America First? The Macroeconomic Implications of Punitive Tariffs*

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Abstract

Since 2018, punitive tariffs have resurged as tools for protecting national economies, particularly between the US and China. This paper examines the macroeconomic and welfare impacts of various tariff scenarios using a four-region dynamic general equilibrium model with a multi-sectoral production network. The scenarios include unilateral US tariffs, coordinated US-EU tariffs, Chinese retaliation, Europe's non-participation, and sector-specific versus broad tariffs. Our results show that tariffs initially boost domestic output by making local goods cheaper. While consumption increases permanently, the output benefits are short-lived. Increased production costs and reduced global income negate the output gains over time. China has an incentive to retaliate and when it does so, welfare losses deepen for the affected partners. Additionally, the rest of the world suffers from reduced aggregate income regardless of direct involvement in tariff conflicts. Sector-specific tariffs are found to be less effective than broad tariffs by failing to protect non-targeted industries. Overall, tariffs appear inefficient for economic protection due to the high possibility of retaliation.

Keywords: Tariffs, Trade Conflict, Protectionism, International Trade, Dynamic General Equilibrium Model, Production Network

JEL classification: F12, F13, F40, D57, E27

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1 Introduction

Since 2018 punitive tariffs are back on the world stage as an instrument to protect and possibly support the home economy. The sectoral tariffs introduced by the first Trump administration on China, the EU and other big trading partners, caused retaliatory tariffs (see for example Fajgelbaum, Goldberg, Kennedy, and Khandelwal, 2020). The Biden administration reversed those tariffs only partly and introduced additional tariffs against Chinese electric vehicles. The EU followed the US with tariffs on Chinese electric vehicles. In February 2025, the new Trump administration introduced tariffs on imports from Mexico, Canada and China. Retaliatory measures were announced or put in place directly. Tariffs on European imports are pending.

The imposition of tariffs often leads to complex tariff conflicts that can escalate into broader trade disputes, affecting not only the countries directly involved but also the global market at large. At the same time, there is a strong political narrative that tariffs serve as an "America first" policy. For countries exposed to such tariffs, it is a fine line to defend themselves with countermeasures without further fueling the trade conflict. Understanding the dynamics of tariff conflicts is hence essential for policymakers to navigate the challenges posed by protectionism and to promote sustainable economic growth.

In order to shed light on the consequences of tariffs, we analyse the macroeconomic and welfare effects of different scenarios in a four region, dynamic general equilibrium model with a multi-sectoral production network (Hinterlang, Martin, Röhe, Stähler, and Strobel, 2023). In the first scenario, the US imposes a 25 % tariff on China. In the second one, China responds with a 25 % retaliation tariff on the US. In Scenarios three to five Europe comes into play. In scenario 3, it follows the US by also imposing a 25 % tariff on China, which China responds to with an equally high retaliation tariff in scenario 4. Per contrast, in scenario 5, Europe refrains from imposing tariffs on China and is itself hit with a 25 % US-tariff. In all five scenarios, the fourth region comprising the rest of the world remains passive. Finally, we exploit the multi-sectoral structure of our model by comparing the results of the described scenarios to an equal set of scenarios with tariffs on selected sectors only.

Our findings can be summarized as follows. In general, we see that in the absence of retaliation measures, the tariff-employing country faces an increase in output and consumption. This is due to higher demand for domestically produced goods. In the medium term, increasing production costs dampen the positive output gains (and translate into higher consumer prices). The production cost increase is due to the higher intermediate input-prices of imported goods, which may differ between sectors depending on their respective import shares of intermediate inputs. As a result, the positive effects diminish. Consumption reacts more favourable than output as tariffs cause higher lumps-sum transfers to the households. In addition, households' consumption share increases with lower capital investment going along with lower output. Last but not least, higher consumption and lower employment (also going along with lower output) increase household welfare in the tariff-employing economy.

Per contrast, the tariff-targeted country looses in terms of output, consumption and welfare due to lower exports to the tariff-inducing region. In addition, regions not affected by the tariff, also loose due to reduced global demand resulting from the distortion in international trade created by the tariff.

Ultimately, we are dealing with a classical beggar-thy-neighbour policy: a unilaterally imposed tariff induces a real wealth transfer from the tariff-targeted country - and to a lesser extent from regions not directly affected - to the tariff-employing country. While all regions are negatively affected by the tariff induced trade distortion, the tariff-employing country benefits from the additional revenue. Depending on how it redistributes these revenues, they can more or less compensate the negative effect.

If the tariff-targeted country imposes retaliation measures, the described mechanisms add up with the same effects, now working in the opposite direction. Applied to our five scenarios, this leads to the following strategic insights.

The US benefits in a scenario where it imposes tariffs on China as long as China does not imply retaliation measures. The same is true for Europe, if it follows the US in taxing Chinese imports.

However, China has no reason to refrain from imposing retaliatory tariffs against the US or the West (i.e. the US and Europe). In both scenarios, its welfare improves slightly if it retaliates, while the US or the West are significantly worse off. The latter is possibly a welfare-enhancing element in itself, but at the very least, it has considerable threatening potential.

If Europe anticipates probable retaliation measures by China, the best would be not to impose tariffs in the first place. This generates the smallest welfare losses. However, faced with two bad options to either impose tariffs on China or provoking US-tariffs on Europe, the first option is slightly welfare improving. Forging such an alliance with the EU would actually reduce benefits for the US, due to lower world demand. However, if the goal of US policies is to hamper the advance of Chinese manufacturing, it might have a strong incentive to get the EU to levy tariffs on Chinese exports as well.

Overall (and in line with the literature), tariffs do not seem to be a good option for "protecting" the own economy, unless one believes the tariff targeted countries refrain from retaliation. Given the described incentive structure, there is no reason to believe so.

As mentioned before, the rest of the world suffers in all scenarios from the tariff induced trade distortions, which hamper world demand. Losses are highest, when tariffs are highest, hence in an escalated trade conflict between the entire West and China. Its strategic options are the same as for Europe: if possible, it is best to stay out of the conflict.

Our additional set of scenarios where the tariffs apply on selected sector only, reveals that the choice of sectors matters. If the US or the West apply tariffs on metal and electronic goods only, they benefit significantly less even in the scenario without retaliation measures. The reason is, that these goods are used mainly as inputs for the production the non-tariffed goods and to a lesser extent in the consumption and investment bundles. Hence, domestic production of the non-tariffed goods becomes more expensive. Due to this, consumers will switch to products produced in foreign regions as there is no "protection" of domestic non-tariffed goods by making foreign ones more expensive. As this deteriorates income in these sectors, which are those most people work in and/or own firms of, aggregate income and, thereby, consumption will rise less or even fall immediately. Welfare gains stem from more leisure. Here, well-meaning may not directly lead to well-done.

The rest of the paper is organized as follows. We discuss related literature in Section 2.

The model is introduced in Section 3 and its calibration in Section 4. General simulation results are described in Section 5, while Section 6 focuses on simulations when levying tariffs on specific sectors only. Section 7 concludes.

2 Related literature

This paper related to the literature on macroeconomic effects of trade conflicts. Baqaee and Farhi (2024) analyze the implications of modeling production networks regarding trade and tariffs. Attinasi, Boeckelmann, and Meunier (2023) adapt the Baqaee and Farhi (2024) multi-country, multi-sector model in order to analyze the effects of a decoupling of global supply chains and in specific sectors. The short-run welfare losses are found to be much larger than for the long run. Their results also highlight the importance of trade in intermediate inputs. Quintana (2024) also relies on a multi-country production network model to simulate trade fragmentation between geopolitical blocks by introducing iceberg costs to trade. He finds moderate long-run effects in Western economies and potentially large short-run effects in a severe scenario. Neutral countries gain from rerouting. Ghironi, Kim, and Ozhan (2024) analyze the effect of sanctions on Russia and highlight the necessity and difficulties of international coordination. Moro and Landi (2024) employ a four-region New Keynesian model to analyze an increase in import tax rates. The China-led block and US allies are found to be affected most, while the US is relatively shielded. There is little evidence of spillovers to neutral countries. Dinopoulos, Heins, and Unel (2024) investigate optimal tariffs in a multi-country trade model with occupational choice. Unilateral tariffs are found to be welfare increasing domestically, but also unemployment and top incomes increase. The opposite applies to tariff-targeted countries. A global tariff conflict is welfare reducing for all countries.

With respect to the modelling choice, this paper also relates to contributions applying multi-sector frameworks in different contexts. Atalay (2017) lays out how sectoral shocks impact business cycle fluctuations. Similar models were used to investigate the Covid-19 crisis (Baqaee and Farhi, 2022), the fiscal policy response to the crisis (Hinterlang, Moyen, Röhe, and Stähler, 2023), as well as to assessing the government spending multiplier in general (Bouakez, Rachedi, and Santoro, 2023, and Devereux, Gente, and Yu, 2023). How the monetary transmission channel depends on heterogenous production structures with a focus on price rigidities is investigated in Pasten, Schoenle, and Weber (2020) and Bouakez, Cardia, and Ruge-Murcia (2014). The sectoral dimension is also important for studying climate-related adjustment processes (see e.g. Ernst, Hinterlang, Mahle, and Stähler, 2023, Hinterlang, Martin, Röhe, Stähler, and Strobel, 2022, Hinterlang et al., 2023, Hinterlang, 2024) and the impact of digitalization on labour productivity (Falck, Röhe, and Strobel, 2024).

3 The model

Our model features multiple regions and sectors that all interact. The general model description draws on Ernst et al. (2023), with a special focus on inter-regional tariffs. Time t is discrete and runs forever. The model economy comprises $\mathcal{S} = \{1, 2, .., S\}$ production sectors and four regions $i = a, b, c, d$. World population is normalized to unity such that ω^i indicates (relative) population size of region i. It holds that $\omega^a + \omega^b + \omega^c + \omega^d = 1$.

Each region is inhabited by a representative household, perfectly competitive labor and capital agencies, consumption, investment, and intermediate-goods retailers, as well as a fiscal authority. The representative household receives income from providing labor and capital to labor and capital agencies that channel them to sectoral goods producers. Labor is immobile internationally and only imperfectly mobile across sectors. International capital mobility is modelled by trade in international interest-bearing assets.[1] Households use their income for consumption and investment in physical capital as well as international bonds.

Sectoral output is transformed into bundles of consumption, investment, and intermediate goods. This is accomplished by perfectly competitive retailers. Besides the purchase of intermediate input bundles, firms rent capital and labor from the corresponding agencies. Producers are price setters and prices may differ across sectors due to different markups. There is also heterogeneity with respect to factor intensities. All goods are traded internationally. In what follows, we will describe the economy in more formal detail. Unless otherwise indicated, variables are expressed in (regional) per-capita terms.

3.1 Representative household

A representative household in region i chooses consumption $C_{i,t}$, labor supply $N_{i,t}$, physical capital investments $I_{i,t}$ and purchases of internationally traded assets $nfa_{i,t}$ in order to maximize expected utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_{i,t} - \kappa_{i,N} \cdot N_{i,t}^{\psi} \cdot O_{i,t}\right)^{1-\sigma} - 1}{1-\sigma} \right]. \tag{1}$$

GHH preferences (as specified, for example, by Jaimovich and Rebelo, 2009), which shut off the wealth effect on the labor supply (see Greenwood, Hercowitz, and Huffman, 1988), are commonly used in open economy DSGE models. The parameter σ denotes the inverse of the elasticity of intertemporal substitution. As $\sigma \to 1$, utility is log. β is the discount rate. The curvature of labor supply disutility is determined by ψ, and $\kappa_{i,N}$ is its weight relative to consumption. Note that we allow only the latter parameter to be region-specific. $O_{i,t} = O_{i,t-1}^{1-\gamma^{ghh}} \cdot C_{i,t}^{\gamma^{ghh}}$ makes preferences non-time-separable in consumption and labor. $\mathbb{E}_0$ is the expectations operator at $t = 0$. Given the consumer price index (CPI) in region i, $P_{i,t}^C$, the choices of the representative household are subject to the real budget constraint

$$\begin{aligned}(1+\tau_{i,t}^c)C_{i,t} + (1+\tau_{i,t}^I)P_{i,t}^I\left(I_{i,t} + S(I_{i,t}, K_{i,t-1})\right) \quad + \quad & nfa_{i,t} = w_{i,t}N_{i,t} + r_{i,t}^k K_{i,t-1} \\ & + R_{i,t-1} nfa_{i,t-1} + TR_{i,t} + \Pi_{i,t}, \end{aligned} \tag{2}$$

where $P_{i,t}^I$ is the regional CPI-deflated real price of a basket of investment-goods, $I_{i,t}$ the corresponding basket of investment-goods, $w_{i,t}$ the real wage rate and $r_{i,t}^k$ the real

[1] Hence, any domestic household who wants to invest in foreign physical capital must purchase international assets (i.e. lend money to the foreign household). The foreign household can use these funds to invest them in foreign capital and must pay interest to the domestic household.

rental rate of capital $K_{i,t}$. $R_{i,t}$ is the gross regional CPI-deflated real interest rate on regional holdings on net foreign assets. The average tax rate on the consumption bundle is $\tau^c_{i,t}$ and on the investment bundle $\tau^I_{i,t}$. $TR_{i,t}$ are lump-sum transfers received from the government and $\Pi_{i,t}$ denote aggregate firm profits. Capital accumulation is represented by the following law of motion

$$K_{i,t} = (1 - \delta_i)K_{i,t-1} + I_{i,t}, \tag{3}$$

with δ_i denoting the regional rate of depreciation. $S(I_{i,t}, K_{i,t-1}) = \kappa^I_i/2 \cdot (I_{i,t}/K_{i,t-1} - \delta_i)^2$ are capital adjustment costs as in Ireland (2003) and Hinterlang et al. (2023). First-order conditions are standard (see Appendix A).

3.2 Consumption and investment-goods retailers

The representative household demands bundles of consumption and investment goods $C_{i,t}$ and $I_{i,t}$, which are traded at prices $P^C_{i,t}$ and $P^I_{i,t}$, respectively. The production technology of a perfectly competitive, representative retailer that bundles sector-level consumption and investment goods of the S sectors, $C_{s,i,t}$ and $I_{s,i,t}$, is given by

$$X_{i,t} = \left[\sum_{s=1}^{S} \psi_{X,s,i}^{1-\sigma_{X,i}} X_{s,i,t}^{\sigma_{X,i}} \right]^{\frac{1}{\sigma_{X,i}}},$$

where $X \in \{C, I\}$. The parameters $\psi_{X,s,i}$ and $\sigma_{X,i}$ determine the weight in the consumption/investment bundle and the elasticity of substitution between sector-level consumption/investment goods in region i, respectively. The representative retailer's optimization problem in CPI-deflated real terms can be written as

$$\max_{X_{s,i,t}} (1 + \tau^X_{i,t}) P^X_{i,t} X_{i,t} - \sum_{s=1}^{S} (1 + \tilde{\tau}^X_{s,i,t}) P^X_{s,i,t} X_{s,i,t},$$

where $P^X_{s,i,t}$ is the CPI-deflated price of sectoral consumption/investment good $s \in \mathcal{S}$. It will depend on how much of this good is purchased domestically and how much comes from abroad, which we will determine in more formal detail below. $\tilde{\tau}^X_{s,i,t}$ is the corresponding average tax rate for this good, also depending on where the good is produced and on whether or not tariffs apply. Fist-order conditions and the expressions for relative prices can be found in Appendix A.

3.3 Labor and capital agencies

As mentioned above, labor and the capital stock are not perfectly mobile across sectors, and not at all across regions (remember that domestic households can take the detour via international assets to participate in foreign capital investments). To capture this, we assume that a perfectly competitive, representative regional labor/capital agency hires the total amount of labor/capital, $N_{i,t}$ and $K_{i,t}$, at the CPI-deflated real wage/capital interest rate, $w_{i,t}$ and r^K_t, and sells it to intermediate goods producers operating in S

different domestic sectors, such that

$$X_{i,t} = \left[\sum_{s=1}^{S} \omega_{X,i,s}^{1-\nu_{X,i}} X_{s,i,t}^{\nu_{X,i}} \right]^{\frac{1}{\nu_{X,i}}},$$

where $X \in \{N, K\}$. $\omega_{X,i,s}$ is the weight attached to labor/capital provided to sector $s \in \mathcal{S}$, and $\nu_{X,i}$ determines the elasticity of substitution of labor/capital across sectors. This captures the degree of (imperfect) labor/capital mobility. The labor/capital agency's optimization problem can be written as

$$\max_{X_{s,i,t}} \tilde{p}_{s,i,t} X_{s,i,t} - \tilde{p}_{i,t} \cdot X_{i,t},$$

where $\tilde{p} \in \{w, r^k\}$. The first-order conditions and expressions for wages and interest rates are relegated to Appendix A.

3.4 Production

In each sector $s \in \mathcal{S}$ in region $i \in \{a, b, c\}$, a monopolistically competitive firm $z \in [0, 1]$ produces a differentiated sectoral variety $y_{s,i,t}(z)$ by transforming labor, $N_{s,i,t}(z)$, capital, $K_{s,i,t-1}(z)$, and a bundle of intermediate inputs, $H_{s,i,t}(z)$. The differentiated sectoral variety is sold at price $P_{s,i,t}(z)$ to a representative wholesaler who aggregates varieties into a single sectoral good $Y_{s,i,t}$ and sells these wholesale goods to households and investors according to the consumption and investment demand baskets previously described at a price $P_{s,i,t}$. Operating under perfect competition, the optimization problem of the representative wholesaler is given by

$$\max_{y_{s,i,t}(z)} P_{s,i,t} Y_{s,i,t} - \int_0^1 P_{s,i,t}(z) y_{s,i,t}(z)\, dz \quad \forall s \in \mathcal{S} \quad and \quad i \in \{a, b, c\}$$

subject to

$$Y_{s,i,t} \leq \left(\int_0^1 y_{s,i,t}(z)^{\frac{\theta_{s,i}^P - 1}{\theta_{s,i}^P}}\, dz \right)^{\frac{\theta_{s,i}^P}{\theta_{s,i}^P - 1}}.$$

The parameter $\theta_{s,i}^P > 1$ governs the elasticity of substitution between different varieties and may differ across sectors. This yields standard variety demand functions and sectoral prices (see Appendix A).

The production technology of a monopolistically competitive firm z in sector s and region i exhibits constant returns to scale and is given by

$$y_{s,i,t}(z) = \varepsilon_{s,i,t} \left(\alpha_{H,s,i} \cdot \tilde{y}_{s,i,t}(z)^{sub_{yh}} + (1 - \alpha_{H,s,i}) \cdot H_{s,i,t}(z)^{sub_{yh}} \right)^{1/sub_{yh}}, \tag{4}$$

where $\varepsilon_{s,i,t}$ is total factor productivity and $(1 - \alpha_{H,s,i})$ determines the "factor intensity" of intermediate goods in the production process. $\tilde{y}_{s,i,t}(z)$ is self-production (sometimes also referred to as value added in the literature) given by

$$\tilde{y}_{s,i,t}(z) = \left(\alpha_{N,s,i} \cdot N_{s,i,t}(z)^{sub_{nk}} + (1-\alpha_{N,s,i}) \cdot K_{s,i,t-1}(z)^{sub_{nk}}\right)^{1/sub_{nk}}, \tag{5}$$

where $\alpha_{N,s,i}$ determines the factor intensity of labor and $(1-\alpha_{N,s,i})$ the intensity of the capital stock. sub_{yh} determines the substitutability between self-production and intermediate goods, sub_{nk} the one between labor and capital. It holds that labor and capital as well as self-production and intermediates are gross complements for $sub_{yh}, sub_{nk} < 0$ and gross substitutes for $sub_{yh}, sub_{nk} > 0$. Taking factor prices and acknowledging the symmetric equilibrium (which allows dropping the index z), we get the standard first-order conditions for labor, capital and intermediate inputs (see Appendix A).

What also needs to be determined is factor demand for sector j-intermediates by sector s in each region i, with $j, s \in \mathcal{S}$. In analogy to consumption/investment goods bundles, we assume that intermediates are bundled according to

$$H_{s,i,t} = \left[\sum_{j=1}^{S} \psi_{H,s,j,i}^{1-\sigma_{H,s,i}} H_{s,j,i,t}^{\sigma_{H,s,i}}\right]^{\frac{1}{\sigma_{H,s,i}}} \quad \forall s, j \in \mathcal{S} \quad and \quad i \in \{a, b, c\}.$$

Hence, the CES aggregator for each sector $s \in \mathcal{S}$ aggregates the intermediate goods from all sectors $j \in \mathcal{S}$, after weighting them by the parameter $\psi_{H,s,j,i}$ and taking into account the elasticity of substitution between those intermediate goods which is determined by $\sigma_{H,s,i}$. These parameters may differ across sectors. The optimization problem is

$$\max_{H_{s,j,i,t}} (1+\tau^H_{s,i,t}) P^H_{s,i,t} H_{s,i,t} - \sum_{j=1}^{S} (1+\tilde{\tau}^H_{j,i,t}) P_{j,i,t} H_{s,j,i,t} \quad \forall s, j \in \mathcal{S} \quad and \quad i \in \{a, b, c\},$$

where $\tilde{\tau}^H_{s,i,t}$ is the average tax rate on intermediate input s (again depending on whether purchased at home or abroad when differentiated taxation applies, which we will discuss below). The demand functions are standard (see Appendix A).

3.5 Policy

The fiscal authority in region i sets transfers to run a balanced budget each period:

$$TR_{i,t} = \tau^c_{i,t} \cdot C_{i,t} + \tau^I_{i,t} \cdot P^I_{i,t} \cdot I_{i,t} + \sum_{s=1}^{S} \tau^H_{s,i,t} \cdot P^H_{s,i,t} \cdot H_{s,i,t}. \tag{6}$$

Tax rates are given exogenously or derived according to the simulation design described below. Allowing for public debt and different fiscal rules along the lines of, for example, Mitchell, Sault, and Wallis (2000), is possible. For a discussion about the impact of using different fiscal instrument in our model, see also Hinterlang et al. (2023).

3.6 International linkages, market clearing and aggregation

International trade in goods and assets implies that the four regions are linked together, which not only affects the net foreign asset position but also the market clearing conditions. We assume that households and firms in region i purchase domestic goods as well as goods from the other regions. The corresponding CES bundle for consumption, investment and intermediate goods is given by

$$X_{s,i,t} = \left[\sum_{\tilde{i} \in \{a,b,c\}} hb_{X,s,i,\tilde{i}}^{1-\sigma_{X,s,i,\tilde{i}}} X_{s,i,\tilde{i},t}^{\sigma_{X,s,i,\tilde{i}}} \right]^{\frac{1}{\sigma_{X,s,i,\tilde{i}}}} \quad \forall s \in \mathcal{S} \quad and \quad i, \tilde{i} \in \{a,b,c,d\},$$

where $X \in \{C, I, H\}$.[2] The parameter $hb_{X,s,i,\tilde{i}}$ is the sector-s preference bias of region i towards goods produced in region $\tilde{i}$. Hence, $hb_{X,s,i,i}$ can be interpreted as home bias. $\sigma_{X,s,i,\tilde{i}}$ is the corresponding elasticity of substitution between home and foreign goods. Given bundle, sector and region-specific taxes for each good, the optimization problem in CPI-deflated real terms can be written as

$$\max_{X_{s,i,\tilde{i},t}} (1+\tilde{\tau}_{s,i,t}^X) P_{s,i,t}^X X_{s,i,t} - \sum_{\tilde{i} \in \{a,b,c\}}^{S} (1+\tau_{s,i,\tilde{i},t}^X) P_{s,i,\tilde{i},t} X_{s,i,\tilde{i},t} \quad \forall s \in \mathcal{S} \quad and \quad i \in \{a,b,c\},$$

where $P_{s,i,\tilde{i},t}$ is the producer price of region $\tilde{i}$ deflated by CPI of region i (to be derived below). $\tau_{s,i,\tilde{i},t}^X$ denotes region i's tariff on goods of sector s that are produced in region $\tilde{i}$ and purchased in region i. It is a policy variable, and we allow policy makers to differentiate between taxes in the consumption, investment and intermediate goods bundles. If region i wants to discriminate imports by a tariff, it must hold that$\tau_{s,i,\tilde{i},t}^X > \tau_{s,i,i,t}^X$ for $i \neq \tilde{i}$. These tax rates are exogenously given as specified in detail when describing the simulation design below.

With these demands for home and foreign goods at hand, we can derive the sectoral trade balances for each region as

$$TB_{s,i,t} = \frac{P_{s,i,i,t}}{\omega^i} \cdot \sum_{\tilde{i} \neq i} \omega^{\tilde{i}} \left(C_{s,\tilde{i},i,t} + I_{s,\tilde{i},i,t} + \sum_{j=1}^{S} H_{s,j,\tilde{i},i,t} \right) - \sum_{\tilde{i} \neq i} P_{s,i,\tilde{i},t} \cdot \left(C_{s,i,\tilde{i},t} + I_{s,i,\tilde{i},t} + \sum_{j=1}^{S} H_{s,j,i,\tilde{i},t} \right) \tag{7}$$

for all sectors s and regions i. Note that, for exports, we have to take into account country size as the other variables are represented in regional per-capita terms. The aggregate trade balance of region i is, then, given by $TB_{i,t} = \sum_{s=1}^{S} TB_{s,i,t}$. Net foreign assets evolve according to

$$nfa_{i,t} = R_{i,t-1} \cdot nfa_{i,t-1} + TB_{i,t} \tag{8}$$

where $R_{i,t}$ is assumed to include a risk premium as in Schmitt-Grohe and Uribe (2003), among others.[3]

[2]For notational convenience, please note the following. For the intermediate input bundle, sector s decides about inputs from sector j, which is not the case for the consumption and investment bundles. Hence, the "true" bundles should actually be denoted by $C_{s,i,t}$, $I_{s,i,t}$ and $H_{s,j,i,t}$, and the corresponding inputs by $C_{s,i,\tilde{i},t}$, $I_{s,i,\tilde{i},t}$ and $H_{s,j,i,\tilde{i},t}$. We subsume all this in the X's to save space.

[3]In standard open-economy DSGE models along the lines of Obstfeld and Rogoff (1995), which we also have here, the net foreign asset position is exogenous (zero in our initial steady state). Stationarity is reached by adding a friction to the financial market that kicks in whenever the exogenously fixed reference level is missed (see Schmitt-Grohe and Uribe, 2003, Hunt and Rebucci, 2005, Lubik, 2007 and Benigno, 2009, for a discussion). The risk premium does the job in our model.

It remains to derive some inter-regional prices. When region i buys a product of region $\tilde{i}$ from sector s, region $\tilde{i}$ sells it at its own CPI-deflated producer price $P_{s,\tilde{i},t}$. For country i, this has to be translated by using its own CPI deflator. Hence, $P_{s,i,\tilde{i},t} = P_{s,\tilde{i},t} \cdot P^C_{\tilde{i},t}/P^C_{i,t}$, where the latter ratio of consumer prices yields the real exchange rate between the two region: $rer_{i,\tilde{i},t} = P^C_{\tilde{i},t}/P^C_{i,t}$. As internationally traded assets are in zero net supply, we can use this to show that $\omega^d \cdot nfa_{d,t} = -rer_{a,d,t} \cdot \omega^a \cdot nfa_{a,t} - rer_{b,d,t} \cdot \omega^b \cdot nfa_{b,t} - rer_{c,d,t} \cdot \omega^c \cdot nfa_{c,t}$ must hold.

In each sector s and region i, product market clearing implies

$$P_{s,t}y_{s,t} = P^C_{s,t}C_{s,t} + P^I_{s,t}I_{s,t} + TB_{s,i,t} + \sum_{\tilde{s}=1}^{S} P_{s,h,t}H_{\tilde{s},s,t}.$$

Defining aggregate output as gross value added, i.e. intermediate inputs cancel out, we get

$$Y^{va}_{i,t} = C_{i,t} + P^I_{i,t} \cdot I_{i,t} + TB_{i,t} + P^I_{i,t}S(I_{i,t}, K_{i,t-1}). \tag{9}$$

This completes the model description. All decisions must be such that they are mutually consistent and the above equations hold. We now turn to the model calibration.

4 Calibration

The calibration comprises two sets of model parameters. The first set covers general parameters taken from the literature. The second set encompasses sector-specific parameters, customized for the selected regions and sectors. This set includes parameters such as capital and labor shares, factor intensities, input-output relationships, and contributions to final demand.

We calibrate the model for four regions (a, b, c, d). Region a refers to the USA, region b to China, region c to the European Union including UK, and region d represents the rest of the world. The regions are selected to simulate different trade conflict scenarios between and within "The West" and China and their implications for the rest of the world. Detailed calibration tables are provided in Appendix A for reference.

General Parameters The model is calibrated to quarterly frequency. Population data for calculating relative sizes and value-added per capita are sourced from the United Nations World Population Prospects for 2020. The discount factor is set at $\beta = 0.985$. Consistent with Jaimovich and Rebelo, 2009, we set $\sigma = 1$ and $\gamma^{ghh} = 0.001$. The Frisch elasticity of labor supply is calibrated to 0.5 (implying $\Psi = 2$) following Coenen, Straub, and Trabandt (2013). The region-specific disutility of labor weights $\kappa_{i,N}$ target an aggregate labor supply of $\bar{N}_i = 0.33$. Capital depreciation is assumed to be 10% annually, with the adjustment cost parameter κ^I fixed at 25. The consumption, labor and capital tax rates are uniform across all regions and are set to 0.2, 0.4 and 0.21, respectively.

The selection of elasticities of substitution for goods from different sectors is based on estimates from the literature. For the consumption basket, we assume a value of 0.9, consistent with Atalay (2017) and Baqaee and Farhi (2022), i.e., $\sigma_C = 1 - 1/0.9$. The investment goods basket assumes a lower elasticity of 0.75, i.e., $\sigma_I = 1 - 1/0.75$. Intermediate inputs have an elasticity of 0.3, following Bouakez et al. (2023) and Atalay

(2017), i.e., $\sigma_H = 1 - 1/0.3$. The elasticity between domestic and foreign goods is set close to one, and the elasticities of labor and capital are set to 2, i.e., $\nu_N = \nu_K = 2$, similar to Bouakez et al. (2023) and the references therein. For computational convenience, the relative prices in the initial steady state are normalized to one.

Sector-Specific Production Parameters Utilizing the NACE Rev. 2 classification, we distinguish between $S = 6$ production sectors across the four regions ($i \in a, b, c, d$). The choice of sectors is based on the fact that current tariff policies (discussions) target specific products instead of a broad sector coverage. These targeted sectors include manufacture of food products, beverages and tobacco products ($C10 - 12$), manufacture of basic metals ($C24$), manufacture of computer, electronic and optical products as well as electrical equipment ($C26 - 27$) and manufacture of machinery and equipment, motor vehicles, trailers and semi-trailers, and other manufacturing $C28\_29\_31\_32$). The remaining two sectors represent aggregates. The first one covers agriculture, mining and quarrying, the rest of manufacturing, energy, water supply and construction ($A\_B\_RoC\_D\_E\_F$). The second one comprises the service sectors ($G - S$), excluding financial and public sectors. Table B.1 provides a comprehensive overview of the regions and sectors modeled.

The sectors within the model are distinguished by several attributes. Sectoral shares in labor and capital are explicitly modeled in CES bundles. Heterogeneity in production technologies for intermediate goods producers is captured through varying factor intensities for labor, capital, and intermediate inputs. Additionally, each sector's contribution to final demand is distinct. These sector-specific parameters are derived from the latest release of the World Input–Output Database (WIOD), which spans the years 2000 to 2014, with the 2014 data being utilized for calibration (Timmer, Dietzenbacher, Los, Stehrer, and De Vries, 2015). The WIOD provides comprehensive data on socioeconomic accounts and input–output tables for 56 sectors across 43 countries, which are aggregated into the four regions as previously described.

Using the socioeconomic accounts (SEA), we calculate sector-specific labor and capital supplies, denoted as $\omega_{N,s,i}$ and $\omega_{K,s,i}$, as well as factor intensities $\alpha_{N,s,i}$ and $\alpha_{H,s,i}$ for each region.[4] The shares of labor and capital in each sector are determined by their respective contributions to the total number of people employed and to the nominal capital stock. Factor intensities for intermediate inputs, $1 - \alpha_{H,s,i}$, are calculated by dividing the value of intermediate inputs by the gross output for each industry. The labor share of gross output, $\alpha_{N,s,i}$, is then derived from the share of labor compensation.

Parameters $\psi_{H,s,j,i}$ represent the share of intermediate inputs used by sector s produced by sector j, calibrated using input–output tables. The same methodology is applied to compute the preference bias parameters $hb_{H,s,i,\bar{i}}$ for intermediate goods, and the CES bundle shares $\psi_{C,s,i}$ and $\psi_{I,s,i}$, which reflect the distribution of a household's final consumption expenditure and gross fixed capital formation across sectors. These are derived from WIOD's national accounts data. Preference biases $hb_{X,s,i,\tilde{i}}, X \in C, I$, indicate the regional preferences for consumption or investment goods produced in different regions. Notably, preference biases for region d are used to close the model and may not align accurately with the data.

[4]SEA data are presented in national currencies. We convert these data to USD using the WIOD exchange rate series.

5 Baseline simulations

This sections describes the simulation design, the transmission mechanism of introducing tariffs and simulation results. For the latter, we start with the transition dynamics and the long run effects, before turning to welfare and strategic implications.

Simulation design We simulate five different scenarios. Each scenario represents a combination of tariffs levied on foreign imports by a subset of countries. For simplicity we assume all tariffs to be a 25% general import tariff on all imports from the targeted country. We neglect any sectoral differentiation for now. The scenarios considered are:

- **S1**: Tariffs from region a on b (US $\rightarrow$ China),
- **S2**: as above, but b also puts tariffs on a (US $\leftrightarrow$ China).
- **S3**: Tariffs from a and c on b ("the West"(US + EU) $\rightarrow$ China),
- **S4**: as above, but b also on a and c ("the West" $\leftrightarrow$ China).
- **S5**: Bi-directional tariffs between a on b, and tariffs from a on c, while c remains passive (US $\leftrightarrow$ China; US $\rightarrow$ EU).

Transmission mechanism Generally, implementing import tariffs increases the (gross, i.e. including customs duties) price of imported goods and generates government revenue. Demand for goods produced domestically or in untaxed regions increases as their prices become relatively cheaper. The targeted region is therefore exposed to a negative demand shock. Output, consumption, capital stock, employment and wages decline. However, part of the drop in output will be offset because producers in the targeted region reduce net prices and the real exchange rate declines. The negative income effect can spill-over to other regions, depending on their trade relations with the targeted region. Moreover, producers in the tariff-imposing region also face an increase in production costs when imported intermediate inputs become more expensive through the tariffs. Still, households in the tariff-imposing region benefit from an "implicit real wealth transfer" due to the relative price changes and the assumption that generated revenues from the import tariff are redistributed lump-sum.[5] Consequently, output in this country might be backed by domestic consumption in the short run, while capital stock and employment decrease. The lower capital stock translates into a smaller positive output effect in the longer run.

Results Figure 1 summarizes the effects on selected key macroeconomic variables. Figure 2 shows the effects on wages and real exchange rates as well as world-wide aggregates. Table 1 summarizes the long-run implications, whereas Figure 3 brakes these down to different sectors.

We find that introducing tariffs unilaterally (S1 in red) increases output in the US (region a). Due to the relative price changes and the redistributed revenues in form of

[5]Note that the benefit would be even larger when the revenues are used to reduce distorting taxes such as consumption or labor taxes.

lump-sum transfers, households increase consumption, while the capital stock and employment decrease. Hence, long-run effects on output and consumption are smaller though still positive (see Table 1). The targeted region China (*b*) suffers strong contractions in all macroeconomic aggregates during the transition and in the long run. The effects on Europe (*c*) and the rest of the world (*d*) are smaller but also negative. The negative income effect outweighs the potential stronger demand from the US for goods produced in these regions. Overall, world-wide macro aggregates decrease (see Figure 2),

The second scenario (S2 in purple) considers the effects of Chinese retaliation to US tariffs. Interestingly, levying tariffs on imports from the US only slightly increases Chinese consumption in the long run compared to S1, while output remains at almost the same level. Taking a look at the preference biases (see Appendix) reveals that the US imports a larger share from China than vice versa. Hence, China does not generate much revenue from imposing tariffs on the US that can be redistributed. At the same time, US exports suffer, leading to lower US consumption and output. This also reduces demand from the US for products produced abroad. Hence, negative effects in Europe and the Rest of the world are a bit larger than in the first scenario.

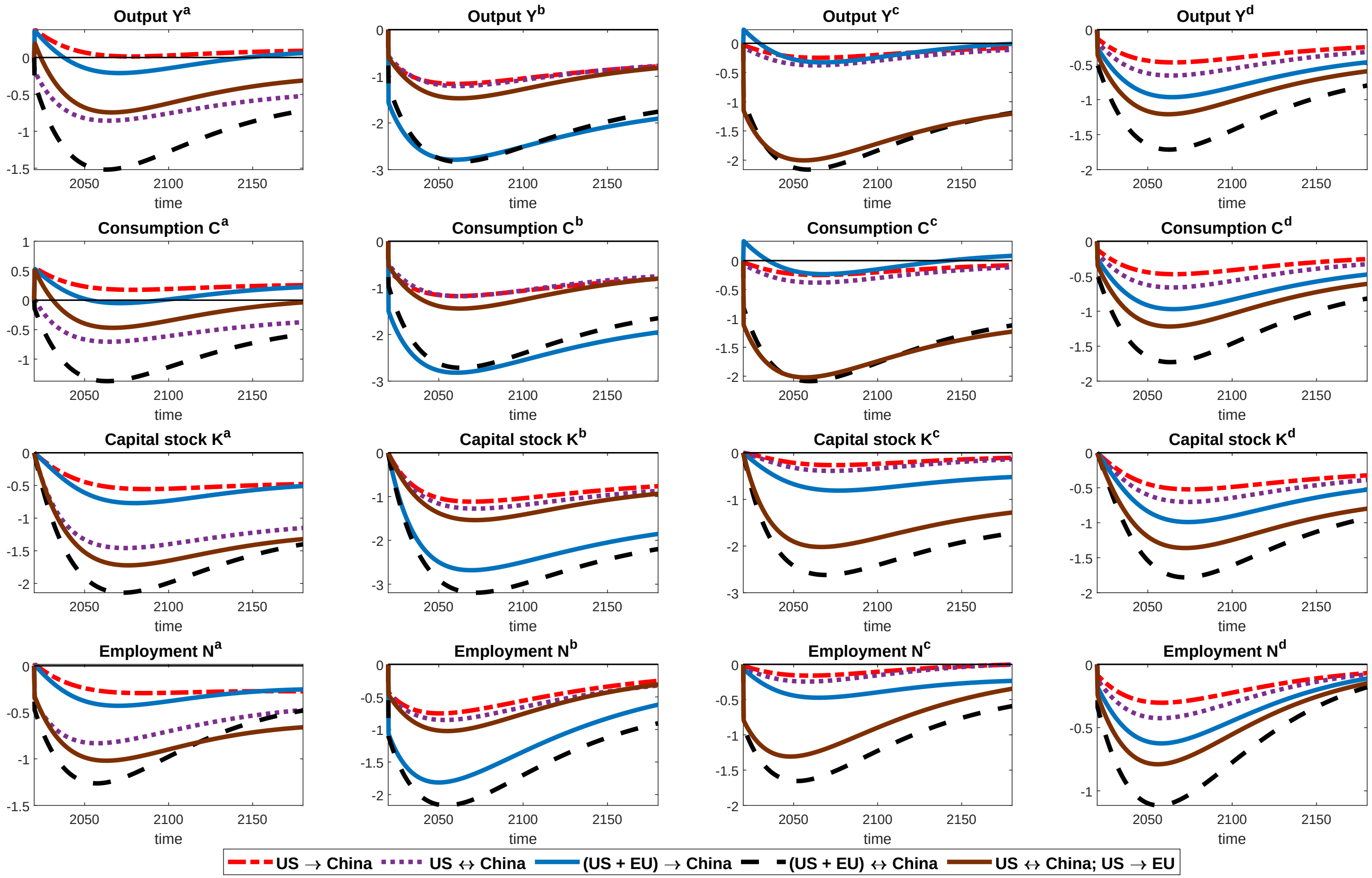
Scenario 3 (S3 in blue) looks at a united west levying tariffs on China without retaliatory tariffs by China. Compared to the previous scenarios, Chinese output and consumption is hit even harder. In contrast to the scenario S1 with unilateral tariffs, the US looses during the transition. The reason is that strong additional income losses in China and the rest of the world reduce demand for US products. Long-run effects on output and consumption are positive for the US, but still worse than under S1. Compared to the previous scenarios, Europe now benefits from the real wealth transfer described above. This leads to higher consumption. However, output is still negatively affected in the long run. This is partly due to the reduced global demand. In addition, production costs increase as intermediate inputs from China become more expensive and shares of intermediate imports produced in China are relatively high. Capital stock and working hours accompany the decline in output.

The fourth scenario (S4 in black) considers China retaliating by imposing tariffs on imports from the whole western block. As global trade is affected most by this scenario all regions are hit hard, with strong reductions in consumption and output as well as capital stocks and working hours. China is hit the hardest but is slightly better off compared to scenario S3 due to the real wealth transfer going along with the retaliating tariffs. All the other regions are worse off compared to Scenario S3.

The final scenario (S5 in brown) assumes that the US levies tariffs on the EU punishing it for not following US tariffs against China. In terms of output and consumption, the EU incurs similar or slightly larger losses compared to S4 combined with somewhat higher employment. US output falls less than under S4, due to smaller output losses in China and the rest of the world.

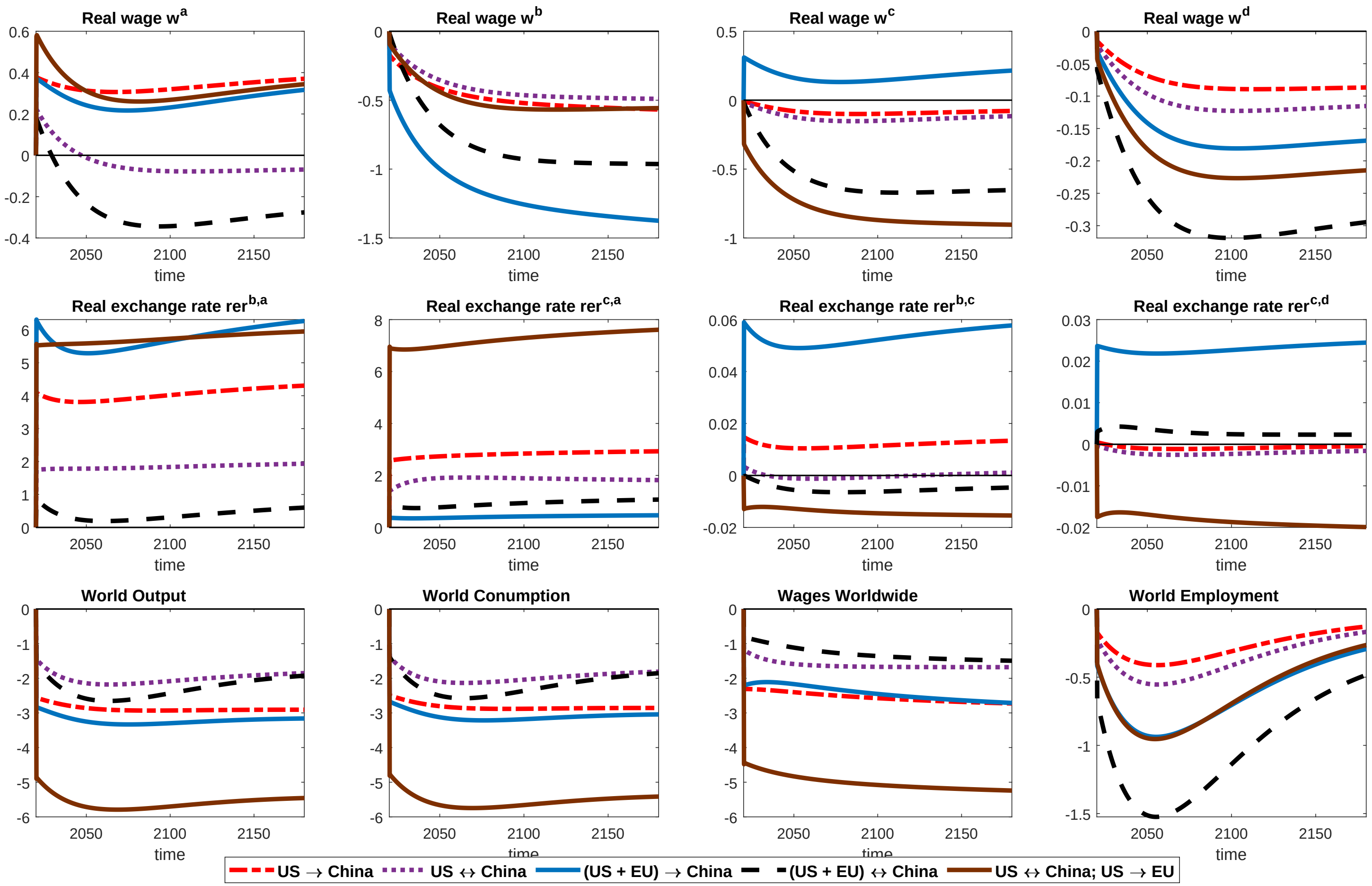
Figure 3 reveals that sectors are affected differently depending on the region and the scenario. TBD...

Figure 1: Implications of tariffs for selected key macroeconomic variables



Notes: Figure plots (projected) implications of tariffs for selected key macroeconomic variables in percentage deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents the West imposing tariffs on China, in dashed black China retaliates. The straight brown line denotes bi-directional tariffs between the US and China and the US levying import tariffs on the EU.

Figure 2: Implications of tariffs for selected factor/relative prices



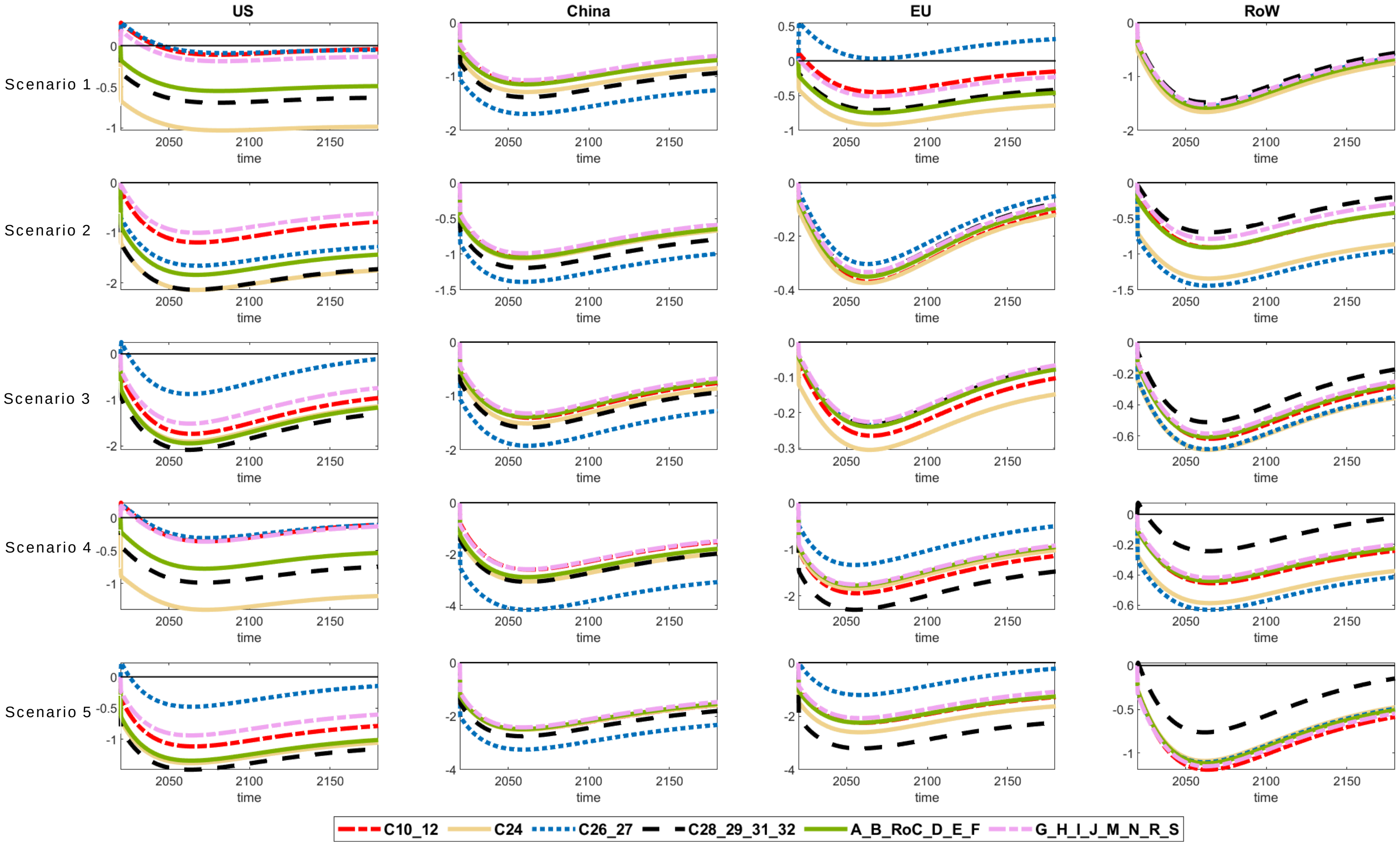
Notes: Figure plots (projected) implications of tariffs for selected factor/relative prices in percentage(point) deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents the West imposing tariffs on China, in dashed black China retaliates. The straight brown line denotes bi-directional tariffs between the US and China and the US levying import tariffs on the EU.

Table 1: Long-run effects

Scenario:	US $\rightarrow$ CHN	US $\leftrightarrow$ CHN	West $\rightarrow$ CHN	West $\leftrightarrow$ CHN	US $\leftrightarrow$ CHN; US $\rightarrow$ EU
Output in a	0.05	-0.43	0.03	-0.56	-0.28
Consumption in a	0.21	-0.28	0.19	-0.42	-0.00
Hours in a	-0.37	-0.38	-0.37	-0.39	-0.71
Wages in a	0.43	-0.06	0.41	-0.21	0.43
Output in b	-0.60	-0.60	-1.46	-1.36	-0.62
Consumption in b	-0.62	-0.57	-1.51	-1.25	-0.60
Hours in b	-0.01	-0.11	-0.02	-0.46	-0.11
Wages in b	-0.62	-0.52	-1.52	-1.01	-0.55
Output in c	-0.05	-0.08	-0.01	-0.92	-0.92
Consumption in c	-0.05	-0.08	0.08	-0.85	-0.95
Hours in c	-0.00	-0.00	-0.31	-0.33	-0.01
Wages in c	-0.05	-0.08	0.30	-0.65	-0.95
Output in d	-0.18	-0.22	-0.32	-0.56	-0.43
Consumption in d	-0.19	-0.23	-0.33	-0.57	-0.44
Hours in d	-0.01	-0.01	-0.01	-0.02	-0.02
Wages in d	-0.19	-0.23	-0.34	-0.58	-0.45
Output worldwide	-3.00	-1.76	-3.26	-1.82	-5.48
Consumption worldwide	-2.94	-1.71	-3.14	-1.74	-5.44
Hours worldwide	-0.03	-0.06	-0.09	-0.22	-0.09
Wages worldwide	-2.91	-1.69	-3.01	-1.64	-5.43

Notes: Table shows long-run effects on selected aggregate macro variables of different tariff scenarios for regions a, b, c and d, in percent deviations from initial steady state.

Figure 3: Changes in total sectoral output implied by tariffs



Notes: Figure plots (projected) implications of tariffs for selected sectoral output variables in percentage deviation from initial steady state. Last scenario includes tariffs from CHN to US but not EU! Line description...

Welfare Though economic effects of trade-policies are of interest, the welfare implications remain to be examined. In doing so, we compute the lifetime consumption-equivalent gain of the representative household in line with Lucas (2003) as a result of the change in trade policy. The welfare function of region i is given by equation (1). The alternative region-i welfare function is given by

$$\sum_{t=0}^{\infty} \beta^t \left[\frac{\left[(1+ce_i)\cdot \bar{C}_i\right]^{1-\sigma}}{1-\sigma} - \kappa_{i,N} \frac{\bar{N}_i^{1+\psi}}{1+\psi} \right],$$

where the bar indicates initial steady-state values. If we equate this equation with equation (1), we can extract the corresponding lifetime consumption-equivalent gain ce_i. We define world-welfare as a population-weighted average, i.e. $ce_w = \omega^a \cdot ce_a + \omega^b \cdot ce_b + \omega^c \cdot ce_c$. Results are summarized in Table 2. The previous discussion as well as the results shown in Table 1 indicate that, in the long run, and from a pure steady-state comparison, increased trade frictions due to tariffs decrease world-wide welfare (see also Table 2). These losses are even more pronounced when the transition is taken into account. From an aggregate perspective, increasing the number of trade frictions in the model leads to worse outcomes for the involved parties as well as the rest of the world suffering from decreased world demand. Only in some cases, we find positive welfare effects including transition dynamics. In particular, the US faces the largest positive welfare effects in a unilateral tariff scenario against China (S1). Welfare effects are also positive when Europe joins them (S3) or if they impose tariffs on the EU (S5). Europe only benefits in S3, where the west imposes tariffs on China.

Table 2: Welfare effects

Scenario:	US $\rightarrow$ CHN	US $\leftrightarrow$ CHN	West $\rightarrow$ CHN	West $\leftrightarrow$ CHN	US $\leftrightarrow$ CHN; US $\rightarrow$ EU
Steady state...					
...in US	0.32	0.01	0.31	-0.08	0.34
...in CHN	-0.41	-0.33	-1.00	-0.64	-0.35
...in EU	-0.03	-0.05	0.21	-0.38	-0.60
...in ROW	-0.13	-0.16	-0.23	-0.39	-0.30
...worldwide	-0.17	-0.18	-0.35	-0.44	-0.32
With transition...					
...in US	0.42	-0.07	0.34	-0.34	0.33
...in CHN	-0.62	-0.54	-1.50	-1.09	-0.63
...in EU	-0.09	-0.14	0.19	-0.82	-1.04
...in ROW	-0.21	-0.29	-0.43	-0.78	-0.56
...worldwide	-0.27	-0.33	-0.60	-0.85	-0.59

Notes: Table shows welfare implications of the different policy scenarios, expressed in consumption-equivalent gain for the representative household of the respective region in line with Lucas (2003), in percentage deviations from initial steady state.

Strategic Interactions We see that some scenario lead to positive welfare effects for the US or the EU. But how credible and stable are these scenarios? The US benefits from unilateral tariffs against China, as it is better off both in the long term and during the transition. However, this scenario is not stable as China has an incentive to retaliate. It benefits mildly while turning positive welfare effects in the US into slightly negative ones (including the transition). Given the rivalry between both regions, the latter might be an incentive to retaliate on its own. Given China retaliates on the US, US might put pressure on Europe to impose tariffs on China as well.
From the perspective of Europe, joining the US appears promising because of positive welfare effects. However, this scenario (S3) is not reasonable either as China has an incentive to retaliate on the West. If the thread of Chinese retaliation is credible, Europe would prefer to stay out of the trade conflict. However, in this case, the EU could be left with the choice to either join the US or to get tariffed by the US themselves. Faced with two bad options, joining the US yields slightly higher welfare whilst output losses are lower if the EU remains passive. The welfare effects are mostly driven by reduced disutility from labor in S4.

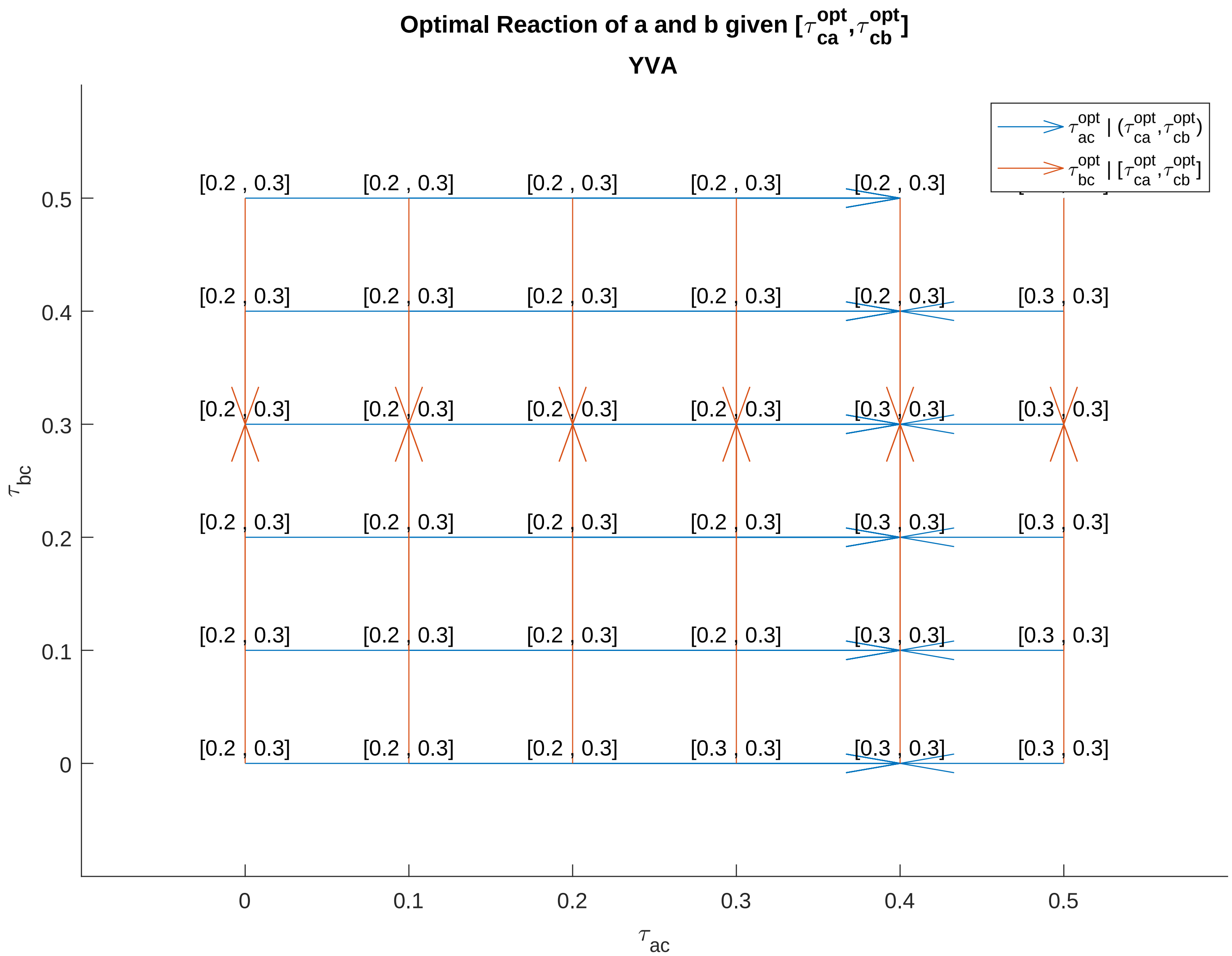
Optimal Tariffs So far, we have assumed tariff rates of 25 %. In this section, we allow for tariff rates between 0 and 50 % and determine optimal tariffs numerically.[6] Specifically, we examine the strategic options of the EU given an exogenous set of tariffs $(\bar{\tau}_{a,b}, \bar{\tau}_{b,a}, \bar{\tau}_{a,c}, \bar{\tau}_{b,c})$ levied by China and the US. Therefore, we parameterize different outcomes in the respective reaction, given by $V(\tau_{c,a}, \tau_{c,b})|\bar{\tau}_{a,b}, \bar{\tau}_{b,a}, \bar{\tau}_{a,c}, \bar{\tau}_{b,c}$. Here, $V^{\text{Value Added}_c}(\cdot)$ represents value added in country the EU (region c), parameterized in the tariffs put on Chinese and US exports. For a limited set of parameter values we maximize $V(\cdot)$ to trace out optimal reactions $\{\tau_{c,a}, \tau_{c,b}\}$ given by

$$\{\tau_{c,a}, \tau_{c,b}\} = \arg\max_{\tau_{c,a}, \tau_{c,b} \in [0, \tau_{max}]} V(\tau_{c,a}, \tau_{c,b})|\bar{\tau_{a,b}}, \bar{\tau_{b,a}}, \bar{\tau_{a,c}}, \bar{\tau_{b,c}}$$

Figure 4 depicts the optimal reaction of Europe given a pair of tariffs $(\bar{\tau}_{a,c}, \bar{\tau}_{b,c})$ depicted on the x- and y-axis. Arrows depict the respective optimal reaction answering the choice of the EU. Starting in the bottom left corner (no tariffs), the US (blue arrow) introduces a tariff of 40% vis-a-vis Europe. China chooses 30% (red arrow). Given this set of tariffs, the EU chooses its optimal reaction depicted in brackets. Reactions does not consider possible retaliation of trading partners. It can be seen that countries choose tariffs $\tau > 0$ if they do not consider the reaction of their trading partners. However, countries still choose an interior solution (30% on both sides), not going for the highest tariff allowed in our analysis (50%). Furthermore, optimal tariffs on China are slightly higher than on the US.

[6] We simulate the model multiple times, increasing tariff rates by 10% incrementally.

Figure 4: Changes in total sectoral output implied by tariffs

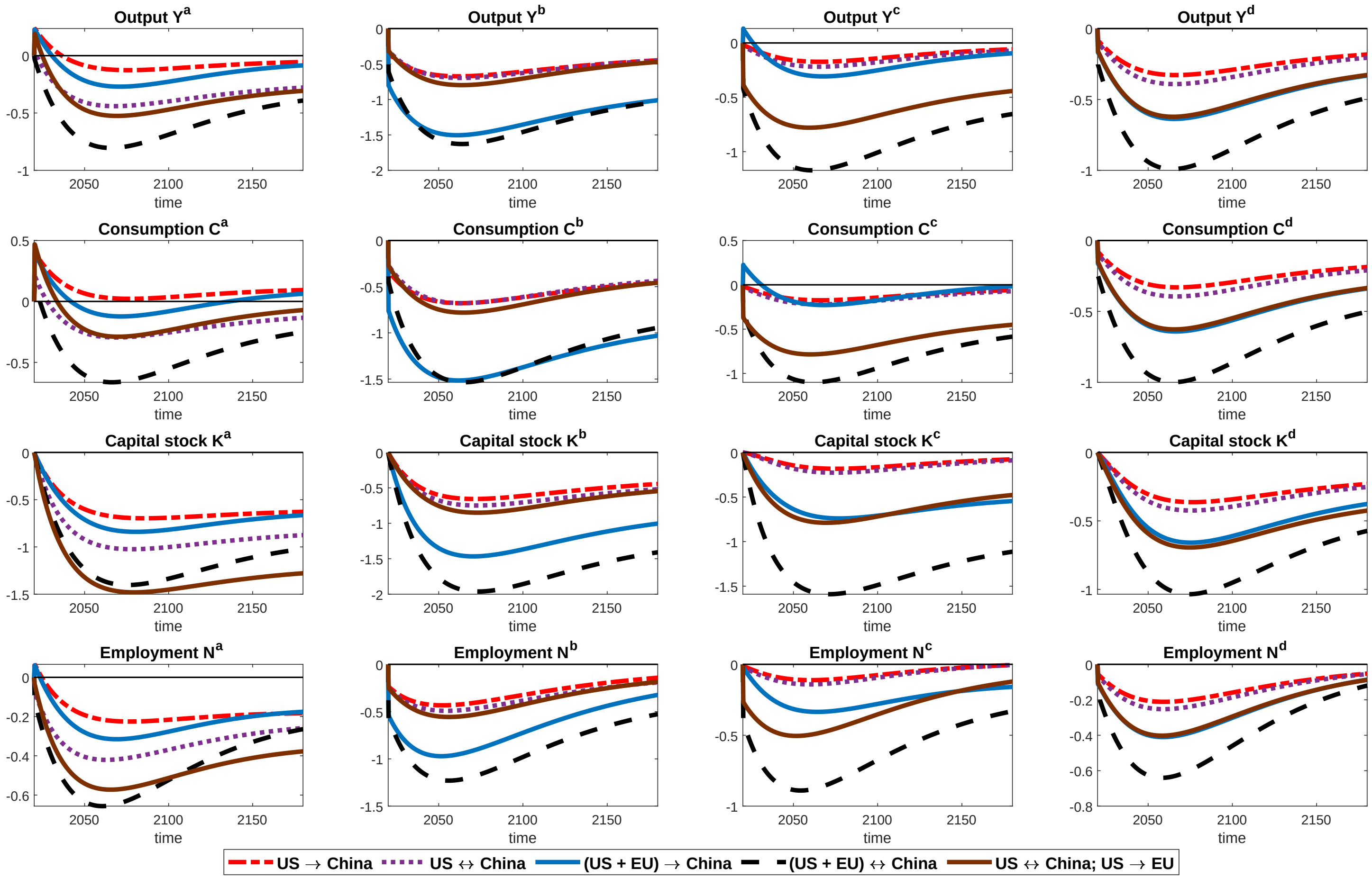


Notes: Figure shows the optimal set of tariffs from the EUs perspective given a combination of tariffs levied by China and the US.

6 Discussion and alternative simulations

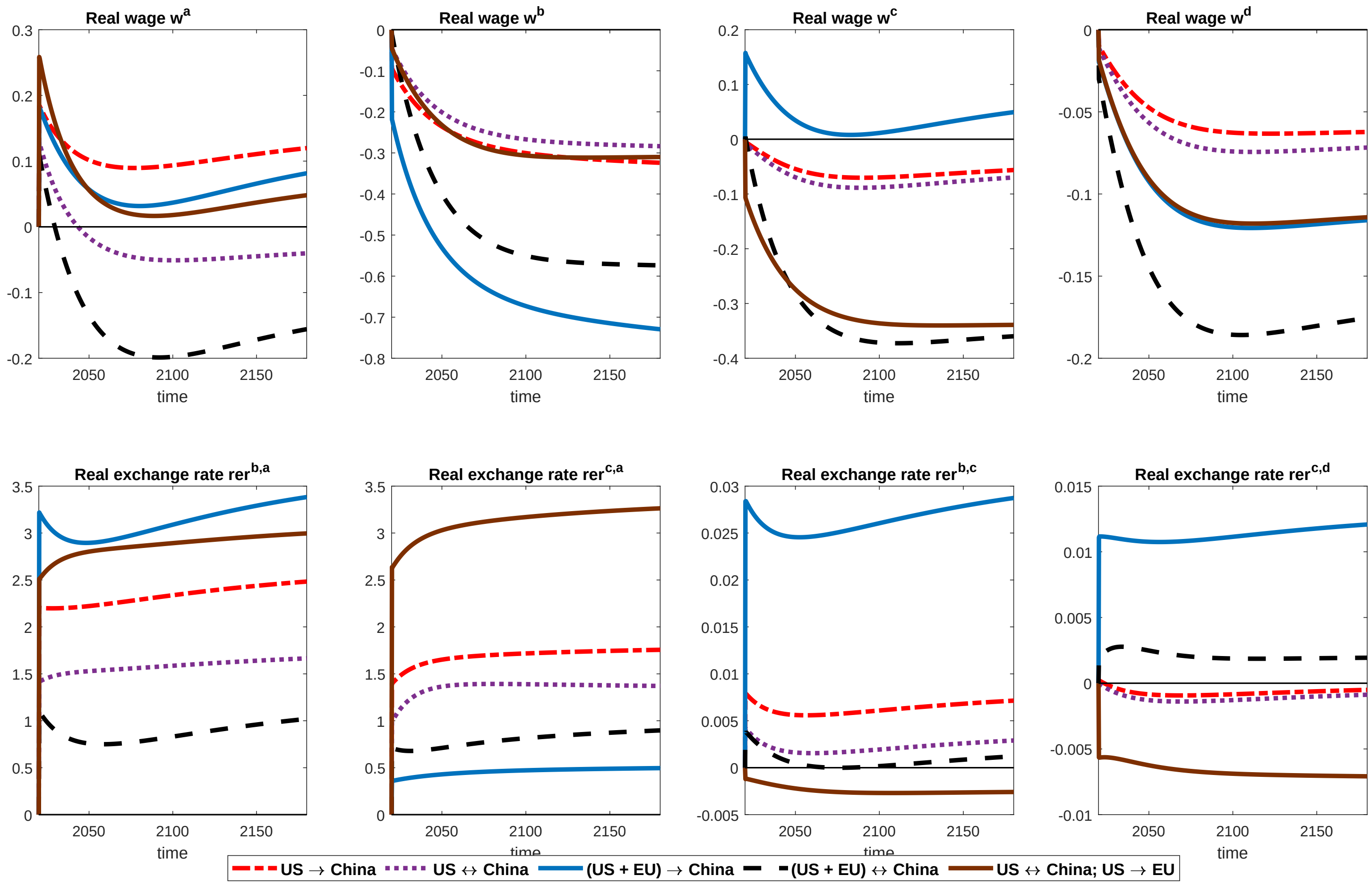
The results of the previous section indicate that [...]. Levy tariffs only on sectors 1 to 4 as discussed. See Figure 5 to 7 and Tables 3 to 4

Figure 5: Implications of tariffs for selected key macroeconomic variables when taxin S1-4



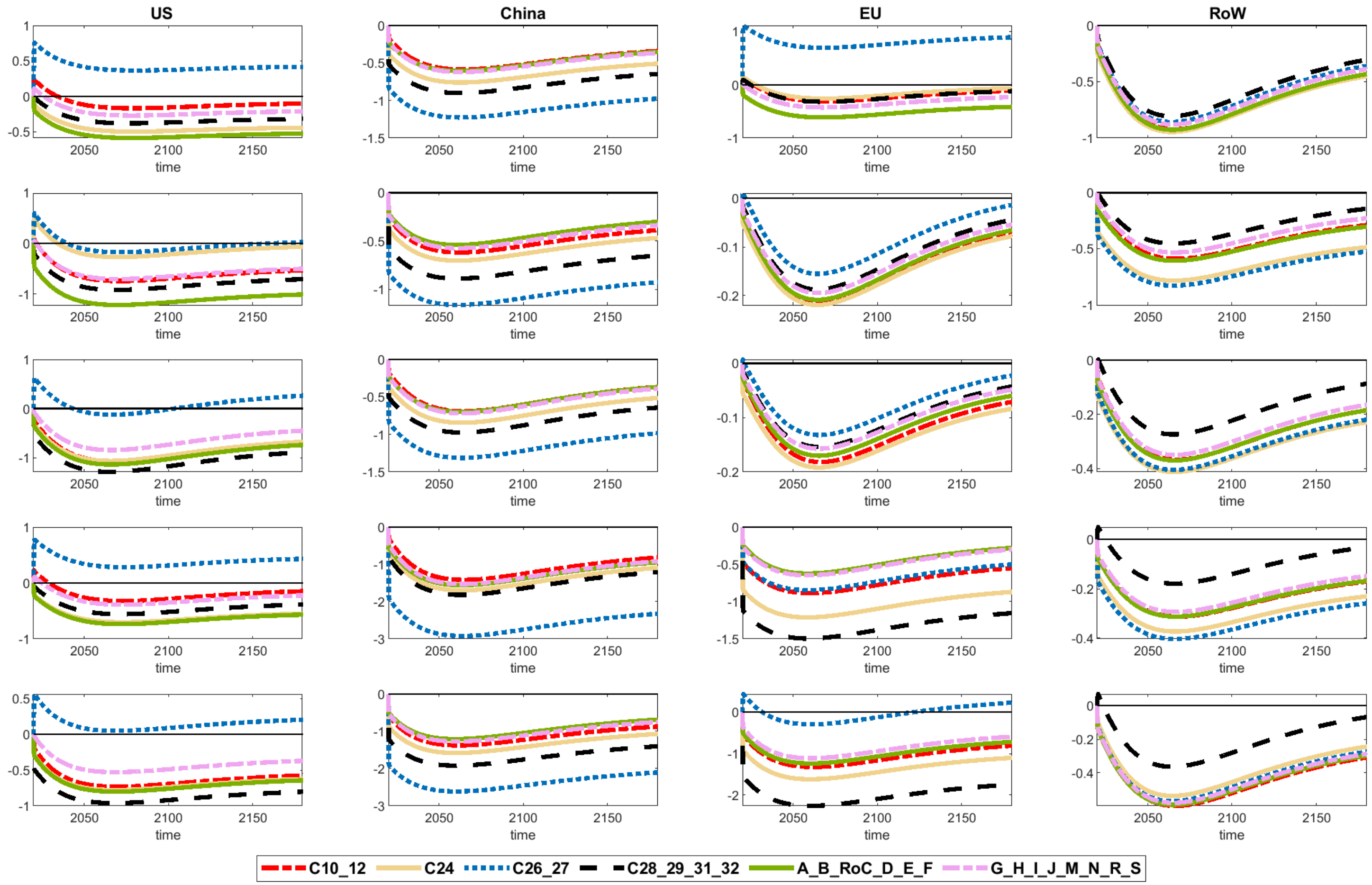
Notes: Figure plots (projected) implications of tariffs for selected key macroeconomic variables in percentage deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents the West imposing tariffs on China, in dashed black China retaliates. The straight brown line denotes bi-directional tariffs between the US and China and the US levying import tariffs on the EU.

Figure 6: Implications of tariffs for selected factor/relative prices when taxin S1-4



Notes: Figure plots (projected) implications of tariffs for selected factor/relative prices in percentage(point) deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents the West imposing tariffs on China, in dashed black China retaliates. The straight brown line denotes bi-directional tariffs between the US and China and the US levying import tariffs on the EU.

Figure 7: Changes in total sectoral output implied by tariffs when taxin S1-4



Notes: Figure plots (projected) implications of tariffs for selected sectoral output variables in percentage deviation from initial steady state. Last scenario includes tariffs from CHN to US but not EU! Line description...

Table 3: Long-run effects when taxing only S1-4

Scenario:	US → CHN	US ↔ CHN	West → CHN	West ↔ CHN	US ↔ CHN; US → EU
Output in a	-0.07	-0.24	-0.08	-0.32	-0.27
Consumption in a	0.08	-0.09	0.07	-0.17	-0.04
Hours in a	-0.22	-0.23	-0.22	-0.23	-0.38
Wages in a	0.15	-0.03	0.13	-0.11	0.08
Output in b	-0.34	-0.35	-0.77	-0.80	-0.35
Consumption in b	-0.35	-0.33	-0.79	-0.71	-0.34
Hours in b	-0.01	-0.07	-0.01	-0.26	-0.07
Wages in b	-0.35	-0.30	-0.79	-0.60	-0.31
Output in c	-0.04	-0.05	-0.08	-0.51	-0.33
Consumption in c	-0.04	-0.05	0.00	-0.44	-0.34
Hours in c	-0.00	-0.00	-0.18	-0.19	-0.01
Wages in c	-0.04	-0.05	0.09	-0.35	-0.34
Output in d	-0.13	-0.15	-0.24	-0.35	-0.24
Consumption in d	-0.14	-0.15	-0.24	-0.36	-0.24
Hours in d	-0.00	-0.00	-0.01	-0.01	-0.01
Wages in d	-0.14	-0.15	-0.25	-0.36	-0.25

Notes: Table shows long-run effects on selected aggregate macro variables of different tariff scenarios for regions a, b, c and d, in percent deviations from initial steady state.

Table 4: Welfare effects when taxing only S1-4

Scenario:	US → CHN	US ↔ CHN	West → CHN	West ↔ CHN	US ↔ CHN; US → EU
Steady state...					
...in a	0.16	0.05	0.15	0.00	0.16
...in b	-0.23	-0.19	-0.52	-0.36	-0.20
...in c	-0.02	-0.03	0.09	-0.18	-0.21
...in d	-0.09	-0.10	-0.17	-0.25	-0.17
With transition...					
...in a	0.24	0.07	0.19	-0.07	0.22
...in b	-0.35	-0.30	-0.79	-0.58	-0.34
...in c	-0.06	-0.08	0.08	-0.38	-0.38
...in d	-0.14	-0.17	-0.28	-0.44	-0.27

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Scenario:	US → CHN	US ↔ CHN	West → CHN	West ↔ CHN	US ↔ CHN; US → EU

Notes: Table shows welfare implications of different carbon pricing scenarios, expressed in consumption-equivalent gain for the representative household of region $i = a, b, c, d$ as well as the weighted average of households in the entire world (to be included) in line with Lucas (2003), in percentage deviations from initial steady state.

7 Conclusions

In a dynamic, four-region multi-sector general equilibrium model, we analyze the macroeconomic and welfare implications of tariffs. Our findings indicate that tariffs can initially enhance domestic output and consumption by making local products more competitive. However, the output benefits are transient, as rising production costs and decreased global income ultimately undermine the initial gains. China is likely to retaliate, leading to further welfare losses for the involved parties. Additionally, the global economy experiences reduced aggregate income even for nations not directly engaged in the tariff conflicts. Sector-specific tariffs are less effective than broad tariffs because they fail to protect non-targeted industries. Overall, tariffs prove inefficient for economic protection due to the high possibility of retaliation.

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Appendix A: First-order conditions and further model details

In this appendix, we provide some more model details and the first-order conditions of the above mentioned maximization problems.

From the standard intratemporal first-order conditions for household consumption and labor (see also Section 3.1), it follows that the marginal utility of consumption is denoted by $\lambda_{i,t} = C_{i,t}^{-\sigma}/(1+\tau_t^c)$, while labor supply is determined by $\kappa_{i,N} N_{i,t}^{\psi} = \lambda_{i,t}(1-\tau_{i,t}^w)w_{i,t}$. The optimal intertemporal savings decision is characterized by

$$1 = \beta \cdot \mathbb{E}_t \left\{ \frac{\lambda_{i,t+1}}{\lambda_{i,t}} \cdot \frac{r_{i,t+1}^k + (1-\delta_i)\cdot(1+\tau_{i,t+1}^I)\cdot P_{i,t+1}^I}{(1+\tau_{i,t}^I)\cdot P_{i,t}^I} \right\} = \beta \cdot \mathbb{E}_t \left\{ \frac{\lambda_{i,t+1}}{\lambda_{i,t}} \cdot R_{i,t} \right\}. \tag{A.1}$$

Taking into account the bundling technology described in Section 3.2, we get the following first-order condition for $X \in \{C, I\}$:

$$X_{s,i,t} = \psi_{X,s} \left(\frac{(1+\tilde{\tau}_{s,i,t}^X)P_{s,i,t}^X}{(1+\tau_{i,t}^X)} \right)^{\left(-\frac{1}{1-\sigma_{X,i}}\right)} X_{i,t} \quad \forall s \in \mathcal{S} \quad \textit{and} \quad i \in \{a,b,c\}. \tag{A.2}$$

Plugging this expression into the constant elasticity of substitution aggregator of consumption/investment goods shows that $P_{i,t}^X$ is equal to the weighted sectoral consumption/investment-good prices. We obtain the following relation:

$$(1+\tau_{i,t}^X)\cdot P_{i,t}^X = \left[\sum_{s=1}^{S} \psi_{X,i,s} \left((1+\tilde{\tau}_{s,i,t}^X) P_{s,i,t}^X \right)^{-\frac{\sigma_{X,i}}{(1-\sigma_{X,i})}} \right]^{-\frac{(1-\sigma_{X,i})}{\sigma_{X,i}}}, \tag{A.3}$$

where the aggregate tax rate on consumption is determined by

$$(1+\tau_{i,t}^X) = \frac{\left[\sum_{s=1}^{S} \psi_{X,i,s} \left((1+\tilde{\tau}_{s,i,t}^X) P_{s,i,t}^X \right)^{-\frac{\sigma_{X,i}}{(1-\sigma_{X,i})}} \right]^{-\frac{(1-\sigma_{X,i})}{\sigma_{X,i}}}}{\left[\sum_{s=1}^{S} \psi_{X,i,s} \left(P_{s,i,t}^X \right)^{-\frac{\sigma_{X,i}}{(1-\sigma_{X,i})}} \right]^{-\frac{(1-\sigma_{X,i})}{\sigma_{X,i}}}} \tag{A.4}$$

as in Blazquez, Galeotti, Manzano, Pierru, and Pradhan (2021).

The maximization problem of the labor and capital agency (Section 3.3) leads to the following first-order condition characterizing the sector specific demand for labor/capital

$$X_{s,i,t} = \omega_{X,i,s} \left(\frac{\tilde{p}_{s,i,t}}{\tilde{p}_{i,t}} \right)^{-\left(\frac{1}{1-\nu_{X,i}}\right)} X_{i,t} \quad \forall s \in \mathcal{S} \quad \textit{and} \quad i \in \{a,b,c,d\}, \tag{A.5}$$

where $X \in \{N, K\}$ and $\tilde{p} \in \{w, r^k\}$. After plugging this expression into the CES aggregator of labor goods, we obtain the aggregate wage index

$$\tilde{p}_{i,t} = \left[\sum_{s=1}^{S} \omega_{X,i,s} \tilde{p}_{s,i,t}^{-\frac{\nu_{X,i}}{\left(1-\nu_{X,i}\right)}}\right]^{-\frac{\left(1-\nu_{X,i}\right)}{\nu_{X,i}}}. \tag{A.6}$$

Variety demand by a sectoral final goods producer (Section 3.4)is given by the standard first-order conditions

$$y_{s,i,t}(z) = \left[\frac{P_{s,i,t}(z)}{P_{s,i,t}}\right]^{-\theta^P_{s,i}} Y_{s,i,t}, \tag{A.7}$$

and the (CPI-deflated) producer price of the sectoral bundle as

$$P_{s,i,t} = \left[\int_0^1 P_{s,i,t}(z)^{1-\theta^P_{s,i}}\, dz\right]^{\frac{1}{1-\theta^P_{s,i}}} \quad \forall s \in \mathcal{S} \quad and \quad i \in \{a,b,c,d\}. \tag{A.8}$$

For the intermediate goods producers, factor demand is given by

$$w_{s,i,t} = \alpha_{H,s,i} \cdot \alpha_{N,s,i} \cdot mc_{s,i,t} \cdot \left(\frac{y_{s,i,t}}{\tilde{y}_{s,i,t}}\right)^{1-sub_{yh}} \cdot \left(\frac{\tilde{y}_{s,i,t}}{N_{s,i,t}}\right)^{1-sub_{nk}}, \tag{A.9}$$

$$r^k_{s,i,t} = \alpha_{H,s,i} \cdot (1-\alpha_{N,s,i}) \cdot mc_{s,i,t} \cdot \left(\frac{y_{s,i,t}}{\tilde{y}_{s,i,t}}\right)^{1-sub_{yh}} \cdot \left(\frac{\tilde{y}_{s,i,t}}{K_{s,i,t-1}}\right)^{1-sub_{nk}} \tag{A.10}$$

$$(1+\tau^H_{s,t})P^H_{s,i,t} = (1-\alpha_{H,s,i}) \cdot mc_{s,i,t} \cdot \left(\frac{y_{s,i,t}}{Hs_{,i,t}}\right)^{1-sub_{yh}}, \tag{A.11}$$

where $\tau^H_{s,i,t}$ is the average tax rate on intermediate inputs in sector s and $P^H_{s,i,t}$ the CPI-deflated real price of these inputs. $mc_{s,i,t}$ are real marginal production costs in each sector. Firms are price setters and charge a markup on their marginal production costs. Under flexible prices, it holds that

$$P_{s,i,t} = \frac{\theta^P_{s,i}}{\theta^P_{s,i}-1} \cdot mc_{s,i,t}, \tag{A.12}$$

which is the standard pricing equations with markups. Note that, as $\theta^P_{s,i} \to \infty$, $P_{s,i,t} = mc_{s,i,t}$.

For the intermediate inputs, it is straightforward that we will get

$$H_{s,j,i,t} = \psi_{H,s,j,i} \left(\frac{(1+\tilde{\tau}^H_{j,i,t})P_{j,i,t}}{(1+\tau^H_{s,i,t})}\right)^{\left(-\frac{1}{1-\sigma_{H,s,i}}\right)} H_{s,i,t}, \tag{A.13}$$

$$(1+\tau^H_{s,i,t})P^H_{s,i,t} = \left[\sum_{j=1}^{S} \psi_{H,s,j,i}\left((1+\tilde{\tau}^H_{s,j,i,t})P_{j,i,t}\right)^{-\frac{\sigma_{H,s,i}}{\left(1-\sigma_{H,s,i}\right)}}\right]^{-\frac{\left(1-\sigma_{H,s,i}\right)}{\sigma_{H,s,i}}}, \tag{A.14}$$

and

$$(1+\tau^H_{s,i,t}) = \frac{\left[\sum_{j=1}^{S} \psi_{H,s,j,i} \left((1+\tilde{\tau}^H_{j,i,t})P_{j,i,t}\right)^{-\frac{\sigma_{H,s,i}}{\left(1-\sigma_{H,s,i}\right)}}\right]^{-\frac{\left(1-\sigma_{H,s,i}\right)}{\sigma_{H,s,i}}}}{\left[\sum_{j=1}^{S} \psi_{H,s,j,i} \left(P_{j,i,t}\right)^{-\frac{\sigma_{H,s,i}}{\left(1-\sigma_{H,s,i}\right)}}\right]^{-\frac{\left(1-\sigma_{H,s,i}\right)}{\sigma_{H,s,i}}}} \tag{A.15}$$

$\forall s, j \in \mathcal{S}$ and $i \in \{a, b, c, d\}$. The latter equation represents the implicit (aggregate/average) tax rate on (all) intermediate inputs of sector s in region i.

Appendix B: Calibration details

In this Appendix, we provide tables with detailed calibration parameters.

Table B.1: Choice of regions and sectors

Regions:	
a :	USA
b :	CHN
c :	EU27, UK
d :	ROW
Sectors:	
1)	MF of food products, beverages and tobacco products ($C10-12$)
2)	MF of basic metals ($C24$)
3)	MF of computer, electronic and optical products, electrical equipment ($C26-27$)
4)	MF of machinery and equipm., motor vehicles, (semi-)trailers, other MF $C28\_29\_31\_32$)
5)	Agriculture, mining, rest of MF, energy, water, construction ($A\_B\_RoC\_D\_E\_F$)
6)	Services ($G\_H\_I\_J\_M\_N\_R\_S$)

Notes: The table gives an overview of the modeled regions and sectors.

Table B.2: Baseline calibration of general parameters

Variable/Parameter	Symbol	Value
Relative population size, region a	ω^a	0.069
Relative population size, region b	ω^b	0.301
Relative population size, region c	ω^c	0.156
Relative population size, region d	ω^d	0.474
Relative value-added-per-capita, region a		1
Relative value-added-per-capita, region b		0.323
Relative value-added-per-capita, region c		0.552
Relative value-added-per-capita, region d		0.214
Discount factor	β	0.985
Elasticity of intertemporal substitution	σ	2.000
Inverse of Frisch elasticity of lab. supply	ζ	2.000
Labor disutility scaling	$\kappa_{a,N}$	1.7257
	$\kappa_{b,N}$	1.6805
	$\kappa_{c,N}$	1.8614
	$\kappa_{d,N}$	1.7135
Capital depreciation rate	δ^k	0.025
Consumption tax rate	$\bar{\tau}_i^c$	0.200
Labor tax rate	$\bar{\tau}_i^w$	0.400
Capital tax rate	$\bar{\tau}_i^c$	0.214
AR(1) coefficients	ρ^x	0.8
Substitution elasticities:		
Elasticity of substitution, consumption	σ_C	1-1/0.9091
Elasticity of substitution, investment	σ_I	1-1/0.7511
Elasticity of substitution, labor	ν_N	2
Elasticity of substitution, capital	ν_K	2
Elasticity of substitution, intermediates	$\sigma_{H,z}$	1-1/0.3

Notes: The table shows calibrated values for general parameters as described in the main text.

Table B.3: Baseline calibration of sector-specific parameters

	$\alpha_{N,s,i}$	$\alpha_{H,s,i}$	$\omega_{N,s,i}$	$\omega_{K,s,i}$	$\psi_{C,s,i}$	$\psi_{I,s,i}$
Region $i = a$ (USA)						
1) MF of food, beverages, tobacco	0.412	0.253	0.017	0.020	0.088	0.001
2) MF of basic metals	0.539	0.212	0.004	0.010	0.001	0.000
3) MF of computer, electronic and opt. products, electrical equipm.	0.518	0.627	0.014	0.035	0.019	0.073
4) MF of machinery and equip., motor vehicles, other MF	0.570	0.320	0.030	0.036	0.055	0.177
5) Agriculture, mining and quarrying, rest of MF, energy, water, construction	0.465	0.453	0.180	0.417	0.163	0.392
6) Services	0.621	0.599	0.754	0.481	0.674	0.357
Region $i = b$ (CHN)						
1) MF of food, beverages, tobacco	0.342	0.228	0.023	0.056	0.260	0.000
2) MF of basic metals	0.344	0.153	0.009	0.045	0.001	0.002
3) MF of computer, electronic and opt. products, electrical equipm.	0.529	0.162	0.035	0.057	0.046	0.056
4) MF of machinery and equip., motor vehicles, other MF	0.471	0.214	0.040	0.080	0.054	0.191
5) Agriculture, mining and quarrying, rest of MF, energy, water, construction	0.603	0.274	0.553	0.422	0.272	0.690
6) Services	0.557	0.495	0.340	0.340	0.367	0.061
Region $i = c$ (EU27, UK)						
1) MF of food, beverages, tobacco	0.584	0.242	0.030	0.030	0.121	0.002
2) MF of basic metals	0.677	0.181	0.007	0.010	0.002	0.003
3) MF of computer, electronic and opt. products, electrical equipm.	0.595	0.369	0.017	0.023	0.022	0.059
4) MF of machinery and equip., motor vehicles, other MF	0.638	0.316	0.047	0.049	0.066	0.146
5) Agriculture, mining and quarrying, rest of MF, energy, water, construction	0.609	0.344	0.273	0.387	0.183	0.522
6) Services	0.681	0.530	0.625	0.501	0.606	0.268
Region $i = d$ (ROW)						
1) MF of food, beverages, tobacco	0.408	0.276	0.025	0.029	0.136	0.000
2) MF of basic metals	0.499	0.206	0.007	0.028	0.002	0.005
3) MF of computer, electronic and opt. products, electrical equipm.	0.554	0.306	0.008	0.038	0.037	0.056
4) MF of machinery and equip., motor vehicles, other MF	0.606	0.278	0.032	0.045	0.059	0.124
5) Agriculture, mining and quarrying, rest of MF, energy, water, construction	0.533	0.393	0.583	0.451	0.230	0.686
6) Services	0.597	0.583	0.344	0.409	0.536	0.128

Notes: The table shows calibrated values for sector-specific parameters as described in the main text. The values were computed by the authors based on the World Input-Output Database values for 2014.

Table B.4: Input-Output matrix, $\psi_{H,s,j,i}$

	Consumer s					
Producer j	1)	2)	3)	4)	5)	6)
Region $i = a$						
1)	0.26	0.00	0.00	0.00	0.02	0.03
2)	0.01	0.40	0.14	0.10	0.04	0.00
3)	0.01	0.02	0.29	0.06	0.03	0.03
4)	0.01	0.03	0.03	0.30	0.04	0.03
5)	0.47	0.28	0.21	0.25	0.59	0.16
6)	0.25	0.27	0.33	0.29	0.29	0.75
Region $i = b$						
1)	0.33	0.01	0.01	0.01	0.04	0.10
2)	0.00	0.41	0.12	0.14	0.08	0.00
3)	0.00	0.01	0.53	0.10	0.03	0.10
4)	0.00	0.07	0.04	0.42	0.03	0.06
5)	0.52	0.42	0.16	0.18	0.67	0.27
6)	0.15	0.08	0.14	0.16	0.14	0.46
Region $i = c$						
1)	0.29	0.00	0.00	0.00	0.02	0.04
2)	0.00	0.40	0.08	0.08	0.04	0.00
3)	0.00	0.01	0.36	0.06	0.02	0.02
4)	0.01	0.03	0.06	0.34	0.03	0.03
5)	0.40	0.34	0.17	0.24	0.59	0.15
6)	0.29	0.21	0.33	0.27	0.30	0.75
Region $i = d$						
1)	0.20	0.00	0.00	0.00	0.02	0.05
2)	0.00	0.38	0.09	0.12	0.06	0.00
3)	0.00	0.01	0.49	0.07	0.02	0.04
4)	0.01	0.03	0.05	0.39	0.04	0.05
5)	0.51	0.43	0.17	0.19	0.62	0.24
6)	0.28	0.16	0.20	0.23	0.24	0.62

Notes: This table reports the share of total intermediates (in expenditure terms and %) used by the consuming sector that comes from the producing sector. (For example, 14% of the total intermediates used by the third sector stem from the second sector in region $i = a$.) The shares were computed by the authors based on the World Input-Output Database values for 2014.

Table B.5: Preference biases, consumption and investment, $hb_{X,s,i,\bar{i}}$

Region $i = a$	$hb_{C,s,a,a}$	$hb_{C,s,a,b}$	$hb_{C,s,a,c}$	$hb_{C,s,a,d}$	$hb_{I,s,a,a}$	$hb_{I,s,a,b}$	$hb_{I,s,a,c}$	$hb_{I,s,a,d}$
1) MF of food, beverages, tobacco	0.895	0.008	0.025	0.072	0.915	0.021	0.049	0.015
2) MF of basic metals	0.419	0.435	0.030	0.117	0.164	0.407	0.119	0.310
3) MF of computer, electronic and opt. products, electrical equipm.	0.507	0.209	0.020	0.264	0.442	0.287	0.042	0.229
4) MF of machinery and equip., motor vehicles, other MF	0.630	0.067	0.080	0.222	0.667	0.033	0.092	0.208
5) Agriculture, mining, rest of MF, energy, water, construction	0.731	0.067	0.042	0.161	0.980	0.003	0.005	0.011
6) Services	0.974	0.001	0.009	0.016	0.987	0.000	0.005	0.008
Region $i = b$	$hb_{C,s,b,a}$	$hb_{C,s,b,b}$	$hb_{C,s,b,c}$	$hb_{C,s,b,d}$	$hb_{I,s,b,a}$	$hb_{I,s,b,b}$	$hb_{I,s,b,c}$	$hb_{I,s,b,d}$
1) MF of food, beverages, tobacco	0.004	0.950	0.011	0.034	0.000	0.827	0.122	0.052
2) MF of basic metals	0.000	0.925	0.009	0.067	0.001	0.940	0.018	0.040
3) MF of computer, electronic and opt. products, electrical equipm.	0.006	0.832	0.013	0.148	0.019	0.588	0.052	0.341
4) MF of machinery and equip., motor vehicles, other MF	0.031	0.767	0.117	0.084	0.013	0.879	0.061	0.047
5) Agriculture, mining, rest of MF, energy, water, construction	0.004	0.931	0.016	0.048	0.004	0.992	0.002	0.002
6) Services	0.004	0.952	0.013	0.031	0.000	0.931	0.022	0.047
Region $i = c$	$hb_{C,s,c,a}$	$hb_{C,s,c,b}$	$hb_{C,s,c,c}$	$hb_{C,s,c,d}$	$hb_{I,s,c,a}$	$hb_{I,s,c,b}$	$hb_{I,s,c,c}$	$hb_{I,s,c,d}$
1) MF of food, beverages, tobacco	0.005	0.006	0.926	0.064	0.003	0.007	0.970	0.020
2) MF of basic metals	0.001	0.185	0.757	0.058	0.002	0.055	0.890	0.052
3) MF of computer, electronic and opt. products, electrical equipm.	0.015	0.226	0.577	0.183	0.029	0.220	0.580	0.170
4) MF of machinery and equip., motor vehicles, other MF	0.014	0.045	0.845	0.096	0.027	0.036	0.839	0.098
5) Agriculture, mining, rest of MF, energy, water, construction	0.014	0.046	0.801	0.138	0.014	0.003	0.970	0.013
6) Services	0.009	0.002	0.967	0.022	0.014	0.001	0.957	0.029
Region $i = d$	$hb_{C,s,c,a}$	$hb_{C,s,c,b}$	$hb_{C,s,c,c}$	$hb_{C,s,c,d}$	$hb_{I,s,c,a}$	$hb_{I,s,c,b}$	$hb_{I,s,c,c}$	$hb_{I,s,c,d}$
1) MF of food, beverages, tobacco	0.026	0.071	0.038	0.865	0.026	0.071	0.038	0.865
2) MF of basic metals	0.077	0.155	0.059	0.709	0.077	0.155	0.059	0.709
3) MF of computer, electronic and opt. products, electrical equipm.	0.179	0.192	0.177	0.451	0.179	0.192	0.177	0.451
4) MF of machinery and equip., motor vehicles, other MF	0.159	0.105	0.012	0.724	0.159	0.105	0.012	0.724
5) Agriculture, mining, rest of MF, energy, water, construction	0.054	0.078	0.079	0.788	0.054	0.078	0.079	0.788
6) Services	0.011	0.031	0.046	0.911	0.011	0.031	0.046	0.911

Notes: This table reports parameter values for the sector-specific preference biases $hb_{X,s,i,\bar{i}}$, $X \in C, I$ of region i towards goods produced in region $\bar{i}$. These were computed for region $i = a, b, c$ by the authors based on the World Input-Output Database values for 2014. Parameters for region $i = d$ were used to close the model.

Table B.6: Preference biases, intermediate inputs, $hb_{H,s,i,\bar{i}}$

Producer j	**Consumer** s 1)	2)	3)	4)	5)	6)
Region $i = a$						
$\bar{i} = a$						
1)	0.969	0.836	0.826	0.781	0.920	0.965
2)	0.753	0.758	0.758	0.756	0.718	0.740
3)	0.591	0.668	0.483	0.538	0.554	0.545
4)	0.708	0.738	0.681	0.689	0.679	0.715
5)	0.920	0.778	0.845	0.845	0.760	0.859
6)	0.968	0.961	0.950	0.948	0.950	0.962
$\bar{i} = b$						
1)	0.002	0.014	0.011	0.014	0.003	0.002
2)	0.014	0.010	0.011	0.013	0.012	0.021
3)	0.107	0.089	0.142	0.128	0.125	0.123
4)	0.053	0.049	0.063	0.045	0.061	0.042
5)	0.006	0.008	0.024	0.025	0.013	0.012
6)	0.001	0.001	0.001	0.001	0.001	0.001
$\bar{i} = c$						
1)	0.004	0.089	0.113	0.088	0.037	0.007
2)	0.037	0.036	0.036	0.037	0.036	0.042
3)	0.041	0.037	0.042	0.046	0.046	0.040
4)	0.075	0.077	0.082	0.066	0.081	0.065
5)	0.011	0.030	0.033	0.028	0.031	0.033
6)	0.010	0.014	0.021	0.018	0.019	0.014
$\bar{i} = d$						
1)	0.025	0.061	0.049	0.117	0.039	0.026
2)	0.196	0.196	0.195	0.195	0.234	0.196
3)	0.261	0.206	0.333	0.287	0.275	0.292
4)	0.164	0.135	0.173	0.200	0.179	0.179
5)	0.063	0.185	0.098	0.102	0.196	0.096
6)	0.021	0.024	0.028	0.033	0.030	0.023
Region $i = b$						
$\bar{i} = a$						
1)	0.002	0.003	0.004	0.003	0.003	0.003
2)	0.000	0.001	0.001	0.001	0.001	0.000
3)	0.003	0.002	0.003	0.002	0.002	0.002
4)	0.005	0.006	0.005	0.003	0.005	0.003
5)	0.008	0.002	0.003	0.003	0.003	0.003
6)	0.003	0.004	0.005	0.004	0.004	0.007
$\bar{i} = b$						
1)	0.985	0.969	0.976	0.977	0.981	0.985
2)	0.961	0.932	0.933	0.933	0.933	0.943
3)	0.898	0.889	0.813	0.866	0.917	0.847
4)	0.899	0.789	0.912	0.952	0.913	0.923
5)	0.958	0.856	0.948	0.958	0.930	0.962
6)	0.979	0.904	0.947	0.968	0.960	0.958
$\bar{i} = c$						
1)	0.001	0.003	0.004	0.004	0.002	0.002
2)	0.004	0.006	0.006	0.006	0.006	0.005
3)	0.018	0.008	0.006	0.009	0.012	0.009
4)	0.025	0.025	0.025	0.020	0.024	0.020
5)	0.002	0.003	0.007	0.006	0.004	0.005
6)	0.006	0.014	0.011	0.011	0.008	0.012
$\bar{i} = d$						
1)	0.011	0.026	0.017	0.016	0.014	0.011
2)	0.035	0.062	0.061	0.060	0.060	0.051
3)	0.081	0.101	0.178	0.122	0.069	0.142
4)	0.070	0.179	0.059	0.025	0.059	0.055
5)	0.032	0.139	0.042	0.033	0.063	0.030
6)	0.012	0.078	0.036	0.017	0.029	0.023
Region $i = c$						
$\bar{i} = a$						
1)	0.002	0.010	0.012	0.011	0.008	0.002
2)	0.009	0.008	0.007	0.008	0.008	0.007
3)	0.037	0.023	0.029	0.024	0.026	0.033
4)	0.027	0.021	0.021	0.014	0.024	0.017
5)	0.010	0.027	0.016	0.013	0.023	0.022
6)	0.031	0.012	0.045	0.016	0.024	0.025
$\bar{i} = b$						
1)	0.003	0.004	0.006	0.007	0.003	0.002
2)	0.020	0.013	0.013	0.013	0.014	0.020
3)	0.059	0.078	0.153	0.115	0.101	0.123
4)	0.032	0.030	0.042	0.025	0.036	0.028
5)	0.006	0.006	0.018	0.019	0.012	0.008
6)	0.004	0.004	0.007	0.006	0.004	0.006

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Producer j	**Consumer** s 1)	2)	3)	4)	5)	6)
$\bar{i} = c$						
1)	0.947	0.946	0.942	0.929	0.934	0.955
2)	0.852	0.820	0.831	0.831	0.812	0.842
3)	0.806	0.769	0.549	0.666	0.719	0.626
4)	0.876	0.881	0.847	0.874	0.862	0.874
5)	0.894	0.771	0.889	0.901	0.817	0.882
6)	0.934	0.924	0.888	0.946	0.921	0.926
$\bar{i} = d$						
1)	0.048	0.039	0.040	0.053	0.054	0.041
2)	0.118	0.159	0.149	0.148	0.166	0.132
3)	0.098	0.131	0.269	0.194	0.154	0.218
4)	0.066	0.068	0.090	0.087	0.079	0.080
5)	0.090	0.195	0.077	0.067	0.148	0.088
6)	0.031	0.060	0.061	0.032	0.052	0.043
Region $i = d$						
$\bar{i} = a$						
1)	0.026	0.026	0.026	0.026	0.026	0.026
2)	0.077	0.077	0.077	0.077	0.077	0.077
3)	0.179	0.179	0.179	0.179	0.179	0.179
4)	0.159	0.159	0.159	0.159	0.159	0.159
5)	0.054	0.054	0.054	0.054	0.054	0.054
6)	0.011	0.011	0.011	0.011	0.011	0.011
$\bar{i} = b$						
1)	0.071	0.071	0.071	0.071	0.071	0.071
2)	0.155	0.155	0.155	0.155	0.155	0.155
3)	0.192	0.192	0.192	0.192	0.192	0.192
4)	0.105	0.105	0.105	0.105	0.105	0.105
5)	0.078	0.078	0.078	0.078	0.078	0.078
6)	0.031	0.031	0.031	0.031	0.031	0.031
$\bar{i} = c$						
1)	0.038	0.038	0.038	0.038	0.038	0.038
2)	0.059	0.059	0.059	0.059	0.059	0.059
3)	0.177	0.177	0.177	0.177	0.177	0.177
4)	0.012	0.012	0.012	0.012	0.012	0.012
5)	0.079	0.079	0.079	0.079	0.079	0.079
6)	0.046	0.046	0.046	0.046	0.046	0.046
$\bar{i} = d$						
1)	0.865	0.865	0.865	0.865	0.865	0.865
2)	0.709	0.709	0.709	0.709	0.709	0.709
3)	0.451	0.451	0.451	0.451	0.451	0.451
4)	0.724	0.724	0.724	0.724	0.724	0.724
5)	0.788	0.788	0.788	0.788	0.788	0.788
6)	0.911	0.911	0.911	0.911	0.911	0.911

Notes: This table reports parameter values for the sector-specific preference biases $hb_{H,s,i,\bar{i}}$, of region i towards goods produced in region $\bar{i}$. These were computed for region $i = a, b, c$ by the authors based on the World Input-Output Database values for 2014. Parameters for region $i = d$ were used to close the model.