity and no retaliation by trade partners. However, there are several reasons why reshoring might be less benign for local economic activity. We analyse three such scenarios: (i) a (permanent) rise in local firm price markups (from increased market power), (ii) a fall in local firm productivity (from the use of lower-quality local inputs) and (iii) a retaliation by trade partners.

We find that a unilateral reshoring of some production by the euro area is inflationary, implies transition costs and generally has a negative long-run effect on aggregate domestic output, considering plausible detrimental effects on local competition and productivity. A symmetric retaliation by trade partners also results in persistently higher euro area inflation, although less pronounced than in the unilateral scenario. Retaliation also attenuates any positive effects from reshoring on output and implies a reduction in the volume of overall international trade.

The move towards Open Strategic Autonomy is rooted in concerns over and beyond economics. However, European policymakers should consider the economic trade-offs related to the implementation of localisation policies and understand the main transmission channels through which these policies affect the economy.

To counter the inflationary pressures of reshoring, it is essential to minimise the crowding out of resources (i.e. capital and labour) that pushes up costs and prices in our simulations. This finding calls for limiting the scope of reshoring, such as by focusing on vital goods that are most susceptible to supply chain disruptions.

Another important finding is that if local tradable firms use their greater market power to increase their markups, this likely negates any positive effect of reshoring on domestic output, and amplifies inflationary pressures. Therefore, policymakers should avoid excessively weakening Europe's long-established state aid rules and competition laws, as reduced foreign competition may ultimately undermine the local economy. It could also lead to demands for support in other industries, which are not the focus of reshoring initiatives.

Our results also indicate that if locally produced inputs are inferior to their imported counterparts, reduced productivity amplifies the economic costs of reshoring. As such, policymakers should focus localisation policies on goods where there is already an existing comparative advantage in production (or, at least, where the distance from the technological frontier is not too large). Either that, or the economic costs are considered a worthwhile trade-off for an increase in security of supply, for example.

*“European strategic autonomy is goal number one for our generation.”*

Charles Michel, President of the European Council

## 1 Introduction

The COVID-19 pandemic and heightened geopolitical tensions from events such as Brexit, the US/China trade dispute and the Russian invasion of Ukraine, have increased concerns over the smooth functioning and security of global supply chains. European policymakers, like many others around the world, have introduced legislation to spur the local production of key manufacturing inputs and reduce “excessive dependencies” on external suppliers. These initiatives seek to help Europe achieve *Open Strategic Autonomy*, one of the key policy objectives of the von der Leyen European Commission.<sup>1</sup> Broadly speaking, this term refers to the European Union (EU)’s ability to protect its interests and adopt its preferred economic, defence and foreign policy without depending heavily on foreign states.

While arguments about comparative advantage, the potential forgone benefits of international specialisation and industry- and product-specific disruptions are familiar, there is less analysis on the macroeconomic effects of supply chain changes resulting from localisation policies. Recent supply chain shocks have had large effects, with disruptions in 2021 estimated to have reduced euro area GDP by around two percent and doubled the rate of manufacturing producer inflation (Celasun et al., 2022). These disruptions contributed to the need for a large fiscal response – first to the COVID-19 pandemic, and later to the energy crisis.<sup>2</sup> The large sensitivity of the global economy to the smooth functioning of supply chains suggests that the international trade reconfiguration implied by localisation policies could also have sizable impacts on key macroeconomic variables such as output, employment and inflation.

To analyse this issue, we simulate a (partial) reshoring of production back to Europe in a global dynamic general equilibrium framework. Our model covers three regions: the euro area (EA), the United States (US) and the rest of the world (RW). These economies are linked

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<sup>1</sup>In Appendix A, we discuss a specific piece of legislation that illustrates the concept of Open Strategic Autonomy: the European Chips Act. This legislation aims to bolster the supply of (strategically important) semiconductors and demonstrates the shift in emphasis towards the domestic production of some essential goods. Note that we use the euro area and Europe interchangeably throughout, and that we also use domestic, local and regional as synonyms.

<sup>2</sup>European countries have allocated over €750 billion in supports since the energy crisis erupted, according to a Bruegel database (Sgaravatti et al., 2022). To put this in context, German supports are equivalent to almost 7.5% of GDP.

through bilateral trade and participation in international financial markets, with region-specific calibration. We model the reshoring of production by (permanently) replacing a proportion of imported inputs used in the creation of export goods with locally produced inputs. Thus, localisation focuses on the goods in our model most closely related to global supply chains.<sup>3</sup> We model reshoring through a direct change to the export goods' production-function parameters. Our approach is a proxy for non-tariff measures, such as the stricter enforcement of regulatory standards, which reduce import quantity but do not directly alter costs and prices.

We start by analysing the effects of the EA *unilaterally* reshoring part of its production. In a basic scenario, whereby there is no impact from reshoring on local competition and productivity and no retaliation by trade partners, aggregate output in the economy increases by around 0.5% in the *long run*. An important aspect of this economic expansion is the reaction of foreign firms, who *drop* their prices in response to the anticipated fall in demand. Since the reshoring is only partial, the cost savings on remaining imported inputs boosts the competitiveness of EA exporters and allows them to export more. This long-run effect more than compensates for the real effective exchange rate appreciation from the rise in domestic costs and prices (due to increased demand for factor inputs). The positive wealth effect from increased export earnings facilitates a rise in consumption and a decrease in work effort, with increased investment required for the capital-intensive rise in production.

Another crucial aspect of these long-run results is the rise in foreign demand for EA exports. This occurs because of the reduction in a source of inefficiency: the market power of export firms, which enables them to set a markup over marginal costs. At each stage of the supply chain, producers charge markups (assumed, for now, to be constant over time). Since reshoring effectively shortens the supply chain, the sum of markups along the chain falls. These cost savings facilitate the expansion in demand in all three regions and are key to our finding of increased aggregate output in this basic scenario.

A value added of our framework is that we can analyse the *medium-term* adjustment process following a decision to reshore. We find that aggregate economic output is lower and inflation is higher initially, while the economy adjusts. Increased costs and prices result in a (real effective) exchange rate appreciation that worsens external competitiveness and leads to a shift in resources

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<sup>3</sup>Our exercise looks at reshoring the production of goods that are solely intended for export. This captures only one component of trade, and production that ends in domestic use may still use foreign inputs in the same way as before. This means that imports that are at the end of the supply chain (i.e. final goods) remain unaffected. Our results are robust to the reshoring of imported final goods. This analysis is available upon request.



from tradable to non-tradable production. Gradually, as lower import prices feed into lower export prices, the effect of the appreciation is more than offset and demand for EA exports rises. This, and the increase in domestic demand for tradable goods (from the decision to reshore), results in a need for greater tradable production and the transition towards the new steady state is set in motion.

In the basic scenario we have described so far, reshoring leads to higher economic activity in the long run at the cost of increased prices. However, there are several reasons why reshoring might be less benign for local economic activity. We analyse three such scenarios and find that the size (and sign) of the impact of unilateral reshoring on aggregate output depends on the extent to which it results in: (i) a (permanent) rise in local firm price markups (from increased market power), (ii) a fall in local firm productivity (from the use of lower-quality local inputs) and (iii) a retaliation by trade partners. We find that the adverse impacts of the markup and productivity shocks resulting from reshoring would likely more than offset the positive impact from moving production back home, resulting in permanently lower domestic aggregate output. Finally, if Europe's trade partners *retaliate* by also reshoring (a symmetric amount of) production, the increase in EA economic activity and inflation is attenuated by a less pronounced wealth effect and, in contrast to the unilateral scenarios, global trade declines.

***Related literature:*** Our analysis fits within the broad literature examining the role of global supply chains as a mechanism for the propagation and amplification of shocks (Carvalho et al., 2021). In particular, our work relates to papers examining the potential for countries to reduce their exposure to global supply chains. Rodrik (1998) and Giovanni and Levchenko (2009) find that greater openness increases an economy's exposure to external shocks. In contrast, Caselli et al. (2020) show that international trade reduced volatility in most countries and Bonadio et al. (2021) demonstrate that reduced reliance on foreign inputs does not mitigate pandemic-induced contractions in labour supply. D'Aguanno et al. (2021) find no evidence of a relationship between global value chain integration and macroeconomic volatility.

The onset of the COVID-19 pandemic and the severe supply chain issues seen in many countries has fostered a narrative that countries and regions could be better off reducing their exposure to foreign shocks that propagate into their economies through trade in intermediate goods. Baldwin and Freeman (2021) provide a comprehensive discussion of proposals to reduce this exposure, such as decoupling from global supply chains through greater use of domestic



inputs, shortening value chains and through further diversification of input sources. Additionally, the rising global tensions following Russia's invasion of Ukraine suggests that a more fragmented international system could replace previous norms of ever more open markets and increasing globalisation. In particular, strategic geopolitical rivalries may decrease the weight on economic gains from trade. This dynamic, along with factors such as natural disasters, climate-change induced volatility and terrorism mean that supply chain disruptions could be a new normal (Grossman et al., 2021).

Our work contributes to the literature providing dynamic general equilibrium analyses of protectionist policies, in particular those using global macroeconomic models to quantify trade policy changes. Faruqee et al. (2008) analyse the effect of a rise in protectionism in response to rising global trade imbalances. They find that imposing import tariffs does not help reduce these imbalances. Lindé and Pescatori (2019) find that although the macroeconomic costs of a trade war are substantial, a fully symmetric retaliation is the best response. Cappariello et al. (2020) consider a rich input-output structure and demonstrate that closer integration amplifies the adverse effects of protectionist trade policies. Other papers to analyse trade policy issues using the EAGLE model framework include Pisani and Vergara Caffarelli (2018), Bolt et al. (2019) and Jacquinot et al. (2022).

Several recent studies have also examined the economic effects of a global trade fragmentation. Góes and Bekkers (2022) find that Europe could suffer substantial welfare losses from a split into a two-bloc world along geopolitical lines. The size of the effect depends crucially on the extent to which this decoupling reduces the cross-border diffusion of ideas and therefore innovation. A common finding is that distortions to trade from geopolitical fragmentation generally entail higher prices and lower welfare (Javorcik et al., 2022; Felbermayr et al., 2023; Attinasi et al., 2023; Campos et al., 2023).<sup>4</sup> Greater localisation may also increase vulnerability to (external and domestic) shocks (OECD, 2020).

We contribute to this literature in a number of ways. First, we modify a dynamic general equilibrium model of the global economy in order to analyse the transmission of localisation policies. This allows for a comprehensive treatment of cross-border macroeconomic interdependencies and spillovers between the different regions.

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<sup>4</sup>There is, however, substantial cross-country heterogeneity in terms of impact, with small open economies (SOEs) reliant on global supply chains more affected. Clancy et al. (2023) analyse spillovers to SOEs from the localisation policies of (much) larger trade partners and examine the use of fiscal policy instruments to reshore production. See Aiyar et al. (2023) and Ioannou et al. (2023) for comprehensive discussions of the wider economic implications of the changing geopolitical environment.

Second, we are able to assess both long-run effects and the transition dynamics of localisation policies. We believe that the short- to medium run effects are crucial from a policy perspective. Our model contains a detailed monetary block and captures inflation dynamics, which is a key concern for supply chain reorientation. These important macroeconomic features are typically highly stylised, or omitted, from static international trade models.

Third, our approach permits an analysis of non-tariff measures (NTMs), which are so far dominating the localisation agenda. The generic nature of our shock means it is a suitable proxy for a broad range of NTMs, including potential future new measures. Another advantage of our approach is that implementing reshoring through NTMs means that a rise in inflation and an output loss is not a pre-determined outcome, as is the case when modelling reshoring through import tariffs and/or a rise in (iceberg) trade costs.

The main limitations of our approach, compared to international trade models, are the lack of differentiation between goods at the detailed product level. A more granular production structure, such as differentiating between the production of essential and non-essential goods, would enhance our modelling of cross-border linkages.<sup>5</sup> The generic nature of our reshoring shock also does not allow for an analysis of specific policy measures.

Overall, our paper contains a careful analysis of the key aspects of the localisation debate, including effects of localisation on domestic competition and efficiency. The outline of the paper is as follows. Section 2 provides a brief overview of the model, the modifications to examine global supply chain reorientation, some key details on the calibration and a brief discussion of the nature of our exercise. We present the results of our simulations of the unilateral reshoring scenarios in Section 3 and the retaliation scenario in 4. Finally, in Section 5, we summarise our findings and discuss their policy implications.

## 2 Model overview

We conduct our analysis using an extended version of the EAGLE, a dynamic general equilibrium model. This framework permits the implementation of counterfactual exercises and avoids issues of causal identification faced by empirical studies. Here we only provide an overview of the model, with the reader referred to [Gomes et al. \(2012\)](#) for details on the original model, [Brzoza-Brzezina et al. \(2014\)](#) for the import content of exports component and [Clancy et al. \(2016\)](#) for

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<sup>5</sup>See [Hunt et al. \(2020\)](#) and [Smith et al. \(2020\)](#) for discussions of the relative strengths and weaknesses of trade and macroeconomic models in assessing large economic shocks.

government imports.<sup>6</sup>

We model three regions of the global economy: the euro area (EA), the United States (US) and the rest of the world (RW). The structure of each economy is symmetric and linked with each other through bilateral trade and participation in international financial markets, with bloc-specific calibration. This allows for a comprehensive treatment of cross-border macroeconomic interdependences and spillovers between the different regions. We include a number of real and nominal rigidities in order to match the sluggish reaction of prices and wages found in macroeconomic data. We display the structure of the model in Figure 1.

Each economy features both Ricardian and liquidity-constrained households, firms, and monetary and fiscal authorities. The (infinitely-lived) households consume final goods, allocate time between work and leisure and offer imperfectly substitutable labour services to domestic firms. They use their market power to set wages with a markup over the marginal rate of substitution between labour and consumption. Households own domestic firms and the capital stock, which it rents to firms in a fully competitive market.

Firms produce non-tradable final goods, tradeable and non-tradeable intermediate goods, and provide intermediation services. Non-tradable final goods are produced by perfectly competitive firms and include consumption goods, investment goods and public goods. Tradable goods are an aggregate of domestically produced and imported goods. Final goods are produced using domestic tradable and non-tradable intermediate goods and imported goods, combined according to a constant elasticity of substitution technology. Different varieties of intermediate goods are imperfect substitutes, produced under monopolistic competition. This market power allows firms to set nominal prices with a markup over marginal costs. Each intermediate good is produced using domestic and (internationally immobile) labour and capital that are combined according to a Cobb–Douglas technology. Intermediate goods are sold both in the domestic and in the export market. Importantly for our analysis, this implies that there are five types of imports in the model: imports of intermediate goods for private consumption and investment, for government consumption and investment and for exports.

The monetary authority sets the national short-term nominal interest rate according to a standard Taylor-type rule, by reacting to changes in consumer inflation and real output. The fiscal authority sets government consumption and investment expenditures (contributing

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<sup>6</sup>Further extensions of the EAGLE model framework have added search and matching frictions in the labour market (Jacquinot et al., 2018), financial frictions in (country-specific) banking sectors (Bokan et al., 2018) and import tariffs (Jacquinot et al., 2022).

to domestic capital stock) with an explicit imported component. On the revenue side, the government (exogenously) sets labour income tax and social contribution rates, capital income tax rates and consumption tax rates. Public debt is stabilised through a fiscal rule that induces an endogenous adjustment through lump-sum taxes.

## 2.1 Supply chain reorientation

Our analysis focuses on imported inputs used to produce goods for export, as the introduction of localisation policies is in response to recent disruptions to global supply chains. These are a composite of imports from the other regions of the world, with the quantity and price of bilateral imports a function of preference shares and the elasticity of substitution from different trading partners. Imported inputs are then combined with domestic tradable inputs, produced using domestic capital and labour. Depending on demand, which is a function of preferences and relative prices, these goods are either packaged with locally produced non-tradables as final goods for private and public consumption and investment or exported for use in other countries' production. More formally, exports in our model are a combination of locally produced tradable inputs and intermediate imports (Armington, 1969):

$$X_t(h) = \left[ \nu_{X,t}^{\frac{1}{\mu_X}} HT_t^X(h)^{\frac{\mu_X-1}{\mu_X}} + (1 - \nu_{X,t})^{\frac{1}{\mu_X}} IM_t^X(h)^{\frac{\mu_X-1}{\mu_X}} \right]^{\frac{\mu_X}{\mu_X-1}} \quad (1)$$

where  $X_t(h)$  denotes exports of the tradeable intermediate good produced by firm  $h$ ,  $HT_t^X$  denotes locally produced tradeable goods,  $IM_t^X$  denotes intermediate imports destined for re-export and  $\mu_X$  represents the intertemporal elasticity of substitution between local tradable goods and imported inputs. In order to examine the macroeconomic effect of supply chain reorientation, we introduce *time-varying* weights of local inputs  $\nu_{X,t}$  in the export good bundle:

$$\nu_{X,t} = (1 - \rho_{\nu_X}) \bar{\nu}_X + \rho_{\nu_X} \nu_{X,t-1} + \epsilon_{\nu_{X,t}}, \quad (2)$$

allowing us to simulate (permanent or temporary) changes in these weights. One can think of these weights as preferences, formed due to historical linkages, shared language / culture, geographical distance, quality of products and ease of procurement (such as the existence and/or extent of non-tariff barriers) for example.<sup>7</sup>

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<sup>7</sup>Our use of these weights to pin down the steady-state import content of exports means they represent a region's revealed (trade) preference.

In our simulations, we increase the value of  $\overline{\nu_X}$ , thereby permanently increasing the home bias of export firms and causing them to use a greater proportion of local inputs in production. The modelling of this variable as an autoregressive process means that this change is implemented gradually (i.e. the transition speed is dictated by the size of the parameter  $\rho_{\nu_X}$ ). As we employ a general equilibrium framework, this change will affect costs, prices and demand for all other goods in the economy. We provide some more details on how this change propagates through the model system in Appendix B.

As our framework does not have internationally mobile firms, we cannot endogenously capture the impact of reshoring on local competition and productivity. Since these are important considerations in the debate surrounding supply chain reorientation, we analyse these as separate scenarios by imposing an additional shock on top of the change in the weight in local inputs in export goods.

To model the potential effect of reduced local competition following a supply chain reorientation, we introduce a *time-varying* elasticity of substitution of tradable firms' goods to increase their market power:

$$HT_{t+k}(h) = \left( \frac{P_{t+k}(h)}{P_{HT,t+k}} \right)^{-\theta_{T_t}} HT_{t+k} \quad (3)$$

where  $HT_t(h)$  is demand for tradable firm  $h$ 's goods sold in the domestic market,  $P_t(h)$  is the firm-specific price of these goods,  $P_{HT,t}$  is the aggregate price of tradable goods,  $\theta_{T_t}$  is the elasticity of substitution for their brand and  $HT_t$  is aggregate demand for tradables (taken as given). Tradable sector firms can also sell their differentiated output in foreign markets:

$$IM_{t+k}^{CO}(h) = \left( \frac{P_{X,t+k}}{P_{X,t+k}^{H,CO}} \right)^{-\theta_{T_t}} IM_{t+k}^{CO,H}. \quad (4)$$

where  $IM_t^{CO}(h)$  is demand for tradable firm  $h$ 's goods sold in the foreign market  $CO$  (either the US or the RW),  $P_{X,t}(h)$  is the firm-specific price of these goods,  $P_{X,t}^{H,CO}$  is the aggregate price of tradable goods from the euro area (region  $H$ ) in region  $CO$  and  $IM_t^{CO,H}$  is aggregate demand for tradables imports from the euro area in region  $CO$  (again, taken as given). By reducing the elasticity of substitution, firms have greater market power and can charge a larger markup over their marginal cost. We model these time-varying elasticities of substitution in a similar way to the weights of local inputs in the export bundle (i.e. as an autoregressive process).

Finally, we also consider the potential side effect of having to use lower-quality goods in areas where Europe is not at the technological frontier. Returning to the example of semi-conductors, Europe is substantially behind global leaders (such as South Korea and Taiwan) in terms of advanced chip manufacturing capabilities. To examine this aspect of the supply chain reorientation debate, we implement a shock to the total factor productivity term in the local tradable good firm's production function:

$$Y_{T,t}(h) = \max \{z_T K_t(h)^{\alpha_T} N_t(h)^{1-\alpha_T} - \psi_T, 0\} \quad (5)$$

where  $Y_{T,t}$  is the output of tradable firm  $h$ ,  $K_t^D$  and  $N_t^D$  are the firms' capital and labour, the parameter  $\alpha_T$  represents the share of capital used in the production of tradable goods, the parameter  $\psi_T$  represents fixed costs of production (calibrated to ensure zero profits in the steady state and therefore ruling out an incentive for other firms to enter the market in the long run) and  $z_{T,t}$  are (permanent or temporary) sector-specific productivity shocks. As with the other shocks, we model productivity as an autoregressive process to facilitate a gradual transition to the new steady state level.

## 2.2 Calibration

To get a sense of the euro area's trade relationships in the model, we detail the key steady state ratios and bilateral trade partners in Table C1. The most important dimension of our analysis relates to international trade. The euro area is the smallest and most open region. [Arriola et al. \(2020\)](#) note that countries that tend to rely more on foreign inputs and ship larger portions of their production to foreign markets are more exposed to global value chain disruptions. Unsurprisingly, given the relative size of the regions, the RW is the EA's largest trading partner for all types of imports. The value of parameters in the model (Tables C2-C7) are either based on region-specific empirical evidence, where available, or kept consistent with the original model which uses standard values, prevalent in the literature. See [Gomes et al. \(2012\)](#) and [Clancy et al. \(2016\)](#) for details.

It is worth highlighting that we follow the principle that the elasticity of substitution between tradable and non-tradable goods is substantially lower than the elasticity of substitution between different types of tradable goods. We set the (long-run) elasticity of substitution between tradable goods to 2.5 and the (long-run) elasticity of substitution between tradable and

non-tradable goods to 0.5. These values come from [Faruqee et al. \(2008\)](#) and are in line with the literature.<sup>8</sup> The elasticities of substitution between local tradable goods and imports (of 2.5) are closer to the macroeconomic literature than the trade literature, which often uses higher values (see, for example, [Imbs and Mejean \(2015\)](#)).

Regarding the focus of our study, the value for  $\nu_X$  is greatest for the US (where only 15% of exports contain imported components) and lowest for the RW (where over one third of exports are composed of imported inputs). The EA lies closer to the middle of this range, with an import content of exports of around one fifth. The  $\mu_X$  for each region is set at 1.5, meaning that intermediate imports used in the creation of exports are substitutes and not complements.

Finally, price and wage markups are generally larger in the EA, indicating a somewhat less competitive economy than the other regions.<sup>9</sup> Markups in the non-traded sector are larger than for the tradable and export sectors in all regions, as they are less exposed to foreign competition. We assume that nominal (price and wage) rigidities are the same across regions.

### 2.3 Nature of the exercise

Our approach to modelling localisation involves a permanent change to the export goods' production-function parameters. This change in international trade structure is not the endogenous result of an explicit policy decision in the model. As such, this change is efficient, in the sense that it does not impose any deadweight loss, as would occur if we modelled reshoring using import tariffs, subsidies or through iceberg trade costs for example.<sup>10</sup>

However, we believe that our approach is a useful proxy of a generic rise in non-tariff measures (NTMs). Examples of NTMs include the imposition of local content requirements, stricter quality standards and alterations in national procurement rules to favour local sellers and promote strategic sectors. [Fugazza \(2013\)](#) provides a comprehensive discussion of these policy instruments. We focus on NTMs, as these are becoming the dominant instrument of trade protectionism ([Niu et al., 2018](#)) and are a likely policy tool through which countries may attempt

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<sup>8</sup>Note that because of adjustment costs on bilateral imports, actual *short-run* elasticities in the model are smaller, in line with the empirical evidence ([Peter and Ruane, 2023](#)). [Drozd et al. \(2021\)](#) model a dynamic elasticity, that is low in the short run but high in the long run, by imposing a convex adjustment cost on trade shares. This represents an interesting avenue for future research within our framework.

<sup>9</sup>Our results are not dependent on this region-specific calibration. We verified this by also assessing the effects of reshoring production in a fully symmetric model, with all regions being of equal size and having the same calibrated values.

<sup>10</sup>Obstfeld and Rogoff (2000) note that imposing home bias is isomorphic to the effects of trade costs. The size of such costs depend on the elasticity of substitution. Future research could seek to ascertain the value for the elasticity of substitution for which our approach to modeling reshoring becomes inefficient.



to reshore production (Kratz et al., 2022). They are also extremely flexible. Grundke and Moser (2019) provide empirical evidence that the stricter enforcement of product standards, a typical form of an NTM, is countercyclical and reacts to business cycle developments. Since NTMs are often de facto, rather than de jure, policy changes, they are less likely to draw attention from trade partners and thereby risk retaliation.<sup>11</sup>

An additional advantage of implementing reshoring with these policy instruments is that changes in prices and output are not a pre-determined outcome. For example, modelling reshoring through import tariffs and/or a rise in (iceberg) trade costs imposes a rise in import prices. Instead, modelling localisation measures directly through a change in trade shares does not presuppose a particular response in costs and prices (and, therefore, demand for and production of affected goods). Directly altering trade shares, without imposing cost and price increases, is therefore a close proxy of a localisation policy driven by local content, quota and other legally based trade *volume* distorting NTMs.

These instruments are not barriers that exporters can overcome through price adjustments. They lock out a share of, or all, imports of a product. Other non-tariff barriers can have a similar effect through a prohibitively-high cost of compliance. For example, the European Communities (EC)'s health restrictions on beef imports in 1989 lead to an immediate alteration of trade shares due to the collapse in US beef exports to the EC (Johnson, 2017). The change in EC standards meant that US industry would have had to completely restructure to meet the new criteria, an infeasible adjustment for producers. In this case, the NTM essentially ruled out price and cost adjustments to regain trade shares and US producers in these industries were essentially blocked from the market.

### 3 Unilateral reshoring

We utilise scenario analysis to examine the effects of Europe reshoring production. For now, we assume that this is unilateral (i.e. the other regions do not retaliate by also reshoring production). This basic, and arguably simplistic, scenario allows us to explore the main mechanisms through which reshoring policies affect the economy, but without the additional complications resulting from simultaneous changes in the production structure of the other regions.<sup>12</sup>

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<sup>11</sup>Moral suasion is another channel through which governments can encourage desired behavioural changes (Ongena et al., 2019).

<sup>12</sup>After describing the effects from this simple case, we examine more realistic scenarios that also consider impacts on local competition and productivity and a retaliation by trade partners. These additions could also

We model reshoring by increasing the bias for locally produced inputs used in the creation of exports from the other regions in favour of locally produced inputs. We impose this change in the production structure by inducing a permanent 1% of GDP decrease, relative to the initial steady state, in the EA's imported inputs used in the production of export goods. This transition occurs gradually, with almost all of the change complete after 10 years. As we solve our model using perfect foresight, all agents in the model are fully aware of the path the shock will take.<sup>13</sup>

We first discuss the long-term implications of reshoring. This facilitates a comparison of our results with international trade models, which generally focus on comparative statics. We display these long-term results in the second column of Table 1.

This shock raises aggregate output in the economy by around 0.5% in the long run.<sup>14</sup> Increasing the share of local inputs used to produce exports decreases demand for the imported component of these goods. Foreign exports firms react to this drop in demand by reducing the price of these goods.<sup>15</sup> Since the reshoring is only partial, the cost savings on remaining imported inputs results in a fall in the marginal cost for EA exporters. This is despite the higher demand for factor inputs feeding through into higher costs, with local tradable good prices rising as a result. The reduction in costs allows export firms to reduce their prices, boosting their competitiveness and leading to an increase in foreign demand for their goods. There is a decline in the terms of trade as export prices fall by more than import prices.

The increased demand for local inputs results in an increase in tradable sector production. Higher domestic demand, and therefore costs and prices, induces a real effective exchange rate (REER) appreciation. There is a positive wealth effect from the REER appreciation and increased export earnings, boosting domestic households' consumption of both imported (consumption and investment) and domestic non-tradable goods. The boost in domestic demand requires an increase in non-tradable production, further boosting aggregate production. Investment also increases, as the positive wealth effect reduces work effort (resulting in higher wages)

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capture other salient aspects of international trade that are not endogenous in our model. [Feenstra \(2018a\)](#) notes the particular importance of pro-competitive (i.e. reduced markups) and productivity gains from trade, which he estimates account for roughly 30 and 40% respectively of total US gains.

<sup>13</sup>Our model is deterministic and is solved using a non-linear Newton-type algorithm in Dynare (see [Adjemian et al. \(2011\)](#) for details). Not having to linearise the model around a given steady state allows us to plot the transition dynamics between the initial and new steady state (i.e. after the supply chain reorientation).

<sup>14</sup>The quantitative size of this effect is similar for a unilateral 1% of GDP reshoring of imported inputs for export goods in both the RW and US regions (an increase in aggregate output of around 0.3%). The underlying transmission channel is also the same. These results are available from the authors upon request.

<sup>15</sup>[Khalil and Strobel \(2021\)](#) provide empirical evidence that cuts to import prices as a result of (trade-policy induced) exchange rate appreciations largely offset tariff price increases.

and the rise in tradable production is driven by increases in capital usage (reducing the rental cost of capital). Domestic debt falls as increased economic activity boosts tax revenue.

A crucial aspect of these long-run results is the rise in foreign demand for EA exports. Why does this occur, when, all else being equal, the reduction in demand for some of their exports to the EA should have a negative effect on the RW and US? The reason all regions benefit in this basic scenario is due to the reduction of a source of inefficiency: the market power of export firms, which enables them to set a markup over marginal costs. At each stage of the supply chain, producers charge markups (assumed, for now, to be constant over time). Since reshoring effectively shortens the supply chain, the sum of markups along the chain falls. This means that less resources are lost due to inefficiencies from markups.<sup>16</sup> These cost savings facilitate the expansion in demand in all three regions and are key to our finding of increased aggregate output in the basic scenario.

Importantly, despite engaging in unilateral reshoring, these savings are not entirely captured by the EA. This is clear from the roughly 0.5% increase in aggregate production in the EA following the reshoring of 1% additional output. The RW and US also benefit through the endogenous response of prices and reallocation of production that boosts EA demand for other types of imports and lowers the price of EA exports. The RW and US increase production to meet increased EA demand, and can do so at lower prices due to the cost savings passed on from EA production being less subject to inefficient distortions from firm market power.

A value added of our framework is the ability to analyse the dynamic response. For policymakers, it is essential to understand the adjustment process. There are some important considerations from the short- to medium-term responses to reshoring production. We display these results (solid line) in Figure 2.

In adjusting to this change, inflation rises by roughly 10 basis points on impact. This effect is highly persistent, with inflation elevated for over a decade. The anticipated rise in production, and therefore factor input costs and prices, results in an expected interest rate differential and an immediate jump in the exchange rate. This appreciation boosts demand for other (i.e. untargeted for localisation) imports, and results in a trade deficit. There is local currency pricing, which means the change in exchange rate is not fully passed through to exports (i.e. the appreciation of the euro does not result in an immediate large increase in the price charged in

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<sup>16</sup>In a model where product variety is endogenously determined by firm entry, [Bilbiie et al. \(2019\)](#) demonstrate that markups (and the profits they provide) can be welfare enhancing.

foreign markets). As a result, the increased demand for exports takes some time to materialise, and this weighs on tradable production in the short run. Indeed, this reduction in tradable production is sufficiently large to result in a decrease of aggregate production.

Gradually, as lower import prices (from foreign firms reacting to reduced demand for their goods in EA) feed into lower export prices (by reducing their marginal costs), the effect of the appreciation is fully offset and demand for EA exports rises. This, and the increase in domestic demand for tradable goods, results in a need for greater tradable production and the transition towards the new steady state is set in motion.

### 3.1 Increased firm market power

Greater economic openness exposes local firms to foreign competition. However, efforts to boost local production would likely reduce existing producers' exposure to foreign competition. The large setup costs involved in global supply chains, as well as relaxations in EU state-aid rules aimed at facilitating greater public support for existing firms, make it more difficult for new entrants. By signalling a clear increase in preference for local intermediate inputs, localisation policies could (unintentionally) increase market power of domestic firms in supported sectors and allow them to increase their price markups.

We now amend our simplified unilateral reshoring scenario to include an additional (permanent) shock to EA tradable-good firms' market power. In the absence of conclusive evidence of what the size of this increase in market power would likely be, we scale this shock to induce a 0.5 percentage-point increase in tradable-good price markups (from 30% to 30.5%). Given the uncertainty as regards the size of this effect, we emphasise that this is a scenario and is largely for illustrative purposes.<sup>17</sup> We nevertheless believe that this calibration is within a plausible range. This increase in markups is similar to increases documented in the literature for typical fluctuations in markups due to business cycle shocks (Nekarda and Ramey, 2021).

As before, the shock occurs gradually and is almost fully absorbed after 10 years. We display the results (dashed line) in Figure 2. As in the basic scenario, we first describe the long-run effects. The long-run effect on euro area output is negative in this scenario, as losses from lower competition more than offset gains from bringing production back home (third column of

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<sup>17</sup>There are wide range of estimates of the pro-competitive gains from trade. Feenstra (2018b) estimates the US gains from trade (between 1992 and 2005) at just over 1% of GDP, of which he ascribes approximately 0.4% to decreased markups. However, Costinot and Rodríguez-Clare (2018) estimate gains from trade for the US over a similar period (1995 to 2011) at between 2 and 8% of GDP.

Table 1). The underlying mechanism is similar to the basic scenario. A decrease in demand for imported inputs in the production of exports results in foreign firms reducing their prices. This boosts the competitiveness of euro area exporters, and therefore exports rise despite the REER appreciation. A positive wealth effect spurs consumption and non-tradable sector production, while lowering work effort.

What is different to the basic scenario is that the greater market power of tradable firms allows them to increase their prices by far more. This reduces demand for tradable goods and therefore tradable sector output falls (while there is an increase in the production of the local input for export goods, these are only one component of overall tradable production). Demand for factor inputs is lower, with investment falling in line with reduced aggregate production.

In terms of the adjustment process, the rise in inflation is much larger than in the basic scenario. This reduces the real interest rate, spurring consumption and resulting in a stronger, but shorter-lived, monetary-policy response. Reduced domestic demand due to higher tradable good prices means that investment and employment both decline sharply over the short to medium term. Accordingly, the improvement in public finances is mitigated in this scenario.

### 3.2 Reduced firm productivity

Reshoring production weakens the interaction of the domestic economy with global supply chains. Openness affects growth positively, as economies that are more open have a greater ability to absorb technological advances generated elsewhere (Barro and Sala-i Martin, 1997). Global value chains have important implications for productivity and innovation.<sup>18</sup> Increased competition from foreign suppliers can induce improvements in domestic firms. Firms can have potential gains through specialising in their most productive tasks and from utilising a wider array of new varieties and higher quality foreign goods, services and intangible inputs. Further to these effects, engagement with global firms provides an opportunity for knowledge spillovers to local firms (Crisuolo et al., 2017). Reshoring could potentially weaken all of these transmission channels, resulting in the use of lower quality locally produced inputs.

We next amend our simplified unilateral reshoring scenario to include an additional (perma-

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<sup>18</sup>Trade in our model is motivated by the Armington assumption that countries produce unique goods and consumers have a love of variety. However, this setup is silent on potentially important implications of localisation policies, such as shift patterns of specialisation driving by comparative advantage. Given Arkolakis et al. (2012)'s equivalence result for different classes of quantitative trade models, it is unclear whether incorporating such changes in specialisation would affect our aggregate results. This represents an important avenue for future research.

ment) shock to tradable-good firms' productivity. Again, in the absence of definitive evidence of how big this shock might be, we induce a 0.5% decrease in tradable-good productivity for illustrative purposes.<sup>19</sup> As before, the shock occurs gradually and is almost fully absorbed after 10 years. We display the long-term results in the fourth column of Table 1.

We find that reshoring has a negative effect on EA output in this scenario. As in the basic scenario, there is an increase in non-tradable output, consumption and investment as well as an appreciation of the REER. However, the less efficient use of factor inputs means that the marginal cost of producing tradable goods increases substantially. Export prices fall, but by less than import prices and therefore exports are lower (and the terms of trade improve). Imports are also lower, despite the REER appreciation, because there is no longer a positive wealth effect from increased competitiveness.

The adjustment process is quite similar to the basic scenario, with a key difference being the lower beneficial effect of reshoring on consumption, investment, public finances and the REER appreciation (results displayed using the dotted line in Figure 2). The main differences largely emerge in the medium term, where the more rapid rise in marginal costs means that exports and tradable production remain lower as external competitiveness is weaker. While the response of inflation is initially larger, the muted effect on domestic demand means that the monetary policy response can also be weaker.

## 4 Retaliation by trade partners

Our analysis has thus far focused on the case of Europe unilaterally reshoring production. In reality, such developments would almost certainly induce a retaliation from trade partners.<sup>20</sup> In our framework, retaliation is not endogenous and we model it as an exogenous change. More specifically, we analyse a symmetric form of retaliation. This means that we need to take into account the differential size of the regions. To match the 1% of GDP reshoring in the EA, we implement a respective 0.4% and 0.65% of GDP reductions in RW and US imports of tradable goods for re-export. This ensures the reduction of the same quantity of imports in each region.

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<sup>19</sup>Feenstra (2018b) estimates that productivity account for around 30% of the total US gains (1.1% of GDP) from trade between 1992-2005.

<sup>20</sup>Martin and Vergote (2008) show that retaliation is a necessary feature of an efficient equilibrium in trade agreements. This is because governments do not, or cannot, compensate trade partners for terms-of-trade externalities.

As before, these changes occur gradually and take roughly 10 years to implement.<sup>21</sup> We display the long-term results in the fifth column of Table 1.

Following a partial reshoring of production by all regions, the long-term effects on the EA economy are quite similar to the unilateral scenario. Indeed, the response of almost all variables has the same sign in the medium to long run, with the prominent exception of foreign trade, which declines in the retaliation scenario. Magnitudes also differ, along with the short-term response of inflation and nominal interest rates. We focus our discussion on the variables that now have an opposite-signed response to the unilateral scenario.

The positive wealth effect from the increase in exports, despite the appreciated exchange rate, reduced work effort in the unilateral scenario. When the other regions retaliate, this effect is no longer present and hours worked no longer decrease. The less pronounced wealth effect also means that imports fall as the rise in domestic demand is dampened. Exports now decrease, despite the reduction in the marginal cost of producing these goods, due to lower foreign demand for imported inputs for export goods. The increase in economic activity facilitates a fall in domestic debt, with consumption rising from higher labour income (wages and hours worked increase). Investment increases to facilitate the expansion in production in both the tradable and non-tradable sectors.

As with the unilateral scenarios, there are some useful insights from analysing the adjustment process (we display the results from this scenario using the dashed line in Figure 3). On impact, the REER appreciates due to the anticipated rise in factor input costs and therefore prices associated with increased tradable good production. However, this process takes time to play out, and in the short-run the reduction in tradable output means there is an initial decline in inflation and nominal interest rates. The decline in exports is sharper than for imports, and a trade deficit opens. As production gradually ramps up prices and inflation rise and induce a tightening of monetary policy. Domestic debt remains relatively stable initially, before declining once aggregate output begins to increase.

Overall, our analysis shows that retaliation attenuates the positive effect of reshoring on domestic economic activity. However, the savings from the reduction of inefficient distortions remain sufficient for an increase in aggregate production in the EA. However, this result does

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<sup>21</sup>We abstract from analysing potential knock-on effects on local competition and productivity in this scenario, as this would require us making assumptions regarding differential impacts of decreased competition and productivity across the three regions. Of course, even if technically feasible, the imposition of multiple simultaneous region-specific shocks would raise important concerns over interpretation. Therefore, this scenario is essentially the global equivalent of the basic scenario analysed in Section 3.



not include the likely detrimental effects on local competition and productivity (as analysed in Section 3). Another concern is that international trade decreases in this scenario, with imports and exports in all three regions lower. This fragmentation of the global economy runs counter to the EU's aim to achieve *Open Strategic Autonomy*.

## 5 Conclusion

The move towards Open Strategic Autonomy is rooted in concerns over and beyond economics. However, European policymakers should consider the economic trade-offs related to the implementation of localisation policies and understand the main transmission channels through which these policies affect the economy. We find that a unilateral reshoring of some production by the euro area is inflationary, implies transition costs and generally has a negative long-run effect on aggregate domestic output, considering plausible detrimental effects on local competition and productivity. A symmetric retaliation by trade partners also results in persistently higher EA inflation, although less pronounced than in the unilateral scenario. Retaliation also attenuates any positive effects from reshoring on output and implies a reduction in the volume of overall international trade.

To counter the inflationary pressures of reshoring, it is essential to minimise the crowding out of resources (i.e. capital and labour) that pushes up costs and prices in our simulations. This finding calls for limiting the scope of reshoring, such as by focusing on vital goods that are most susceptible to supply chain disruptions.

Another important finding is that if local tradable firms use their greater market power to increase their markups, this likely negates a positive effect of reshoring on domestic output, and amplifies inflationary pressures. Therefore, policymakers should avoid excessively weakening Europe's long-established state aid rules and competition laws, as reduced foreign competition may ultimately undermine the local economy. It could also lead to demands for support in other industries, which are not the focus on reshoring initiatives.<sup>22</sup>

Our results also indicate that if locally produced inputs are inferior to their imported counterparts, reduced productivity amplifies the economic costs of reshoring. As such policymakers should focus localisation policies on goods where there is already an existing comparative advantage in production (or, at least, where the distance from the technological frontier is not too

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<sup>22</sup>Experience with past initiatives, such as the Common Agricultural Policy, demonstrates that industries can become reliant on public support (Kazukauskas et al., 2013).

large). Either that, or the economic costs are considered a worthwhile trade-off for an increase in security of supply.

We believe there are several other interesting avenues for future research on this topic using our modelling approach. An important aspect, given our finding that localisation policies are inflationary, is the monetary policy response. In our simulations, all regions have the same calibrated values in their Taylor rules. Making these values region specific would allow one to analyse how monetary policy could affect the adjustment following localisation initiatives. Our model framework is also capable of analysing other forms of supply chain reorientation. For example, reorientation of production towards “trusted partners” (friendshoring) could be approximated by increasing their share in intermediate-good imports from one region at the expense of another.

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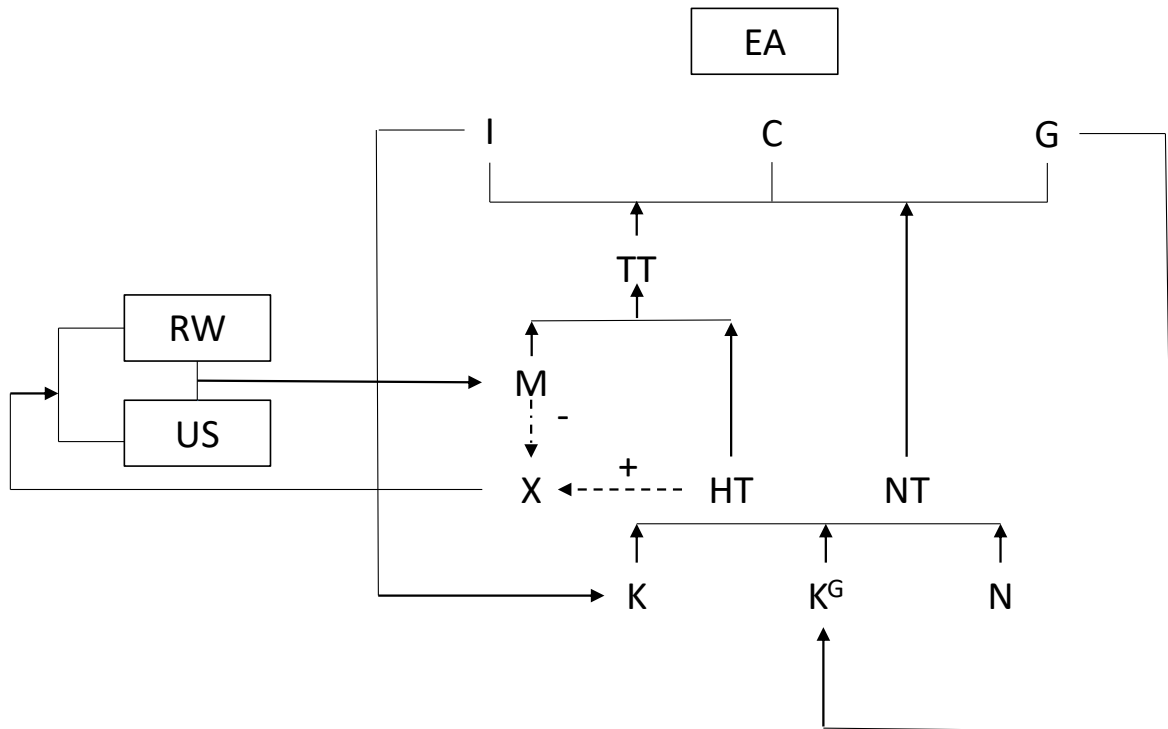
## Tables and Figures

TABLE 1. Long-term effects of reshoring (% deviation from initial steady state)

	<b>Unilateral</b>	<b>Markups</b>	<b>Productivity</b>	<b>Retaliation</b>
Imported inputs for exports (% of aggregate output)	-1.0	-1.0	-1.0	-1.0
Aggregate output	0.5	-0.3	-0.4	0.3
Tradable output	0.5	-1.4	-1.1	0.5
Nontradable output	0.5	0.6	0.2	0.1
Consumption	1.4	1.2	0.6	0.4
Investment	1.9	0.0	0.8	0.9
Hours worked	-0.1	-0.3	0.0	0.0
Real effective ex. rate	-1.9	-2.3	-1.6	-1.0
Effective terms of trade	0.3	0.9	-0.1	1.3
Imports	0.7	1.6	-0.1	-1.6
Exports	1.0	2.5	-0.2	-0.2
Tradable marginal costs	0.7	0.1	1.5	0.2
Imports for re-export prices	-2.1	-2.1	-1.5	-0.8
Export prices	-2.5	-3.0	-1.5	-2.3
Domestic debt	-1.8	-0.4	-0.8	-0.7

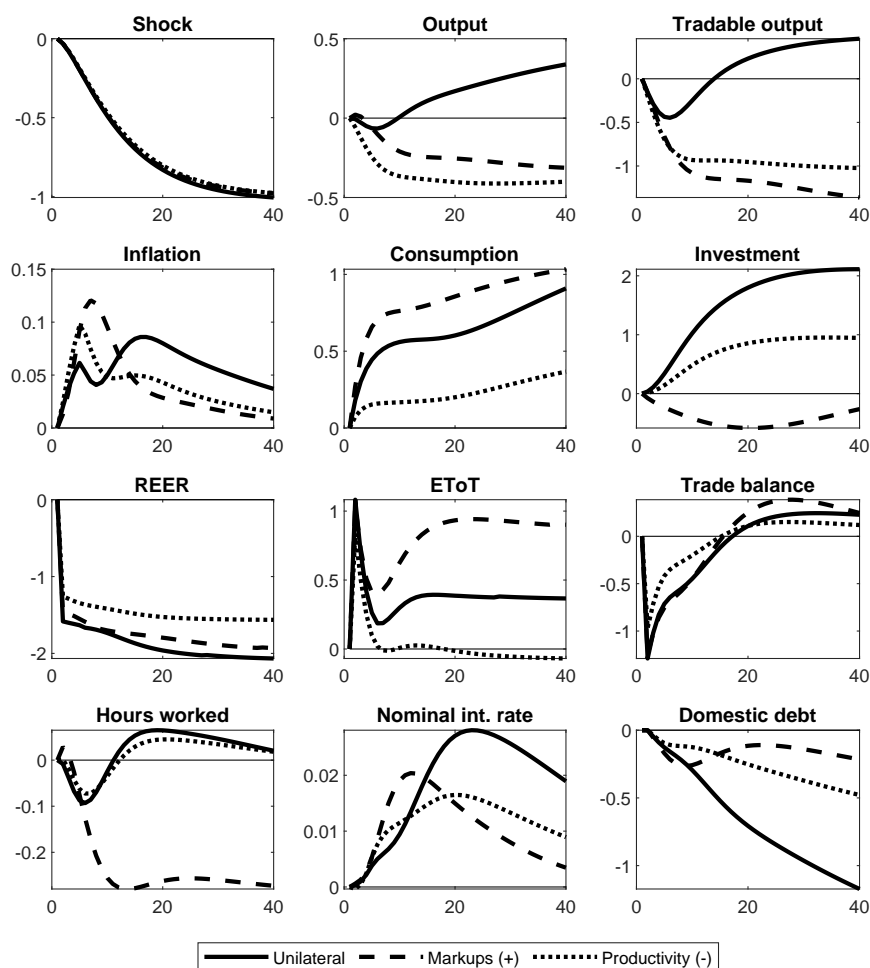
*Notes:* This table compares the initial steady-state values to those of following a permanent 1% of aggregate output reduction in imported inputs used in the production of export goods. “Unilateral” examines the case where the EA enacts this reshoring on its own. “Markups” adds an increase in EA tradable firms’ price markups to the unilateral scenario. “Productivity” adds a decrease in EA tradable firms’ productivity to the unilateral scenario. “Retaliation” adds a symmetric reduction (i.e. scaled by region size) in the imported content of exports-to-output ratio in both the RW and US regions to the unilateral scenario. All variables are in percentage deviations from the initial steady state, except for the imported inputs for exports (i.e. the reshoring shock) that is in percentage-point deviations.

FIGURE 1. Model structure



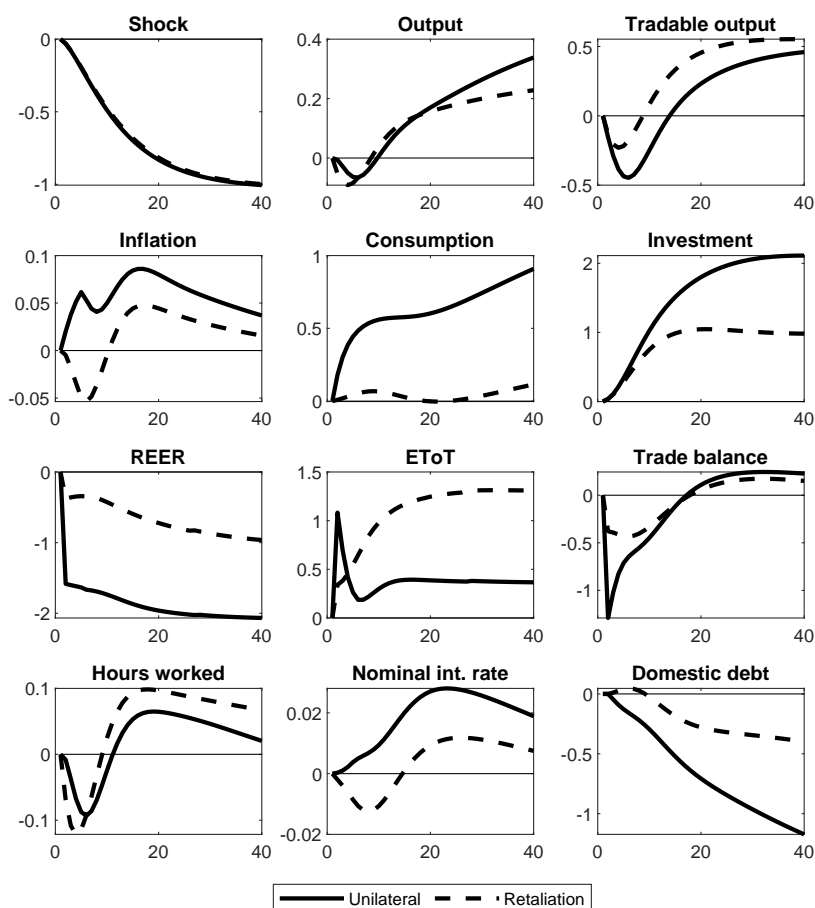
*Notes:* This figure shows the structure of our model. We model reshoring through a change to the export goods' production-function parameters. The dashed arrows indicate this *direct* channel of reshoring. However, by affecting the relative price of all goods produced in the economy, and therefore their quantity demanded and supplied, there are considerable *indirect* effects captured by our general equilibrium framework. For conciseness, the figure focuses on the euro area (EA) economy. The structure of each regional economy is symmetric and linked with each other through bilateral trade and participation in international financial markets, with a region-specific calibration. US represents the United States, while RW is the rest of the world. M denotes imports, X exports, K private capital,  $K^G$  public capital (i.e. infrastructure), N labour, NT non-tradeable goods, HT domestically produced tradeable goods, TT total tradeable goods, I investment, C consumption and G government spending (which has both current expenditure and capital expenditure components).

FIGURE 2. Unilateral reshoring



*Notes:* This figure shows the effect on the euro area (EA) of a permanent increase in EA-only preferences for domestically produced inputs for export goods (i.e. a partial reshoring of production). We analyse three scenarios: (i) a “unilateral” reshoring; (ii) unilateral plus reduced local competition (“markup”) and; (iii) unilateral plus reduced local “productivity”. The plotted lines represent transition dynamics between the initial and new steady state. We scale the shock such that the import content of exports-to-output ratio decreases by 1 percentage point in the long run, with almost all of this adjustment complete after 10 years. All variables are in percentage deviations from the initial steady state, except for the imported inputs for exports (i.e. the reshoring shock), consumer price inflation and the nominal interest rate that are in percentage-point deviations. Domestic debt is expressed as a nominal value (not as a ratio of GDP). For context, debt is 60% of GDP in the initial steady state.

FIGURE 3. Symmetric retaliation



*Notes:* This figure shows the effect on the euro area (EA) of a permanent increase in EA-only preferences for domestically produced inputs for export goods (i.e. a partial reshoring of production). In addition to the “unilateral” reshoring scenario, we now also examine a (symmetric) “retaliation” by trade partners. The plotted lines represent transition dynamics between the initial and new steady state. We scale the shock such that the import content of exports-to-output ratio decreases by 1 percentage point in the long run, with almost all of this adjustment complete after 10 years. All variables are in percentage deviations from the initial steady state, except for the imported inputs for exports (i.e. the reshoring shock), consumer price inflation and the nominal interest rate that are in percentage-point deviations. Domestic debt is expressed as a nominal value (not as a ratio of GDP). For context, debt is 60% of GDP in the initial steady state.

## A The European Chips Act

Public policy choices emphasising security considerations over cost minimisation, foreshadowing a less-integrated global economy with shorter supply chains, are already apparent in the sectors providing critical intermediate inputs. As an essential component of electronic devices, semiconductors are vital for the global economy. Post-pandemic shortages forced production slowdowns, and even shutdowns, in many parts of the world and exposed global reliance on a small number of producers in a small number of countries. These few and geographically concentrated production locations must operate at close to full capacity in order to cover the very high capital investment costs, leaving little capacity to accommodate demand volatility.

European policymakers have identified securing the supply of the most advanced chips as an economic and geopolitical priority, with industrial automation equipment highly dependent on their supply. As an example of the disruption due to the global chips shortage, Europe produced over 11 million less cars in 2021, a substantial shock that brought production back to 1975 levels ([Commission, 2022](#)).

The European Chips Act aims to double Europe's semiconductor global market share, to 20% from less than 10% currently, by 2030. This requires the mobilisation of substantial public and private investment in this industry. Given the high entry barriers and the capital intensity of the sector, the European Commission will allow greater than usually permitted (under state aid rules) public support for chips manufacturing. Through the Important Project of Common European Interest on Microelectronics and Communication Technologies, approval of state aid is possible for facilities where the economic benefit outweighs the potentially negative impact on trade and competition. The legislation also contains mechanisms for greater cooperation and coordination amongst EU member states to provide early warnings of, and reaction to, supply chain bottlenecks.

However, Europe is not alone in seeking to enhance the resilience of its semiconductor supply. In China, a series of initiatives, such as “Made in China 2025”, will provide substantial financing to boost this industry. Planned public support, through tax incentives and investment, is orders of magnitude larger again in South Korea and Taiwan, the global leaders in the production of the most advanced semiconductor chips. In the US, the CHIPS and Science Act has a similar set of aims to the European Chips Act and goes a step further by explicitly stating a partial motivation is to “counter China”.

Such legislation marks an important turning point in European Industrial Policy.<sup>23</sup> After decades of emphasis on reducing costs and maintaining competition, policymakers are beginning to reconsider the efficiency versus resilience trade off. Since strategic autonomy as a whole is too broad a concept to analyse, we consider the European Chips Act as a proxy for the types of initiatives that policymakers may implement to meet this objective.

## B Locally produced intermediate inputs

In this section, we provide some more details on how changes in the share of imported inputs used in the production of exports can affect the prices and quantities of other goods in the economy.<sup>24</sup> Imported inputs are a composite of tradable goods produced in other regions of the world:

$$IM_t^X(h) = \left[ \sum_{CO \neq H} \left( \nu_{IM^X}^{H,CO} \right)^{\frac{1}{\mu_{IM^X}}} \left( IM_t^{X,H,CO}(h) \left( 1 - \gamma_{IM^X}^{H,CO}(h) \right) \right)^{\frac{\mu_{IM^X}-1}{\mu_{IM^X}}} \right]^{\frac{\mu_{IM^X}}{\mu_{IM^X}-1}} \quad (\text{B1})$$

where  $IM_t^X$  denotes imported inputs used by firm  $h$  to produce export goods,  $\nu_{IM^X}$  represents the share of imports from each region in total imports (and so must sum to one),  $\mu_{IM^X}$  is the intertemporal elasticity of substitution between imports from different trading partners and  $\gamma_{IM^X}^{H,CO}$  are (quadratic) adjustment costs on bilateral imported inputs for export goods of firm  $h$ . Firm  $h$  then combines these intermediate-good imports with local (i.e. regional) tradable inputs, produced using regional capital  $K_t$  and labour  $L_t$  subject to productivity shocks  $z_T$  and fixed costs  $\psi_T$ :

$$Y_{T,t}(h) = \max \{ z_T K_t(h)^{\alpha_T} N_t(h)^{1-\alpha_T} - \psi_T, 0 \} \quad (\text{B2})$$

to produce exports goods  $X_t$ :

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<sup>23</sup>Of course, such a change is not necessarily an improvement. See [Tagliapietra et al. \(2023\)](#) for a critique of the Net Zero Industry Act, which is essentially the EU's response to the US Inflation Reduction Act.

<sup>24</sup>Here we only provide the aspects of the model most directly related to our analysis. We refer the interested reader to [Gomes et al. \(2012\)](#) for details on the original EAGLE model, [\(Brzoza-Brzezina et al., 2014\)](#) for the import content of exports component and [Clancy et al. \(2016\)](#) for the fiscal extension. These papers also provide detailed discussion on the calibration choices documented in Appendix C.

$$X_t(h) = \left[ \nu_{X,t}^{\frac{1}{\mu_X}} HT_t^X(h)^{\frac{\mu_X-1}{\mu_X}} + (1 - \nu_{X,t})^{\frac{1}{\mu_X}} IM_t^X(h)^{\frac{\mu_X-1}{\mu_X}} \right]^{\frac{\mu_X}{\mu_X-1}} \quad (B3)$$

that are in turn used as inputs in other countries' production of (public and private) consumption, investment and export goods. Importantly for our analysis,  $\nu_{X,t}$  represents the time-varying weight of local goods  $HT_t^X$  in the export good bundle and  $\mu_X$  represents the intertemporal elasticity of substitution between local and foreign tradable goods. The marginal cost  $MC_{T,t}$  of producing regional intermediate tradable goods are:

$$MC_{T,t} = \frac{1}{z_{T,t} K_{G,t}^{\alpha_G} (\alpha_T)^{\alpha_T} (1 - \alpha_T)^{1-\alpha_T}} (R_t^K)^{\alpha_T} \left( (1 + \tau_t^{W_f}) W_t \right)^{1-\alpha_T} \quad (B4)$$

where  $\alpha_T$  is the capital share in the tradable sector,  $\alpha_G$  determines the productivity of public capital  $K_{G,t}$ ,  $\tau_t^{W_f}$  is the labour tax rate paid by firms,  $W_t$  are wages and  $R_t^K$  is the rental cost of capital. The marginal cost of producing export goods  $MC_{X,t}$  is therefore:

$$MC_{X,t} = \left[ \nu_{X,t} [MC_{T,t}]^{1-\mu_X} + 1 - \nu_{X,t} [P_{IM^X,t}]^{1-\mu_X,t} \right]^{\frac{1}{1-\mu_X,t}} \quad (B5)$$

where the aggregate price of imported inputs for re-export is:

$$P_{IM^X,t} = \left[ \sum_{CO \neq H} \nu_{IM^X}^{H,CO} \left( \frac{P_{IM,t}^{H,CO}}{\gamma_{IM^X}^{H,CO,\dagger}(h)} \right)^{1-\mu_{IM^X}} \right]^{\frac{1}{1-\mu_{IM^X}}}, \quad (B6)$$

where  $P_{IM,t}^{H,CO}$  is the price of imports in region H produced by firms in region CO and  $\gamma_{IM^X}^{H,CO,\dagger}$  is the derivative of bilateral import adjustment costs. Demand for local tradables produced by firm  $h$  is then:

$$HT_t^X(h) = \nu_{X,t} \left( \frac{MC_{T,t}}{MC_{X,t}} \right)^{-\mu_X} X_t \quad (B7)$$

where  $X_t$  is aggregate demand for tradables (taken as given), while demand for imported inputs is:

$$IM_t^X(h) = (1 - \nu_{X,t}) \left( \frac{P_{IM^X,t}}{MC_{X,t}} \right)^{-\mu_X} X_t. \quad (B8)$$

Firms producing tradable goods sell their (differentiated) output in the domestic and foreign markets, charging different prices (set in local currency) in each market. The price setting

process is analogous for the (domestic) tradable and non-tradable goods, so to save space we only provide details of pricing in foreign markets. In setting prices abroad, tradable firms use their monopoly power to set their prices with a markup over marginal costs:

$$\frac{\tilde{P}_{X,t}}{P_{X,t}} = \frac{\theta_X}{\theta_X - 1} \frac{f_{X,t}}{g_{X,t}} \quad (\text{B9})$$

$$f_{X,t} = X_t MC_{X,t} + \beta \xi_X E_t \left[ \frac{\Lambda_{I,t+1}}{\Lambda_{I,t}} \left( \frac{\Pi_{X,t+1}}{\Pi_{X,t+1}^{\chi_X} \bar{\Pi}^{(1-\chi_X)}} \right)^{\theta_X} f_{X,t+1} \right] \quad (\text{B10})$$

$$g_{X,t} = P_{X,t} X_t + \beta \xi_X E_t \left[ \frac{\Lambda_{I,t+1}}{\Lambda_{I,t}} \left( \frac{\Pi_{X,t+1}}{\Pi_{X,t+1}^{\chi_X} \bar{\Pi}^{(1-\chi_X)}} \right)^{\theta_X - 1} g_{X,t+1} \right] \quad (\text{B11})$$

where  $\theta_X$  is the elasticity of substitution between different export brands and the ratio  $f_{X,t}/g_{X,t}$  reflects the fact that only a fraction of export firms can change their prices in every period (i.e. some firms may be stuck with the same price for a number of periods). In this staggered framework (Calvo, 1983) prices evolve according to:

$$P_{X,t} = \left[ \Xi_X \left( \Pi_{X,t-1}^{\chi_X} \bar{\Pi}^{1-\chi_X} P_{X,t-1} \right)^{1-\theta_X} + (1 - \chi_X) \left( \tilde{P}_{X,t} \right)^{1-\theta_X} \right]^{\frac{1}{1-\theta_X}}. \quad (\text{B12})$$

Adjusting the share of local inputs in export goods, of course, affects prices and quantities all along the supply chain. As an illustration, consider the effect of a change in preferences for local intermediate inputs on demand for (final) consumption goods  $Q_t^C$ . These are a bundle comprised of tradables  $TT_t^C$  and non-tradable  $NT_t^C$  intermediates:

$$Q_t^C = \left[ \nu_C^{\frac{1}{\mu_C}} (TT_t^C)^{\frac{\mu_C-1}{\mu_C}} + (1 - \nu_C)^{\frac{1}{\mu_C}} (NT_t^C)^{\frac{\mu_C-1}{\mu_C}} \right]^{\frac{\mu_C}{\mu_C-1}}. \quad (\text{B13})$$

where  $\nu_C$  represents the share of tradables in the final consumption good and  $\mu_C$  represents the intertemporal elasticity of substitution between tradable and non-tradable goods. Tradables are themselves a bundle of locally produced  $HT_t^C$  and imported  $IM_t^C$  consumption goods:

$$TT_t^C = \left[ \nu_{TC}^{\frac{1}{\mu_{TC}}} (HT_t^C)^{\frac{\mu_{TC}-1}{\mu_{TC}}} + (1 - \nu_{TC})^{\frac{1}{\mu_{TC}}} (IM_t^C)^{\frac{\mu_{TC}-1}{\mu_{TC}}} \right]^{\frac{\mu_{TC}}{\mu_{TC}-1}}. \quad (\text{B14})$$

where  $\nu_{TC}$  represents the share of local inputs in the tradable consumption good and  $\mu_{TC}$  represents the intertemporal elasticity of substitution between local tradable consumption goods



and imported consumption goods. Demand for local tradables used for consumption goods is:

$$HT_t^C = \nu_{TC} \left( \frac{P_{HT,t}}{P_{TTC,t}} \right)^{-\mu_{TC}} TT_t^C \quad (\text{B15})$$

where  $P_{HT,t}$  is the price of the local tradable input and  $P_{TTC,t}$  is the aggregate price of tradable consumption goods. The price of the latter is:

$$P_{TTC,t} = [\nu_{TC}[P_{HT,t}]^{1-\mu_{TC}} + 1 - \nu_{TC}[P_{IMC,t}]^{1-\mu_{TC}}]^{\frac{1}{1-\mu_{TC}}} \quad (\text{B16})$$

that in turn affects the price of final consumption goods  $P_{C,t}$ :

$$P_{C,t} = [\nu_C[P_{TTC,t}]^{1-\mu_C} + 1 - \nu_C[P_{NTC,t}]^{1-\mu_C}]^{\frac{1}{1-\mu_C}}. \quad (\text{B17})$$

Finally, market clearing condition for locally produced tradable good  $h$  is:

$$Y_{T,t}(h) = HT_t^C(h) + HT_t^I(h) + HT_t^{GC}(h) + HT_t^{GI}(h) + \sum_{CO \neq H} HT_t^{X,H,CO}(h), \quad (\text{B18})$$

which therefore implies that a change in preference for local inputs in export goods will affect demand for tradable and final consumption goods by changing  $P_{HT,t}$ .

## C Model calibration

TABLE C1. Key steady-state ratios (as a % of aggregate output)

	EA	RW	US
<i>Domestic demand</i>			
Private consumption	58.5	58.6	65.9
Public consumption	20.5	16.6	14.7
Private investment	17.0	21.0	15.0
Public investment	4.0	4.0	4.0
<i>Trade</i>			
Total imports	27.9	11.3	17.1
Private consumption goods	14.0	2.6	6.9
Public consumption goods	1.2	1.0	0.9
Private investment goods	8.6	4.1	7.2
Public investment goods	0.4	0.4	0.4
Import content of exports	3.7	3.2	1.8
<i>Bilateral trade</i>			
Imported consumption goods	14.0	2.6	6.9
From EA	-	1.1	1.3
From RW	13.2	-	5.6
From US	0.7	1.5	-
Imported investment goods	8.6	4.1	7.2
From EA	-	1.4	1.2
From RW	5.7	-	6.0
From US	2.8	2.7	-
Imported goods for re-exports	3.7	3.2	1.8
From EA	0.0	0.0	0.0
From RW	-	1.3	0.4
From RW	3.2	-	1.4
From US	0.4	1.9	-
Size of region (% of world output)	20.0	49.0	31.0

*Notes:* Euro area (EA), rest of the world (RW) and the United States of America (US). Rounding may affect totals.

TABLE C2. Household and firm behaviour

	EA	RW	US
<b><i>Households</i></b>			
Subjective discount factor	1.03 <sup><math>\frac{1}{4}</math></sup>	1.03 <sup><math>\frac{1}{4}</math></sup>	1.03 <sup><math>\frac{1}{4}</math></sup>
Depreciation rate (private capital)	0.025	0.025	0.025
Int. elasticity of substitution	1.00	1.00	1.00
Habit formation	0.70	0.70	0.70
Frisch elasticity of labour (inverse)	2.00	2.00	2.00
<b><i>Intermediate goods firms</i></b>			
Tradable - bias toward capital	0.30	0.30	0.30
Non-tradable - bias toward capital	0.30	0.30	0.30
<b><i>Final consumption goods</i></b>			
Subst. btw. local and imported	2.50	2.50	2.50
Subst. imported	2.50	2.50	2.50
Bias toward local tradables	0.24	0.92	0.56
Subst. btw. tradable and non-tradable	0.50	0.50	0.50
Bias toward tradables	0.35	0.35	0.35
<b><i>Final investment goods</i></b>			
Subst. btw. local and imported	2.50	2.50	2.50
Subst. imported	2.50	2.50	2.50
Bias toward local tradables	0.25	0.83	0.24
Subst. btw. tradable and non-tradable	0.50	0.50	0.50
Bias toward tradable	0.75	0.75	0.75
<b><i>Export goods</i></b>			
Subst. btw. local and imported	1.50	1.50	1.50
Subst. imported	2.50	2.50	2.50
Bias toward local tradables	0.80	0.65	0.85

TABLE C3. Government behaviour

	EA	RW	US
<b><i>Consumption Expenditure</i></b>			
Domestic consumption goods (% of output)	20.5	16.6	14.7
Imported consumption goods (% of output)	1.2	0.9	1.0
Quasi-share of govt cons.	0.75	0.80	0.80
Complementarity of consumption	0.29	0.33	0.33
Subst. btw. local and imported	2.50	2.50	2.50
Subst. imported	2.50	2.50	2.50
Bias toward local	0.73	0.80	0.66
Subst. btw. tradable and non-tradable	0.50	0.50	0.50
Bias toward tradable	0.80	0.80	0.80
<b><i>Investment expenditure</i></b>			
Domestic investment goods (% of output)	4.0	4.0	4.0
Imported investment goods (% of output)	0.4	0.4	0.4
Subst. btw. local and imported	2.50	2.50	2.50
Subst. imported	2.50	2.50	2.50
Bias toward local	0.54	0.60	0.46
Subst. btw. tradable and non-tradable	0.50	0.50	0.50
Bias toward tradable	0.80	0.80	0.80
Depreciation rate (public capital)	0.025	0.025	0.025
<b><i>Taxation</i></b>			
Consumption tax rate	0.183	0.077	0.077
Labour income tax rate	0.122	0.154	0.154
Capital tax rate	0.19	0.16	0.16
SSC rate paid by firms	0.219	0.071	0.071
SSC rate paid by households	0.118	0.071	0.071
<b><i>Fiscal rule</i></b>			
Target public debt (% of annual output)	60.0	60.0	60.0
Sensitivity of lump-sum taxes to debt	0.1	0.1	0.1

TABLE C4. Monetary policy

	EA	RW	US
Inflation target	1.02	1.02	1.02
Interest rate inertia	0.87	0.87	0.87
Sensitivity to inflation gap	1.70	1.70	1.70
Sensitivity to output growth	0.10	0.10	0.10

TABLE C5. Real and nominal rigidities

	EA	RW	US
<b><i>Real rigidities</i></b>			
Investment adjustment	6.00	4.00	4.00
Import adjustment (cons.)	5.00	5.00	5.00
Import adjustment (inv.)	2.00	2.00	2.00
Import adjustment (inter.)	2.00	2.00	2.00
<b><i>Nominal rigidities</i></b>			
Wage stickiness	0.75	0.75	0.75
Wage indexation	0.75	0.75	0.75
Price stickiness (local)	0.75	0.75	0.75
Price indexation (local)	0.50	0.50	0.50
Price stickiness (imported)	0.75	0.75	0.75
Price indexation (imported)	0.50	0.50	0.50
Price stickiness (services)	0.75	0.75	0.75
Price indexation (services)	0.50	0.50	0.50

TABLE C6. Price and wage markups (implied elas. of substitution)

	EA	RW	US
Tradables	1.30 (4.3)	1.20 (6.0)	1.20 (6.0)
Non-tradables	1.50 (3.0)	1.30 (4.3)	1.30 (4.3)
Exports	1.30 (4.3)	1.20 (6.0)	1.20 (6.0)
Wages	1.30 (4.3)	1.16 (7.3)	1.16 (7.3)

TABLE C7. Bilateral trade relations (% of category total)

	EA	RW	US
<b><i>Imported consumption goods</i></b>			
From REA	-	42.3	18.8
From RW	94.3	-	5.6
From US	5.7	57.7	-
<b><i>Imported investment goods</i></b>			
From REA	-	34.1	16.7
From RW	66.3	-	83.3
From US	33.7	65.9	-

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