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FRANK: FRAGMENTATION IN THE NK MODEL

by Alessandro Moro* and Valerio Nispi Landi**

Abstract

We set up a multi-country New Keynesian model to study the effects of a geoeconomic fragmentation shock, modelled as an increase in the tax rates on goods, commodities, and bonds purchased from rival countries. First, we derive a closed-form solution of the model by using a symmetric calibration on two blocks of countries and we show analytically that geoeconomic fragmentation reduces output. The effect on PPI inflation is ambiguous, depending positively on the importance of commodities in the production function. Then, we calibrate the model for four regions (the United States, their allies, a China-led block, and the neutral rest of the world) and find that fragmentation predominantly affects the China-aligned bloc and the US allies, with these countries experiencing larger declines in production and consumption. In contrast, the US are relatively shielded from the shock because of their limited exposure to the rival bloc. The spillovers to neutral countries are negligible.

JEL Classification: F36, F41, F62, F65.

Keywords: open economy macroeconomics, financial aspects of economic integration, economic impacts of globalization, capital flows.

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1 Introduction[1]

In this paper, we analyze the effects of geoeconomic fragmentation using a multi-country New Keynesian model, termed FraNK. We examine various sources of fragmentation, both real and financial, and study their impact on global and local economic activity, inflation, capital flows, and exchange rates.

Since the global financial crisis, several events have halted the long-standing trend of increasing global economic integration. Measures of integration such as trade openness, financial openness, and the number of sanctions and conflicts, point indeed to a halt in the increase or even a decrease in globalization (Fernandez-Villaverde et al., 2024). Brexit, US-China trade tensions, the pandemic, Russia's invasion of Ukraine, and the conflict in the Middle East have all contributed to a reduction in trade and financial linkages between countries. These developments have increased the risk of a world divided into blocs, reminiscent of the Cold War era. A reversal in the process of economic integration is likely to have major effects on the global economy (Caldara et al., 2024; Fernandez-Villaverde et al., 2024).

Following Aiyar et al. (2023), we define geoeconomic fragmentation as a policy-driven reversal of integration, often guided by strategic considerations. With this definition in mind, we explore the following questions: How does geoeconomic fragmentation impact economic activity and inflation at both the national and global levels? What are its effects on exchange rates, capital, and trade flows? Do various sources of fragmentation produce distinct outcomes? Is fragmentation a positive or negative shock for countries that remain neutral?

To this end, we develop a New Keynesian model (FraNK) with several modifications relative to Galí and Monacelli (2005), which is the benchmark in the literature. First,

[1]We thank Paolo Conteduca, Antonio Di Cesare, Simone Emiliozzi, Sergio Santoro, Marco Taboga, Valerio Della Corte, two anonymous reviewers of the Bank of Italy's working paper series, and the participants at the Bank of Italy's REI Reading Group for their insightful comments and suggestions. The opinions expressed in the paper are those of the authors and do not necessarily reflect the views of the Bank of Italy.

we adopt a multi-country framework instead of a small-open economy model. Second, we assume incomplete international financial markets, thereby relaxing the assumption of perfect risk sharing, which is implausible in a fragmented world. Third, we posit that each domestic good is produced using labor and a bundle of commodities, which includes both domestic and foreign commodities. This approach is crucial for capturing major disruptions in commodity markets, as observed during Russia's invasion of Ukraine. Following our definition of policy-driven reversal of integration, we model a fragmentation shock as the increase of three tax rates that countries impose against their rivals: a tax on imports of final goods, a tax on imports of commodities, and a tax on the purchase of foreign bonds. In principle, these three sources of fragmentation may have different macroeconomic implications.

We study the effects of a fragmentation shock in two different versions of FraNK. In the first version, we adopt a symmetric calibration, assuming that all countries are equal in terms of economic fundamentals and are divided into two blocks. Countries impose taxes on goods, commodities, and bonds, specifically targeting countries in the rival block. Although a symmetric calibration may be implausible for modeling the world economy, it serves as a useful benchmark for deriving clear analytical results, which provide a transparent understanding of the three sources of fragmentation.

We derive a closed-form solution for the symmetric model, analytically showing that the three sources of fragmentation have distinct macroeconomic implications. The tax on imports of goods negatively impacts both aggregate demand, by reducing consumption of foreign goods, and aggregate supply, by increasing firms' real marginal costs. Consequently, output unambiguously decreases. The effect on PPI inflation depends on the relative strength of these channels: we find that the demand channel is stronger, leading to a decrease in PPI inflation. However, since import taxes directly raise the CPI, we observe an initial increase in CPI inflation. The tax on imported commodities negatively affects aggregate supply because commodities are inputs in the production of consumption goods. As a result, output decreases, while both CPI and PPI inflation increase.

The tax on foreign bonds reduces the purchase of bonds issued by countries in the rival block, which in turn reduces their issuance: the net foreign position of each country is unchanged, thus the tax is neutral on macroeconomic variables. Notice that, given the model's symmetry, the three tax rates do not affect net capital flows or exchange rates, as economic variables in each country respond uniformly.

In the second version, we calibrate the model to four regions: the United States (region US); a region of countries allied with the US, including the European Union (region WE); China, Russia, and their allies (region CR); and the rest of the world, which is neutral (region NE). We assume that the US and WE impose the three tax rates on region CR, and vice versa. Region NE remains neutral, neither imposing nor being targeted by taxes. This setup also allows us to assess the spillover effects of fragmentation on countries that stay neutral. We then simulate numerically the effects of the three tax shocks in each country.

In the asymmetric model we show five main results. First, fragmentation mainly impacts the China-led and US allies blocks, which see a decline in both consumption and production. Second, the US is largely insulated from the fragmentation shock given its relatively lower exposure to the rival bloc compared to its allies. Third, the spillover effects on neutral countries are minimal, as two opposing forces cancel each other out: the expenditure switching channel, which boosts demand for NE goods and commodities, and the global income channel, which works in the opposite direction as the rest of the world becomes poorer. Fourth, fragmentation does not necessarily lead to inflation. Fifth, the bilateral exchange rates most affected are those of the China-aligned block, which appreciate when fragmentation is driven by taxes on goods and assets, and depreciate when driven by taxes on commodities.

The main contribution of our analysis is to develop a unified theoretical framework encompassing different forms of geopolitical fragmentation, both real and financial, and allowing for the analysis of their specific effects and spillovers. Our framework is well suited to provide a comprehensive assessment of the consequences of geoeconomic fragmentation on rival blocks and to identify the countries most heavily exposed to the different sources of fragmentation. To the best of our knowledge, we are the first to model these aspects in a multi-country New Keynesian model.

Related literature. Our paper contributes to the recent literature examining the macroeconomic consequences of geoeconomic fragmentation.

The existing DSGE literature has focused its attention on the effects of economic sanctions and trade wars. This area of research gained momentum with the debate on the effects of economic sanctions imposed on Russia by Western powers following the invasion of Ukraine.[2] Ghironi et al. (2024) set up a three-country model to study international trade and macroeconomic dynamics triggered by economic sanctions. Compared to this paper, among other differences, our model features nominal rigidities to study the inflationary effects of fragmentation and provides several closed-form results. Itskhoki and Mukhin (2022) consider a small-open economy model targeted to Russia, focusing on the effects of economic sanctions on the exchange rates. Bianchi and Sosa-Padilla (2023) set up a model to analyze the strategic game between a sanctioning (creditor) country and a sanctioned (debtor) country. These papers have reignited the debate on the effects of import tariffs and trade wars (Gopinath, 2017; Barbiero et al., 2019; Cavallo et al., 2021; Auray et al., 2024; Ambrosino et al., 2024) and the impact of capital controls on international capital flows (Korinek, 2011; Farhi and Werning, 2014; Korinek and Sandri, 2016; Erten et al., 2021).

Attinasi et al. (2023) and Conteduca et al. (2024b) use the Baqaee and Farhi (2024) model to study the effects of trade fragmentation. Relative to the New Keynesian framework or other DSGE models, these papers use a very rich production network, which is particularly important to study fragmentation shocks. Compared to these contributions, our paper is dynamic rather than static[3] and also allows countries to trade also financial assets, an essential feature to study financial fragmentation. Moreover, we provide

[2]See Eichengreen et al., 2023 for an empirical evaluation of economic sanctions.

[3]See Quintana (2024) for an initial step to study fragmentation in a dynamic version of Baqaee and Farhi (2024), and Okuda and Tsuruga (2024) for a dynamic two-country model of trade fragmentation.

some closed form results, to give transparent intuitions about the mechanisms of our model. However, our framework is admittedly simpler in terms of production structure and number of countries.

Clayton et al. (2024) is another important theoretical contribution. The authors provide a general theory of the incentives behind geoeconomic integration/fragmentation, developing a model in which a small open economy faces the trade-off between the benefits of being integrated in the global economy and its costs in terms of dependency on a hegemon country.

Several papers have explored geoeconomic fragmentation from an empirical point of view. Caldara et al. (2024), using historical data within a VAR framework, find that elevated geopolitical risk tends to have stagflationary effects, depressing economic activity while increasing inflation. Fernandez-Villaverde et al. (2024) identify a significant heterogeneity in the effects of geoeconomic fragmentation: the latter has a more detrimental impact on emerging markets compared to advanced economies, and within economies, sectors that are more integrated into the global economy experience the most severe adverse effects. Focusing on trade, Hakobyan et al. (2023), Conteduca et al. (2024a), Gopinath et al. (2024), and Panon et al. (2024) show that geoeconomic fragmentation leads to a contraction in trade flows and to a utility loss due to lower diversification opportunities.

Relatively less explored in the academic literature, the consequences of geopolitical fragmentation for international capital reallocation and the associated macro-financial risks are the main focus in Catalán and Tsuruga (2023). Looking at firm-level evidence, D'Orazio et al. (2024) find that firms with greater exposure to geopolitical risk experience an increased probability of default, reduced market valuations, and higher financing costs.

The rest of the paper is organized as follows. Section 2 describes the model. Section 3 provides a closed-form solution of the model under a symmetric calibration. In Section 4 we derive numerically the impulse response functions to the alternative fragmentation shocks under a more realistic asymmetric calibration. Finally, Section 5 concludes.

2 FraNK model

We set up a multi-country version of Galí and Monacelli (2005), augmented with domestic and imported commodity inputs. In each country a representative firm produces the country's final good using differentiated intermediate goods, which are produced by firms that operate in monopolistic competition and face nominal rigidities. The production function of intermediate-good firms consists of local labor and local and imported commodities. In each country, a representative firm produces commodities using labor. The representative household consumes final goods produced by each country, supply labor to local firms, and invest in domestic and foreign bonds. The central bank sets the interest rate according to a standard Taylor rule. The government sets trade policy and capital controls. In what follows, the indexes $i, j \in \mathcal{I} = \{1, 2, ..., N\}$ denote countries (with $N > 2$ being an even natural number), the index $t \in \{1, 2, ..., \infty\}$ denotes time, the index $f \in [0, 1]$ denotes intermediate-good firms. Each country has relative population size n_i, with $\sum_{i=1}^{N} n_i = 1$.

2.1 Households

2.1.1 Intratemporal problem

The consumption bundle C_{it} in country i is given by:

$$C_{it} = \left\{ (1-\gamma_i)^{\frac{1}{\eta}} (C_{iit})^{\frac{\eta-1}{\eta}} + \sum_{j \neq i} \gamma_{ij}^{\frac{1}{\eta}} (C_{ijt})^{\frac{\eta-1}{\eta}} \right\}^{\frac{\eta}{\eta-1}} \tag{1}$$

where C_{ijt} is consumption of country j's final good by households in country i; $\eta > 0$ is the elasticity of substitution between goods produced by different countries; $\gamma_{ij} \in (0, 1)$ is the weight of country j in the consumption bundle of country i and $\gamma_i \equiv \sum_{j \neq i} \gamma_{ij}$. Given the consumption bundle, the representative household in country i has the following demand functions:

$$C_{iit} = (1-\gamma_i)\left(\frac{P^{\$}_{iYt}}{P^{\$}_{it}}\right)^{-\eta} C_{it}$$

$$C_{ijt} = \gamma_{ij}\left(\frac{P^{\$}_{ijt}}{P^{\$}_{it}}\right)^{-\eta} C_{it} \quad \forall j$$

where $P^{\$}_{ijt}$ is the price of the good produced by country j for households in country i (so expressed in the currency of country i): the superscript \$ reminds us that the price is expressed in nominal terms; $P^{\$}_{it}$ is the price of country i's consumption bundle (i.e. the CPI); $P^{\$}_{iYt}$ is the price of the good produced by country i for households in country i: the subscript Y reminds us that this is the price of the country's final good Y_{it} as it will be clear in what follows (i.e. $P^{\$}_{iYt}$ is the PPI). We assume producer currency pricing and that the law of one price holds up to an import tax:

$$P^{\$}_{ijt} = E_{ijt}\left(1+\tau_{ijt}\right) P^{\$}_{jYt} \quad \forall j \tag{2}$$

where E_{ijt} is the price of one unit of currency j in terms of currency i: if E_{ijt} increases, currency i depreciates vis à vis currency j; τ_{ijt} is a tax on imports of goods from country j to country i, set by country i. We can rewrite the previous equation in terms of real (i.e. in terms of CPI) variables:

$$P_{ijt} = Q_{ijt}\left(1+\tau_{ijt}\right) P_{jYt} \quad \forall j \tag{3}$$

where $P_{ijt} \equiv \frac{P^{\$}_{ijt}}{P^{\$}_{it}}$, $P_{iYt} \equiv \frac{P^{\$}_{iYt}}{P^{\$}_{it}}$, and $Q_{ijt} \equiv \frac{E_{ijt}P^{\$}_{jt}}{P^{\$}_{it}}$ is the real exchange rate between country i and j. Given the consumption bundle, the CPI index reads:

$$P^{\$}_{it} = \left\{(1-\gamma_i)\left(P^{\$}_{iYt}\right)^{1-\eta} + \sum_{j\neq i}\gamma_{ij}\left[E_{ijt}\left(1+\tau_{ijt}\right)P^{\$}_{jYt}\right]^{1-\eta}\right\}^{\frac{1}{1-\eta}}, \tag{4}$$

and in real terms (i.e. divided by $P_{it}^{\$}$):

$$1 = (1 - \gamma_i) (P_{iYt})^{1-\eta} + \sum_{j \neq i} \gamma_{ij} [Q_{ijt} (1 + \tau_{ijt}) P_{jYt}]^{1-\eta} . \tag{5}$$

Under these assumptions, we can write total nominal consumption spending $C_t^{\$}$ as follows:

$$C_t^{\$} \equiv P_{iYt}^{\$} C_{iit} + \sum_{j \neq i} P_{ijt}^{\$} C_{ijt} = P_{it}^{\$} C_{it}. \tag{6}$$

The last equation will be useful to write the budget constraint in the next section.

2.1.2 Intertemporal problem

The representative household in country i solves the following problem:

$$\max_{\left\{C_{it}, H_{iYt}, H_{iOt}, \{B_{ijt}\}_{j \in \mathcal{I}}\right\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{it}^{1-\sigma}}{1-\sigma} - \frac{H_{iYt}^{1+\varphi}}{1+\varphi} - \frac{H_{iOt}^{1+\varphi}}{1+\varphi} \right)$$

$$s.t.\ C_{it} + B_{iit} + \sum_{j \neq i} Q_{ijt} B_{ijt} = W_{iYt} H_{iYt} + W_{iOt} H_{iOt} + \frac{R_{it-1}}{\Pi_{it}} B_{iit-1} + \Gamma_{it} + T_{it} +$$

$$+ \sum_{j \neq i} \left[\frac{R_{jt-1} (1 - \theta_{ijt-1})}{\Pi_{jt}} Q_{ijt} B_{ijt-1} - \frac{\psi_{ijF}}{2} Q_{ijt} \left(B_{ijt} - \bar{B}_{ij} \right)^2 \right] \quad \forall j,$$

where $\mathbb{E}_t$ denotes the expectation operator, conditional on being in time t; H_{iYt} and H_{iOt} denote hours worked in the intermediate-good and in the commodity sector, remunerated at the real wage W_{iYt} and wage W_{iOt}, respectively; B_{ijt} denotes investment by households in country i in nominal bonds denominated in the currency of (and issued by) country j (expressed in terms of the CPI of country j); R_{it} is the nominal interest rate on bonds issued by country i; $\Pi_{it} \equiv \frac{P_{it}^{\$}}{P_{it-1}^{\$}}$ is the gross CPI inflation rate; Γ_{it} and T_{it} denote profits from firms ownership and lump-sum transfers from the government, respectively; θ_{ijt} is a tax on investment in bonds issued by country j, set by the government of country i: if positive, the tax discourages capital outflows from country i to country j and we refer to this instrument as a bond tax or a capital control;[4] $\beta \in (0,1)$ is the discount factor; $\sigma > 0$ is the coefficient of relative risk aversion; φ is the inverse of the Frisch elasticity of labor supply; $\psi_{ijF} > 0$ governs the strength of bond transaction costs, paid whenever the bond position is different from the steady state $\bar{B}_{ij}$: assuming bond costs is necessary to get a determinate steady state and a stationary solution (see Schmitt-Grohé and Uribe, 2003). The first order conditions yield the Euler equation for bonds issued by country i:

$$1 = \beta \mathbb{E}_t \left[\left(\frac{C_{it}}{C_{it+1}} \right)^{\sigma} \frac{R_{it}}{\Pi_{it+1}} \right], \tag{7}$$

a Euler equation for bonds issued by country $j \neq i$:

$$1 = \beta \mathbb{E}_t \left[\left(\frac{C_{it}}{C_{it+1}} \right)^{\sigma} \frac{R_{jt} \left(1 - \theta_{ijt}\right)}{\Pi_{jt+1}} \frac{Q_{ijt+1}}{Q_{ijt}} \right] - \psi_{ijFF} \left(B_{ijt} - \bar{B}_{ij} \right), \tag{8}$$

the labor supply in the intermediate-good sector:

$$H_{iYt}^{\varphi} C_{it}^{\sigma} = W_{iYt}, \tag{9}$$

and the labor supply in the commodity sector:

$$H_{iOt}^{\varphi} C_{it}^{\sigma} = W_{iOt}. \tag{10}$$

2.2 Firms

2.2.1 Final-good firm

In each country i, a representative final-good firm produces the country's final good using a CES bundle of intermediate goods:

$$Y_{it} = \left[\int_0^1 Y_{it}(f)^{\frac{\varepsilon-1}{\varepsilon}} df \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{11}$$

[4] Capital controls are typically modeled as a tax on external bonds (see for instance Farhi and Werning, 2014 and Nispi Landi, 2020).

where $Y_{it}(f)$ is the intermediate good produced by firm f and $\varepsilon > 0$ is the elasticity of substitution between intermediate goods. The demand function for each intermediate good reads:

$$Y_{it}(f) = \left(\frac{P^{\$}_{iYt}(f)}{P^{\$}_{iYt}}\right)^{-\varepsilon} Y_{it} \tag{12}$$

where $P^{\$}_{iYt}(f)$ is the price of the good produced by firm f in country i. Given the demand function, we can obtain an expression for country $i's$ PPI:

$$P^{\$}_{iYt} = \left[\int_0^1 P^{\$}_{iYt}(f)^{1-\varepsilon}\, df\right]^{\frac{1}{1-\varepsilon}}. \tag{13}$$

2.2.2 Intermediate-good firms

In each country i, there is a continuum of intermediate-good firms of measure one, producing differentiated goods and operating in monopolistic competition. The production function of firm f in country i is a CES bundle of two productive inputs, hours worked H_{it} and a commodity bundle O_{it}:

$$Y_{it}(f) = A_i \left[(1-\alpha_i)^{\frac{1}{\xi}} H_{iYt}(f)^{\frac{\xi-1}{\xi}} + \alpha_i^{\frac{1}{\xi}} O_{it}(f)^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}}, \tag{14}$$

where $A_i > 0$ is constant TFP, ξ is the elasticity of substitution between labor and the commodity bundle, and α_i is the relative weight of commodity. Given the production function, the representative firm in country i has the following demand functions for the productive inputs:

$$H_{iYt}(f) = (1-\alpha_i)\frac{Y_{it}(f)}{A_i}\left(\frac{W_{iYt}}{MC_{it}}\right)^{-\xi} \tag{15}$$

$$O_{it}(f) = \alpha\frac{Y_{it}(f)}{A_i}\left(\frac{F_{it}}{MC_{it}}\right)^{-\xi}, \tag{16}$$

where F_{it} is the price of the commodity bundle, and MC_{it} denote real marginal costs. The commodities bundle consists of commodities extracted domestically and abroad:

$$O_{it}(f) = \left[\left(1-\gamma_i^O\right)^{\frac{1}{\zeta}} \left(O_{iit}(f)\right)^{\frac{\zeta-1}{\zeta}} + \sum_{j\neq i} \left(\gamma_{ij}^O\right)^{\frac{1}{\zeta}} \left(O_{ijt}(f)\right)^{\frac{\zeta-1}{\zeta}} \right]^{\frac{\zeta}{\zeta-1}}, \tag{17}$$

where $\zeta > 0$ measures the elasticity of substitution between commodities and γ_{ij}^O is the weight of the commodity imported from country j. The demand for commodities reads:

$$O_{iit}(f) = \left(1-\gamma_i^O\right) \left(\frac{P_{iOt}}{F_{it}}\right)^{-\zeta} O_{it}(f) \tag{18}$$

$$O_{ijt}(f) = \gamma_{ij}^O \left(\frac{P_{ijOt}}{F_{it}}\right)^{-\zeta} O_{it}(f), \tag{19}$$

where P_{iOt} is the price of the commodity produced by country i and faced by firms in country i, and P_{ijOt} is the price of the commodity produced by country j faced by firms in country i (so expressed in the currency of country i). We assume that firms in country i pay a commodity import tax equal to τ_{ijt}^O to import the commodity produced by country j. Hence, the following condition holds:

$$P_{ijOt} = Q_{ijt}\left(1+\tau_{ijt}^O\right) P_{jOt}, \tag{20}$$

and the price of the commodity bundle of country i can be written as:

$$F_{it} = \left\{ \left(1-\gamma_i^O\right) \left(P_{iOt}\right)^{1-\zeta} + \sum_{j\neq i} \gamma_{ij}^O \left[Q_{ijt}\left(1+\tau_{ijt}^O\right) P_{jOt}\right]^{1-\zeta} \right\}^{\frac{1}{1-\zeta}}. \tag{21}$$

We assume that intermediate-good firms pay quadratic adjustment costs à la Rotemberg (1982) (expressed in CPI terms):

$$Adj_{it}(f) = \frac{\psi_P}{2} \left(\frac{P_{iYt}^{\$}(f)}{P_{iYt-1}^{\$}(f)} - \bar{\Pi}_{iY} \right)^2 \frac{P_{iYt}^{\$}}{P_{it}^{\$}} Y_{it} \tag{22}$$

where $\psi_P > 0$ governs the strength of adjustment costs and $\bar{\Pi}_{iY} \geq 1$ denotes the central bank's inflation target. Using the production function, we can write the problem of generic firm i that maximizes real profits subject to its demand function (equation 12) as follows:

$$\max_{\left\{P_{iYt}^{\$}(f), Y_{it}(f)\right\}_{t=0}^{\infty}} \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{i0}}{C_{it}}\right)^{\sigma} \left[\frac{P_{iYt}^{\$}(f)}{P_{it}^{\$}} Y_{it}(f) - (1-\tau_L) MC_{it} Y_{it}(f) - Adj_{it}(f) \right] \right\}$$

$$s.t. \; Y_{it}(f) = \left(\frac{P_{iYt}^{\$}(f)}{P_{iYt}^{\$}}\right)^{-\varepsilon} Y_{it},$$

where τ_L is an input subsidy, introduced only with the goal of simplifying the steady-state solution. Firms are identical, so they choose the same price $P_{iYt}^{\$}(f) = P_{iYt}^{\$} \forall f$ (and thus the same production), which implies that the Phillips curve is the same for every firm and we can get rid of the index f:

$$\Pi_{iYt}\left(\Pi_{iYt} - \bar{\Pi}_{iY}\right) = \mathbb{E}_t \left[\beta \left(\frac{C_{it}}{C_{it+1}}\right)^{\sigma} \frac{Y_{it+1}}{Y_{it}} \frac{P_{iYt+1}}{P_{iYt}} \Pi_{iYt+1}\left(\Pi_{iYt+1} - \bar{\Pi}_{iY}\right) \right] + \\ + \frac{\varepsilon}{\psi_P} \left[\frac{(1-\tau_L) MC_{it}}{P_{iYt}} - \frac{\varepsilon - 1}{\varepsilon} \right] \tag{23}$$

where PPI inflation $\Pi_{iYt} \equiv \frac{P_{iYt}^{\$}}{P_{iYt-1}^{\$}}$ is linked to CPI inflation Π_{it} according to the following equation:

$$\Pi_{iYt} = \frac{P_{iYt}}{P_{iYt-1}} \Pi_{it} \tag{24}$$

and we remind that $P_{iYt} = \frac{P_{iYt}^{\$}}{P_{it}^{\$}}$.

2.3 Commodity producers

In the commodity sector, the representative firm uses a linear production function to produce the domestic commodity Y_{iOt}:

$$Y_{iOt} = A_{iO} H_{iOt}, \tag{25}$$

where A_{iO} is productivity in the commodity sector and it could be interpreted as the per-capita endowment of natural resources of country i. The first order condition equalizes marginal costs and marginal revenues:

$$W_{iOt} = A_{iO} P_{iOt}. \tag{26}$$

2.4 Policy

The central bank sets the nominal interest rate using a Taylor rule:

$$\frac{R_{it}}{R} = \left(\frac{\Pi_{iYt}}{\bar{\Pi}_{iY}}\right)^{\phi_\pi}. \tag{27}$$

The government sets import taxes on final goods τ_{ijt}, import taxes on commodities τ^O_{ijt}, capital controls θ_{ijt}, the input subsidy τ_L, and transfers the net tax revenues to households (including the bond transaction costs):

$$T_{it} = \sum_{j \neq i} \left[\frac{R_{jt-1}\theta_{ijt-1}}{\Pi_{jt}} Q_{ijt} B_{ijt-1} + \frac{\psi_F}{2} \left(Q_{ijt}B_{ijt} - Q_{ij}\bar{B}_{ij}\right)^2 + \tau_{ijt} Q_{ijt} P_{jYt} C_{ijt} + \tau^O_{ijt} Q_{ijt} P_{jOt} O_{ijt} \right] +$$

$$- \tau_L MC_{it} Y_{it}. \tag{28}$$

2.5 Market clearing

The market clearing condition for the final good produced by country i reads:

$$Y_{it} = \underbrace{(1-\gamma_i)\left(P_{iYt}\right)^{-\eta} C_{it}}_{C_{iit}} + \sum_{j \neq i} \frac{n_j}{n_i} \underbrace{\gamma_{ji} \left(\frac{(1+\tau_{jit}) P_{iYt}}{Q_{ijt}}\right)^{-\eta} C_{jt}}_{C_{jit}} +$$

$$+ \frac{\psi_P}{2} \left(\Pi_{iYt} - \bar{\Pi}_{iY}\right)^2 Y_{it}, \tag{29}$$

which includes domestic demand, foreign demand (where τ_{jit} is an import tax set by country j, which reduces foreign demand for country i), and price adjustment costs. The market clearing condition for the bond issued by country i reads:

$$\sum_{j \in I} n_j B_{jit} = 0. \tag{30}$$

The market clearing condition for the commodity produced by the i country is:

$$\sum_{j \in I} n_j O_{jit} = n_i Y_{iOt}. \tag{31}$$

The resource constraint reads:

$$\tilde{P}_{it} C_{it} + \frac{\psi_P}{2} \left(\Pi_{iYt} - \bar{\Pi}_{iY} \right)^2 P_{iYt} Y_{it} + B_{iit} + \sum_{j \neq i} Q_{ijt} B_{ijt} = P_{iYt} Y_{it} + \tag{32}$$

$$+ \underbrace{P_{iYt} Y_{it} + P_{iOt} Y_{iOt} - P_{iOt} O_{iit} - \sum_{j \neq i} Q_{ijt} P_{jOt} O_{ijt}}_{gdp_{it}} + \frac{R_{it-1}}{\Pi_{it}} B_{iit-1} + \sum_{j \neq i} \frac{R_{jt-1}}{\Pi_{jt}} Q_{ijt} B_{ijt-1},$$

where consumption plus adjustment costs and the net financial asset position ($NFA_t = B_{iit} + \sum_{j \neq i} Q_{ijt} B_{ijt}$) are equal to GDP plus net returns on foreign assets, with:

$$\tilde{P}_{it} = \left[(1 - \gamma_i) \left(P_{iYt} \right)^{1-\eta} + \sum_{j \neq i} \gamma_{ij} \left(Q_{ijt} P_{iYt} \right)^{1-\eta} \left(1 + \tau_{ijt} \right)^{-\eta} \right] \tag{33}$$

being the “effective” real CPI. Normally, by definition the real CPI is one (i.e. the price index divided by itself). Given that import taxes, which increase the cost of foreign goods, are rebated to households through lump-sum transfers, in our model the “effective” real CPI may differ from one. If taxes are 0, equation (33) is equivalent to equation (5) and $\tilde{P}_{it} = 1$. Finally, notice that GDP is defined as the sum of domestic production (good and commodity) minus domestic and imported commodities (which are intermediate inputs and are subtracted to avoid double counting).

2.6 Equilibrium

For each country i, the equilibrium of the following $14+N$ variables

$$\left\{C_{it}, Y_{it}, \Pi_{it}, \Pi_{iYt}, R_{it}, W_{iYt}, P_{iYt}, \tilde{P}_{it}, \{B_{ijt}\}_{j\in I}, P_{iOt}, O_{it}, F_{it}, H_{iYt}, MC_{it}, H_{iOt}\right\}_{i\in I}$$

and of the $N-1$ bilateral real exchange rates[5] of country 1 $\{Q_{1jt}\}_{j\neq 1}$ is described by equations (5), (7), (9),(10),(14), (15), (16), (21), (23), (24), (27), (29), (30), (31), (32),[6] and (33), plus the $N-1$ versions of equation (8): these are $15+N$ equations for each country, minus 1 market clearing condition that is redundant by Warlas Law. Therefore we have:

$$N\,(14+N)+(N-1)=N\,(15+N)-1$$

variables for $N\,(15+N)-1$ equations.

3 Theoretical results

3.1 Symmetric calibration and fragmentation shock

In order to get an analytical solution of the model, we consider a symmetric calibration: we relax this assumption in Section 4, where we solve the model numerically. In this way we can provide a transparent intuition of the global effects of a fragmentation shock. To achieve symmetry we make the following assumptions:

1. Every country i has same size, productivity, commodity weight, and bond costs: $n_i = n \equiv \frac{1}{N}\ \forall i$, $A_i = A\ \forall i$, $A_{iO} = A_O\ \forall i$, $\alpha_i = \alpha\ \forall i$, and $\psi_{ijF} = \psi_F\ \forall i, j$.

2. In steady state, every country invests the same amount of resources in other countries' bonds: $\bar{B}_{ij} = \bar{B}\ \forall j \neq i$.

[5]Once we have all the $N-1$ bilateral exchange rate of one country (say country 1, without loss of generality), we can easily obtain all the other bilateral exchange rates. For instance if we have Q_{12t} and Q_{13t}, we can get $Q_{23t} = \frac{Q_{13t}}{Q_{12t}}$ and, of course, $Q_{32t} = \frac{1}{Q_{23}}$.

[6]In equations (31)-(32) we can use equation (25) to replace Y_{iOt}. In equation (32) we can replace all the O_{ijt} using (19) and (20).

3. The inflation target is the same in each country: $\bar{\Pi}_{iY} = \bar{\Pi}\ \forall i$.

4. Each country has the same preferences for other countries' goods and commodities: $\gamma_{ij} = \tilde{\gamma},\ \gamma_{ij}^{O} = \tilde{\gamma}^{O}\ \forall i, j$, with $i \neq j$. This also implies $\gamma_i = \gamma \equiv (N-1)\,\tilde{\gamma},\ \gamma_i^{O} = \gamma^{O} \equiv (N-1)\,\tilde{\gamma}^{O}\ \forall i$.[7]

Now we explain how we model the fragmentation shock. For a fragmentation shock we mean a simultaneous increase in both bond and import taxes targeted only to a specific set of countries. We assume that the shock divides the world in two equal blocs of $\frac{N}{2}$ countries. We label these two subsets of countries with $\mathcal{W}$ and $\mathcal{E}$: if $i \leq \frac{N}{2}$, then $i \in \mathcal{W}$, otherwise $i \in \mathcal{E}$. Countries only impose import and bond taxes to countries in the other bloc. Formally, in each country $i \in \mathcal{W}$:

$$\tau_{ijt} = \tau_{ijt}^{O} = \theta_{ijt} = 0\ \forall j \in \mathcal{W}$$

$$\tau_{ijt} = \tau_t > 0\ \forall j \in \mathcal{E}$$

$$\tau_{ijt}^{O} = \tau_t^{O} > 0\ \forall j \in \mathcal{E}$$

$$\theta_{ijt} = \theta_t > 0\ \forall j \in \mathcal{E}.$$

Similarly, each country in bloc $\mathcal{E}$ imposes an import tax on goods τ_t, on commodities τ_t^{O}, and a tax on bonds θ_t to countries in bloc $\mathcal{W}$, without taxing other countries in bloc $\mathcal{E}$. We assume that the taxes follow an autoregressive process of order 1, with parameter $\rho \in [0, 1)$.

3.2 Steady state

Variables without time index are meant to be in the deterministic steady state. We remove the country index, given the symmetric calibration. Assuming a labor subsidy $\tau_L = \frac{1}{\varepsilon}$, zero taxes in steady state, and setting A and A_O such that in steady state GDP

[7] For instance, equation (1) becomes: $C_{it} = \left\{ (1-\gamma)^{\frac{1}{\eta}} \left(C_{iit}\right)^{\frac{\eta-1}{\eta}} + \tilde{\gamma}^{\frac{1}{\eta}} \sum_{j \neq i} \left(C_{ijt}\right)^{\frac{\eta-1}{\eta}} \right\}^{\frac{\eta}{\eta-1}}$.

is 1 and the commodity production GDP ratio is equal to $\omega > 0$ ($\omega = \frac{P_O A_O H_O}{GDP}$), we can find the following symmetric steady state (see Appendix A):

$$C = Y = MC = P_Y = \tilde{P} = 1$$

$$\Pi = \Pi_Y = \bar{\Pi}_Y$$

$$R = \frac{\bar{\Pi}_Y}{\beta}$$

$$H_O = \omega^{\frac{1}{1+\varphi}}$$

$$H_Y = (1-\omega)^{\frac{1}{1+\varphi}}$$

$$F = P_O = \left\{ \frac{(1-\omega)^{\frac{1+\varphi\xi}{1+\varphi}} \omega}{(1-\alpha)\,\alpha} \right\}^{\frac{1}{\xi-1}}$$

$$O = \left[\frac{1-\alpha}{\alpha} \frac{\omega^{\xi}}{(1-\omega)^{\frac{1+\varphi\xi}{1+\varphi}}} \right]^{\frac{1}{\xi-1}}$$

$$B_F = \bar{B}$$

$$B_H = -(N-1)\,\bar{B},$$

where we define with B_F (B_H) the investment that a generic country i makes in another country's (domestic) bonds. Given symmetry, all the exchange rates Q_{ij} are equal to 1.

3.3 Log-linearization and solution

We solve the model by log-linearizing it around the steady state. We denote with lower-case letters variables in percentage deviations from the steady state: for example, $c_{it} \equiv \frac{C_{it}-C}{C}$. Our goal is to find a closed-form solution for every endogenous variable as a function of the exogenous ones (τ_t, τ_t^O, and θ_t).

Given that countries are all equal and are hit by the same shocks, there is a solution of the model where every country features the same impulse response functions: in what follows, we show that this solution exists and we analyze it.[8]

Proposition 3.1. *A fragmentation shock (i.e. an increase in τ_t, τ_t^O, and θ_t) has the same effect in every country and does not impact exchange rates and net financial asset positions.*

Proof. See Appendix A. □

This result is quite intuitive: given that countries are identical, a shock that hits all countries equally has no effects on international relative prices and net positions. This result also implies that we can remove the country index i and that the model can be reduced to the canonical three equations of the New Keynesian model, as we state in the following proposition.

Proposition 3.2. *The non-linear multi-country model can be written using three equations, up to a first order approximation:*

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}\left(r_t - \mathbb{E}_t \pi_{Yt+1}\right) - \frac{\tilde{\gamma} N}{2\sigma}\mathbb{E}_t\left(\tau_t - \tau_{t+1}\right) \tag{34}$$

$$\pi_{Yt} = \beta \mathbb{E}_t \pi_{Yt+1} + \kappa\left(y_t - y_t^n\right) \tag{35}$$

$$r_t = \phi_\pi \pi_{Yt} \tag{36}$$

where $\kappa \equiv \frac{(\varepsilon-1)(\sigma+\varphi)}{\psi_P \Pi_Y^2}$ and y_t^n is the natural level of output, i.e. the output level that would result without price rigidities, given by:

$$y_t^n = -\frac{N}{2\left(\varphi+\sigma\right)}\left(\omega \tilde{\gamma}^O \tau_t^O + \tilde{\gamma}\tau_t\right). \tag{37}$$

Proof. See Appendix A. □

[8] Given the complexity of the model, we are not able to prove that the Blanchard-Khan conditions are satisfied and thus show that the symmetric solution is also unique. So, even if implausible as the model does not have strictly peculiar features, we cannot rule out the alternative possibility, i.e. an infinite number of solutions. Nevertheless, we have conducted extensive numerical checks across various parameter combinations, consistently confirming the uniqueness of the solution within this model.

We leave the formal proof in the appendix but give an outline in what follows, in order to understand why the good import tax shows up both in the Euler equation and in the Phillips curve, while the commodity tax appears only in the latter. By log-linearizing equation (5) and applying Proposition 3.1 we obtain:

$$\underbrace{p_{Yt}}_{rel.PPI} = -\frac{1}{1-\gamma}\left(\underbrace{\frac{\tilde{\gamma}N}{2}\tau_t + \gamma p_{Yt}}_{rel.IPI}\right). \tag{38}$$

This equation shows that the relative PPI p_{Yt} (i.e. relative to the CPI) is negatively related to the relative import price index (IPI), which includes the good import tax (set by the $\frac{N}{2}$ countries in the other bloc) and the foreign PPIs; the latter are in turn identical to the domestic one by Proposition 3.1. So we obtain that a worldwide increase in import taxes on goods reduces the relative PPI:

$$p_{Yt} = -\frac{\tilde{\gamma}N}{2}\tau_t. \tag{39}$$

Good import taxes also enter the market clearing conditions (equation 29), whose log-linearized version reads:

$$y_t = \underbrace{(1-\gamma)\left(c_t - \eta p_{Yt}\right)}_{domestic\ demand} + \underbrace{\gamma\left(c_t - \eta p_{Yt}\right) - \frac{\eta\tilde{\gamma}N}{2}\tau_t}_{foreign\ demand}. \tag{40}$$

According to this equation, the supply of good y_t must be equal to domestic and foreign demand. On the one hand, the good import tax set by foreign governments directly reduces foreign demand for the domestic good. On the other hand, by equation (39), the tax reduces the relative PPI, increasing both domestic and foreign demand. Using equation (39), we observe that the two opposite effects cancel out each other:

$$y_t = c_t. \tag{41}$$

Using equation (41) in the log-linearized version of equation (15), we obtain an expression for real marginal costs:

$$mc_t = (\varphi + \sigma) y_t + \frac{\tilde{\gamma}^O N\omega}{2}\tau_t^O, \tag{42}$$

which shows that the commodity tax, by inducing higher import costs for commodities, increases firms' marginal costs. Log-linearizing equation (23), we get:

$$\pi_{Yt} = \beta \mathbb{E}_t \pi_{Yt+1} + \frac{\varepsilon - 1}{\psi_P \bar{\Pi}_Y^2} (mc_t - p_{Yt}). \tag{43}$$

Using equations (39), (42), and (43), we derive the Phillips curve:

$$\pi_{Yt} = \beta \mathbb{E}_t \pi_{Yt+1} + \kappa \left\{ y_t + \frac{N}{2(\varphi + \sigma)} \left[\omega \tilde{\gamma}^O \tau_t^O + \tilde{\gamma} \tau_t \right] \right\}. \tag{44}$$

The commodity tax enters the Phillips curve as it directly increases marginal costs. The good import tax also enters the Phillips curve because, by reducing the relative PPI, it raises the PPI real marginal costs (i.e. $mc_t - p_{Yt}$) of firms, which respond by raising prices. We now derive equation (34) by log-linearizing equation (7):

$$c_t = \mathbb{E}_t c_{t+1} - \frac{1}{\sigma} (r_t - \mathbb{E}_t \pi_{t+1}). \tag{45}$$

Using the log-linear version of equation (24) to replace π_{t+1}:

$$\pi_{t+1} = \pi_{Yt+1} - (p_{Yt+1} - p_{Yt}) \tag{46}$$

and equation (41) to replace c_t, we end up with:

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma} (r_t - \mathbb{E}_t \pi_{Yt+1} + \mathbb{E}_t p_{Yt+1} - p_{Yt}). \tag{47}$$

Combining the last equation with (39), we get the aggregate Euler equation:

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}\left(r_t - \mathbb{E}_t \pi_{Yt+1}\right) - \frac{\tilde{\gamma} N}{2\sigma}\left(\tau_t - \mathbb{E}_t \tau_{t+1}\right). \tag{48}$$

Notice that if current good import taxes are higher than future taxes, current demand goes down as future CPI inflation is lower, inducing households to postpone consumption.[9] Proposition 3.2 shows that on the one hand, the worldwide good import tax shock reduces world supply, depressing output and increasing PPI inflation. On the other hand, the shock reduces world demand, reducing output and PPI inflation. The effect on output is unambiguous while that on PPI inflation is not obvious.

Conversely, the effect of the commodity tax is unambiguous: it depresses aggregate supply, inducing lower output and higher PPI inflation. The following proposition clarifies the overall response of output and PPI inflation.

Proposition 3.3. *The solution of the model yields:*

$$\pi_{Yt} = -\Omega_\pi^\tau \tau_t + \Omega_\pi^O \tau_t^O$$

$$y_t = -\Omega_y^\tau \tau_t - \Omega_y^O \tau_t^O,$$

where $\Omega_\pi^\tau \equiv \frac{\tilde{\gamma} N \kappa \varphi (1-\rho)}{2\varsigma}$, $\Omega_y^\tau \equiv \frac{\tilde{\gamma} N [\kappa(\phi_\pi - \rho) + (\sigma+\varphi)(1-\rho)(1-\beta\rho)]}{2\varsigma}$, $\Omega_\pi^O \equiv \frac{\tilde{\gamma}^O N \omega \kappa \sigma (1-\rho)}{2\varsigma}$, $\Omega_y^O \equiv \frac{\tilde{\gamma}^O N \omega \kappa (\phi_\pi - \rho)}{2\varsigma}$, $\varsigma \equiv (\sigma + \varphi)\left[\kappa\left(\phi_\pi - \rho\right) + \sigma\left(1-\rho\right)\left(1-\beta\rho\right)\right]$ *are positive parameters.*

Proof. See Appendix A. □

Both the good and the commodity import taxes induce a fall in output. The tax on imported goods reduces PPI inflation, as its negative impact on aggregate demand (arising from a higher cost of traded goods) is greater than its negative impact on aggregate supply (arising from firms' higher marginal costs). The tax on imported commodities raises PPI inflation as it directly increases firms' marginal costs.

[9] Notice that the reduction in the relative PPI $p_{Yt} = p_{Yt}^{\$} - p_t$ is not necessarily in contrast with the increase in PPI inflation $\pi_{Yt} = p_{Yt}^{\$} - p_{Yt-1}^{\$}$.

What about CPI inflation? Under taxes on imported commodities, CPI inflation increases as much as PPI inflation. Under taxes on imported goods, using equation (46), we know that from period $t+1$ on:

$$\pi_{t+1} = \pi_{Yt+1} - \frac{\tilde{\gamma}N\left(1-\rho\right)}{2}\tau_t$$
$$\pi_{t+1} = -\rho\Omega_{\pi}^{\tau}\tau_t - \frac{\tilde{\gamma}N\left(1-\rho\right)}{2}\tau_t,$$

which implies that future CPI inflation also goes down. In period t:

$$\pi_t = \pi_{Yt} - \frac{\tilde{\gamma}N}{2}\left(\tau_{t-1} - \tau_t\right).$$

Setting $\tau_{t-1} = 0$, we get:

$$\pi_t = \left(\frac{\tilde{\gamma}N}{2} - \Omega_{\pi}^{\tau}\right)\tau_t,$$

which is positive for a reasonable calibration. So CPI inflation goes up on impact, as the import tax directly raises import prices, and then it goes below the steady state in the following periods.

What if the tax on imported goods is equal to the tax on imported commodities? Both taxes reduce output, which falls unambiguously. The effect on PPI inflation depends on the relative weight of imported goods and commodities in their baskets. In particular, if $\omega\tilde{\gamma}^O > \tilde{\gamma}\frac{\varphi}{\sigma}$ PPI inflation increases. This occurs when the weight ω of the commodity sector is relatively large, when the weight $\tilde{\gamma}^O$ of imported commodities is relatively large, when the weight of imported goods $\tilde{\gamma}$ is relatively small.

The attentive reader may have noticed that the bond tax shock does not play any role in affecting output and inflation, which only respond to the import tax. The following proposition clarifies why, showing that the bond tax impacts only bond gross positions (which in turn are not affected by the import taxes). Given Proposition 3.1, each country issues the same amount of bonds (call it $-b_{Ht}$), invests the same amount of bonds issued by countries belonging in the same bloc (call it b_{At}), and invests in the same amount of bonds issued by countries in the other bloc (call it b_{Et}).[10]

Proposition 3.4. *Bond gross positions respond to a fragmentation shock as follows:*

1. *Each country sells bonds issued by countries in the other bloc:* $b_{Et} = -\frac{\theta_t}{\psi_F}$.
2. *Each country does not change its position relatively to country in the same bloc:* $b_{At} = 0$.
3. *Each country issues less bonds:* $-b_{Ht} = -\frac{N}{2}\frac{\theta_t}{\psi_F}$.

Proof. See Appendix A. □

When a country i in bloc $\mathcal{W}$ raises capital controls targeted to bonds issued by bloc $\mathcal{E}$, households in country i reduce investment in bloc $\mathcal{E}$: the effect is stronger the lower ψ_F, which measures the transaction cost of trading with other countries and it can be interpreted as the elasticity of the bond demand to changes in the interest rate differential. Given that capital controls are reciprocal, country i will face a reduction in the demand for its bonds. As already stated in Proposition 3.1, the net financial asset position of each country does not move:

$$NFA_t = \frac{N}{2}b_{Et} + \frac{N-1}{2}b_A + b_H = 0.$$

4 Numerical simulations

Our symmetric calibration allows us to derive a closed-form solution of the model presented in the previous section. However, it does not permit the study of the effects on exchange rates, net capital flows, and trade balances, which remain unchanged after a fragmentation shock under symmetric calibration. Furthermore, an asymmetric calibration will enable us to examine which countries suffer more from fragmentation and the potential spillover effects on neutral countries.

[10] Bonds positions are in deviations from their steady state as a fraction of the country's GDP.

In this Section, we explain how to calibrate the model and simulate the three legs of the fragmentation shock.

4.1 Calibration

We set the number of regions N to four: the US (or country 1); a region of countries allied with the US (WE, or country 2); a region including China, Russia, and their allies (CR, or country 3); and a region of neutral countries (NE, or country 4).

We follow the methodology developed by Den Besten et al. (2023), also employed in Panon et al. (2024), to allocate countries into different blocs. These authors constructed an index of political alignment by combining four geopolitical measures. The first measure is the number of times a country has been sanctioned by China and Russia minus the number of times it has been sanctioned by the United States. The second measure is calculated as the share of military imports from Russia and China minus the share from the United States. The third measure indicates whether a country participates in the Belt and Road Initiative (BRI). The fourth variable is a country's voting behavior on the United Nations General Assembly resolution adopted on 2 March 2022 regarding Russia's invasion of Ukraine. The final index ranges from zero to one, indicating the degree of geopolitical alignment with China and Russia (closer to 1) compared to the United States (closer to 0). Countries with an index below 0.25 are assigned to the US-aligned bloc (WE), while those with an index above 0.75 are assigned to the China-Russia bloc (CR). Other countries are classified into the neutral bloc (NE). The list of countries assigned to the respective blocs is provided in Appendix B.

In the simulations, one period corresponds to one quarter. Some parameters are economy-specific, while the remaining ones are common to all. Table 1 reports the calibrated parameters, while Table 2 shows the steady-state targets. We use IMF World Economic Outlook (WEO) data to calibrate the population shares n_i of the four blocs. WEO data are also used to derive the ratios between the GDP per capita of bloc 1 and those of the other blocs (we denote these ratios with Λ_{1j}) and calculate ex post the total factor productivity (TFP) in the good sector A_i. The GDP of country 1 is normalized to one. We use data on oil and gas production from the Statistical Review of World Energy (SRWE) of the Energy Institute, to calibrate ex ante the commodity production over GDP ratio ω_i and derive ex post the TFP in the commodity sector A_{iO}. SRWE data on oil and gas consumption are used to estimate the commodity share in the production function α_i. The United Nations Comtrade Database is employed to obtain the imports of goods and commodities over GDP of the different blocs and estimate the weights of foreign goods γ_{ij} and commodities γ_{ij}^O in each country bundle. The financial assets of the alternative blocs relative to their GDP are computed considering portfolio assets from the IMF Coordinated Portfolio Investments Survey (CPIS), the stocks of loans and deposits from the BIS Locational Banking Statistics (LBS), and the foreign direct investment assets from the IMF Coordinated Direct Investments Survey (CDIS).[11]. All data refer to 2019 values in order to exclude the impact of the COVID-19 pandemic and to reproduce a steady state not affected by the recent geopolitical developments. However, given that most variables considered in the calibration are stocks, results are robust to the use of time averages.

The common parameters assume standard values in the literature. The degree of risk aversion σ is set to 2. The discount factor β is assumed equal to 0.9975, implying an annual real rate equal to 1%. We assume a steady-state with zero inflation. Following the IMF Integrated Policy Framework (Adrian et al., 2021), we set the elasticity of substitution between goods produced in different countries η equal to 1.5. We assume a quadratic labor disutility ($\varphi = 1$), calibrate the elasticity of substitution between differentiated good ε equal to 6, and set the Taylor rule parameter ϕ_π equal to 1.5; these are all standard values. Assuming a fraction of firms with sticky prices equal to 66% is equivalent to calibrate the price adjustment cost ψ_P around 28. We assume that labor and commodities are complement productive inputs with an elasticity of substitution ξ equal to 0.4, while we set the elasticity of substitution between commodities produced in differ-

[11] We also use the Foreign Holdings of US Securities Survey to compute a more reliable breakdown of US liabilities by counterpart country.

ent countries ζ equal to 1.25 (so different commodities are relatively weak substitutes). Given that international financial markets between the US and its allies are relatively open, we set the bond adjustment cost to a relatively small value $\psi_{12F} = \psi_{21F} = 0.01$, as standard in the literature. All the other ψ_{ijF} are calibrated to higher values ($100\psi_{12F}$). In the robustness subsection 4.3, we perform a sensitivity analysis on these ξ, ψ_{ijF}, and η.

Calibration: parameters

Parameter	Description	Value
σ	Risk aversion	2
β	Discount factor	0.9975
φ	Inverse of the Frisch elasticity	1
ψ_{12F}, ψ_{21F}	Bond transaction cost between 1 and 2	0.01
ψ_{ijF}	Bond transaction cost $(i,j) \neq \{(1,2),(2,1)\}$	1
η	El. of sub. between domestic and foreign goods	1.5
ε	El. of sub. between intermediate goods	6
ξ	El. of sub. between labor and commodity	0.4
ζ	El. of sub. between different commodities	1.25
ψ_P	Price adjustment cost	28.4088
ϕ_π	Taylor rule parameter	1.5
n_1, n_2, n_3, n_4,	Population shares	4.33%, 11.67%, 34.23%, 49.77%
A_1, A_2, A_3, A_4	TFP in good production	0.9946, 0.1828, 0.0117, 0.0090
α_1, α_2, α_3, α_4	Weight of commodities in production	0.0456, 0.0402, 0.0318, 0.0291
A_{1O}, A_{2O}, A_{3O}, A_{4O}	TFP in commodity production	0.5537, 0.0273, 0.5328, 0.1188
γ_{12}, γ_{13},γ_{14}	Weight of foreign goods in 1's bundle	0.0500, 0.0236, 0.0347
γ_{21}, γ_{23},γ_{24}	Weight of foreign goods in 2's bundle	0.0231, 0.0363, 0.0300
γ_{31}, γ_{32},γ_{34}	Weight of foreign goods in 3's bundle	0.0094, 0.0606, 0.0409
γ_{41}, γ_{42},γ_{43},	Weight of foreign goods in 4's bundle	0.0295, 0.0704, 0.0561
γ_{12}^O, γ_{13}^O,γ_{14}^O	Weight of foreign commodities in 1's bundle	0.1075, 0.0175, 0.0746
γ_{21}^O, γ_{23}^O,γ_{24}^O	Weight of foreign commodities in 2's bundle	0.0672, 0.1393, 0.3159
γ_{31}^O, γ_{32}^O,γ_{34}^O	Weight of foreign commodities in 3's bundle	0.0063, 0.0597, 0.3994
γ_{41}^O, γ_{42}^O,γ_{43}^O	Weight of foreign commodities in 4's bundle	0.1717, 0.1099, 0.1133

Table 1: Calibrated parameters

Calibration: steady state values

SS value	Description	Value
GDP_1	Country 1's GDP	1
Λ_{12}, Λ_{13}, Λ_{14}	GDP per capita ratio	1.8500, 9.2498, 14.9643
$Q_{12}B_{12}/4GDP_1$, $Q_{13}B_{13}/4GDP_1$, $Q_{14}B_{14}/4GDP_1$	Country 1's asset positions	69.53%, 3.84%, 11.06%
$Q_{21}B_{21}/4GDP_2$, $Q_{23}B_{23}/4GDP_2$, $Q_{24}B_{24}/4GDP_2$	Country 2's asset positions	73.28%, 8.68%, 18.41%
$Q_{31}B_{31}/4GDP_3$, $Q_{32}B_{32}/4GDP_3$, $Q_{34}B_{34}/4GDP_3$	Country 3's asset positions	12.46%, 10.22%, 2.87%
$Q_{41}B_{41}/4GDP_4$, $Q_{42}B_{42}/4GDP_4$, $Q_{43}B_{43}/4GDP_4$	Country 4's asset positions	15.90%, 7.05%, 2.28%
ω_1, ω_2, ω_3, ω_4	Commodity prod. over GDP	2.12%, 0.84%, 3.50%, 6.87%
$\bar{\Pi}_{iY}$	Targeted inflation rate	1

Table 2: Calibrated values in steady state

4.2 Impulse response functions

We simulate the effects of taxes on imports of goods, imports of commodities, and foreign assets. The US and WE impose taxes on CR, and vice versa. The NE region neither imposes taxes nor is the target of any. We assume that taxes follow an autoregressive process of order 1, with a persistence of 0.9. We solve the model using a first-order approximation around the steady state. We simulate the effects of each tax individually to isolate the impact of each specific aspect of geoeconomic fragmentation. Additionally, simulating all tax shocks simultaneously would require a precise calibration of each tax rate, which is beyond the scope of this paper.

For each region and each shock, we show the impulse response function of 12 variables. Variables for the US, WE, CR, and NE are denoted in green, blue, red, and black, respectively. Most variables, such as output and consumption, are plotted as percentage deviations from their steady state. The real interest rate, inflation rates, and the currency premium versus the US are plotted as annualized deviations from their steady state. The trade balance is plotted as a deviation from the steady state, divided by steady-state GDP. In Appendix C, we show the response of additional variables, all plotted as deviations from the steady state, divided by steady-state GDP.

To better make sense of the impulse response functions, we provide below the two linearized UIP conditions between country i and country j (one has to hold for country i, the other one for country j) :

$$rr_{it} = rr_{jt} + (\mathbb{E}_t q_{ijt+1} - q_{ijt}) - \theta_{ijt} - \frac{\psi_{ijF}}{gdp_i} b_{ijt} \tag{49}$$

$$rr_{jt} = rr_{it} - (\mathbb{E}_t q_{ijt+1} - q_{ijt}) - \theta_{jit} - \frac{\psi_{jiF}}{gdp_j} b_{jit} \tag{50}$$

where $rr_{it} \equiv r_{it} - \mathbb{E}_t \pi_{it+1}$ is the real interest rate. In the impulse response function, the currency premium of country i vs the US is defined as $cp_{i,USt} \equiv (rr_{it} + \mathbb{E}_t q_{US,it+1} - q_{US,it}) - rr_{USt}$.

4.2.1 Tax on imports of goods

We simulate a 10 percentage point increase in the tax rate on imports of goods between rival countries (Figures 1 and C.1). The shock size is arbitrary but, given the linearity of the model, if we double the size of the shock, for example, it is sufficient to multiply all the responses by 2.

Consistent with our analytical results, we find that the shock reduces economic activity and PPI inflation, while it raises CPI inflation on impact in the three regions involved in the fragmentation shock.

CR is by far the region most affected by the shock, as the two largest regions, the US and WE, are taxing the goods it exports. The CR real exchange rate appreciates relative to those of the other countries, as the tax imposed by CR reduces CR demand for US and WE goods and increases demand for domestically produced goods. This effect is only partially offset by the US and WE taxes, which push the CR exchange rate towards depreciation. The CR appreciation reduces the external demand for CR bonds via the UIP condition, inducing an increase in the CR interest rate (see equation 49).

Given that WE trades relatively more with CR compared to the US, the negative effect of fragmentation is relatively larger in WE. The spillover effects to NE are almost nil: on the one hand, other countries increase their demand for NE goods, which are not taxed. On the other hand, other countries are poorer and consume less of all goods.

4.2.2 Tax on imports of commodities

We simulate a 10 percentage point increase in the tax rate on imports of commodities between rival countries (Figures 2 and C.2).

In the US, the shock has almost no impact, as the GDP share of commodity exports and imports is very small.

WE is a commodity importer: the commodity price index spikes, reducing the demand for the commodity input and, thus, the production of the domestic good. Consumption decreases as households become poorer and the policy rate rises to mitigate inflation.

CR is a commodity exporter: the lower commodity demand drives down both commodity production and the domestic commodity price. Production of the domestic good rises as workers move from the commodity sector to the goods sector. The higher supply of the domestic good depreciates the exchange rate, increasing the demand for CR bonds, which are now cheaper, and causing inflation to rise. Higher capital inflows finance a trade deficit.

NE is also a commodity exporter. As in the case of the tax on imported goods, the spillover effects on NE are small. Given that CR commodities are now cheaper (since NE is not taxing them), NE increases their purchases and reduces consumption of their own commodities. However, their commodity production slightly rises to satisfy the higher demand from WE.

4.2.3 Tax on external assets

We simulate a 50 basis point increase in the tax rate on bonds issued by rival countries (Figures 3 and C.3).

In an asymmetric calibration, the tax has macroeconomic effects on top of financial effects. In absolute terms, CR is more affected than the US and WE, given its relatively smaller size.[12] The tax imposed by CR reduces CR demand for US and WE bonds, appreciating the CR currency and lowering the CR interest rate. These effects are mitigated by the reciprocal tax imposed by the US and WE. The reduction in the CR interest rate stimulates consumption, while the currency appreciation decreases inflation and reduces CR production of both goods and commodities. Capital inflows exceed outflows, resulting in a trade deficit.

In the US and WE, the economy experiences the opposite effects, though on a smaller scale. The spillover effects to NE are even milder.

To sum up this numerical section, we identify the following general results. First, fragmentation primarily affects the China-led block and the US allies (including the European Union). With few exceptions, these regions experience a reduction in consumption and production. Second, the US is largely shielded from the fragmentation shock, being relatively less exposed to the China-aligned bloc than its allies. Third, the spillover effect to neutral countries is almost negligible, as two channels offset each other: the expenditure switching channel, which increases demand for NE goods and commodities; and the world income channel, which works in the opposite direction as the rest of the world becomes poorer. Fourth, fragmentation is not necessarily an inflationary phenomenon, as illustrated in the previous section. Fifth, the most affected bilateral exchange rates are those of the China-led block, which appreciate when fragmentation is driven by taxes on goods and assets, and depreciate when it is driven by taxes on commodities.

[12] Just for the sake of the argument, suppose a very small country imposes a tax on foreign bonds issued by the rest of the world, and vice versa. The rest of the world's economy would be barely affected, being de facto a closed economy. All the shock would be absorbed by the small country, which would experience exchange rate and interest rate movements that would significantly impact its economic activity.

Fragmentation: tax on imports of goods

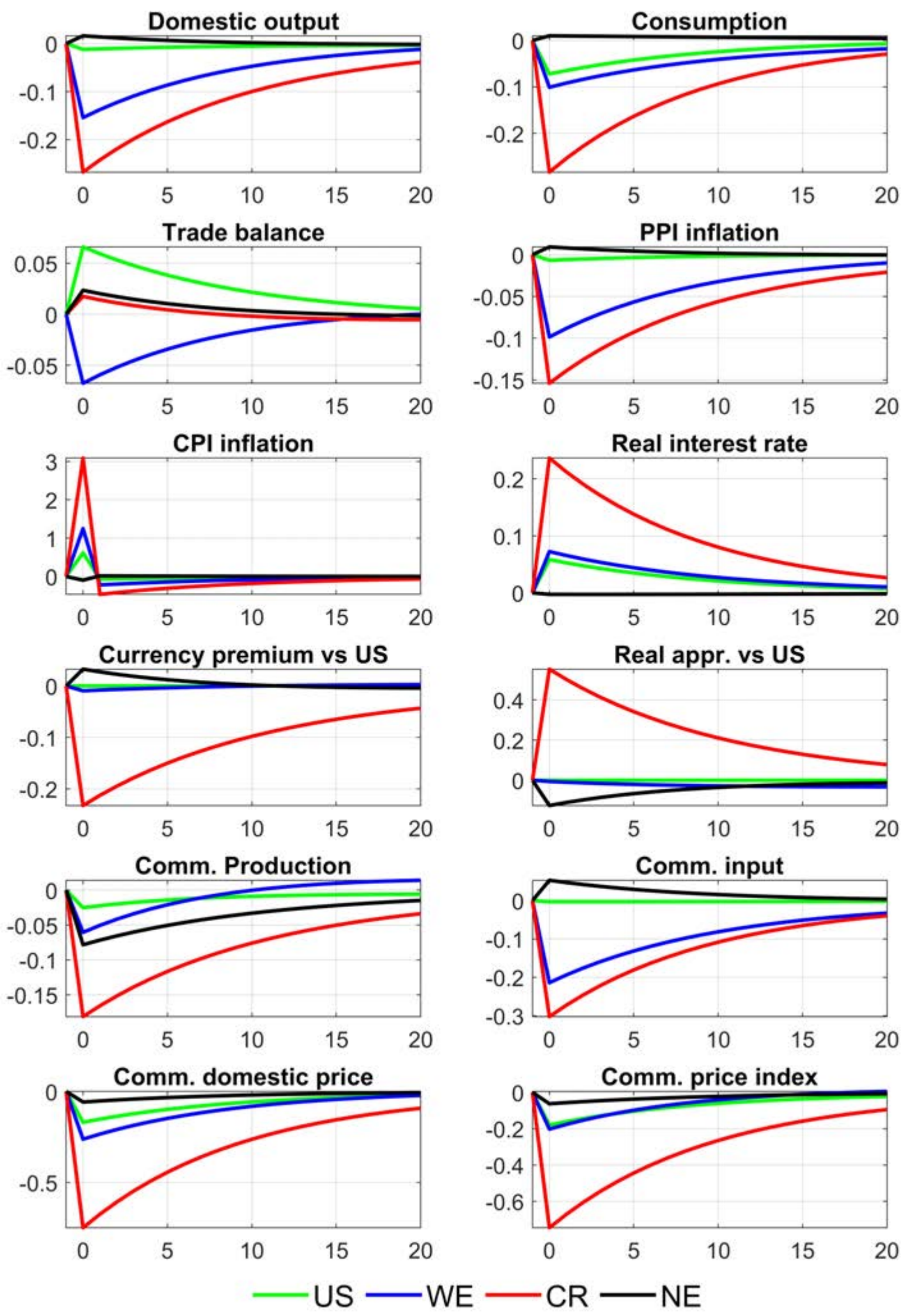

Figure 1: 10 percentage point increase in the tax on imports of goods produced by rival countries.

Fragmentation: tax on imports of commodities

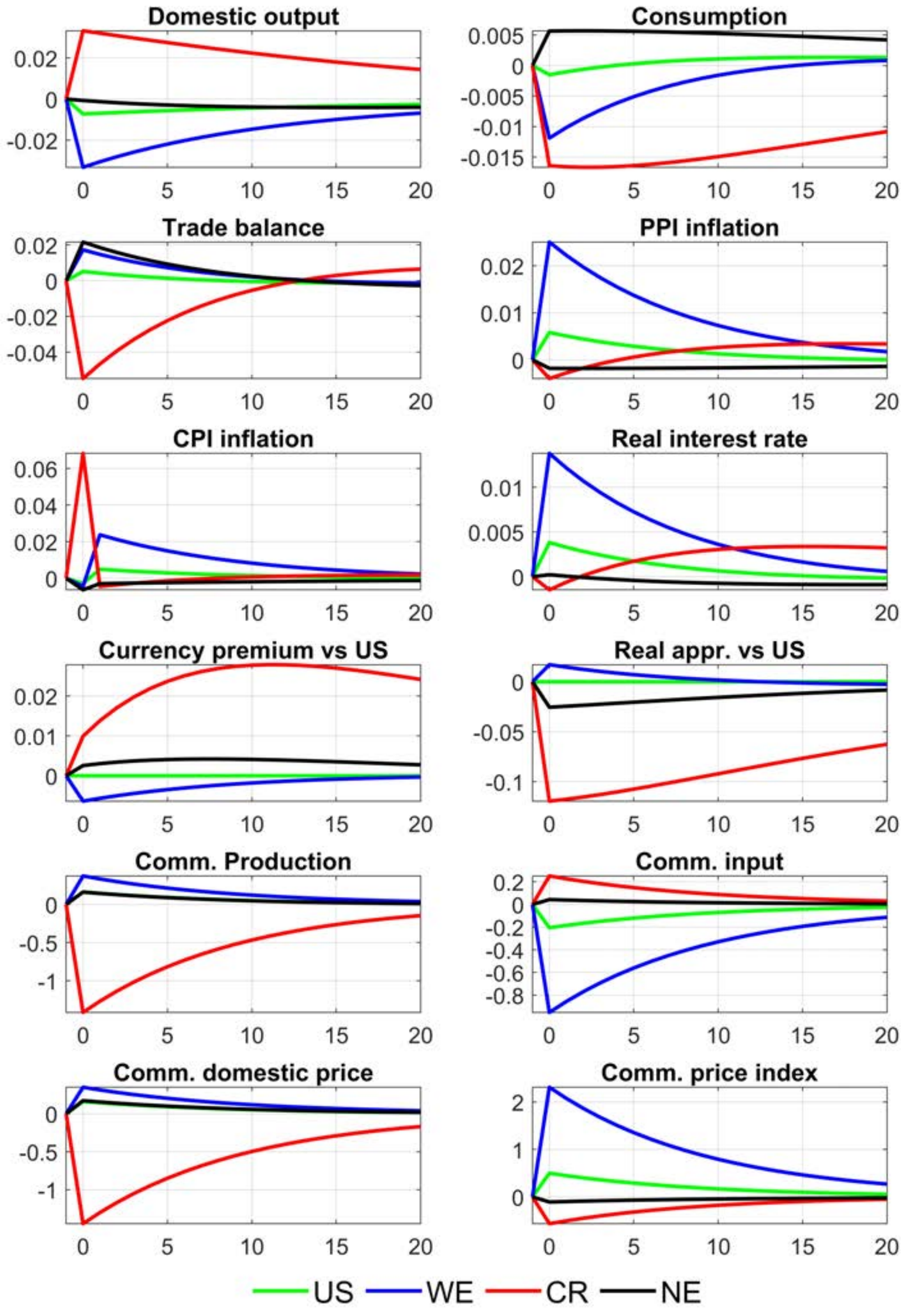

Figure 2: 10 percentage point increase in the tax on imports of commodities produced by rival countries.

Fragmentation: tax on foreign bonds

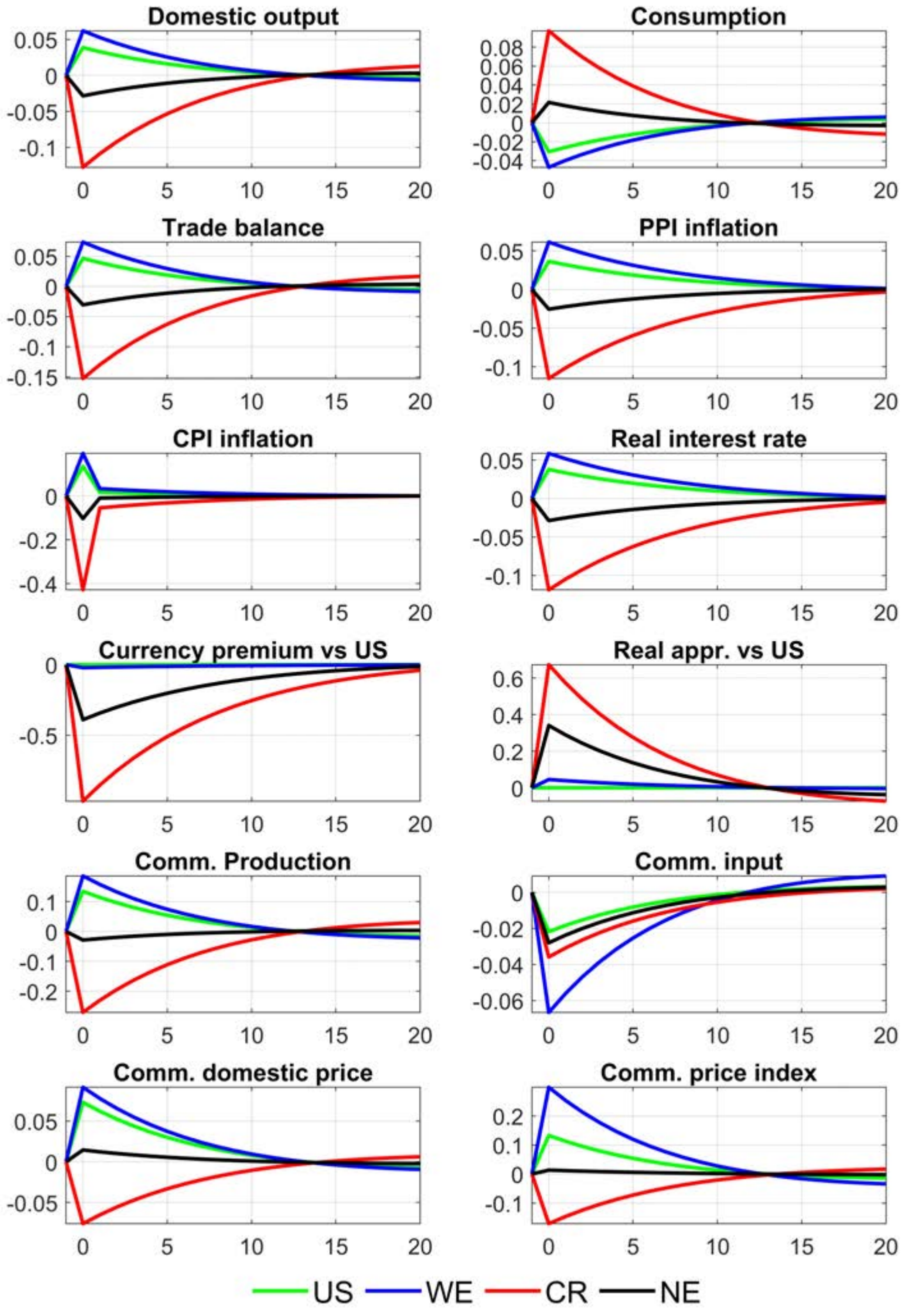

Figure 3: 50 basis point increase in the tax on bonds issued by rival countries.

4.3 Sensitivity analysis

Given the relevance and the uncertainty of some parameters, we change their values to assess how our results change. In particular, we simulate the effects of a tax on imports of goods when the elasticity of substitution between domestic and foreign goods is higher. We simulate the effects of a tax on imports of commodities when the elasticity of substitution between domestic and foreign commodities is lower. We simulate the effects of a tax on assets issued by rival countries when financial markets are relatively less open. We make the shock permanent, taking $\rho \to 1$.

4.3.1 Elasticity of substitution between domestic and foreign goods

We increase η from 1.5 to 5, making domestic and foreign goods more substitute, when fragmentation is modeled as a tax on commodities (see Figures C.4-C.5). The impulse responses are very similar to the baseline case. The only notable change is that countries reduce imports and exports even more, as households increase demand of the local good, which is now a very good substitute of foreign goods.

4.3.2 Elasticity of substitution between labor and commodities

We decrease ξ from 0.4 to 0.1, making labor and commodities more complement, and we consider a fragmentation shock modeled as a tax on commodities (see Figures C.6-C.7). Qualitatively, the effects are very similar to the baseline case. The commodity price index increases more than in the baseline scenario, especially for commodity importers like the US allies. Given the higher complementary between labor and commodities, intermediate-good firms reduce their demand of commodity inputs less and production is decreased to a lesser extent with respect to the baseline, thus reducing the pass-through of higher import prices of commodities to PPI inflation.

4.3.3 Less open financial markets

We multiply by 5, the parameter affecting bond transaction costs (ψ_{ijF}) and, thus, the arbitrage between bonds issued in different countries: when this parameter is higher, households are less able to arbitrage between different bonds, making bond positions less substitutes. When countries impose taxes on bonds issued by rivals, under a higher ψ_{ijF} the volatility of bond purchases falls, with no qualitative change compared to the baseline impulse responses (Figures C.8-C.9).

4.3.4 Permanent shocks

We now assume that fragmentation is permanent, using $\rho \to 1$: the autoregressive process is a unit root.

In Figures C.10 and C.11 we simulate a permanent 10 percentage point increase in the tax rate on imports of goods between rival countries. As in the case of a persistent but transitory shock, output falls, especially in the CR block; the difference however is that output reduction is permanent. CR reduces the demand for US and WE goods, inducing an appreciation of its currency, which in turns reduces the external demand for CR bonds and increases the CR interest rate. Given the higher trade exposure to CR of WE relative to US, the negative effect of the tax increase is relatively larger in WE, while spillovers to NE are almost nil. Hence, results are quite robust with the exception of the effects on PPI inflation, which are close to zero. This is coherent with the closed form solution shown in Proposition 3.3 under a symmetric calibration: when $\rho = 1$ the effect on PPI inflation of a tax on imports of goods is zero.

When we simulate a permanent 10 percentage point increase in the tax on imports of commodities (Figures C.12 and C.13), the shock has almost no impact on US production, as in the case of a transitory shock, while it induces a larger and persistent fall (increase) in production for commodity importers (exporters), like the WE (CR) block. The higher production of the CR good, induces a depreciation of its currency. Again, spillover effects to NE are rather limited, while the impact on PPI inflation is nil, as in the case of a permanent increase in the tax on imports of goods.

Finally, we simulate a permanent 50 basis point increase in the tax rate on bonds issued by rival countries (Figures C.14 and C.15). The impulse responses of such shock are in line with the simulation of a persistent but transitory shock, although the effects have a larger magnitude. The capital restrictions imposed by CR reduce its demand for US and WE bonds, appreciating its currency and lowering its interest rate. The reduction in the CR interest rate stimulates consumption, while the currency appreciation induces lower inflation and production. Capital inflows exceed outflows, generating a trade deficit. In the US and WE, the effects are smaller, but they have the opposite sign. The spillover effects to NE are even milder.

5 Conclusions

We have developed FraNK, a multi-country New Keynesian model designed to study geopolitical fragmentation.

We begin with a symmetric calibration to derive several closed-form results, showing that fragmentation reduces global output but does not necessarily increase inflation. According to our model, geopolitical fragmentation tends to be stagflationary the larger the weight of commodities in production.

We then calibrate our model to four regions: the United States; a bloc of US allies, including the European Union; China, Russia and their allies; and a bloc of neutral countries. In this asymmetric calibration of the model, we show that fragmentation primarily impacts the China-Russia block and the US allies, including the European Union, while the US and the neutral countries are much less affected. The reason is that US allies and the China-led bloc currently have strong financial and trade ties with countries that would become potential rivals in case of a world increasingly fragmented along geopolitical lines.

A few caveats deserve attention. Although our model is sufficiently detailed to include multiple countries and two sectors, for simplicity we have omitted some potentially significant features. First, the model does not include capital accumulation and the above mentioned cross-country production network. Second, domestic financial markets are assumed to be frictionless. Third, while our model accounts for the US being the wealthiest economy, it does not incorporate the dominant role of the dollar in the global economy. We leave these considerations for future research.

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A Theoretical results

A.1 Steady state

Variables without a time index are meant to be in the deterministic steady state. We study a symmetric steady state where all the bilateral exchange rates are one:

$$Q_{ij} = 1 \ \forall i, j \tag{A.1}$$

and $\tau_L = \frac{1}{\varepsilon}$, while import and bond taxes are zero. Given that all countries feature the same steady state, we remove the country index. In steady state the Taylor rule implies that PPI inflation is at the target:

$$\Pi_Y = \bar{\Pi}_Y. \tag{A.2}$$

Given equation (24), we find that CPI inflation is equal to PPI inflation in steady state:

$$\Pi = \Pi_Y \tag{A.3}$$

which yields the nominal interest rate by the domestic Euler equation:

$$R = \frac{\Pi}{\beta}. \tag{A.4}$$

The Euler equation for foreign bonds yield:

$$B_F = \bar{B} \tag{A.5}$$

where $B_F \equiv B_{ij} \ \forall i \neq j$. we can found the volume of bonds issued by each country by equation (30):

$$-B_H = (N-1)\,\bar{B}, \tag{A.6}$$

where $B_H \equiv B_{ii} \forall i$. Using equation (5) and (33)we get:

$$P_Y = 1 \tag{A.7}$$

$$\tilde{P} = P_Y^{1-\eta} = 1. \tag{A.8}$$

From equation (21), in steady state we have $P_O = F$. From the market clearing in the commodity market (31) and the production function of commodity producers, we get:

$$O = A_O H_O. \tag{A.9}$$

Hence, equation (32) becomes in steady state:

$$Y = C. \tag{A.10}$$

Equation (23) in steady state reads:

$$(1 - \tau_L) \, MC = \frac{\varepsilon - 1}{\varepsilon}. \tag{A.11}$$

Using $\tau_L = \frac{1}{\varepsilon}$, we have that $MC = 1$.

In what follows, we set A such that $GDP = 1$ (so $Y = 1$) and A_O such that we set ex ante $\omega \equiv \frac{P_O O}{GDP}$, i.e. the GDP share of oil production. Combining equations (10)-(26), we find:

$$H_O = \omega^{\frac{1}{1+\varphi}}. \tag{A.12}$$

We are left with four equations ((5),(15),(16), and the definition of ω):

$$1 = A\left[(1-\alpha)^{\frac{1}{\xi}} H_Y^{\frac{\xi-1}{\xi}} + \alpha^{\frac{1}{\xi}} (A_O H_O)^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}} \tag{A.13}$$

$$H_Y^{1+\varphi\xi} = (1-\alpha) A^{\xi-1} \tag{A.14}$$

$$A_O H_O = \alpha (F)^{-\xi} A^{\xi-1} \tag{A.15}$$

$$F A_O H_O = \omega \tag{A.16}$$

in four unknowns $\{H_Y, F, A, A_O\}$. Combining the first three, we find:

$$H_Y = (1-\omega)^{\frac{1}{1+\varphi}} \tag{A.17}$$

Use the second one to find A:

$$A = \left\{\frac{(1-\omega)^{\frac{1+\varphi\xi}{1+\varphi}}}{(1-\alpha)}\right\}^{\frac{1}{\xi-1}}. \tag{A.18}$$

We find F using the third one:

$$F = A\left(\frac{\omega}{\alpha}\right)^{\frac{1}{1-\xi}}. \tag{A.19}$$

We can find A_O using the last one:

$$A_O = \frac{\omega}{H_O F}, \tag{A.20}$$

and O using $O = \frac{\omega}{F A_O}$:

$$O = \left[\frac{1-\alpha}{\alpha}\frac{\omega^{\xi}}{(1-\omega)^{\frac{1+\varphi\xi}{1+\varphi}}}\right]^{\frac{1}{\xi-1}}. \tag{A.21}$$

We verify that the symmetric allocation is indeed a solution by checking if the remaining equation (32) is satisfied:

$$\tilde{P}C + B_H\left(1 - \frac{R}{\Pi}\right) + (N-1)\,\bar{B}\left(1 - \frac{R}{\Pi}\right) = P_Y Y$$

$$C = Y$$

which indeed holds.

A.2 Proof of propositions

We provide here a unified proof for Propositions 3.1-3.4. For each variable X_t, define $x_t \equiv \frac{X_t - X}{X}$, while $b_{ijt} \equiv \frac{B_{ijt} - B_{ij}}{P_{iY} Y_i} = B_{ijt} - B_{ij}$. For each country i belonging to bloc $\mathcal{R}$ where $\mathcal{R} = \{\mathcal{W}, \mathcal{E}\}$ the log-linearization of the system including equations (5), (7), (9),(10),(14), (15), (16), (21), (23), (24), (27), (29), (30), (31), (32), and (33), plus the $N-1$ versions of equation (8) is the following:

$$0 = (1-\gamma)\, p_{iYt} + \tilde{\gamma} \sum_{j \neq i} \left(q_{ijt} + p_{jYt}\right) + \frac{\tilde{\gamma} N}{2} \tau_t \tag{A.22}$$

$$c_{it} = \mathbb{E}_t c_{it+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{iYt} - \mathbb{E}_t \pi_{it+1}\right) \tag{A.23}$$

$$p_{iOt} = \varphi h_{iOt} + \sigma c_{it} \tag{A.24}$$

$$y_{it} = (1-\omega)\, h_{it} + \omega o_{it} \tag{A.25}$$

$$h_{iYt} = y_{it} - \xi\left(\sigma c_{it} + \varphi h_{iYt} - mc_{it}\right) \tag{A.26}$$

$$o_{it} = y_{it} - \xi\left(f_{it} - mc_{it}\right) \tag{A.27}$$

$$f_{it} = \left(1-\gamma_i^O\right) p_{iOt} + \sum_{j\neq i} \tilde{\gamma}^O \left(q_{ijt} + \tau_{ijt}^O + p_{jOt}\right) \tag{A.28}$$

$$\pi_{iYt} = \beta \mathbb{E}_t \pi_{iYt+1} + \frac{\varepsilon - 1}{\psi_P}\left(mc_{it} - p_{iYt}\right) \tag{A.29}$$

$$\pi_{iYt} = \pi_{it} + p_{iYt} - p_{iYt-1} \tag{A.30}$$

$$y_{it} = (1-\gamma)\left(c_{it} - \eta p_{iYt}\right) + \tilde{\gamma}\sum_{j\neq i}\left[c_{jt} - \eta\left(p_{iYt} - q_{ijt}\right)\right] - \frac{\eta\tilde{\gamma}N}{2}\tau_t \tag{A.31}$$

$$\sum_i b_{jit} = 0 \tag{A.32}$$

$$\begin{aligned}\tilde{p}_{it} + c_{it} = {} & p_{iYt} + y_{it} + \omega h_{iOt} + tb_{it} + \\ & - \omega\left[\left(\gamma^O\xi - \xi - \gamma^O\right) p_{iOt} + \left(1-\gamma^O\right)\left(o_{it} + \xi f_{it}\right)\right] + \\ & - \omega\left[\sum_{j\neq i}\tilde{\gamma}^O\left[(1-\xi)\left(q_{ijt} + p_{jOt}\right) + \xi f_{it} + o_{it} - \xi\tau_{ijt}^O\right]\right]\end{aligned} \tag{A.33}$$

$$\tilde{p}_{it} = (1-\gamma)(1-\eta) p_{iYt} + \tilde{\gamma}\sum_{j\neq i}\left[(1-\eta)\left(q_{ijt} + p_{jYt}\right)\right] - \frac{\eta\tilde{\gamma}N}{2}\tau_t \tag{A.34}$$

$$c_{it} = \mathbb{E}_t c_{it+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{jYt} - \mathbb{E}_t\pi_{jt+1} + q_{ijt+1} - q_{jt} - \theta_t\right) + \frac{\psi_F}{\sigma} b_{ijt} \; \forall j \neq i, j \notin \mathcal{R} \tag{A.35}$$

$$c_{it} = \mathbb{E}_t c_{it+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{jYt} - \mathbb{E}_t\pi_{jt+1} + q_{ijt+1} - q_{jt}\right) + \frac{\psi_F}{\sigma} b_{ijt} \; \forall j \neq i, j \in \mathcal{R} \tag{A.36}$$

$$h_{iOt} = \left(1-\gamma^O\right)\left[\xi\left(f_{it} - p_{iOt}\right) + o_{it}\right] + \tilde{\gamma}^O\sum_{j\neq i}\left[\xi\left(f_{jt} - p_{iOt} - q_{ijt} - \tau_{jit}^O\right) + o_{jt}\right] \tag{A.37}$$

where tb_{it} is the trade balance:

$$tb_{it} = b_{iit} + \sum_{j\neq i}\left(\bar{B} q_{ijt} + b_{ijt}\right) - \frac{1}{\beta} b_{iit-1} + \bar{B}\left(\phi_\pi \pi_{iYt-1} - \pi_{it}\right) - \sum_{j\neq i}\frac{1}{\beta}\left[b_{ijt-1} + \bar{B}\left(\phi_\pi\pi_{jYt-1} - \pi_{jt}\right)\right] \tag{A.38}$$

and we have eliminated w_{it} and r_{it} using equations (9) and (27).where tb_{it} is the trade balance:

$$tb_{it} = b_{iit} + \sum_{j\neq i} \left(\bar{B}q_{ijt} + b_{ijt}\right) - \frac{1}{\beta} b_{iit-1} + \bar{B}_H \left(\phi_\pi \pi_{iYt-1} - \pi_{it}\right) - \sum_{j\neq i} \frac{1}{\beta} \left[b_{ijt-1} + \bar{B}\left(\phi_\pi \pi_{jYt-1} - \pi_{jt}\right)\right] \tag{A.39}$$

and we have eliminated w_{iYt} and r_{it} using equations (9) and (27).We guess the following symmetric solution $\forall i$:

$$c_{it} = c_t, \quad y_{it} = y_t$$

$$\pi_{it} = \pi_t, \quad \pi_{iYt} = \pi_{Yt}$$

$$p_{iYt} = p_{Yt}, \quad \tilde{p}_{it} = \tilde{p}_t$$

$$q_{ijt} = 0 \ \forall j$$

$$f_{it} = f_t$$

$$p_{iOt} = p_{Ot}$$

$$o_{it} = o_t$$

$$h_{iOt} = h_{iO}$$

$$mc_{it} = mc_t$$

$$h_{iYt} = h_{Yt}$$

$$b_{ii} = b_H$$

$$b_{ij} = b_A \text{ if } i,j \in \mathcal{W} \text{ or } i,j \in \mathcal{E}$$

$$b_{ij} = b_E \text{ if } i \in \mathcal{W}, j \in \mathcal{E} \text{ or } i \in \mathcal{E}, j \in \mathcal{W}$$

$$tb_t = 0$$

and we verify that all equations are still satisfied, meaning that our symmetric guess is indeed a solution of the model. Equation (A.22) implies:

$$p_{Yt} = -\frac{\tilde{\gamma}N}{2}\tau_t. \tag{A.40}$$

Using equation (A.31) we get:

$$y_t = c_t - \eta p_{Yt} - \frac{\eta\tilde{\gamma}N}{2}\tau_t \tag{A.41}$$

which implies by equation (A.40):

$$y_t = c_t. \tag{A.42}$$

Using (A.35) we get:

$$\tilde{p}_t = -\frac{\tilde{\gamma}N}{2}\tau_t = p_{Yt}. \tag{A.43}$$

Using equation (A.37):

$$o_t = \xi\left(p_{Ot} - f_t\right) + h_{Ot} + \frac{N\tilde{\gamma}^O\xi}{2}\tau_t^O.$$

Use the commodity price index:

$$f_t = p_{Ot} + \frac{\tilde{\gamma}^O N}{2}\tau_t^O, \tag{A.44}$$

which implies:

$$o_t = h_{Ot}. \tag{A.45}$$

Our goal now is to find an expression for marginal costs as a function of the taxes, using the remaining equations:

$$h_{Yt} = y_t - \xi \left(\sigma c_t + \varphi h_{Yt} - mc_t \right) \tag{A.46}$$

$$v_t = y_t - \xi \left(f_t - mc_t \right) \tag{A.47}$$

$$y_t = \left(1 - \omega \right) h_{Yt} + \omega o_t \tag{A.48}$$

$$p_{Ot} = \varphi h_{Ot} + \sigma c_t \tag{A.49}$$

which can be re-written using the previous equations as follows:

$$\begin{aligned} h_{Yt} &= y_t - \xi \left(\sigma y_t + \varphi h_{Yt} - mc_t \right) \\ v_t &= y_t - \xi \left(f_t - mc_t \right) \\ y_t &= \left(1 - \omega \right) h_t + \omega o_t \\ f_t &= \varphi o_t + \sigma o_t + \frac{\tilde{\gamma}^O N}{2} \tau_t^O . \end{aligned}$$

Use the second one in the third one to get rid of o_t:

$$h_{Yt} = y_t + \frac{\omega}{1 - \omega} \xi \left(f_t - mc_t \right) . \tag{A.50}$$

Use the second one in the fourth one to get rid of o_t:

$$f_t = \frac{\varphi + \sigma}{1 + \varphi \xi} y_t + \frac{\varphi \xi}{1 + \varphi \xi} mc_t + \frac{\tilde{\gamma}^O N}{2 \left(1 + \varphi \xi \right)} \tau_t^O \tag{A.51}$$

Use the previous equation in equation (A.50):

$$\left(1 + \varphi \xi \right) h_{Yt} = y_t \frac{\left(1 - \omega \right) + \varphi \xi + \sigma \xi - \left(1 - \omega \right) \sigma \xi}{\left(1 - \omega \right)} - \frac{\xi \omega}{1 - \omega} mc_t + \frac{\tilde{\gamma}^O N \xi \omega}{2 \left(1 - \omega \right)} \tau_t^O . \tag{A.52}$$

Get rid of h_{Yt} in equation (A.46):

$$mc_t = (\varphi + \sigma)\, y_t + \frac{\tilde{\gamma}^O N\omega}{2}\tau_t^O. \tag{A.53}$$

We can rewrite the Phillips curve as:

$$\pi_{Yt} = \beta \mathbb{E}_t \pi_{iYt+1} + \kappa \left\{ y_t + \frac{N}{2(\varphi+\sigma)}\left[\omega\tilde{\gamma}^O\tau_t^O + \tilde{\gamma}\tau_t\right] \right\}$$

where $\kappa \equiv \frac{(\varepsilon-1)(\sigma+\varphi)}{\psi_P \Pi_{iY}^2}$. We can rewrite the system in equations (A.23)-(A.37) as follows:

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{Yt} - \mathbb{E}_t \pi_{t+1}\right) \tag{A.54}$$

$$\pi_{Yt} = \beta \mathbb{E}_t \pi_{Yt+1} + \kappa \left\{ y_t + \frac{N}{2(\varphi+\sigma)}\left[\omega\tilde{\gamma}^O\tau_t^O + \tilde{\gamma}\tau_t\right] \right\} \tag{A.55}$$

$$\pi_{Yt} = \pi_t - \frac{\tilde{\gamma}N}{2}\left(\tau_t - \tau_{t-1}\right) \tag{A.56}$$

which form a system of three equations in three unknowns $\{y_t, \pi_{Yt}, \pi_t\}$ and one exogenous variable τ_t. We can obtain c_t from (A.42), p_{Yt} from (A.40), $\tilde{p}_t$ from (A.43), mc_t from (A.53), h_{Yt} from (A.52), f_t from (A.51), p_{Ot} from (A.44), h_{Ot} from (A.49), o_t from (A.45), and we know by our guess that $q_t = 0$. Notice that the capital control θ_t has no effect on $\{y_t, \pi_{Yt}, \pi_t\}$ and, as a result, on $\{c_t, p_{Yt}, \tilde{p}_t, q_t\}$. We now show that also the remaining equations, which will characterize the bond dynamics are satisfied. The Euler equation for bonds issued in the same bloc (equation A.36) read :

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{Yt} - \mathbb{E}_t \pi_{t+1}\right) + \frac{\psi_F}{\sigma} b_{At}, \tag{A.57}$$

which implies by (A.54):

$$b_{At} = 0 \tag{A.58}$$

i.e. countries do not change their investment in bonds issued by countries in the same bloc. The Euler equation for bonds issued by the other bloc (equation A.35) reads:

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{Yt} - \mathbb{E}_t \pi_{t+1} - \theta_t\right) + \frac{\psi_F}{\sigma} b_{Et}, \tag{A.59}$$

which implies by (A.54):

$$b_{Et} = -\frac{\theta_t}{\psi_F}, \tag{A.60}$$

meaning that countries respond to capital controls by reducing investment in bonds issued by the other blocs. Using equation (A.32), we find the amount of bonds issued by each country ($-b_H$):

$$\sum_i b_{jit} = 0$$

$$\frac{N}{2} b_{Et} + \left(\frac{N}{2} - 1\right) b_{At} + b_{Ht} = 0,$$

which implies:

$$-b_{Ht} = \frac{N}{2} b_{Et} = -\frac{N}{2}\frac{\theta_t}{\psi_F} \tag{A.61}$$

which shows that the capital control reduces the amount of bonds that countries issue abroad.

To conclude the proof we use the method of undetermined coefficients to solve the system of equations (A.54)-(A.56). Use (A.56) in (A.54):

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{Yt} - \mathbb{E}_t \pi_{Yt+1}\right) + \frac{\tilde{\gamma} N}{2\sigma} \mathbb{E}_t \left(\tau_{t+1} - \tau_t\right) \tag{A.62}$$

$$y_t = \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}\left(\phi_\pi \pi_{Yt} - \mathbb{E}_t \pi_{Yt+1}\right) - \frac{\tilde{\gamma} N (1-\rho)}{2\sigma} \tau_t \tag{A.63}$$

Guess the following solution:

$$\pi_{Yt} = -\Omega_\pi^\tau \tau_t + \Omega_\pi^O \tau_t^O$$

$$y_t = -\Omega_y^\tau \tau_t - \Omega_y^O \tau_t^O$$

where Ω_π^τ, Ω_y^τ, Ω_π^O, and Ω_y^O are the undetermined coefficients to be found. Let the taxes follow an AR(1) process with autoregressive parameter ρ:

$$\mathbb{E}_t \pi_{Yt+1} = \rho \pi_{Yt}$$

$$\mathbb{E}_t y_{t+1} = \rho y_t.$$

First we determine Ω_π^τ, and Ω_y^τ, assuming $\tau_t^O = 0 \ \forall t$. Hence, we can write:

$$-\Omega_y^\tau \tau_t = -\Omega_y^\tau \rho \tau_t - \frac{1}{\sigma}\left(\rho \Omega_\pi^\tau \tau_t - \phi_\pi \Omega_\pi^\tau \tau_t\right) - \frac{\tilde{\gamma} N (1-\rho)}{2\sigma} \tau_t$$
$$-\Omega_\pi^\tau \tau_t = -\beta \rho \Omega_\pi^\tau \tau_t + \kappa \left[\frac{\tilde{\gamma} N}{2(\sigma + \varphi)} \tau_t - \Omega_y^\tau \tau_t\right],$$

which implies:

$$\Omega_y^\tau = \Omega_y^\tau \rho + \frac{1}{\sigma}\left(\rho \Omega_\pi^\tau - \phi_\pi \Omega_\pi^\tau\right) + \frac{\tilde{\gamma} N (1-\rho)}{2\sigma}$$
$$\Omega_\pi^\tau = \beta \rho \Omega_\pi^\tau - \kappa \left[\frac{\tilde{\gamma} N}{2(\sigma + \varphi)} - \Omega_y^\tau\right],$$

Using the first one, we find:

$$\Omega_y^\tau = -\frac{\phi_\pi - \rho}{\sigma(1-\rho)} \Omega_\pi^\tau + \frac{\tilde{\gamma} N}{2\sigma},$$

and plug it in the second one:

$$
\begin{aligned}
\Omega_\pi^\tau &= -\frac{\kappa}{1-\beta\rho}\left[\frac{\tilde{\gamma}N}{2(\sigma+\varphi)}+\frac{\phi_\pi-\rho}{\sigma(1-\rho)}\Omega_\pi^\tau-\frac{\tilde{\gamma}N}{2\sigma}\right] \\
\Omega_\pi^\tau &= -\frac{\kappa\sigma(1-\rho)}{[\kappa(\phi_\pi-\rho)+\sigma(1-\rho)(1-\beta\rho)]}\frac{\tilde{\gamma}N}{2}\left(\frac{1}{\sigma+\varphi}-\frac{1}{\sigma}\right) \\
\Omega_\pi^\tau &= \frac{\kappa\sigma(1-\rho)}{[\kappa(\phi_\pi-\rho)+\sigma(1-\rho)(1-\beta\rho)]}\frac{\tilde{\gamma}N\varphi}{2\sigma(\sigma+\varphi)} \\
\Omega_\pi^\tau &= \frac{\tilde{\gamma}N}{2}\frac{\kappa\varphi(1-\rho)}{(\sigma+\varphi)[\kappa(\phi_\pi-\rho)+\sigma(1-\rho)(1-\beta\rho)]}
\end{aligned}
$$

and:

$$
\begin{aligned}
\Omega_y^\tau &= -\frac{\phi_\pi-\rho}{\sigma(1-\rho)}\Omega_\pi^\tau+\frac{\tilde{\gamma}N}{2\sigma} \\
\Omega_y^\tau &= -\frac{\phi_\pi-\rho}{\sigma(1-\rho)}\frac{\tilde{\gamma}N}{2}\frac{\kappa\varphi(1-\rho)}{(\sigma+\varphi)[\kappa(\phi_\pi-\rho)+\sigma(1-\rho)(1-\beta\rho)]}+\frac{\tilde{\gamma}N}{2\sigma} \\
\Omega_y^\tau &= \frac{\tilde{\gamma}N}{2\sigma}\left\{\frac{(\sigma+\varphi)[\kappa(\phi_\pi-\rho)+\sigma(1-\rho)(1-\beta\rho)]-\kappa\varphi(\phi_\pi-\rho)}{(\sigma+\varphi)[\kappa(\phi_\pi-\rho)+\sigma(1-\rho)(1-\beta\rho)]}\right\} \\
\Omega_y^\tau &= \frac{\tilde{\gamma}N}{2}\frac{\kappa(\phi_\pi-\rho)+(\sigma+\varphi)(1-\rho)(1-\beta\rho)}{(\sigma+\varphi)[\kappa(\phi_\pi-\rho)+\sigma(1-\rho)(1-\beta\rho)]}.
\end{aligned}
$$

In order to find the effect of commodity taxes Ω_π^O, and Ω_y^O, we assume $\tau_t = 0\ \forall t$. The system of equations (A.54)-(A.56) is reduced to two equations:

$$
\begin{aligned}
y_t &= \mathbb{E}_t y_{t+1} - \frac{1}{\sigma}(\phi_\pi \pi_{Yt} - \mathbb{E}_t \pi_{Yt+1}) \\
\pi_{Yt} &= \beta \mathbb{E}_t \pi_{Yt+1} + \kappa\left\{y_t + \frac{N\omega\tilde{\gamma}^O}{2(\varphi+\sigma)}\tau_t^O\right\},
\end{aligned}
$$

which can be written as:

$$
\begin{aligned}
-\Omega_y^O &= -\Omega_y^O\rho - \frac{1}{\sigma}\left(\phi_\pi\Omega_\pi^O - \Omega_\pi^O\rho\right) \\
\Omega_\pi^O &= \beta\rho\Omega_\pi^O + \kappa\left\{-\Omega_y^O + \frac{N\omega\tilde{\gamma}^O}{2(\varphi+\sigma)}\right\}.
\end{aligned}
$$

From the first equation, we get:

$$\Omega_y^O = \frac{\phi_\pi - \rho}{\sigma\left(1-\rho\right)}\Omega_\pi^O.$$

Plugging this expression in the second equation, we obtain Ω_π^O:

$$\Omega_\pi^O = \frac{N\omega\tilde{\gamma}^O}{2}\frac{\kappa\sigma\left(1-\rho\right)}{\left(\varphi+\sigma\right)\left[\left(1-\beta\rho\right)\sigma\left(1-\rho\right)+\kappa\left(\phi_\pi-\rho\right)\right]},$$

which can be used to determine Ω_y^O:

$$\Omega_y^O = \frac{N\omega\tilde{\gamma}^O}{2}\frac{\kappa\left(\phi_\pi-\rho\right)}{\left(\varphi+\sigma\right)\left[\left(1-\beta\rho\right)\sigma\left(1-\rho\right)+\kappa\left(\phi_\pi-\rho\right)\right]}.$$

Suppose that $\tau_t = \tau_t^O$, the overall effect on PPI inflation is given by $\Omega_\pi = \Omega_\pi^O - \Omega_\pi^\tau$, which is equal to:

$$\Omega_\pi = \frac{\kappa\left(1-\rho\right)}{\left(\varphi+\sigma\right)\left[\left(1-\beta\rho\right)\sigma\left(1-\rho\right)+\kappa\left(\phi_\pi-\rho\right)\right]}\frac{N}{2}\left(\sigma\omega\tilde{\gamma}^O - \tilde{\gamma}\varphi\right).$$

Hence, the overall effect on PPI inflation depends on the relative importance of final goods $\tilde{\gamma}$ and commodities $\tilde{\gamma}^O$ imported from abroad. If the latter is relatively higher than the former, the shock is stagflationary.

To wrap up: we have proved Proposition 3.1 as we have shown that the symmetric solution satisfies all equations. In this symmetric solution, the exchange rate and net positions (i.e. the trade balances) do not respond. We have proved Proposition 3.2 as we have shown how to derive equations (34)-(36). We have proved Proposition 3.3 and Proposition 3.4 as we have derived the solution of the model.

B List of countries allocated to the different blocks

List of US-aligned countries : Aruba, Anguilla, Albania, Netherlands Antilles, American Samoa, French Southern and Antarctic Territories, Australia, Austria, Belgium, Bonaire, Bulgaria, Bosnia Herzegovina, Saint Barthélemy, Belize, Bermuda, Canada, Cocos Islands, Switzerland, Cook Islands, Curacao, Christmas Islands, Cayman Islands, Cyprus, Czechia, Germany, Denmark, Spain, Estonia, Finland, Falkland Islands (Malvinas), France, United Kingdom, Gibraltar, Greece, Greenland, Guatemala, Guam, Croatia, Haiti, Hungary, British Indian Ocean Territory, Ireland, Iceland, Israel, Italy, Japan, Republic of Korea, Liechtenstein, Lithuania, Luxembourg, Latvia, Monaco, Marshall Islands, North Macedonia, Malta, Montenegro, Northern Mariana Islands, Montserrat, New Caledonia, Norfolk Islands, Niue, Netherlands, Norway, Nauru, New Zealand, Pitcairn, Palau, Poland, Portugal, French Polynesia, Romania, Saint Helena, San Marino, Saint Pierre and Miquelon, Slovakia, Slovenia, Sweden, Saint Maarten, Turks and Caicos Islands, Tokelau, Taiwan, Ukraine, British Virgin Islands, Wallis and Futuna Islands.

List of China-aligned countries: Burundi, Benin, Burkina Faso, Bangladesh, Belarus, Bolivia, Central African Republic, China, Republic of Congo, Comoros, Djibouti, Dominica, Eritrea, Ethiopia, Gabon, Guinea, Gambia, Guinea-Bissau, Equatorial Guinea, China (Hong Kong SAR), Iran, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Libya, Sri Lanka, China (Macao SAR), Mali, Mozambique, Mauritania, Nepal, Pakistan, Papua New Guinea, Democratic People's Republic of Korea, State of Palestine, Russian Federation, Sudan, Solomon Islands, Sierra Leone, Somalia, South Sudan, Sao Tome and Principe, Suriname, Togo, Tajikistan, Tonga, Uganda, Venezuela, Yemen, Zambia, Zimbabwe.

List of neutral countries: Afghanistan, Angola, Andorra, United Arab Emirates, Argentina, Armenia, Antigua and Barbuda, Azerbaijan, Bahrain, Bahamas, Brazil, Barbados, Brunei Darussalam, Bhutan, Botswana, Chile, Côte d'Ivoire, Cameroon, Democratic Republic of the Congo, Colombia, Cabo Verde, Costa Rica, Cuba, Dominican Republic, Algeria, Ecuador, Egypt, Fiji, Federated States of Micronesia, Georgia, Ghana, Grenada, Guyana, Honduras, Indonesia, India, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Cambodia, Kiribati, Saint Kitts and Nevis, Kuwait, Liberia, Saint Lucia, Lesotho, Morocco, Moldova, Madagascar, Maldives, Mexico, Myanmar, Mongolia, Mauritius, Malawi, Malaysia, Namibia, Niger, Nigeria, Nicaragua, Oman, Panama, Peru, Philippines, Paraguay, Qatar, Rwanda, Saudi Arabia, Senegal, Singapore, El Salvador, Serbia, Swaziland, Seychelles, Syria, Chad, Thailand, Turkmenistan, Timor-Leste, Trinidad and Tobago, Tunisia, Turkey, Tuvalu, Tanzania, Uruguay, Uzbekistan, Saint Vincent and the Grenadines, Vietnam, Vanuatu, Samoa, South Africa.

C Additional figures

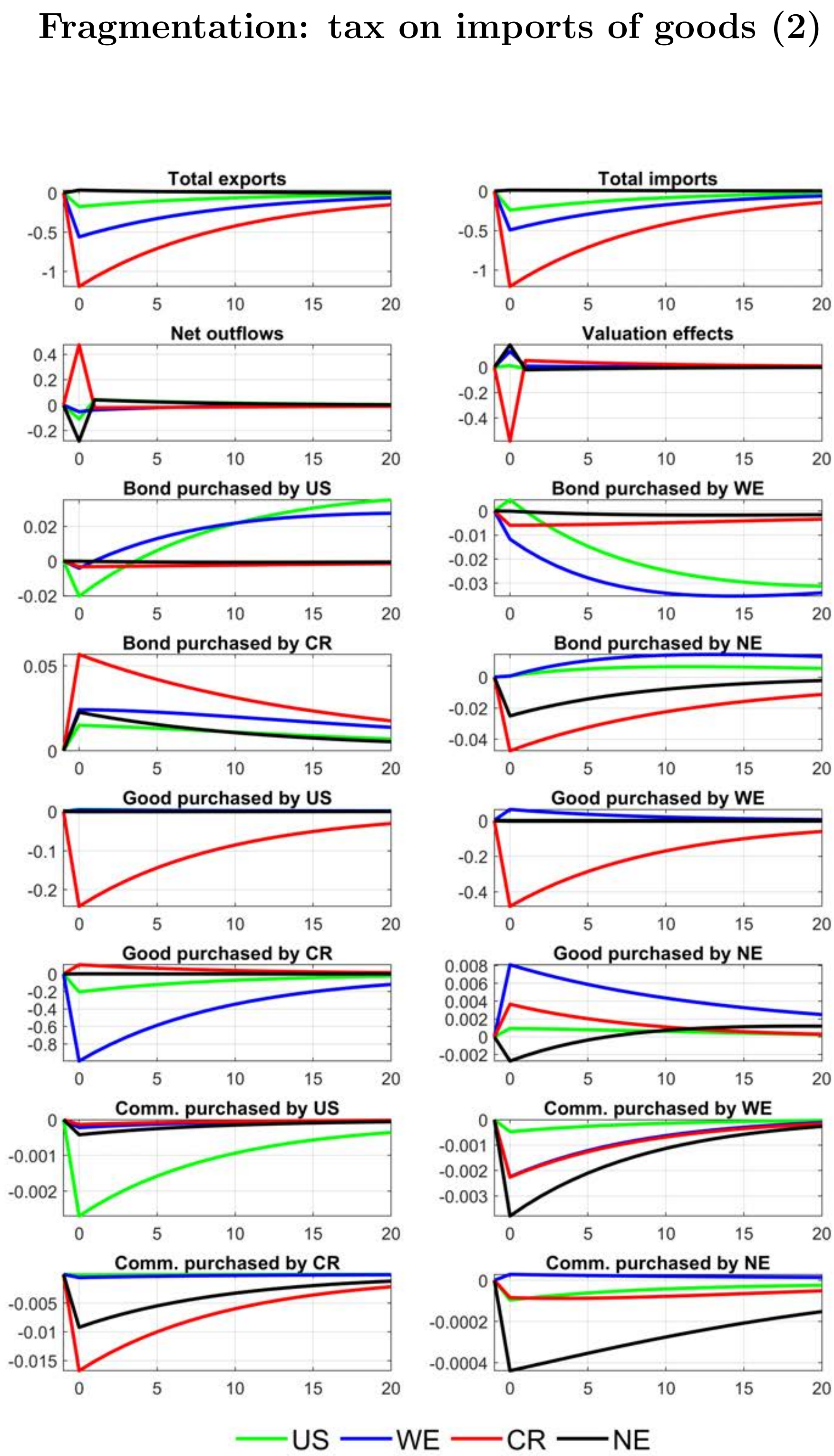

Figure C.1: 10 percentage point increase in the tax on imports of commodities produced by rival countries. All variables are in deviation from its steady state, divided by steady-state GDP. Net outflows are defined as $NO_{it} \equiv \sum_{j\in\mathcal{I}} Q_{ijt}\left(B_{ijt} - B_{ijt-1}\right)$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j\neq i}\left(Q_{ijt} - Q_{ijt-1}\right) B_{ijt-1}$.

Fragmentation: tax on imports of commodities (2)

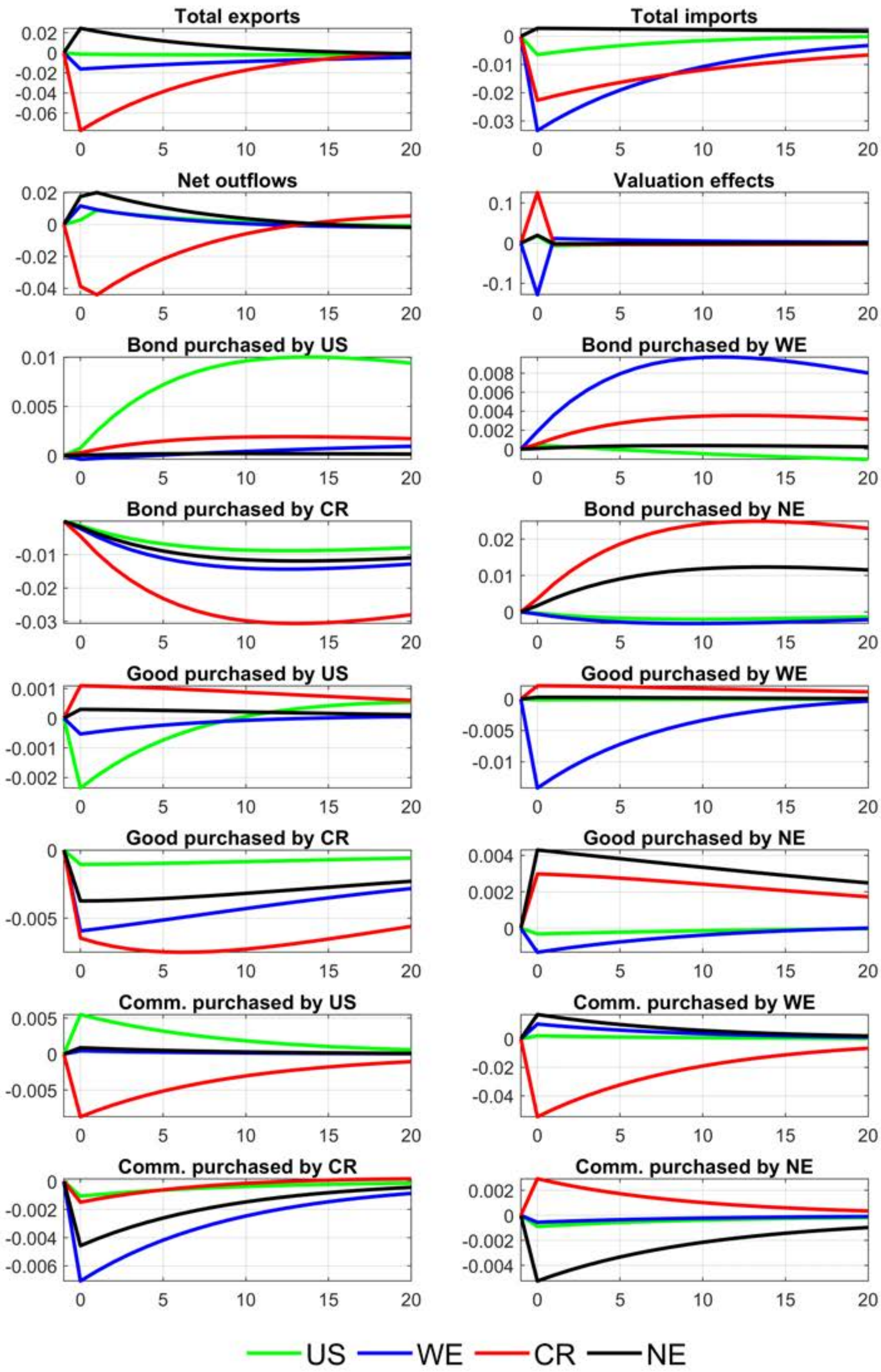

Figure C.2: 10 percentage point increase in the tax on imports of commodities produced by rival countries. All variables are in deviation from its steady state, divided by steady-state GDP. Net outflows are defined as $NO_{it} \equiv \sum_{j\in\mathcal{I}} Q_{ijt}\left(B_{ijt} - B_{ijt-1}\right)$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j\neq i}\left(Q_{ijt} - Q_{ijt-1}\right) B_{ijt-1}$.

Fragmentation: tax on foreign bonds (2)

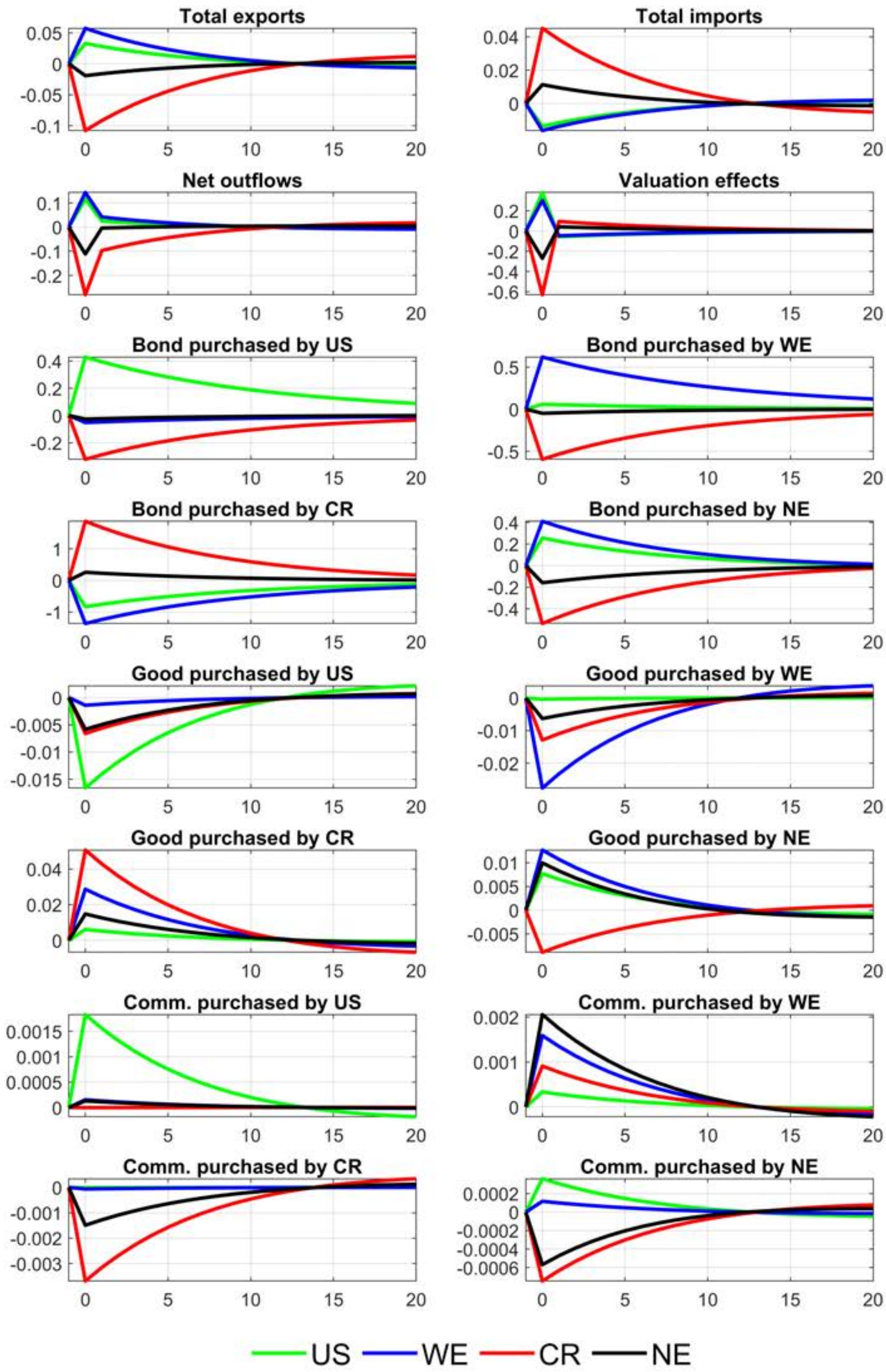

Figure C.3: 50 basis point increase in the tax on bonds issued by rival countries. All variables are in deviation from its steady state, divided by steady-state GDP. Net outflows are defined as $NO_{it} \equiv \sum_{j \in \mathcal{I}} Q_{ijt} (B_{ijt} - B_{ijt-1})$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j \neq i} (Q_{ijt} - Q_{ijt-1}) B_{ijt-1}$.

Tax on imports of goods: increasing η

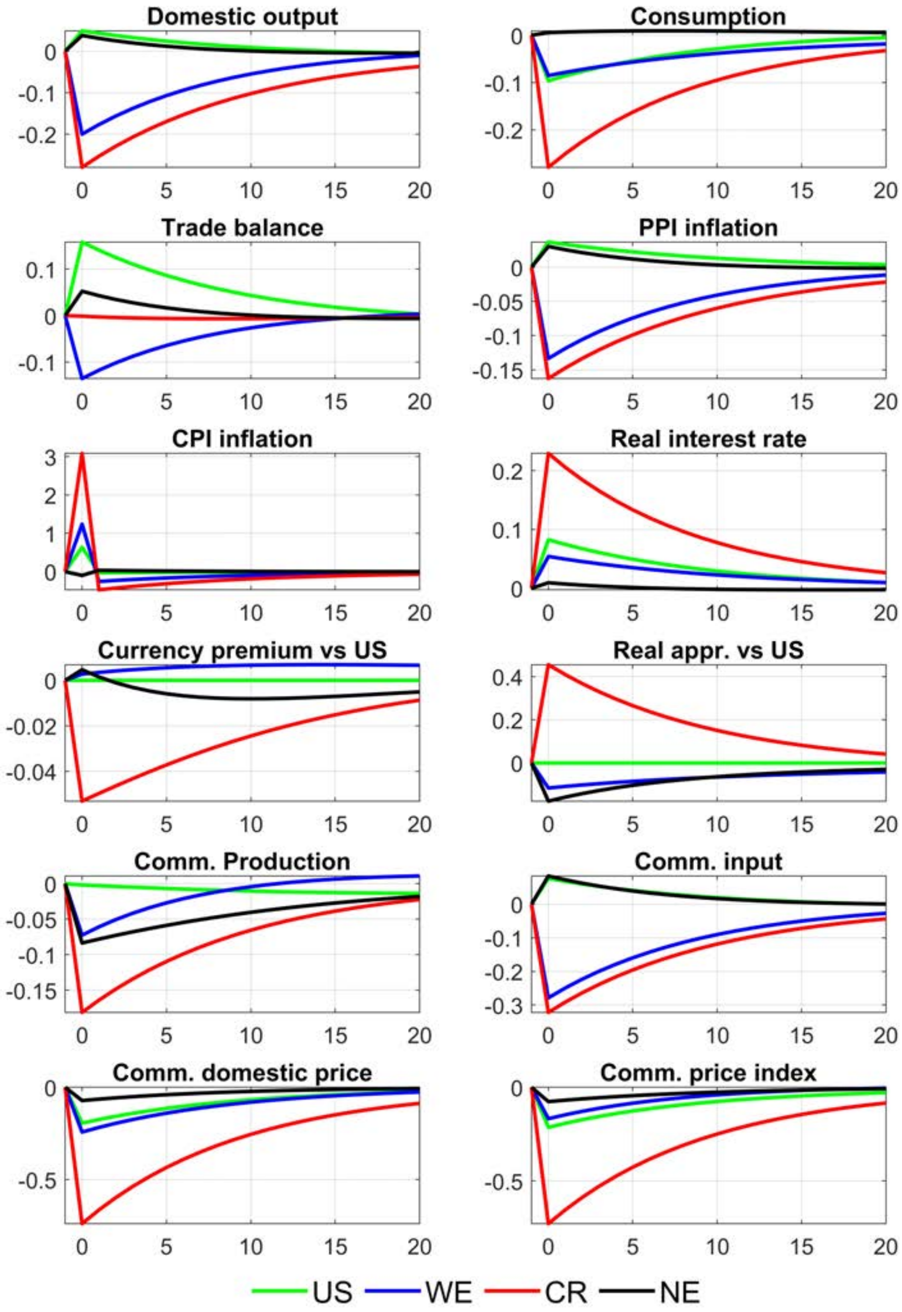

Figure C.4: 10 percentage point increase in the tax on imports of goods produced by rival countries when $\eta = 5$ instead of 1.5.

Tax on imports of goods: increasing η (2)

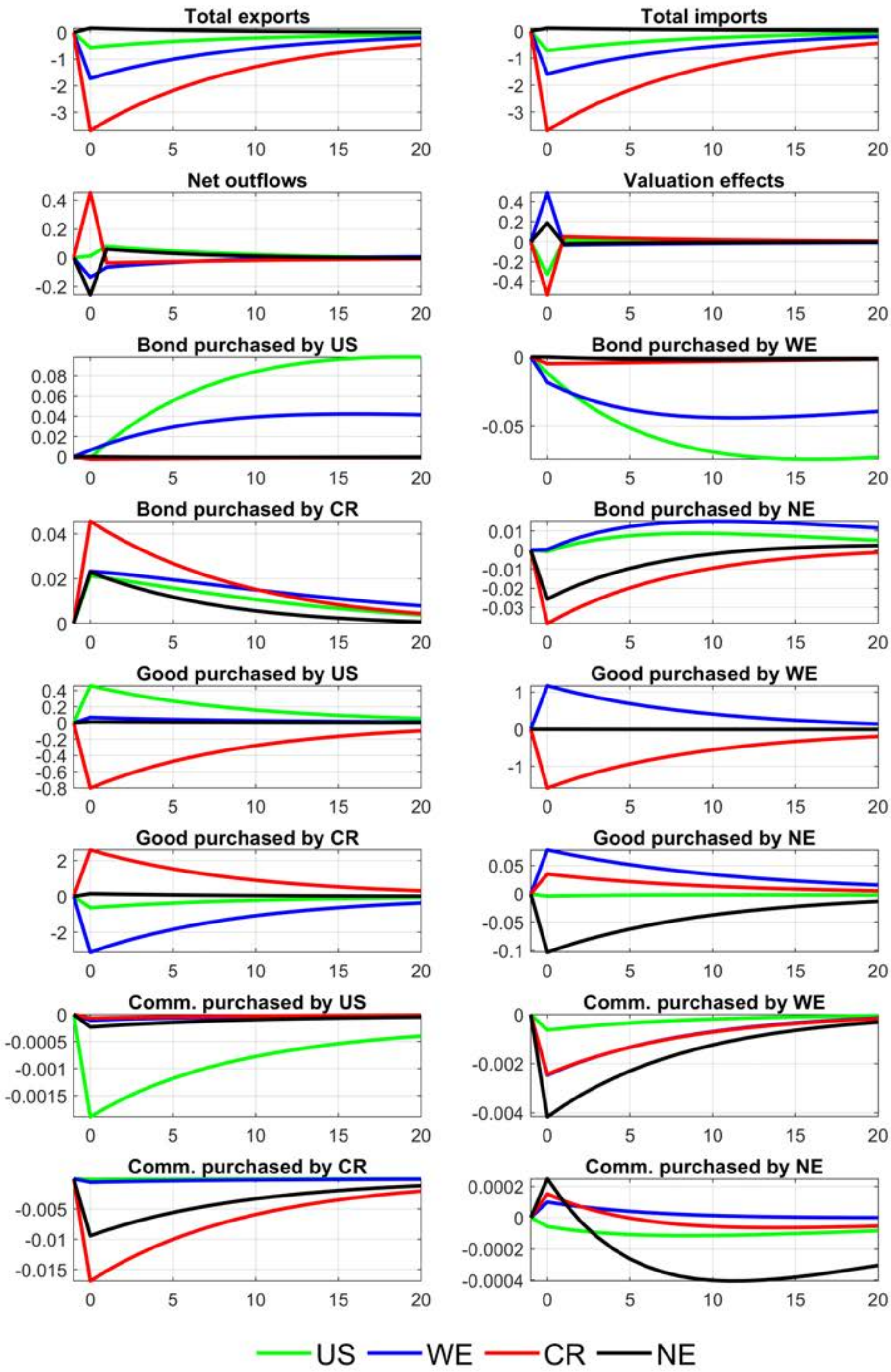

Figure C.5: 10 percentage point increase in the tax on imports of goods produced by rival countries when $\eta = 5$ instead of 1.5. Net outflows are defined as $NO_{it} \equiv \sum_{j \in \mathcal{I}} Q_{ijt} (B_{ijt} - B_{ijt-1})$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j \neq i} (Q_{ijt} - Q_{ijt-1}) B_{ijt-1}$.

Tax on imports of commodities: decreasing ξ

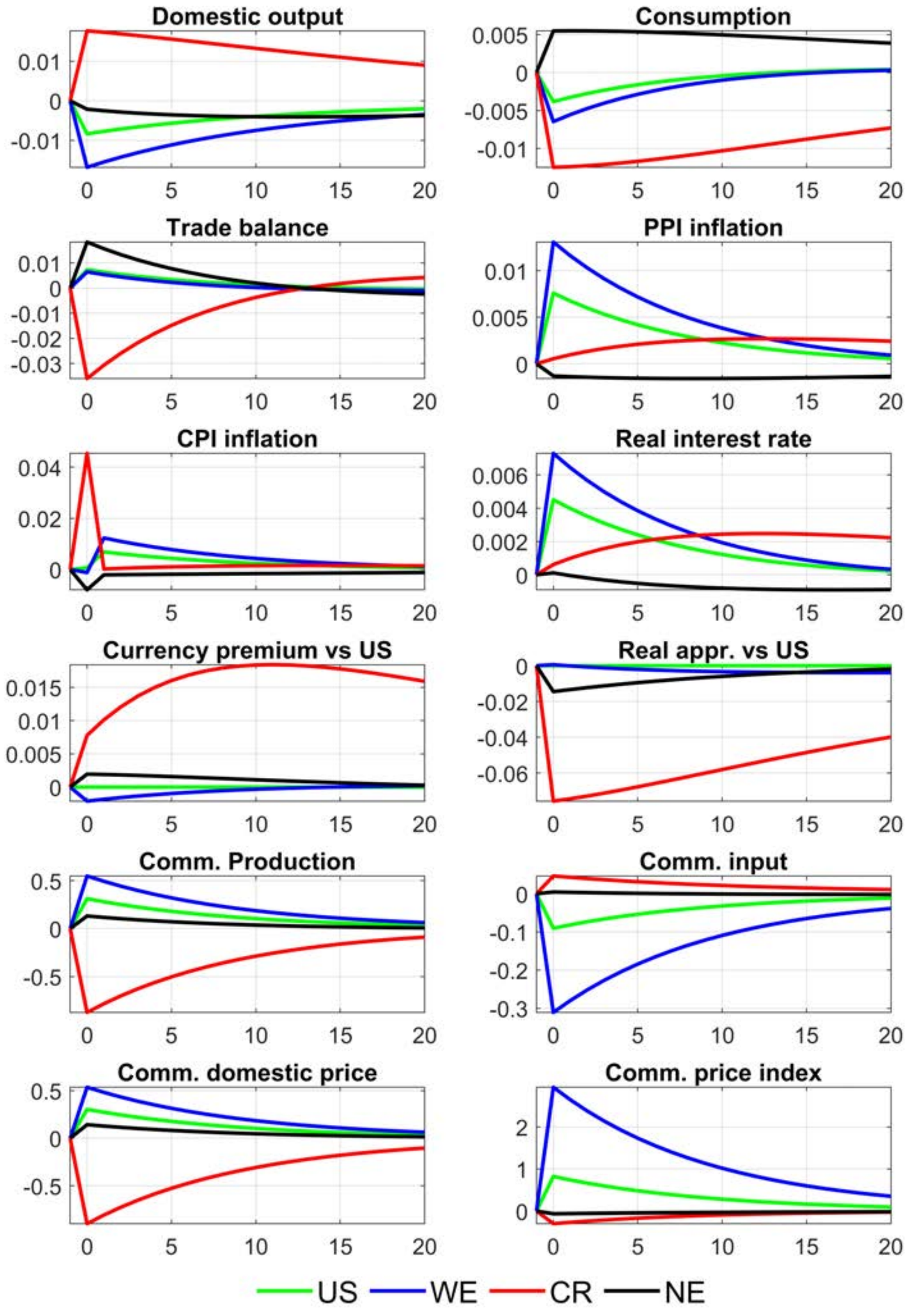

Figure C.6: 10 percentage point increase in the tax on imports of commodities produced by rival countries when $\xi = 0.1$ instead of 0.4.

Tax on imports of commodities: decreasing ξ (2)

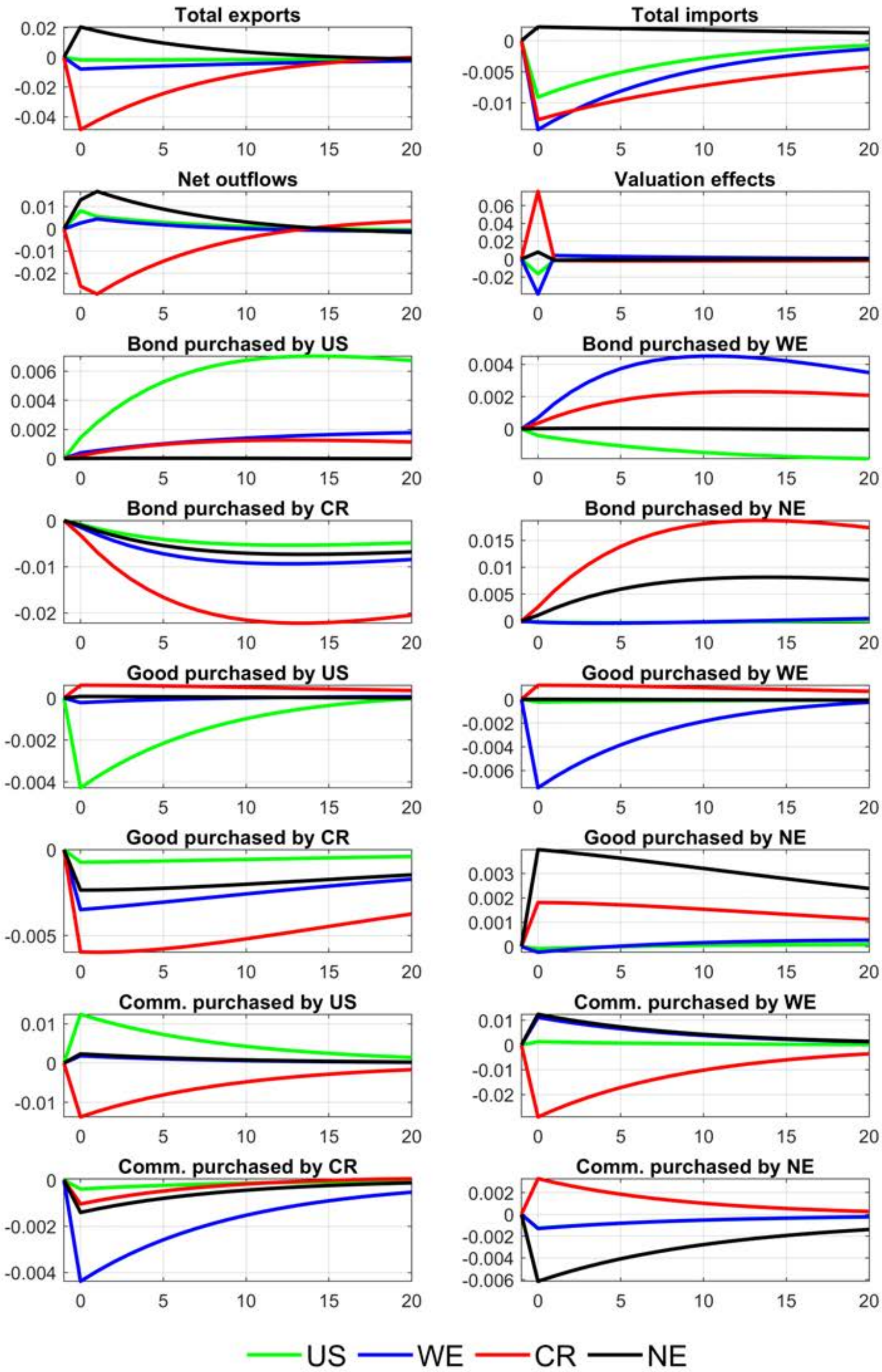

Figure C.7: 10 percentage point increase in the tax on imports of commodities produced by rival countries when $\xi = 0.1$ instead of 0.4. Net outflows are defined as $NO_{it} \equiv \sum_{j\in\mathcal{I}} Q_{ijt} (B_{ijt} - B_{ijt-1})$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j\neq i} (Q_{ijt} - Q_{ijt-1}) B_{ijt-1}$.

Tax on foreign assets: increasing ψ_{ijF}

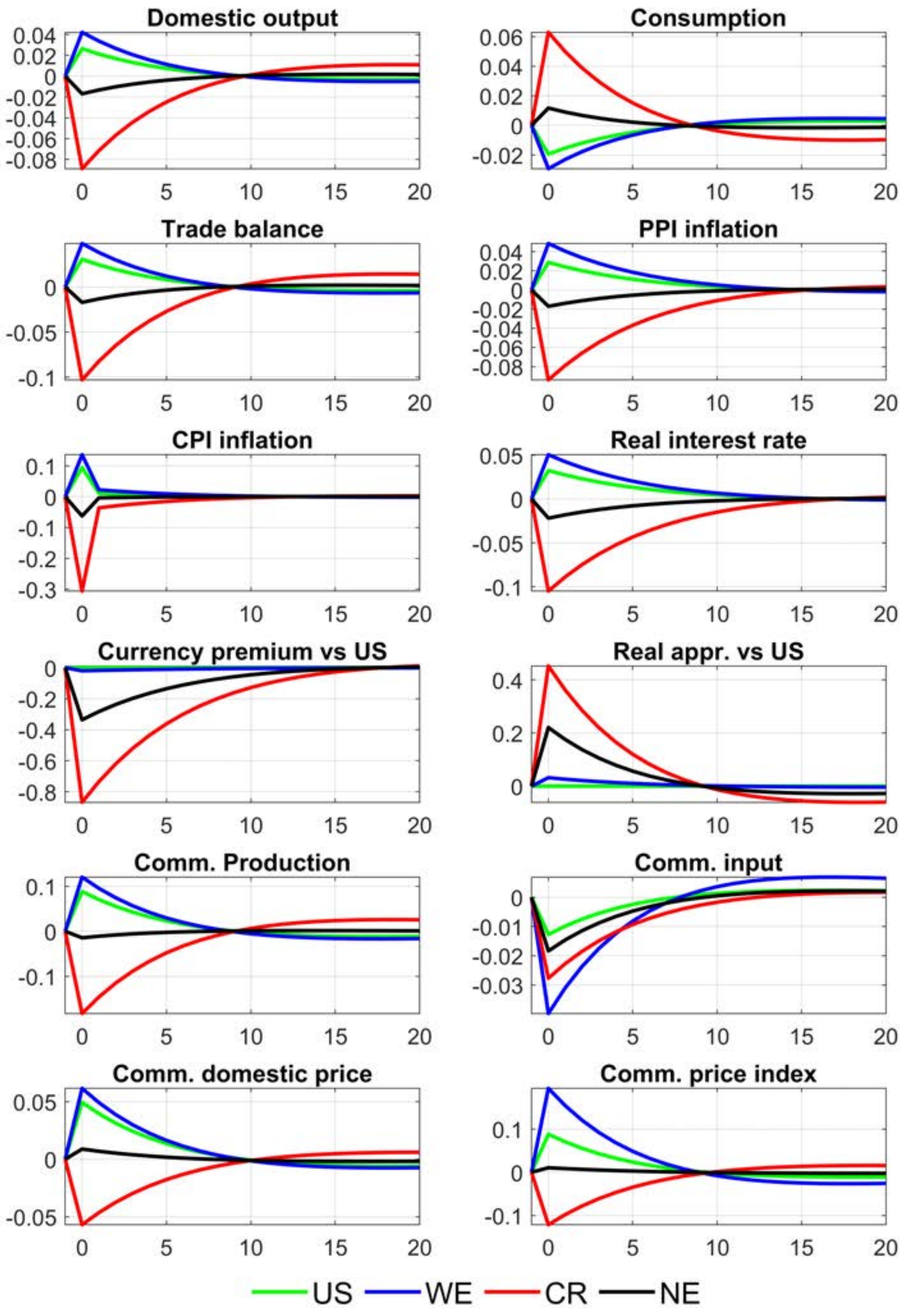

Figure C.8: 50 basis point increase in the tax on bonds issued by rival countries when all $\psi_{ijF} = 5$ except $\psi_{12F} = 0.05$ (i.e. they are multiplied by 5 compared to the baseline calibration).

Tax on foreign assets: increasing ψ_{ijF} (2)

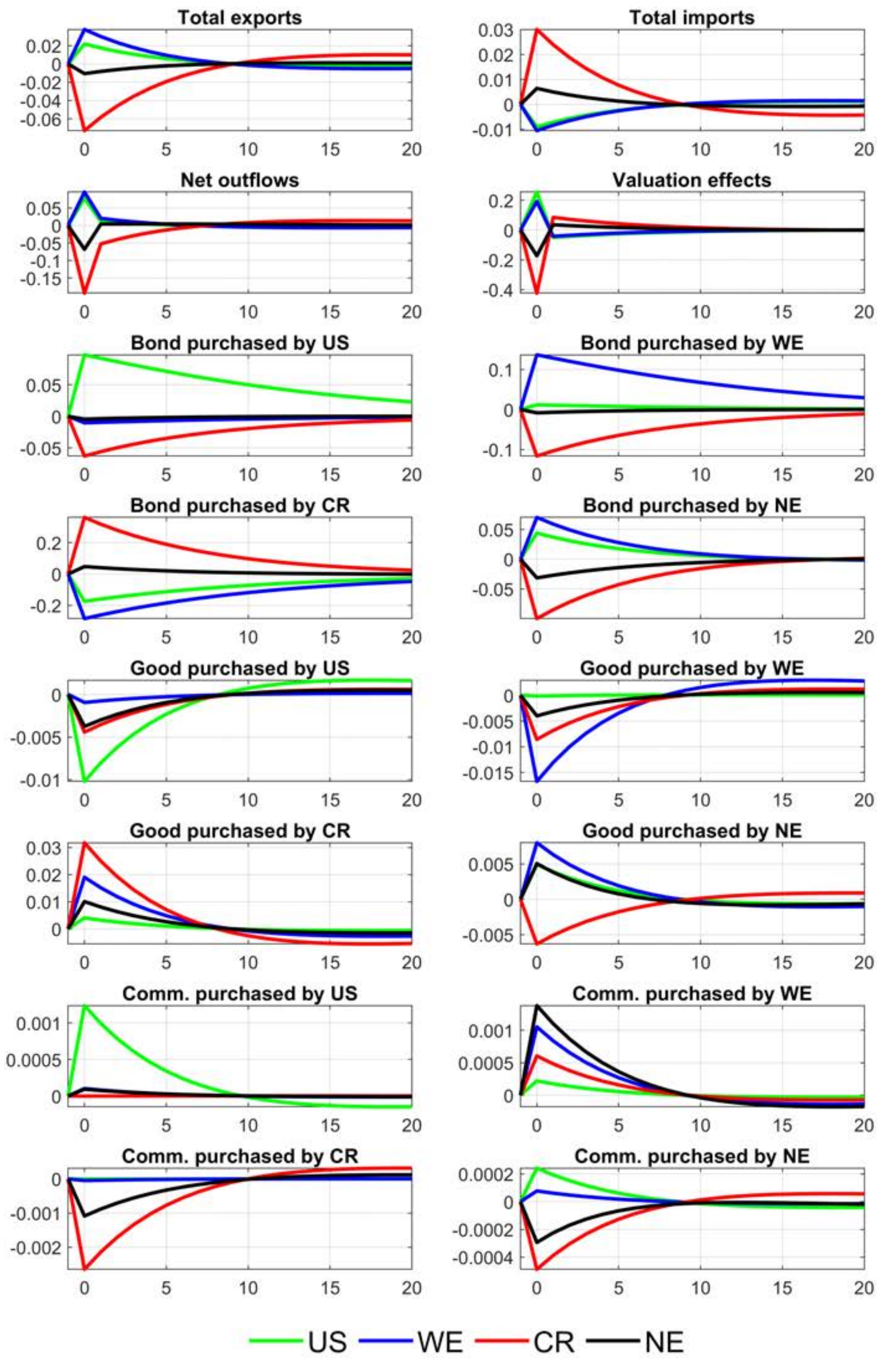

Figure C.9: 50 basis point increase in the tax on bonds issued by rival countries when all $\psi_{ijF} = 5$ except $\psi_{12F} = 0.05$ (i.e. they are multiplied by 5 compared to the baseline calibration). Net outflows are defined as $NO_{it} \equiv \sum_{j \in \mathcal{I}} Q_{ijt} \left(B_{ijt} - B_{ijt-1}\right)$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j \neq i} \left(Q_{ijt} - Q_{ijt-1}\right) B_{ijt-1}$.

Tax on imports of goods: permanent shock

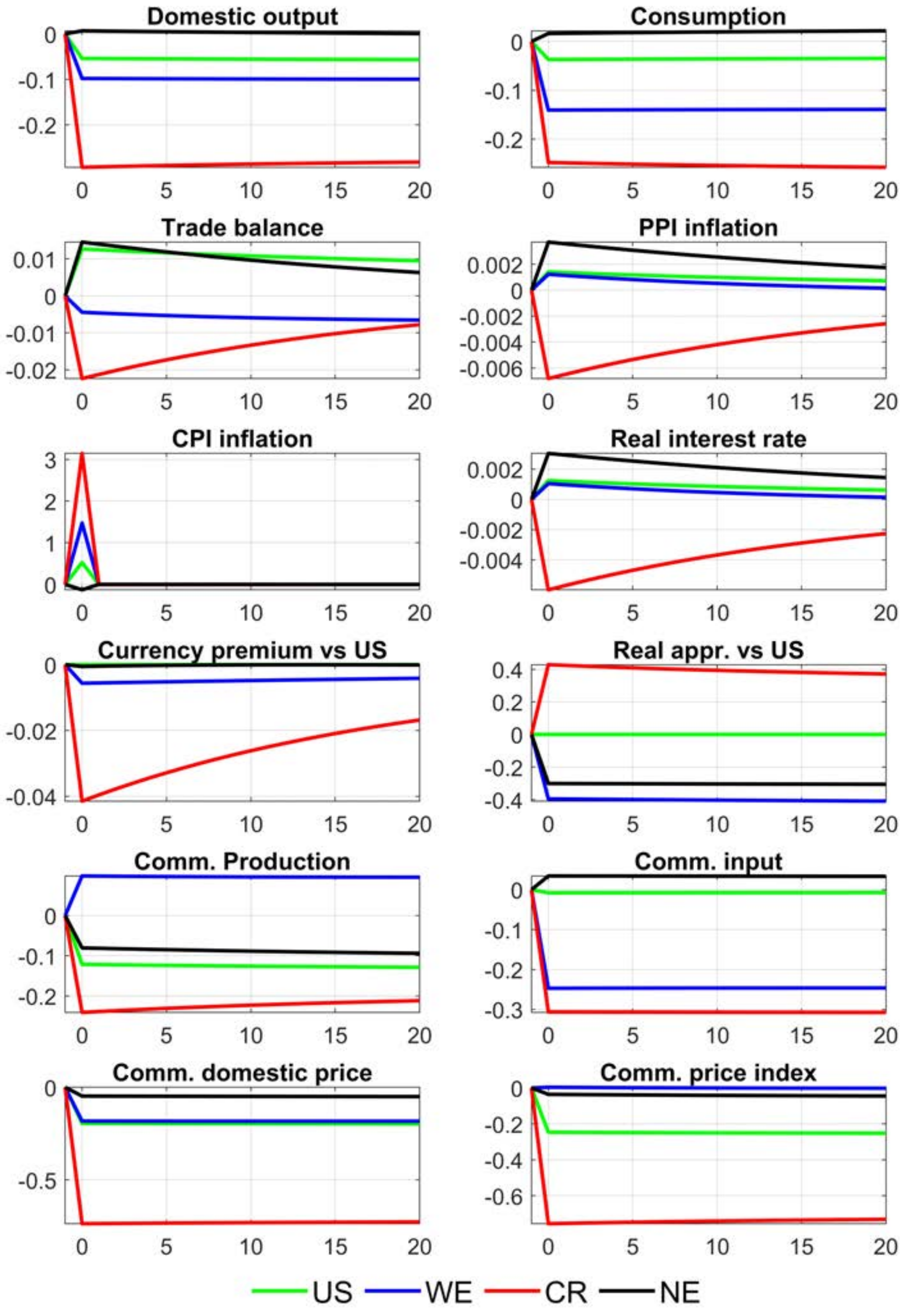

Figure C.10: Permanent 10 percentage point increase in the tax on imports of goods produced by rival countries.

Tax on imports of goods: permanent shock (2)

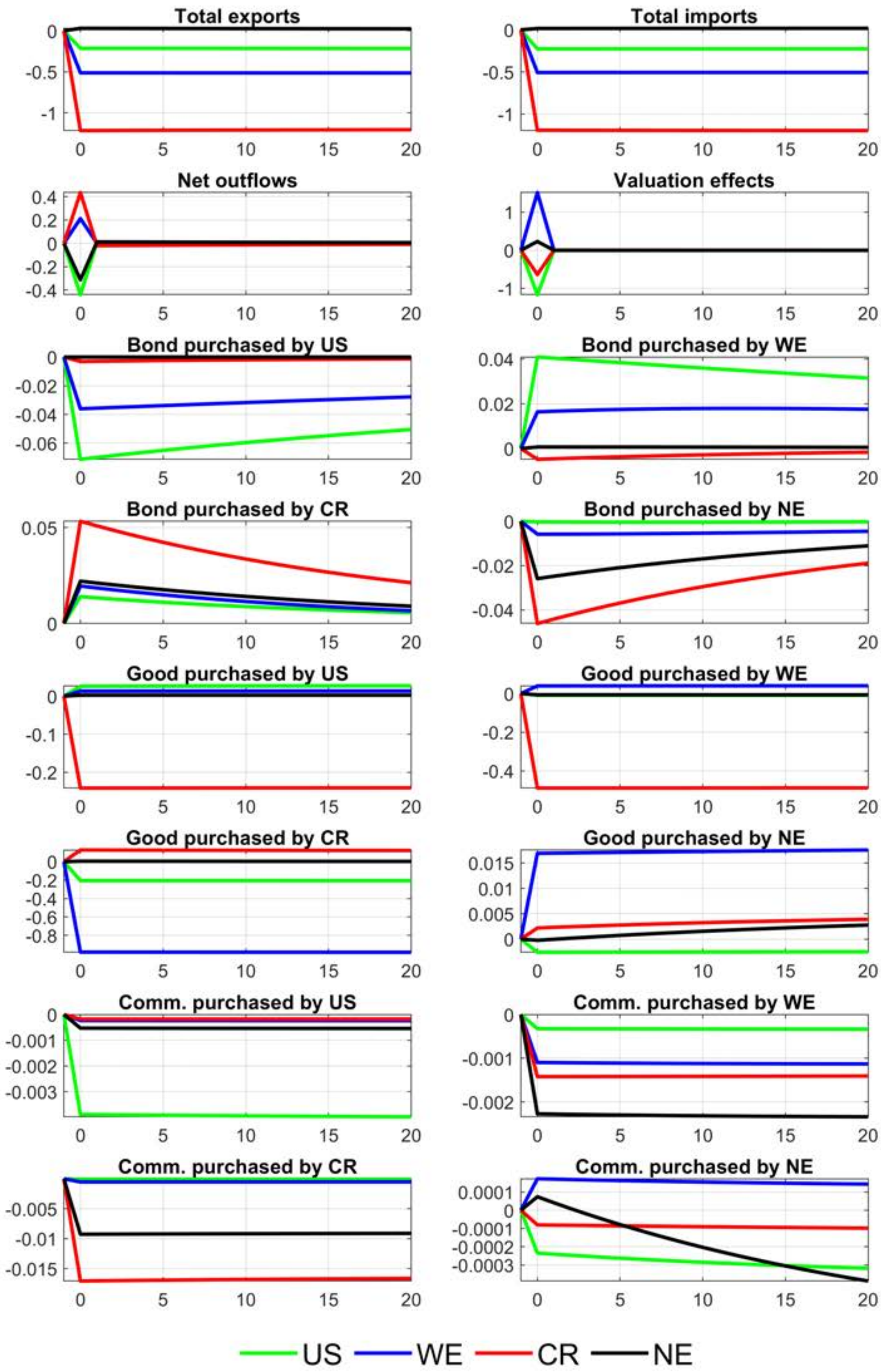

Figure C.11: Permanent 10 percentage point increase in the tax on imports of goods produced by rival countries. Net outflows are defined as $NO_{it} \equiv \sum_{j\in\mathcal{I}} Q_{ijt}\left(B_{ijt} - B_{ijt-1}\right)$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j\neq i}\left(Q_{ijt} - Q_{ijt-1}\right) B_{ijt-1}$.

Tax on imports of commodities: permanent shock

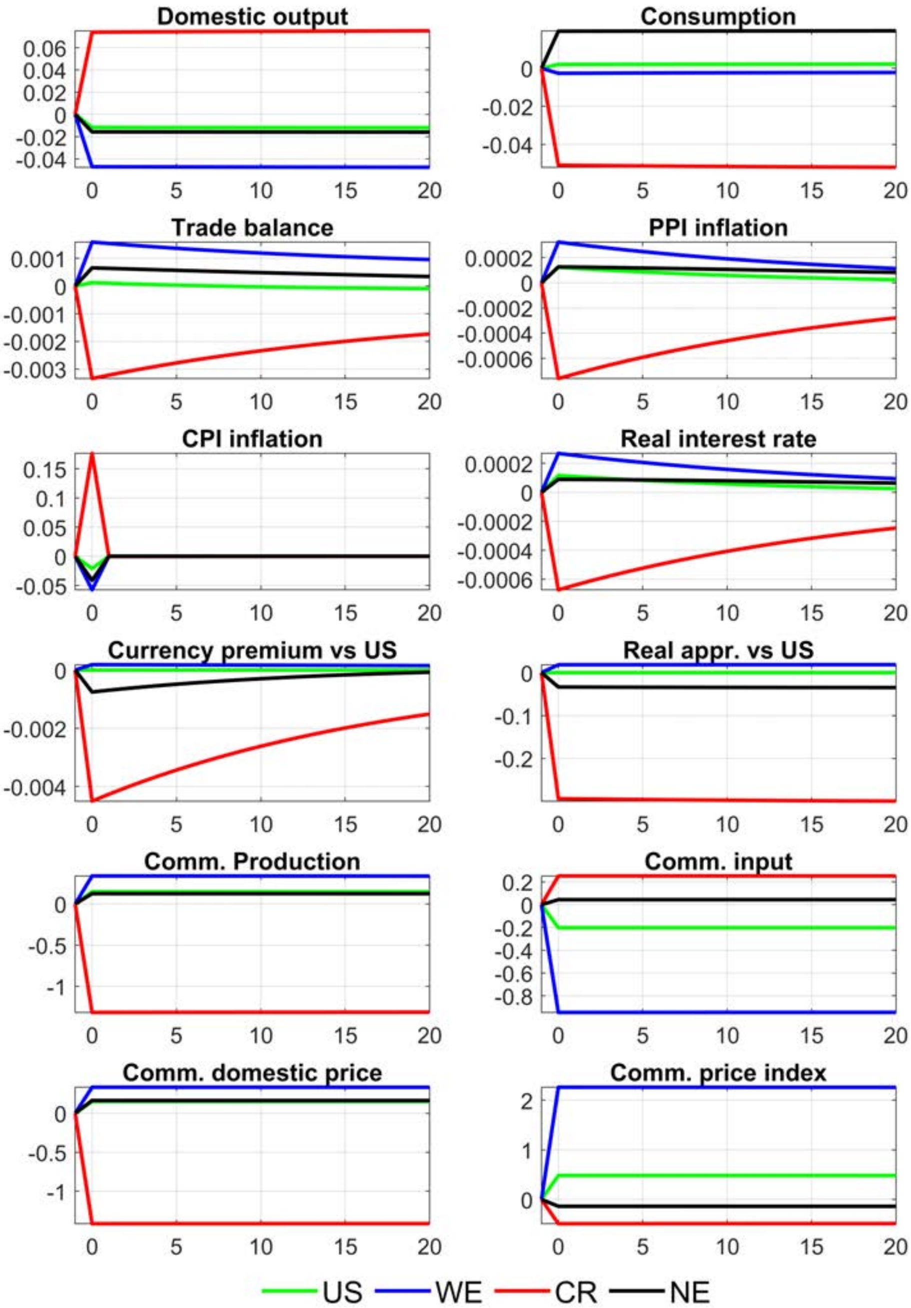

Figure C.12: Permanent 10 percentage point increase in the tax on imports of commodities produced by rival countries.

Tax on imports of commodities: permanent shock (2)

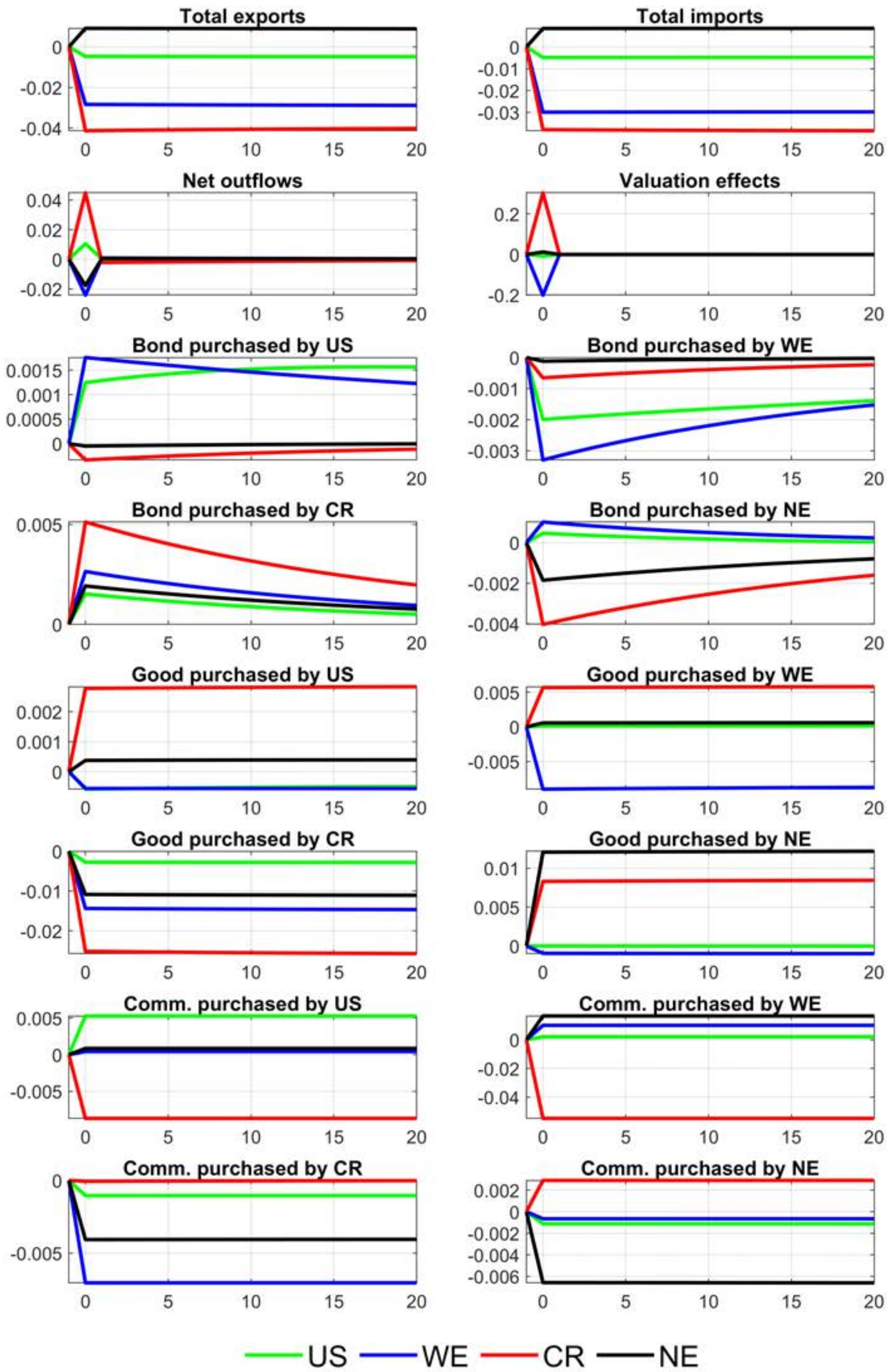

Figure C.13: Permanent 10 percentage point increase in the tax on imports of commodities produced by rival countries. Net outflows are defined as $NO_{it} \equiv \sum_{j \in \mathcal{I}} Q_{ijt} (B_{ijt} - B_{ijt-1})$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j \neq i} (Q_{ijt} - Q_{ijt-1}) B_{ijt-1}$.

Tax on foreign assets: permanent shock

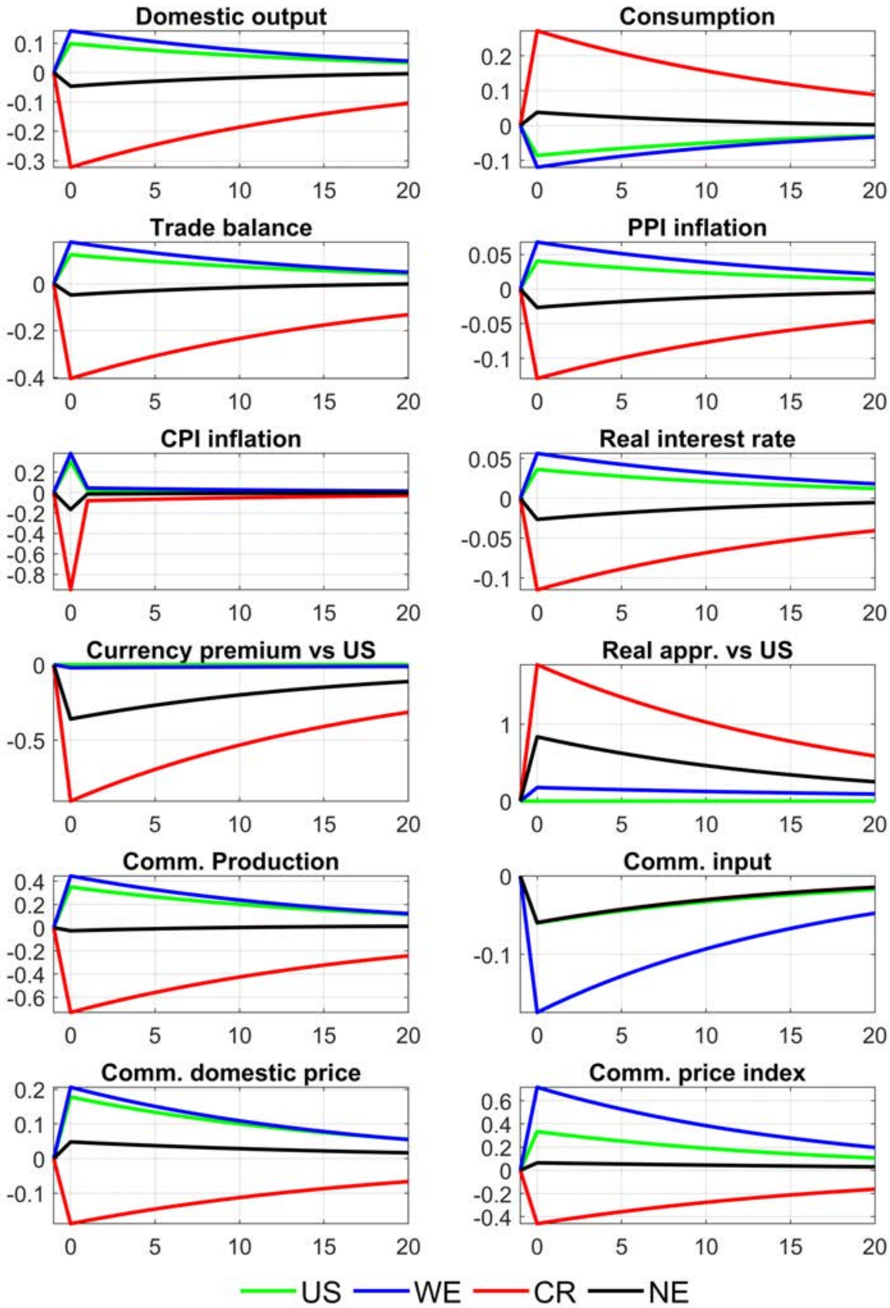

Figure C.14: Permanent 50 basis point increase in the tax on bonds issued by rival countries.

Tax on foreign assets: permanent shock (2)

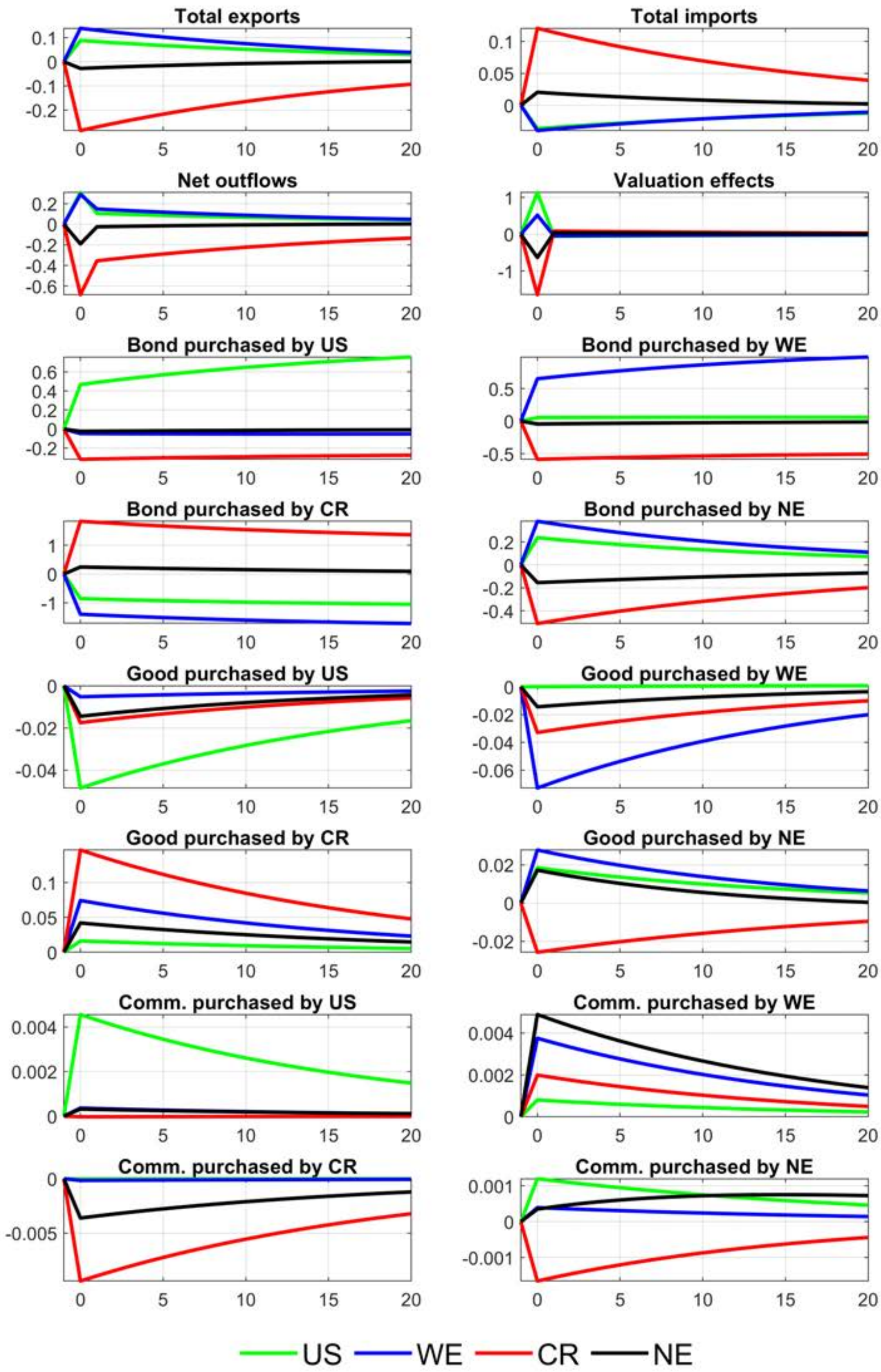

Figure C.15: Permanent 50 basis point increase in the tax on bonds issued by rival countries. Net outflows are defined as $NO_{it} \equiv \sum_{j \in \mathcal{I}} Q_{ijt} (B_{ijt} - B_{ijt-1})$. Valuation effects are the variation in the value of the NFA resulting from changes in the exchange rate: $VE_{it} \equiv \sum_{j \neq i} (Q_{ijt} - Q_{ijt-1}) B_{ijt-1}$.

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