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Abstract

Since 2018, tariffs have re-emerged as a tool for protecting domestic economies, particularly in the US. This paper examines the macroeconomic and welfare effects of various import 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 value-added output by making local goods relatively cheaper. While consumption can increase permanently, the output benefits are short-lived. Increased production costs and reduced global income largely offset the output gains over time. Tariff-targeted countries have an incentive to retaliate, and when they do, these output/consumption gains do not materialize. As a result, welfare effects are negative. Regardless of direct involvement in tariff conflicts, the rest of the world suffers from reduced aggregate income. The effects of tariffs and strategic interactions depend on which sectors are subject to tariffs. Overall, tariffs appear to be an inefficient tool for economic protection due to the high probability 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, 2020a). The Biden administration only partially lifted these tariffs and introduced additional tariffs on Chinese electric vehicles, as did the EU. Since February 2025, the new Trump administration has taken the dispute over tariffs to a new level. In February and March, it first introduced tariffs on imports from Mexico, Canada, China and the EU. On April 2, it announced a long list of so-called reciprocal tariffs on imports from all over the world and in many cases implemented them directly. These include both broad and sector-specific tariffs. The tariffs have triggered numerous countermeasures, to which the US administration has responded with even higher tariffs in the case of China. Some tariffs have since been suspended again, others remain at slightly different levels. Whether the tariffs will remain in place or come into force at all is likely to depend on negotiations between the affected countries and the Trump administration.

The imposition of tariffs often leads to complex tariff conflicts that can escalate into broader trade disputes, affecting not only the directly involved countries but also the global economy 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. This is particularly true for Europe, which is primarily interested in maintaining free trade. Hence, understanding the dynamics of tariff conflicts is 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 (along the lines of Hinterlang, Martin, Röhe, Stähler, and Strobel, 2023, and Ernst, Hinterlang, Mahle, and Stähler, 2023). In the first scenario, the US imposes a 25 % tariff on imports from China. In the second one, China responds with a 25 % retaliatory tariff against 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 retaliatory tariff. In scenario 4, Europe refrains from imposing tariffs on China and is itself hit with a 25 % US-tariff. The EU retaliates on the US in scenario 5. 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 import tariffs on selected sectors only.

Our findings can be summarized as follows. In general, we see that in the absence of retaliatory measures, the tariff-imposing region faces an increase in value-added 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 favourably than output, reflecting relative price changes and higher lump-sum transfers to households. In addition, the share of household consumption is rising, as lower output goes along with lower capital investment. Last but not least, higher consumption and lower employment (the latter going along with lower output) increase household welfare in the tariff-imposing region.

The tariff-targeted region loses in terms of output, consumption and welfare due to lower exports to the tariff-imposing region. In addition, regions not affected by the tariff, also lose as a result of reduced global demand stemming from distortions in international trade created by the tariff. Ultimately, we are dealing with a classic beggar-thy-neighbour policy: A unilaterally imposed tariff induces an implicit wealth transfer from the tariff-targeted region (and to a lesser extent from regions not directly affected) to the tariff-imposing region. While all regions are negatively affected by tariff-induced trade distortion, the tariff-imposing region benefits from relative price changes and additional revenue. Depending on how these revenues are redistributed, they can partly or fully offset the negative effects.

If the tariff-targeted region imposes retaliatory measures, the same mechanisms operate 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 retaliate. However, China has no reason to refrain from imposing retaliatory tariffs against the US or the West (i.e. the US and Europe). Chinese welfare improves slightly in the event of retaliation, while welfare in the US or the West deteriorates significantly. The welfare loss in the West may itself be welfare-enhancing from a political perspective in China given that the US imposes tariffs on Chinese goods. At the very least, retaliation constitutes a credible threat.

For Europe it is optimal to stay out of any trade conflict with the US or China. If Europe anticipates likely retaliatory measures by China, it is preferable not to impose tariffs on Chinese goods in the first place. However, if the EU is subject to US tariffs, it has an incentive to retaliate as well, even though EU output is slightly lower in this case.

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

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

Furthermore, the sectoral structure of the model provides some interesting insights. First, sectors are affected differently depending on the region and the scope of the trade conflict. However, in any case, sectoral output losses are larger in the medium term than in the long run, which indicates structural adaptation of economies to tariffs. Finally, the additional scenarios with sectoral import tariffs show that the choice of sectors matters for macroeconomic effects and may alter strategic implications.

The rest of the paper is organized as follows. We discuss related literature in Section 2. The model and the calibration are introduced in Section 3, the mechanics of tariffs and the implications of model assumptions are discussed 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 relates 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 specific sectoral effects. The short-run welfare losses are found to be substantially larger than those in the long run. Their results also highlight the importance of trade in intermediate inputs. Auray, Devereux, and Eyquem (2025a) study the global macroeconomic effects of US-China trade tensions using a multi-country New Keynesian model with sectoral heterogeneity and production networks. They simulate permanent tariff shocks on both final and intermediate goods and find significant cross-country output losses, especially for highly integrated economies. The paper highlights how global value chains amplify the propagation of trade shocks and the inflationary effects of tariffs, stressing the importance of sectoral linkages and trade structures in shaping outcomes. Kalemli-Özcan, Soylu, and Yildirim (2025) develop a global New Keynesian open economy model with production networks, sectoral price rigidities, and heterogeneous monetary policies. Their results show that tariffs generally cause stagflation, with macroeconomic effects shaped by network structure and policy responses across countries. Tariff threats alone can induce deflation and output losses due to forward-looking expectations.

Gnocato, Gunnella, Montes-Galdon, Schuler, and Stamato (2025) examine how the macroeconomic effects of tariffs differ depending on whether they target final goods or intermediate inputs. Using a two-region, multi-sector New Keynesian model with sticky prices and global production networks, they find that tariffs on intermediate goods result in greater GDP losses and more persistent inflation than those on final goods, due to limited substitutability and cost pass-through along supply chains. Quintana (2024) 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. Ossa (2014) looks at optimal tariffs in a multi-region model. In a non-cooperative sett-up optimal tariffs are as hing as 60%. Under full cooperation this rate goes down to almost zero. 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. The three following papers focus on the role of monetary policy in a trade conflict. Bergin and Corsetti (2023) find that the optimal monetary response to tariff shocks is expansionary in a New Keynesian model with global value chains. Tariffs reduce demand without raising marginal costs, unlike standard supply shocks. Monetary easing offsets output losses even if it worsens headline inflation in the short run. Monacelli (2025) studies tariffs in a New Keynesian open economy model, showing that their effects depend critically on the monetary policy regime. Import tariffs may be expansionary when monetary policy targets the Producer Price Index (PPI) but contractionary when it targets the Consumper Price Index (CPI). Export tariffs are always contractionary, and optimal policy requires exchange rate manipulation to mitigate output losses. Auray, Devereux, and Eyquem (2025b) show that while tariffs improve a country's terms of trade, they impose deflationary costs due to nominal rigidities. Their results suggest that monetary rules targeting CPI or nominal exchange rates exacerbate these costs and lead to lower equilibrium tariff rates. Critically, the results suggests that a trade war can be completely avoided when monetary policy is optimally delegated.

Our paper contributes to the literature by focusing on strategic considerations of trade conflicts in a four-region general equilibrium model with production networks. In particular, we show that macroeconomic and welfare effects as well as incentives for retaliation depend on the choice of sectors which are subject to the tariff.

With respect to the modelling choice, this paper further 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 responses to crises (Hinterlang, Moyen, Röhe, and Stähler, 2023, Hinterlang, Jäger, Stähler, and Strobel, 2025), 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 et al., 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).

Our simulation results are in line with empirical studies such as Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020b) and Fajgelbaum and Khandelwal (2022), showing that tariffs increase production costs for import heavy sectors. Furthermore, unilateral tariffs do not necessarily decrease domestic real income due to redistribution from foreign to domestic producers. Cavallo, Llamas, and Vazquez (2025) and Cavallo, Gopinath, Neiman, and Tang (2021) show that tariff pass-through is incomplete. This may be due to limited substitutability between foreign and domestic production inputs and consumer goods. Dix-Carneiro and Kovak (2017) find that adverse effects of tariffs are more pronounced in the long-run due to imperfect mobility of production factors. Schmitt-Grohé and Uribe (2025) also stress that transitory and permanent tariffs do have different effects on production and trade patterns.

3 The model and calibration

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 (and, of course, the emission of environmental features). We extend the model to four regions $i = a, b, c, d$, while world population is still normalized to unity. Furthermore, note that different from Ernst et al. (2023), the production technology is given by a normalized CES function of the form[1]

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

where the bar indicates steady-state values, $\varepsilon_{s,i,t}$ is total factor productivity and $(1-\alpha_{H,s,i})$ determines the "factor intensity" of intermediate goods in the production process. The CES production structure allows us to address input factor shifts more in detail. $\tilde{Y}_{s,i,t}(z)$ is self-production (sometimes also referred to as value added in the literature) given by

$$\tilde{Y}_{s,i,t}(z) = \bar{\tilde{Y}}_{s,i}(z) \cdot \left(\alpha_{N,s,i} \cdot \left(\frac{N_{s,i,t}(z)}{\bar{N}_{s,i}(z)} \right)^{sub_{nk}} + (1 - \alpha_{N,s,i}) \cdot \left(\frac{K_{s,i,t-1}(z)}{\bar{K}_{s,i}(z)} \right)^{sub_{nk}} \right)^{1/sub_{nk}}, \tag{2}$$

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 $sub_{yh}, sub_{nk} > 0$.

For the calibration strategy, we also follow Ernst et al. (2023). We calibrate the model for four regions (a, b, c, d), where region a refers to the USA, region b to China, region c to the European Union including UK, and region d to the rest of the world. The regions are selected to simulate different trade conflict scenarios between and within "The West", as well as with China, and to assess their implications for the rest of the world.[2] Utilizing the NACE Rev. 2 classification, we distinguish between $S = 6$ production sectors. 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,

[1]Normalization allows us to interpret the values of the factor intensities as the (initial steady-state) factor income shares that we observe in the data independent from the elasticities of substitution (see Klump, McAdam, and Willman, 2012, for an in-depth discussion). Results are not affected.

[2]Note that Canada and Mexico are included in region d. We acknowledge that it would be very interesting to model them as individual countries in the analysis as important training partners of the U.S. However, increasing the number of regions in the model, which is technically possible, comes at the cost of reducing the number of sectors due to computational constraints. With four regions, we are already limited with only 6 sectors. Hence, we refrain from modelling Canada and Mexico separately. This implies that the trade relationship between US and the rest of the world is stronger than in a more differentiated calibration. Still, it does not alter our baseline qualitative results as the rest of the world remains passive in our simulations.

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. The variable and parameter naming is, again, analogous to Ernst et al. (2023). However, in this paper, we use FIGARO tables released by the European Commission on top of the WIOD (Timmer, Dietzenbacher, Los, Stehrer, and De Vries, 2015) to calibrate the production network. Appendix A provides detailed calibration tables for each region and sector.

4 The role of import tariffs in the model and potential extensions

The model description makes clear that whenever a region imposes an import tariff, domestic demand for imported goods is directly affected. As foreign goods, for which the tariff applies become more expensive, domestic demand for these goods declines. At the same time, demand for domestically produced goods increases as they become cheaper in relative terms. To a lesser extent, goods produced in regions not subject to the tariff also serve as substitutes.

From an aggregate perspective, tariffs distort the "optimal" consumption choice and lead to a suboptimal global factor allocation. Especially regions subject to tariffs experience a sharp decline in trade. The falling external demand for their products lowers (net) profit margins of exporting firms, resulting in a decline in households income. This, in turn, lowers their import demand and, thus, also negatively affects regions not directly targeted by the tariff. Their income also falls as the drop in demand of tariff-targeted regions cannot be compensated for by higher demand of tariff-imposing regions due to the trade distortion. Hence, the import tariff induces an "implicit real wealth transfer" from all other regions to the tariff-imposing region.

For the tariff-imposing region, consumption and investment goods become more expensive. However, tariffs generate government revenue, which in our baseline simulation is redistributed back to households in a lump-sum manner (Appendix C provides a supplementary analysis, in which the revenue is used to lower labor income taxes). Consequently, the effective income loss for households is relatively contained. Moreover, the relatively higher demand for domestically produced goods can actually increase households factor income potentially leading to higher consumption. However, this overall positive effect occurs only if the aggregate global income losses induced by the tariffs (which reduce demand for exports from the tariff-imposing region) are not too large and if trading partners do not retaliate.

In our model, import tariffs not only affect final demand, but also increase the costs of imported intermediate inputs. This mitigates positive effects in the tariff-imposing region and amplifies negative effects in the tariff-targeted region. As marginal production costs rise in the tariff-imposing region, relative prices increase further. In Appendix D, we demonstrate the quantitative relevance of this channel by simulating a model in which the input-output-linkage is switched off.

The simulation presented in Appendix C, in which tariff revenues are used to finance a reduction in labor income taxes, is related to a mechanism known in the literature as fiscal devaluation. Fiscal devaluation refers to an increase in indirect (consumption) taxes used to finance a reduction in direct (labor income) taxes. As consumption taxes tend to generate fewer distortions than direct taxes, fiscal devaluation is generally expected to yield positive effects on output, employment, and consumption. The parallel is apparent, as import tariffs can be interpreted as border consumption taxes and therefore constitute an indirect tax. However, when their revenues are used to finance a reduction in labor income taxes, we do not find the universally positive output and consumption effects typically associated with fiscal devaluation, although the share of indirect taxation in government revenue increases. This is partly due to the fact that the tax base of import tariffs is smaller than that of a broad-based consumption tax, limiting the potential efficiency gains from reducing labor income taxation. In addition, unlike a consumption tax, the tariff directly increases production costs by increasing the prices of foreign intermediate inputs. As shown in Appendix D, removing intermediate inputs from production shifts the results closer towards the expected fiscal devaluation result. Finally, the distortions induced by the import tariff can be substantial (particularly when regions are treated asymmetrically) and cannot be fully offset by the positive effects of reducing direct taxation.

In our baseline model, prices are set competitively, meaning that they equal marginal production costs. In Appendix E, we present the results of a model extension with monopolistically competitive firms and endogenous market entry and exit, allowing firms to charge time-varying markups. Results do not change qualitatively. However, the positive or negative effects of import tariffs are amplified. The reason is that under monopolistic competition, exporters in tariff-targeted regions will reduce prices for their export goods in order to mitigate the drop in demand. In relative terms, this improves the situation in the tariff-imposing region, while income in the tariff-targeted region declines further. Hence, the additional change in relative prices exacerbates the implicit real wealth transfer induced by the tariff.

In addition to monopolistic competition, one could introduce nominal frictions into the model. This would expand the transition period before the new steady state is reached. Consumer price inflation in the tariff-imposing region would initially increase before reverting to the central bank's target, as implied by the Taylor-rule response. Due to the general cost increase of tariffs, inflation in the other regions would also rise. Assuming dollar pricing of exporting firms in such a nominal version of the model, would eliminate exchange-rate risk in the other regions.

After this brief discussion of the main mechanisms of the model and potential extensions, we turn to the numerical analysis.

5 Baseline simulations

This section describes the simulation design, the transmission mechanism of introducing tariffs and simulation results. Regarding the results, we start with the transition dynamics and 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 regions. For simplicity, we simulate all tariffs as a 25% broad tariff on all imports from the targeted region. We neglect any sectoral differentiation for now (and discuss them in the next section). The scenarios considered are (in the following referred to as S1 to S5):

1. Tariffs from region a on b (US $\rightarrow$ China),
2. As above, but b also puts tariffs on a (US $\leftrightarrow$ China).
3. Tariffs from a and c on b and vice versa ("the West"(US + EU) $\rightarrow$ China),
4. Bi-directional tariffs between a and b, and tariffs from a on c, while c remains passive (US $\leftrightarrow$ China; US $\rightarrow$ EU).
5. Bi-directional tariffs between a and b, and a and c (US $\leftrightarrow$ China; US $\leftrightarrow$ EU).

In all scenarios, governments redistribute tariff revenue to households by increasing lump-sum transfers. In Appendix C we show that results are analogues when using revenues to reduce labor tax rates.

Transmission mechanism Generally, import tariffs increase the gross prices of imported goods (i.e. prices including tariffs) and generate government revenue. Demand for domestically produced goods or goods from non-tariffed regions increases as their prices become relatively cheaper. As a result, the tariff-targeted region is exposed to a negative demand shock, leading to lower output, consumption, investment, employment and wages. However, part of the drop in output is offset by the fact that producers in the targeted region reduce net prices and the real exchange rate (net of tariffs) declines. The negative income effect can spill over to other regions, depending on their trade relations with the tariff-targeted region. Moreover, producers in the tariff-imposing region face higher production costs as imported intermediate inputs become more expensive as a result of the tariff. Still, households in the tariff-imposing region benefit from an "implicit real wealth transfer" due to the relative price changes and the assumption that tariff revenues are redistributed in a lump-sum manner. The former effect reflects an increase in the real exchange rate. Consequently, value-added output in this region might be backed by domestic consumption in the short run, while the capital stock and employment decrease. The lower capital stock, in turn, 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 worldwide aggregates. Table 1 summarizes the long-run implications, whereas Figure 3 breaks these down to different sectors.

We find that introducing tariffs unilaterally (S1 in red) increases value-added output in the US (region a). Due to relative price changes (see the increasing real exchange rate in Figure 2) and tariff revenues redistributed in the form of lump-sum transfers, households increase consumption, while the capital stock and employment decline. Hence, long-run effects on output and consumption are smaller though still positive (see Table 1).

The tariff-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, as the negative income effect outweighs the potential stronger demand from the US for goods produced in these regions. Overall, worldwide macroeconomic aggregates decline (see Figure 2). In Appendix D, we show that the output-dampening effect is smaller in a model without a production network. In this case, the adverse effects of tariffs for the tariff-imposing region are reduced, since increasing import prices do not affect domestic production costs.

Table 1: Long-run effects

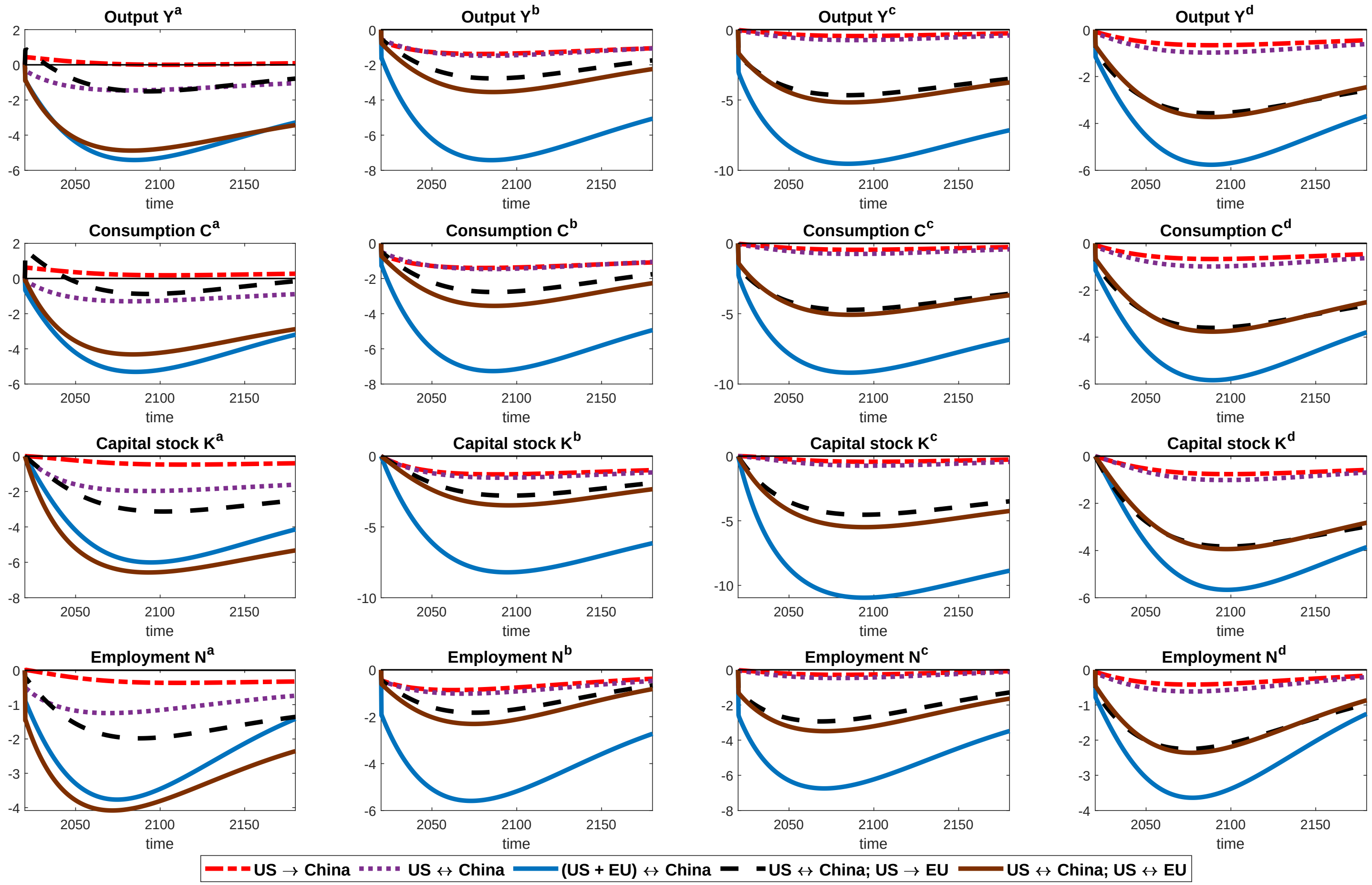
Scenario:	US → CHN	US ↔ CHN	West ↔ CHN	US ↔ CHN; US → EU	US ↔ CHN; US ↔ EU
Output in a	0.09	-0.77	-1.98	-0.44	-2.44
Consumption in a	0.27	-0.61	-1.86	0.21	-1.88
Hours in a	-0.43	-0.47	-0.53	-1.37	-1.49
Wages in a	0.56	-0.34	-1.62	1.05	-1.09
Output in b	-0.78	-0.76	-3.32	-1.02	-1.35
Consumption in b	-0.80	-0.74	-3.17	-1.02	-1.36
Hours in b	-0.02	-0.14	-1.22	-0.16	-0.17
Wages in b	-0.81	-0.68	-2.42	-0.96	-1.31
Output in c	-0.12	-0.21	-5.19	-2.48	-2.64
Consumption in c	-0.13	-0.21	-4.87	-2.57	-2.56
Hours in c	-0.00	-0.01	-1.25	-0.11	-0.46
Wages in c	-0.13	-0.22	-4.59	-2.62	-2.45
Output in d	-0.29	-0.36	-2.20	-1.78	-1.52
Consumption in d	-0.29	-0.37	-2.28	-1.83	-1.57
Hours in d	-0.02	-0.02	-0.12	-0.12	-0.10
Wages in d	-0.30	-0.38	-2.33	-1.88	-1.61
Output worldwide	-0.05	-0.09	-0.66	-0.21	-0.27

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.

If China retaliates against US tariffs (S2 in purple), Chinese consumption increases only slightly compared to S1, while output remains almost unchanged (see Table 1). The preference biases reported in Table A 5 in the Appendix reveal that imports from China play a more important role for US consumption and investment goods than vice versa. Consequently, the implicit real wealth transfer to China induced by the retaliating tariff is comparatively small. At the same time, US exports decline, leading to lower consumption and output in the US. This also reduces US demand for goods produced abroad. As a result, negative effects in Europe and the rest of the world increase compared to the first scenario.

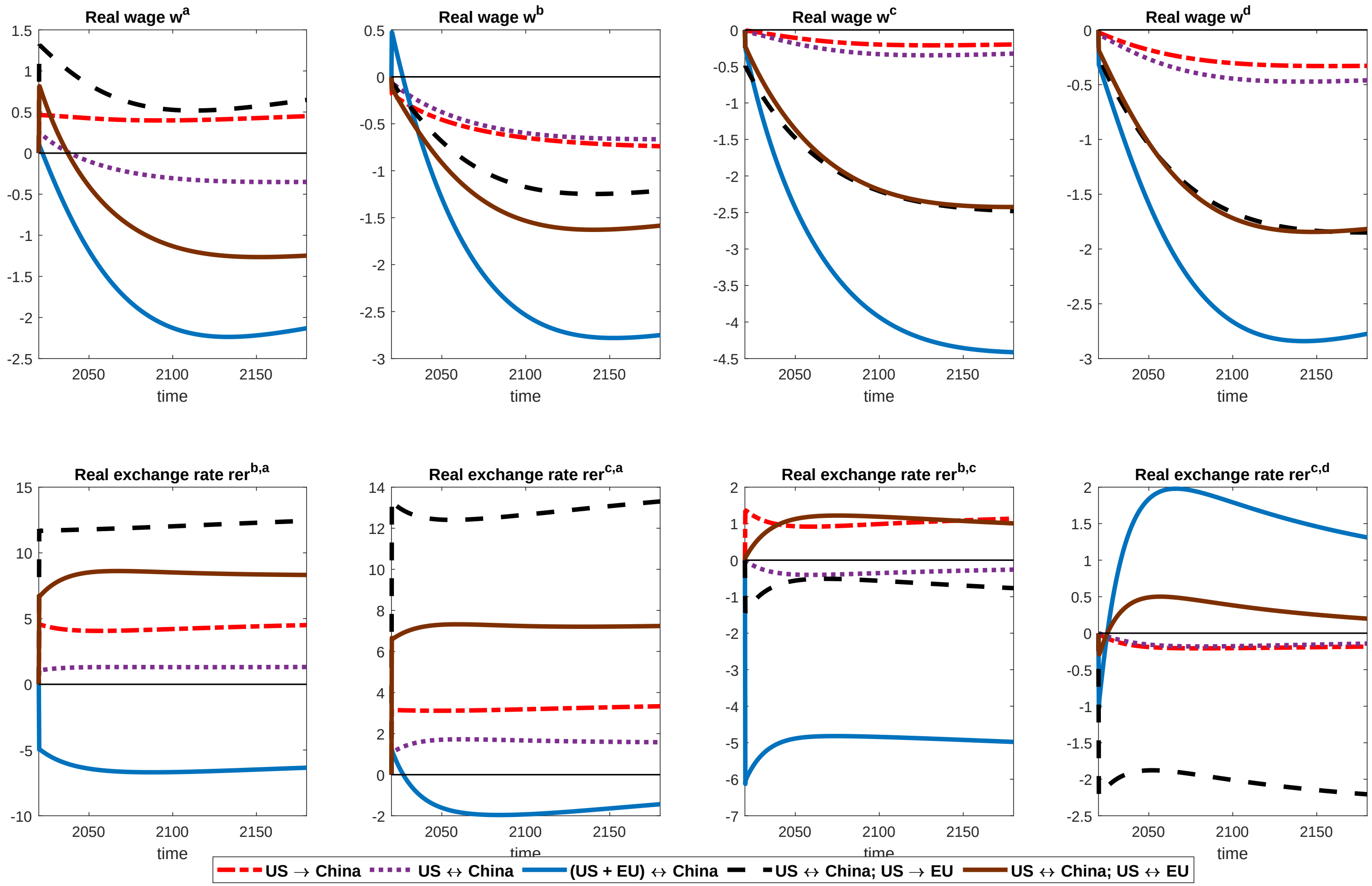
Scenario 3 (S3 in blue) examines a trade conflict between the West and China. In this scenario, all regions suffer most, with pronounced deteriorations across all macroeconomic variables. The EU experiences the largest losses, followed by China.

Figure 1: Implications of tariffs for selected key macroeconomic variables



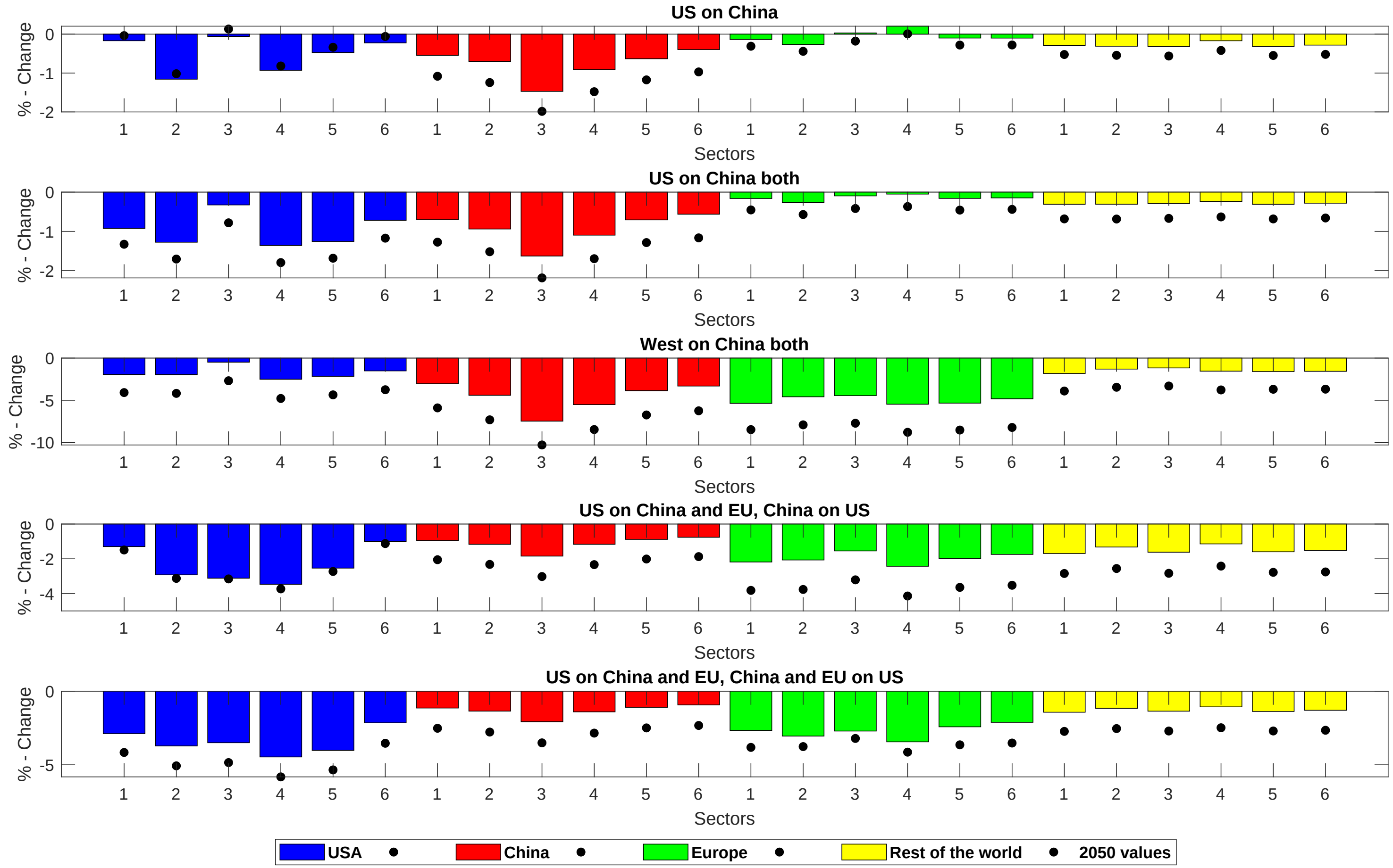
Notes: Figure plots (projected) implications of tariffs for selected key macroeconomic variables in percentage deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents bi-directional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

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



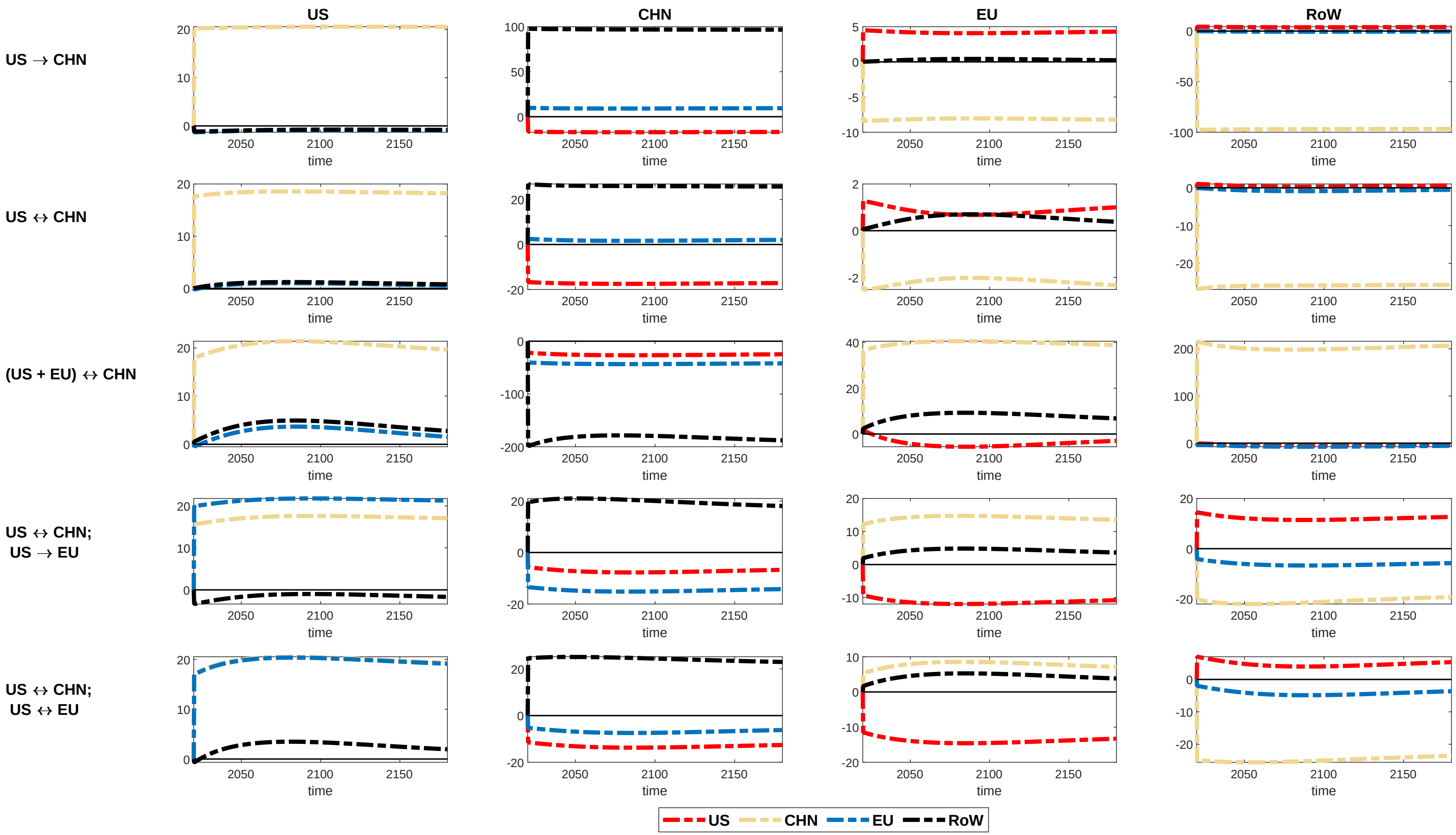
Notes: Figure plots (projected) implications of tariffs for selected factor/relative prices in percentage(point) deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents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

Figure 3: Changes in total sectoral output implied by tariffs



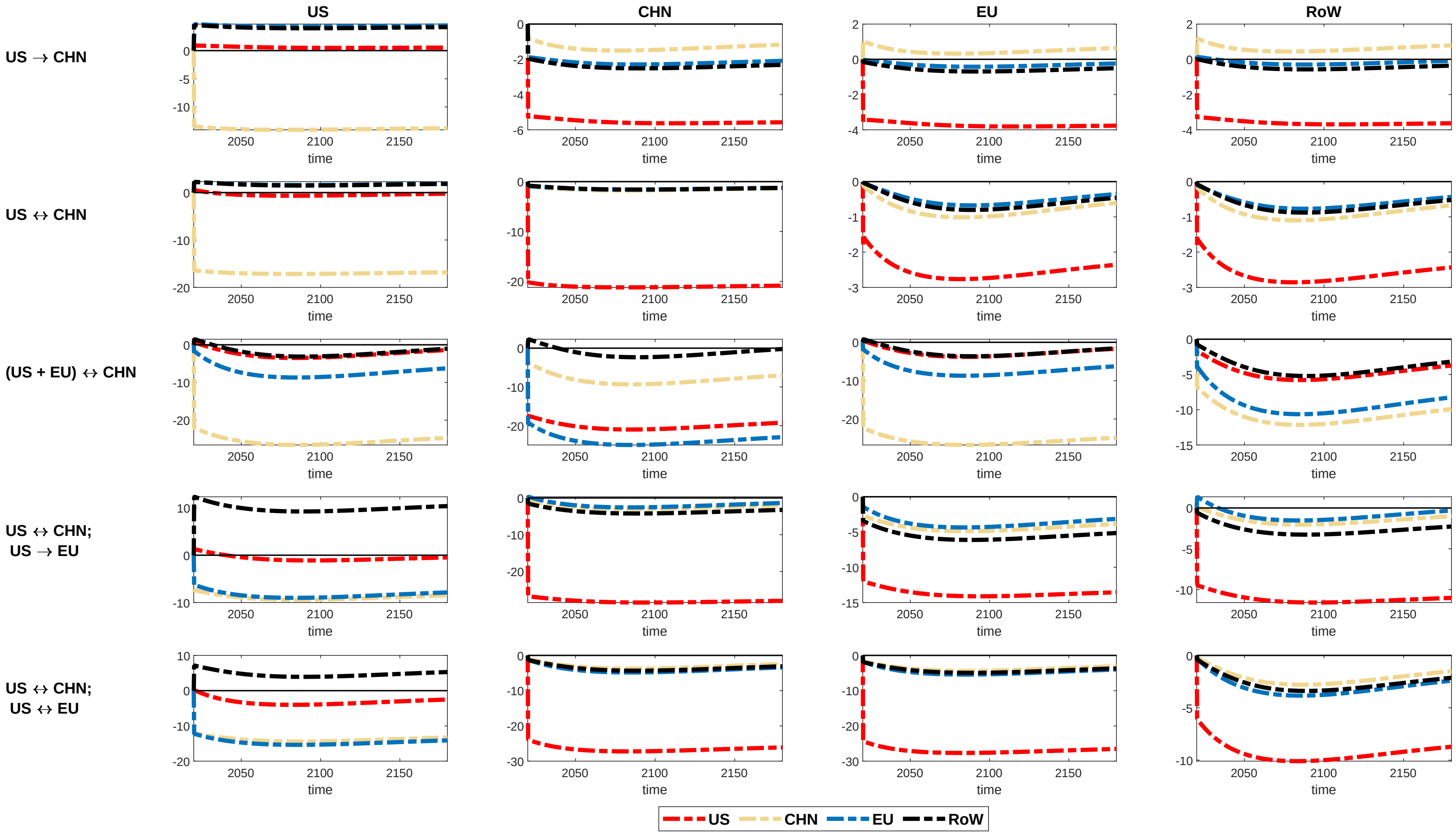
Notes: Figure shows the effects of broad tariffs on sectoral gross output in the medium-term and long-run in percentage deviation from initial steady state. Scenarios are according to headline.

Figure 4: Implications of tariffs on bilateral trade balances



Notes: Figure plots (projected) implications of tariffs for each regions net exports vis-à-vis the other Regions.

Figure 5: Implications of tariffs on used quantities



Notes: Figure plots (projected) implications of tariffs for each countries usage of goods produced in sector 3.

The fourth scenario (S4 in black) assumes that the US levies tariffs on the EU in response to Europe not following US tariffs against China. In terms of output and consumption, this scenario is more favorable for the EU than a trade conflict with China (S3). The US experiences positive effects on consumption due to the additional tariff revenues. However, output effects are negative, and accompanied by a decline in the capital stock and hours worked.

The fifth scenario (S5 in brown) considers EU retaliatory tariffs on imports from the US. While the EU does not benefit notably, the US suffers substantial losses.

Figure 3 reveals that sectors are affected differently depending on the region and the scope of the trade conflict. In China, sector 3 (electronics) is most negatively affected regardless of the scenario, followed by sectors 2 (basic metals) and 4 (motor vehicles). In the US, by contrast, sector 3 is least affected from a trade conflict with China, while sectors 2 and 4 are affected most. In Europe, sector 4 seems to be the one most affected by trade conflicts. It benefits when the US imposes a unilateral tariff on China (S1) and has the least output losses if China retaliates against that (S2). However, once the EU becomes directly involved in the trade conflict, sector 4 faces the largest losses (S3-5). Finally, across all regions and scenarios, sectoral output losses are larger in the medium term than in the final steady state. This shows that the economies adapt over time to tariffs by adjusting sectoral prices and their production structure.

Figure 4 and Figure 5 illustrate the effects on trade variables for each tariff scenario. Specifically, Figure 4 shows the evolution of each region's net exports vis-à-vis the other regions measured in domestic CPI. On impact, tariffs lead to a reduction in traded quantities. Furthermore, the tariff-targeted region experiences a relative drop in producer prices. Whenever a region introduces a tariff on another region, both imports and exports fall. Imports decline due to the direct cost effect of the tariff, while exports decrease as a result of reduced foreign demand and increased domestic demand driven by relative price changes. However, imports decline more than exports, and the price effect exacerbates this. As illustrated in scenario 1, this leads to an increase in net exports if a region introduces a tariff unilaterally. US net exports vis-à-vis China increase by 20%. At the same time, Chinese net exports vis-à-vis the EU and the rest of the world increase due to lower Chinese producer prices induced by US tariffs. US producers and consumers demand more non-Chinese goods, thereby reducing the US trade surplus with these regions. The non-tariffed regions increase their exports to the US, thereby replacing part of the decline in their trade with China. Therefore, net exports of the EU and the rest of the world to the US increase slightly. Chinese exports to the rest of the world increase strongly in relative terms. However, this is mainly due to the fact that the trade balance is close to zero in the initial steady state.

If China retaliates against US tariffs, this only partially offsets the previously described effect on its trade balance vis-à-vis the US. In the initial steady state, Chinese exports to the US are significantly higher than Chinese imports from the US. As a result, in absolute terms, the decline in imports from the US cannot offset the preceding decline in exports (see Figure 5 and Figure B.1). However, in relative terms the adjustment is stronger. As the number of tariffs in the system increases, the general pattern remains unchanged. Regions that introduce tariffs decrease their trade deficit vis-à-vis the tariff-targeted regions. However, as economic damage increases, the effects are increasingly driven by the overall decline in economic activity.

Figure 5 shows the change in utilized quantities across regions. Scenario 1 illustrates the general mechanism of tariffs: domestically produced goods become relatively cheaper, increasing both relative and absolute demand, as long as adverse indirect effects do not outweigh the direct effects. China, which is hit hardest by the tariffs, demands fewer US goods due to relative price changes as well as lower economic activity. Lower economic activity, in turn, reduces demand for other foreign goods, as well as for domestically produced Chinese goods. It is clearly visible that the EU and the rest of the world partially fill the gap resulting from the decline in US import demand. Both regions import larger quantities of Chinese goods, which is consistent with the changes in trade balances.

Scenario 2 shows that bilateral tariffs lead to a decline in traded volumes in general and tend to reduce the trade deficit of the region that initially runs a trade deficit. With the exception of the US, all regions demand fewer goods from all other regions. This is in line with lower economic activity and declining aggregate consumption.

Table 2: Welfare effects

Scenario:	US → CHN	US ↔ CHN	West ↔ CHN	US ↔ CHN; US → EU	US ↔ CHN; US ↔ EU
Steady state...					
...in US	0.36	-0.28	-1.18	0.66	-0.85
...in CHN	-0.59	-0.51	-1.96	-0.71	-0.96
...in EU	-0.10	-0.16	-3.27	-1.90	-1.78
...in ROW	-0.22	-0.28	-1.71	-1.36	-1.17
...worldwide	-0.27	-0.33	-1.99	-1.11	-1.18
With transition...					
...in US	0.51	-0.33	-1.72	0.96	-1.00
...in CHN	-0.75	-0.65	-2.49	-1.01	-1.35
...in EU	-0.14	-0.24	-3.74	-2.29	-2.14
...in ROW	-0.24	-0.36	-2.23	-1.51	-1.42
...worldwide	-0.33	-0.43	-2.51	-1.31	-1.48

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.

Welfare and strategic interactions In order to examine the welfare effects of the different trade conflicts, we compute the lifetime consumption-equivalent gain of the representative household ce_i for region i in line with Lucas (2003) resulting from changes in trade policy. We can extract the corresponding lifetime consumption-equivalent gain ce_i. We define global welfare as a population-weighted average, i.e. $ce_w = \omega^a \cdot ce_a + \omega^b \cdot ce_b + \omega^c \cdot ce_c + \omega^d \cdot ce_d$. Results are summarized in Table 2.

The previous discussion and the results shown in Table 1 indicate that, in the long run and based on a pure steady-state comparison, increased trade frictions due to tariffs reduce global welfare (see also Table 2). These losses are even more pronounced when the transition is taken into account. From an aggregate perspective, an increasing number of trade frictions in the model leads to worse outcomes for the regions involved in the trade conflict, as well as for the rest of the world, which suffers from decreased world demand. Welfare effects are positive for the US, only in the case of unilateral US tariffs on China (S1) or Europe (S4).

Scenarios 1 and 4 lead to positive welfare effects for the US. This raises the question of how credible and stable these scenarios are. The US benefits from unilateral tariffs against China, as it is better off both in the long run and when the transition is taken into account. However, this scenario is not stable, as China has an incentive to retaliate. In that case, China benefits mildly, while welfare effects in the US turn negative. Given the rivalry between the two regions, this outcome may itself be an incentive for China to retaliate. Ultimately, in a trade conflict between the two regions, the US loses more than China. If China retaliates against the US, the US may, in turn, put pressure on Europe to impose tariffs on China.

However, the EU has no incentive to join the Western bloc against China because of large negative welfare losses if China retaliates against Europe (S3). If the threat of Chinese retaliation were credible, Europe would prefer to stay out of the trade conflict. If the US instead imposes tariffs on imports from the EU (S4), the EU is better off retaliating against the US (S5). This effect is driven by a reduced disutility of labor. EU retaliation leads to negative welfare effects for the US. Hence, there is no stable scenario in which the US benefits. We are faced with a race-to-the-top dynamic, in which a tariff-targeted region always has an incentive to retaliate.

We restrict our analysis to a scenario comparison. Though it would be worthwhile to look for region is optimal set of tariffs. Computing a set $(\tau^X_{s,i,\tilde{i},t})_{\forall t\geq 0;\tilde{i}\in\{a,b,c,d\}\setminus i}$ given all other tariffs imposed $(\tau^X_{s,i,\tilde{i},t})_{\forall t\geq 0;\tilde{i},i\in\{a,b,c,d\}|i\neq\tilde{i}}$. This would require either analytic Ramsey-planning or a large number of simulations to approximate. Unfortunately the employed solution technique does not allow that within a reasonable time frame.

6 Alternative simulations: Sector-specific tariffs

So far, we have simulated broad tariffs for all sectors. However, policy discussions also focus on sector-specific tariffs. Regions seek to impose tariffs on sectors in which the positive effects outweigh the negative ones. The following analysis of sectoral tariffs aims to better understand the incentive structure of the individual regions. Accordingly, instead of a broad tariff, we simulate a 25% import tariff on:

1. Food, beverages and tobacco

2. Basic metals

3. Computer, electronic and optical products, electrical equipment

4. Machinery and equipment, motor vehicles, transport equipment, furniture

The configuration of tariff-imposing and tariff-targeted regions remain the same as in the baseline scenarios. In the bilateral and multilateral tariff scenarios, we assume that regions impose tariffs on the same sectors.

Figure 6 shows how a tariff on sector 4 (motor vehicles) affects long-run sectoral production across all policy scenarios. (Corresponding results for the other sectoral tariffs are reported in Appendix B). Compared to the corresponding results under a broad tariff, sectoral tariffs have a greater impact on the sectoral structure of the economy, both in the tariff-imposing and in the tariff-targeted region. In the first scenario with a unilateral US tariff on China, sector 4 benefits in the US, while all other sectors suffer from higher production costs. In China, all sectors experience losses, with the negative impact on sector 4 being particularly pronounced. The EU is again only indirectly affected by the tariffs, namely through higher potential demand from the US and lower global demand. Overall, sector 4 benefits from increased US demand, whereas all other sectors are adversely affected by weaker global demand. In the rest of the world, lower global demand outweighs higher US demand for sector 4, although the resulting losses are smaller than in the other sectors.

Table 3: Welfare effects, sector-specific tariffs

Scenario:	US → CHN	US ↔ CHN	West ↔ CHN	US ↔ CHN; US → EU	US ↔ CHN; US ↔ EU
Baseline					
...in US	0.51	-0.33	-1.72	0.96	-1.00
...in CHN	-0.75	-0.65	-2.49	-1.01	-1.35
...in EU	-0.14	-0.24	-3.74	-2.29	-2.14
...in ROW	-0.24	-0.36	-2.23	-1.51	-1.42
Food					
...in US	0.01	-0.04	-0.09	0.04	-0.04
...in CHN	-0.01	-0.00	0.06	-0.01	-0.02
...in EU	-0.00	-0.01	-0.25	-0.12	-0.10
...in ROW	-0.00	-0.01	-0.13	-0.07	-0.06
Metal					
...in US	0.00	-0.00	-0.11	0.00	-0.04
...in CHN	-0.01	-0.01	-0.19	-0.03	-0.04
...in EU	-0.00	-0.00	-0.24	-0.08	-0.09
...in ROW	-0.00	-0.00	-0.12	-0.06	-0.06
Electronics					
...in US	0.16	0.07	-0.26	0.22	0.08
...in CHN	-0.21	-0.21	-1.07	-0.26	-0.27
...in EU	-0.05	-0.07	-0.49	-0.27	-0.26
...in ROW	-0.11	-0.11	-0.37	-0.25	-0.24
MV					
...in US	0.10	0.03	-0.12	0.33	0.16
...in CHN	-0.15	-0.14	-0.47	-0.22	-0.26
...in EU	-0.03	-0.04	-0.22	-0.47	-0.44
...in ROW	-0.05	-0.06	-0.21	-0.34	-0.33

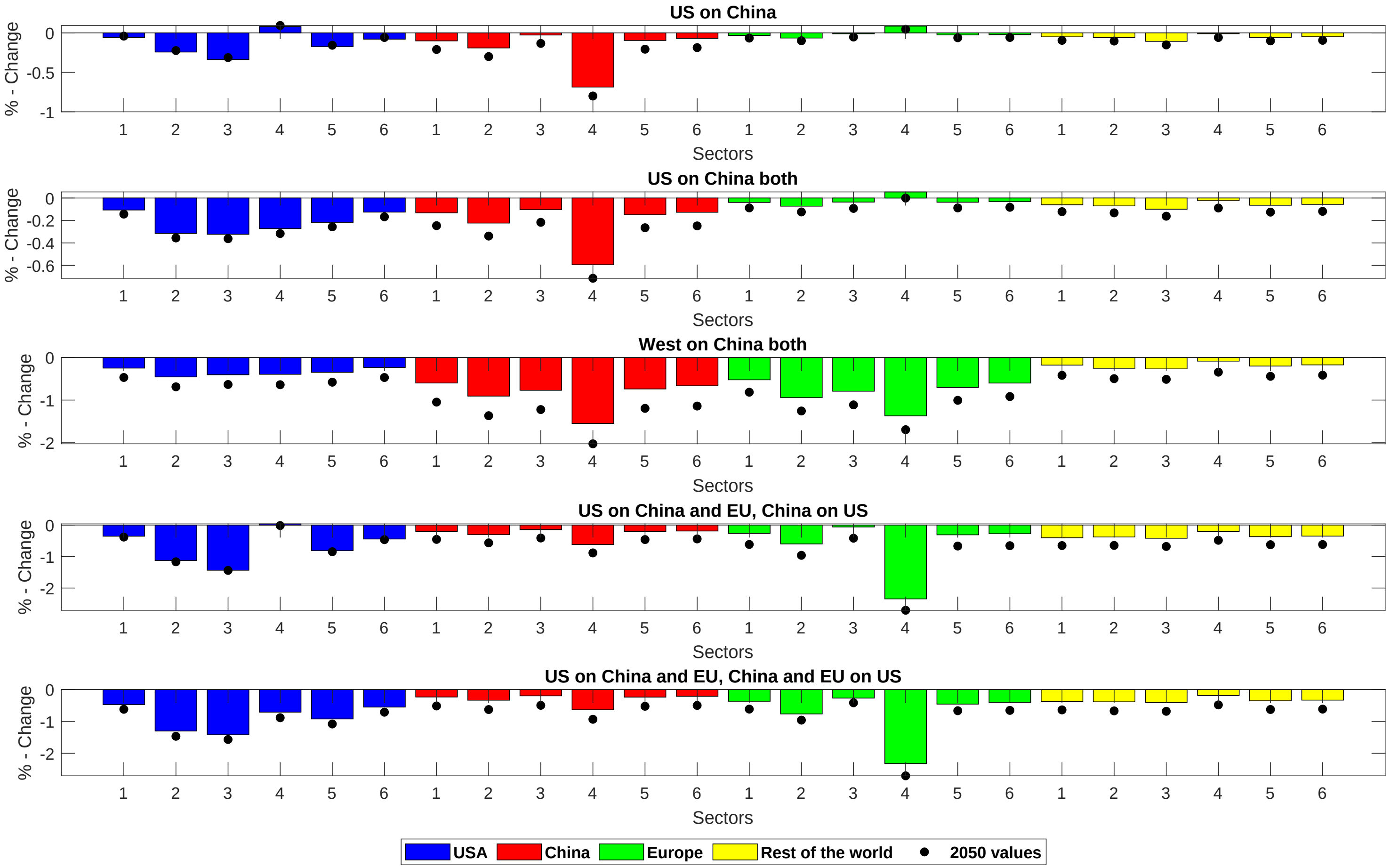
Notes: Welfare effects (including transition) when only one sector is taxed.

Table 3 summarizes the welfare results for the alternative simulations (taking the transition into account). The baseline scenario is associated with the largest distortions in the model. Therefore, it leads to the highest welfare transfer in the case of a unilateral tariff and to the largest losses in the case of reciprocal tariffs. Apart from that, there are three notable differences from our baseline results. First, US welfare may increase compared to the initial steady state, even if other regions retaliate. While US welfare always decreases if a region retaliates against a broad tariff, it rises if China or the EU retaliate against a sector-specific tariff on sectors 3 (electronics) or 4 (motor vehicles). Second, in some cases regions no longer have an incentive to retaliate. For example, the EU has no incentive to retaliate against the US when sector 2 (basic metals) is subject to the tariff. Moreover, China would prefer not to retaliate against US tariffs on sector 3 (electronics). Third, if sector 4 (motor vehicles) is subject to the tariff, the EU is better off joining a Western coalition with the US against China than entering a trade conflict with the US.

Table 4: Welfare ranking, sector-specific tariffs

USA $\rightarrow$ China	
...in US:	Baseline $\succ$ Electr $\succ$ MV $\succ$ Food $\succ$ Metal
...in CHN/ EU/ ROW:	Metal $\sim$ Food $\succ$ MV $\succ$ Electr $\succ$ Baseline
USA $\leftrightarrow$ China	
...in US:	Electr $\succ$ MV $\succ$ Metal $\succ$ Food $\succ$ Baseline
...in CHN/ EU/ ROW:	Food $\succ$ Metal $\succ$ MV $\succ$ Electr $\succ$ Baseline
West $\leftrightarrow$ China	
...in US/ CHN:	Food $\succ$ Metal $\succ$ MV $\succ$ Electr $\succ$ Baseline
...in EU:	MV $\succ$ Food $\sim$ Metal $\succ$ Electr $\succ$ Baseline
...in ROW:	Metal $\succ$ Food $\succ$ MV $\succ$ Electr $\succ$ Baseline
USA $\leftrightarrow$ China & USA $\rightarrow$ EU	
...in US:	Baseline $\succ$ MV $\succ$ Electr $\succ$ Food $\succ$ Metal
...in CHN:	Food $\succ$ Metal $\succ$ MV $\succ$ Electr $\succ$ Baseline
...in EU/ ROW:	Metal $\succ$ Food $\succ$ Electr $\succ$ MV $\succ$ Baseline
USA $\leftrightarrow$ China & USA $\leftrightarrow$ EU	
...in US:	MV $\succ$ Electr $\succ$ Metal $\succ$ Food $\succ$ Baseline
...in CHN:	Food $\succ$ Metal $\succ$ MV $\succ$ Electr $\succ$ Baseline
...in EU/ ROW:	Metal $\succ$ Food $\succ$ Electr $\succ$ MV $\succ$ Baseline

Figure 6: Effects on long-run sectoral output



Notes: Figure shows the effects of tariffs on sector 4 on sectoral gross output in the medium-term and long-run in percentage deviation from initial steady state. Scenarios are according to headline.

Table 4 further illustrates that the welfare ranking of sectoral tariffs depends on the regions involved in the trade conflict. For example, in a trade conflict with China, the US favors tariffs on sector 3 (electronics), while in a trade conflict with the EU it would instead choose tariffs on sector 4 (motor vehicles). The EU, in turn, is significantly affected by tariffs on sector 4 (motor vehicles) in a trade conflict with the US. By contrast, the impact is much smaller in a trade conflict with China. Finally, China is barely affected by sectoral tariffs on sectors 1 (food) or 2 (basic metals). However, it suffers substantial losses from tariffs on sector 3 (electronics) in a trade conflict with the US or the EU.

7 Conclusions

Using a dynamic, four-region, multi-sector general equilibrium model, we analyze the macroeconomic and welfare implications of tariffs. Our findings indicate that, in general, tariffs may initially increase domestic output and consumption by making local products more competitive. However, these output benefits are transient, as rising production costs and declining global income ultimately undermine the initial benefits. Moreover, sectors are affected differently depending on the region and the scope of the trade conflict. Tariff-targeted regions incur welfare losses and have an incentive to retaliate against broad tariffs, whereas in the case of sector-specific tariffs there may be instances in which regions have no incentive to retaliate. Global welfare losses increase with the number of regions introducing tariffs, as regions not directly involved also incur losses. Overall, tariffs prove inefficient for economic protection due to the high likelihood of retaliation. The sectoral structure of the model reveals that the choice of sectors matters for the dynamics of a trade conflict and may alter its strategic implications. Future research could exploit this aspect in greater detail, for example by allowing for different sectoral tariffs across regions. In addition, the role of monetary policy in the trade conflicts described could be an interesting avenue for future research.

Appendix A: Calibration details

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

Table A.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 A.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
Capital adjustment costs	κ^I	25
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
Elasticity of substitution, VA & intermediates	sub_{yh}	-0.1
Elasticity of substitution, labor & capital	sub_{nk}	-0.2

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

Table A.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	0.445	0.291	0.017	0.020	0.085	0.001
2) MF of basic metals	0.443	0.321	0.004	0.010	0.001	0.002
3) MF of computer, electronic and opt. products, electrical equipm.	0.555	0.736	0.014	0.035	0.018	0.066
4) MF of machinery and equipm., motor vehicles, other MF	0.541	0.345	0.030	0.036	0.065	0.148
5) Agriculture, mining, rest of MF, energy, water, construction	0.441	0.464	0.180	0.417	0.149	0.444
6) Services	0.619	0.571	0.754	0.481	0.682	0.340
Region $i = b$ (CHN)						
1) MF of food, beverages, tobacco	0.582	0.255	0.023	0.056	0.280	0.000
2) MF of basic metals	0.640	0.215	0.009	0.045	0.001	0.002
3) MF of computer, electronic and opt. products, electrical equipm.	0.532	0.210	0.035	0.057	0.036	0.051
4) MF of machinery and equipm., motor vehicles, other MF	0.645	0.246	0.040	0.080	0.044	0.176
5) Agriculture, mining, rest of MF, energy, water, construction	0.459	0.327	0.553	0.422	0.313	0.668
6) Services	0.561	0.491	0.340	0.340	0.326	0.103
Region $i = c$ (EU27, UK)						
1) MF of food, beverages, tobacco	0.488	0.276	0.030	0.030	0.140	0.001
2) MF of basic metals	0.583	0.212	0.007	0.010	0.001	0.003
3) MF of computer, electronic and opt. products, electrical equipm.	0.443	0.369	0.017	0.023	0.028	0.065
4) MF of machinery and equipm., motor vehicles, other MF	0.559	0.320	0.047	0.049	0.059	0.163
5) Agriculture, mining, rest of MF, energy, water, construction	0.403	0.411	0.273	0.387	0.255	0.496
6) Services	0.550	0.547	0.625	0.501	0.517	0.272
Region $i = d$ (ROW)						
1) MF of food, beverages, tobacco	0.468	0.281	0.025	0.029	0.142	0.001
2) MF of basic metals	0.505	0.253	0.007	0.028	0.002	0.004
3) MF of computer, electronic and opt. products, electrical equipm.	0.419	0.396	0.008	0.038	0.031	0.064
4) MF of machinery and equipm., motor vehicles, other MF	0.593	0.342	0.032	0.045	0.067	0.146
5) Agriculture, mining, rest of MF, energy, water, construction	0.378	0.420	0.583	0.451	0.224	0.522
6) Services	0.502	0.557	0.344	0.409	0.533	0.263

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 FIGARO Database values for 2021.

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

	Consumer s					
Producer j	1)	2)	3)	4)	5)	6)
Region $i = a$						
1)	0.23	0.00	0.00	0.00	0.01	0.02
2)	0.01	0.39	0.13	0.10	0.04	0.00
3)	0.00	0.02	0.21	0.06	0.03	0.02
4)	0.01	0.01	0.03	0.30	0.04	0.02
5)	0.48	0.17	0.18	0.24	0.51	0.12
6)	0.26	0.41	0.45	0.28	0.37	0.83
Region $i = b$						
1)	0.21	0.00	0.00	0.00	0.03	0.07
2)	0.00	0.34	0.12	0.19	0.07	0.00
3)	0.00	0.01	0.51	0.08	0.03	0.04
4)	0.00	0.02	0.04	0.30	0.03	0.04
5)	0.64	0.52	0.16	0.27	0.66	0.25
6)	0.14	0.11	0.16	0.15	0.18	0.59
Region $i = c$						
1)	0.20	0.00	0.00	0.00	0.02	0.03
2)	0.00	0.39	0.10	0.12	0.05	0.00
3)	0.00	0.01	0.42	0.07	0.02	0.02
4)	0.01	0.02	0.04	0.30	0.02	0.02
5)	0.47	0.36	0.16	0.24	0.60	0.16
6)	0.32	0.22	0.28	0.28	0.29	0.76
Region $i = d$						
1)	0.25	0.00	0.00	0.00	0.02	0.04
2)	0.00	0.37	0.13	0.13	0.05	0.00
3)	0.00	0.01	0.28	0.04	0.02	0.02
4)	0.01	0.03	0.07	0.34	0.03	0.03
5)	0.44	0.39	0.19	0.23	0.59	0.18
6)	0.30	0.20	0.33	0.25	0.29	0.71

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, 13% 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 FIGARO Database values for 2021.

Table A.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	0.883	0.008	0.074	0.035	0.878	0.000	0.058	0.063
2) MF of basic metals	0.424	0.172	0.305	0.099	0.540	0.078	0.265	0.117
3) MF of computer, electronic and opt. products, electrical equipm.	0.259	0.349	0.318	0.074	0.633	0.170	0.159	0.038
4) MF of machinery and equipm., motor vehicles, other MF	0.634	0.075	0.200	0.092	0.678	0.049	0.178	0.095
5) Agriculture, mining, rest of MF, energy, water, construction	0.713	0.084	0.129	0.074	0.982	0.004	0.009	0.006
6) Services	0.983	0.001	0.010	0.006	0.922	0.003	0.048	0.027
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	0.947	0.036	0.014	0.024	0.000	0.408	0.569
2) MF of basic metals	0.001	0.923	0.057	0.019	0.002	0.934	0.046	0.018
3) MF of computer, electronic and opt. products, electrical equipm.	0.008	0.870	0.088	0.033	0.008	0.869	0.087	0.036
4) MF of machinery and equipm., motor vehicles, other MF	0.012	0.878	0.069	0.041	0.011	0.886	0.062	0.041
5) Agriculture, mining, rest of MF, energy, water, construction	0.007	0.958	0.021	0.014	0.001	0.994	0.003	0.002
6) Services	0.007	0.847	0.120	0.026	0.009	0.918	0.050	0.023
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	0.016	0.016	0.895	0.073	0.014	0.000	0.916	0.071
2) MF of basic metals	0.010	0.148	0.735	0.107	0.017	0.131	0.748	0.103
3) MF of computer, electronic and opt. products, electrical equipm.	0.035	0.410	0.430	0.125	0.032	0.356	0.505	0.106
4) MF of machinery and equipm., motor vehicles, other MF	0.029	0.101	0.747	0.123	0.033	0.112	0.732	0.122
5) Agriculture, mining, rest of MF, energy, water, construction	0.023	0.078	0.830	0.069	0.005	0.014	0.966	0.014
6) Services	0.011	0.007	0.955	0.027	0.023	0.013	0.908	0.055
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	0.028	0.086	0.032	0.854	0.028	0.086	0.032	0.854
2) MF of basic metals	0.078	0.092	0.033	0.797	0.078	0.092	0.033	0.797
3) MF of computer, electronic and opt. products, electrical equipm.	0.175	0.010	0.178	0.637	0.175	0.010	0.178	0.637
4) MF of machinery and equipm., motor vehicles, other MF	0.159	0.014	0.015	0.812	0.159	0.014	0.015	0.812
5) Agriculture, mining, rest of MF, energy, water, construction	0.034	0.056	0.028	0.882	0.034	0.056	0.028	0.882
6) Services	0.012	0.059	0.012	0.917	0.012	0.059	0.012	0.917

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 FIGARO Database values for 2021. Parameters for region $i = d$ were used to close the model.

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

	Consumer s					
Producer j	1)	2)	3)	4)	5)	6)
Region $i = a$						
$\bar{i} = a$						
1)	0.870	0.652	0.564	0.730	0.875	0.887
2)	0.804	0.572	0.695	0.778	0.810	0.694
3)	0.479	0.663	0.643	0.517	0.597	0.564
4)	0.492	0.553	0.625	0.620	0.715	0.653
5)	0.924	0.875	0.897	0.835	0.812	0.911
6)	0.946	0.826	0.798	0.903	0.905	0.952
$\bar{i} = b$						
1)	0.008	0.000	0.000	0.000	0.006	0.007
2)	0.013	0.015	0.011	0.010	0.010	0.022
3)	0.230	0.134	0.167	0.217	0.177	0.202
4)	0.092	0.050	0.075	0.047	0.055	0.055
5)	0.010	0.018	0.024	0.046	0.019	0.018
6)	0.003	0.009	0.013	0.007	0.005	0.002
$\bar{i} = c$						
1)	0.083	0.142	0.150	0.101	0.066	0.070
2)	0.090	0.192	0.137	0.102	0.083	0.140
3)	0.231	0.158	0.154	0.214	0.181	0.188
4)	0.261	0.232	0.207	0.216	0.143	0.193
5)	0.045	0.054	0.049	0.073	0.065	0.039
6)	0.033	0.094	0.114	0.058	0.055	0.028
$\bar{i} = d$						
1)	0.039	0.206	0.286	0.169	0.054	0.037
2)	0.093	0.221	0.156	0.110	0.097	0.144
3)	0.060	0.045	0.037	0.052	0.045	0.045
4)	0.154	0.165	0.093	0.117	0.088	0.099
5)	0.022	0.053	0.030	0.046	0.104	0.032
6)	0.019	0.071	0.075	0.032	0.035	0.017
Region $i = b$						
$\bar{i} = a$						
1)	0.004	0.019	0.012	0.006	0.005	0.003
2)	0.001	0.001	0.001	0.001	0.001	0.001
3)	0.005	0.004	0.016	0.008	0.007	0.011
4)	0.008	0.011	0.009	0.011	0.010	0.010
5)	0.010	0.007	0.007	0.004	0.007	0.005
6)	0.007	0.017	0.015	0.008	0.008	0.004
$\bar{i} = b$						
1)	0.947	0.684	0.801	0.895	0.931	0.959
2)	0.925	0.904	0.885	0.932	0.945	0.945
3)	0.914	0.893	0.779	0.875	0.885	0.853
4)	0.898	0.859	0.780	0.896	0.873	0.898
5)	0.957	0.874	0.916	0.946	0.917	0.951
6)	0.963	0.806	0.847	0.928	0.915	0.955
$\bar{i} = c$						
1)	0.036	0.186	0.108	0.060	0.046	0.027
2)	0.049	0.063	0.076	0.045	0.036	0.037
3)	0.057	0.070	0.150	0.083	0.077	0.100
4)	0.052	0.075	0.120	0.058	0.065	0.058
5)	0.016	0.049	0.057	0.036	0.044	0.033
6)	0.020	0.121	0.100	0.044	0.054	0.030
$\bar{i} = d$						
1)	0.014	0.111	0.079	0.039	0.018	0.011
2)	0.024	0.031	0.038	0.022	0.018	0.018
3)	0.024	0.032	0.055	0.034	0.032	0.036
4)	0.043	0.055	0.091	0.035	0.051	0.034
5)	0.016	0.070	0.021	0.014	0.033	0.011
6)	0.010	0.056	0.039	0.020	0.023	0.010
Region $i = c$						
$\bar{i} = a$						
1)	0.016	0.025	0.020	0.016	0.014	0.012
2)	0.017	0.015	0.021	0.022	0.016	0.015
3)	0.022	0.020	0.038	0.035	0.023	0.031
4)	0.025	0.029	0.028	0.034	0.029	0.019
5)	0.019	0.035	0.030	0.024	0.025	0.023
6)	0.021	0.049	0.042	0.031	0.032	0.021
$\bar{i} = b$						
1)	0.017	0.003	0.003	0.006	0.013	0.014
2)	0.101	0.094	0.089	0.077	0.088	0.093
3)	0.200	0.218	0.366	0.304	0.261	0.346
4)	0.078	0.109	0.146	0.067	0.100	0.069
5)	0.020	0.032	0.074	0.079	0.042	0.034
6)	0.012	0.025	0.039	0.019	0.018	0.009

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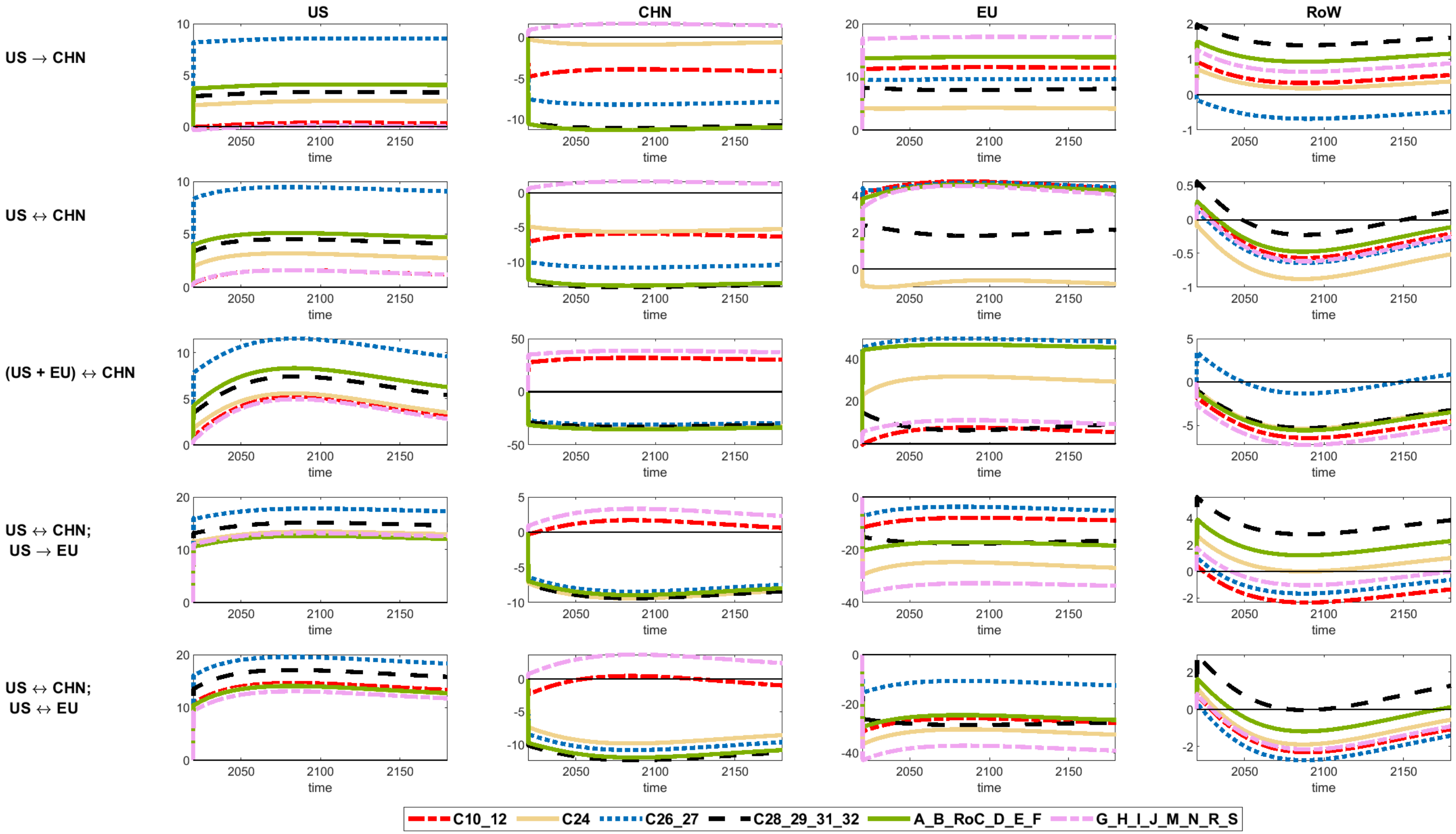
Producer j	**Consumer** s 1)	2)	3)	4)	5)	6)
$\bar{i} = c$						
1)	0.893	0.855	0.882	0.878	0.909	0.922
2)	0.745	0.739	0.765	0.780	0.767	0.756
3)	0.687	0.663	0.513	0.554	0.615	0.522
4)	0.784	0.734	0.689	0.789	0.746	0.818
5)	0.907	0.835	0.832	0.830	0.853	0.883
6)	0.927	0.836	0.845	0.888	0.884	0.918
$\bar{i} = d$						
1)	0.074	0.117	0.095	0.100	0.064	0.052
2)	0.137	0.152	0.126	0.121	0.129	0.136
3)	0.091	0.099	0.083	0.108	0.101	0.101
4)	0.113	0.128	0.138	0.110	0.125	0.094
5)	0.054	0.097	0.065	0.067	0.080	0.060
6)	0.041	0.090	0.074	0.061	0.065	0.051
Region $i = d$						
$\bar{i} = a$						
1)	0.028	0.028	0.028	0.028	0.028	0.028
2)	0.078	0.078	0.078	0.078	0.078	0.078
3)	0.175	0.175	0.175	0.175	0.175	0.175
4)	0.159	0.159	0.159	0.159	0.159	0.159
5)	0.034	0.034	0.034	0.034	0.034	0.034
6)	0.012	0.012	0.012	0.012	0.012	0.012
$\bar{i} = b$						
1)	0.086	0.086	0.086	0.086	0.086	0.086
2)	0.092	0.092	0.092	0.092	0.092	0.092
3)	0.010	0.010	0.010	0.010	0.010	0.010
4)	0.014	0.014	0.014	0.014	0.014	0.014
5)	0.056	0.056	0.056	0.056	0.056	0.056
6)	0.059	0.059	0.059	0.059	0.059	0.059
$\bar{i} = c$						
1)	0.032	0.032	0.032	0.032	0.032	0.032
2)	0.033	0.033	0.033	0.033	0.033	0.033
3)	0.178	0.178	0.178	0.178	0.178	0.178
4)	0.015	0.015	0.015	0.015	0.015	0.015
5)	0.028	0.028	0.028	0.028	0.028	0.028
6)	0.012	0.012	0.012	0.012	0.012	0.012
$\bar{i} = d$						
1)	0.854	0.854	0.854	0.854	0.854	0.854
2)	0.797	0.797	0.797	0.797	0.797	0.797
3)	0.637	0.637	0.637	0.637	0.637	0.637
4)	0.812	0.812	0.812	0.812	0.812	0.812
5)	0.882	0.882	0.882	0.882	0.882	0.882
6)	0.917	0.917	0.917	0.917	0.917	0.917

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 FIGARO Database values for 2021. Parameters for region $i = d$ were used to close the model.

Appendix B: Impacts of tariffs on international trade

Figure B.1 shows the sectoral net exports in each region by scenario.

Figure B.1: Implications of tariffs on sectoral net exports

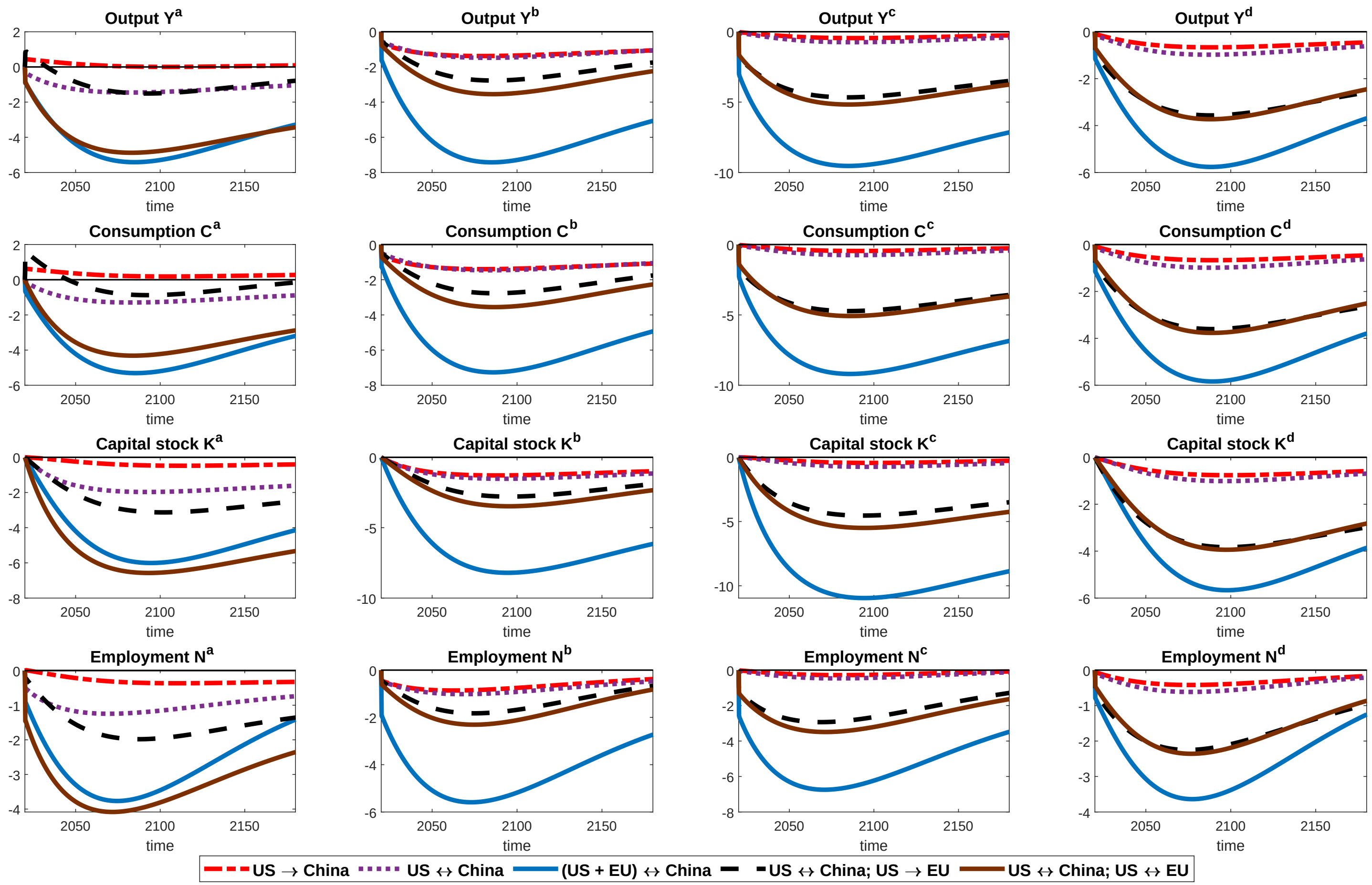


Notes: Figure plots impacts of tariffs on the net exports of each country. The change in net exports of each sector is depicted separately.

Appendix C: Impacts of tariffs when revenues reduce labor taxes

In this appendix, we present the results of using tariff revenues to reduce labor taxes instead of increasing transfers to households. As shown, the results do not change qualitatively.

Figure C.1: Implications of tariffs for selected key macroeconomic variables when revenues reduce labor taxes

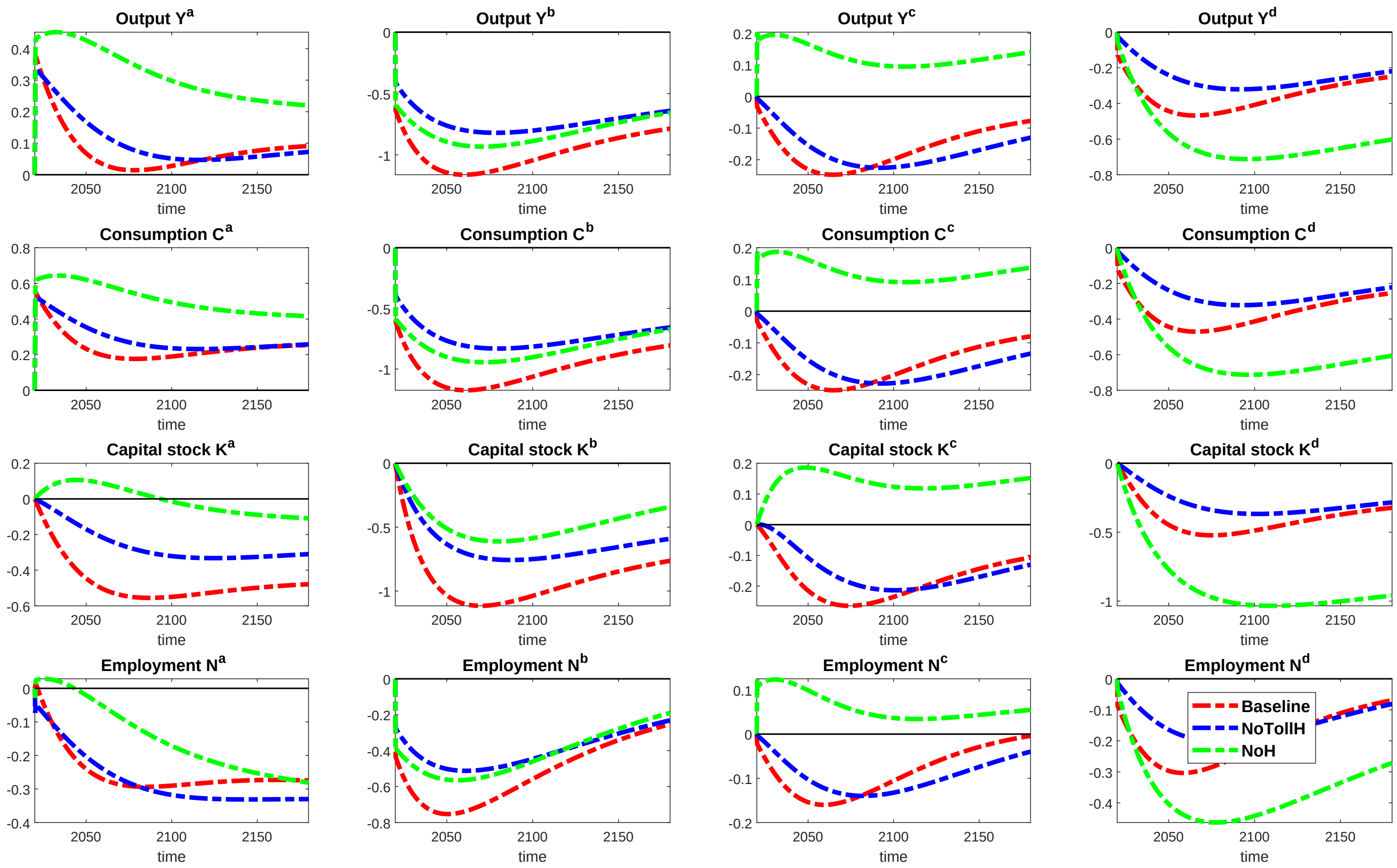


Notes: Figure plots (projected) implications of tariffs for selected key macroeconomic variables in percentage deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents bi-directional tariffs between the West and China. The dashed black line denotes bi-directional tariffs between the US and China and the US levying import tariffs on the EU. The straight brown line denotes bi-directional tariffs between the US and China as well as the US and the EU. Labor taxes are reduced (while transfers to households are increased in the analyses in the main body of the paper).

Appendix D: Impacts of tariffs without a production network

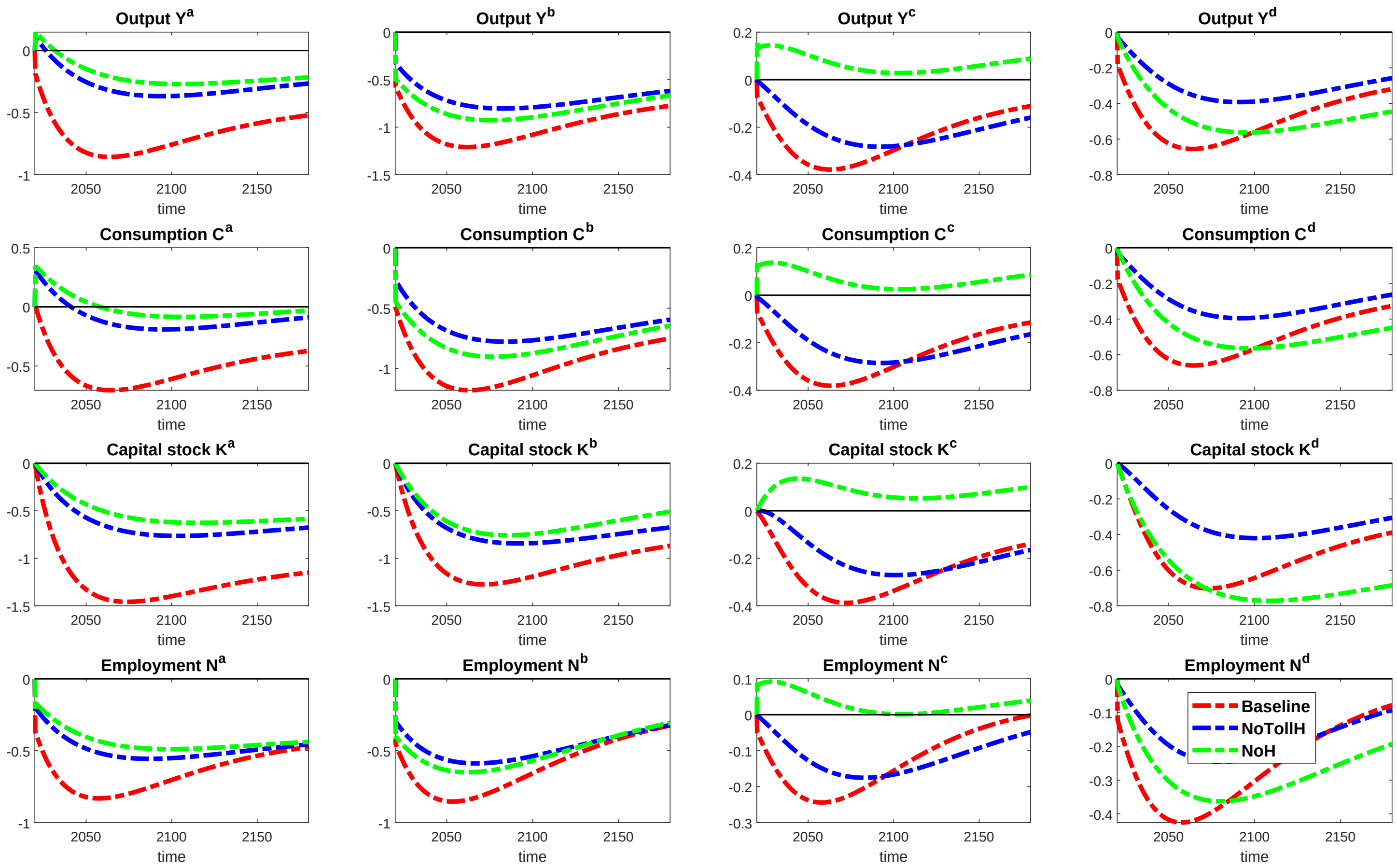
To assess the effects of tariffs via the production network, we set the $\alpha_H = 1$. This implies that optimal H-use is zero in all sectors and regions. We further include simulation results for a tariff on imported consumption and investment goods only. As Figure D.1 shows, without production linkages the positive output effects in the tariff-imposing region are higher, while the adverse effects in the tariff-targeted regions are lower.

Figure D.1: Implications of tariffs for selected key macroeconomic variables without production network (scenario 1



Notes: Figure plots (projected) implications of tariffs. All results refer to the case of bi-directional tariffs between China and the US. The red dashed line indicates the baseline scenario (i.e. US → China). The blue and green dashed lines deviate from the baseline by either shutting off the production network completely (green) or setting the tariff on imported production inputs to zero (blue).

Figure D.2: Implications of tariffs for selected key macroeconomic variables without production network (scenario 2)

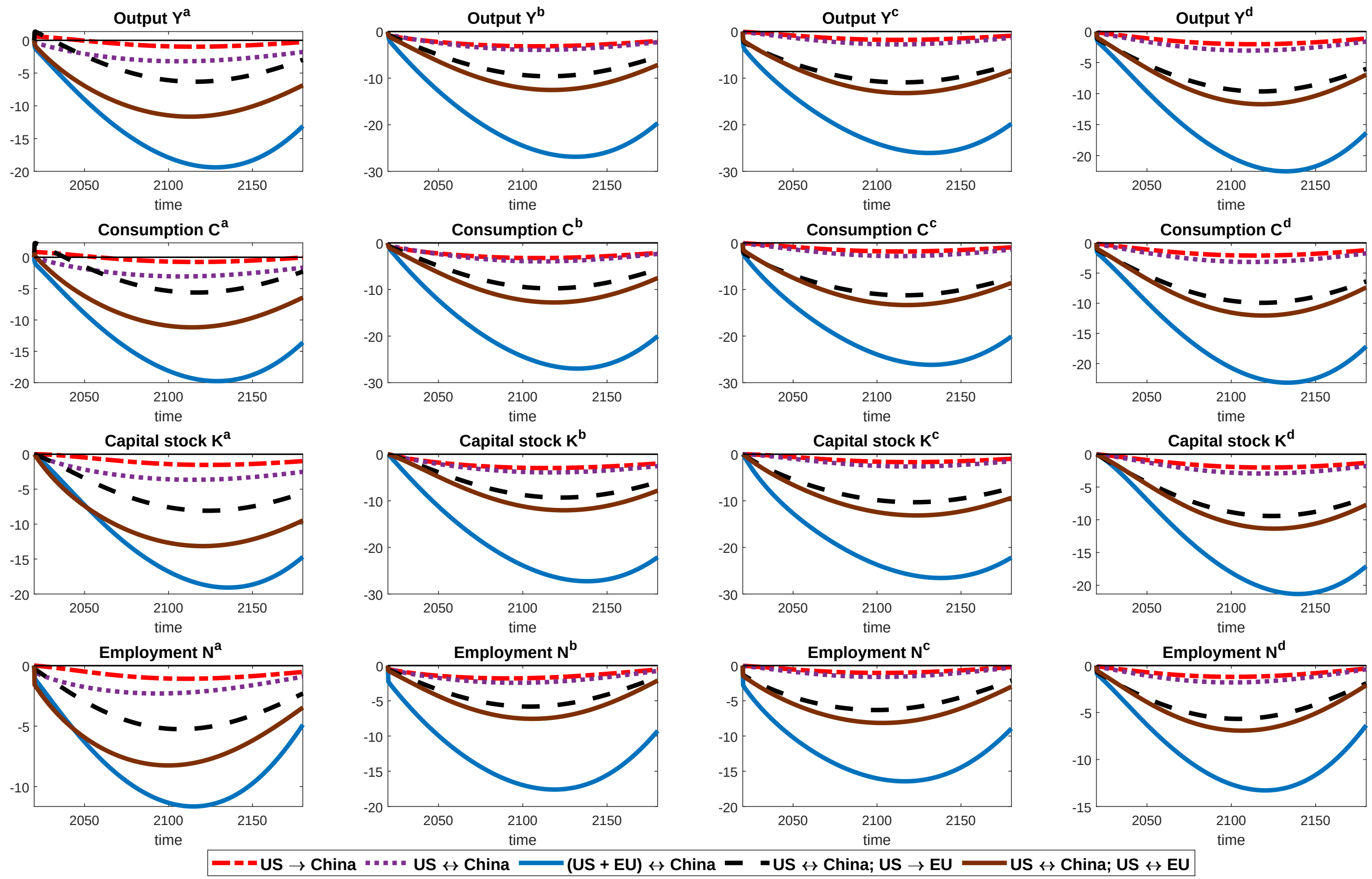


Notes: Figure plots (projected) implications of tariffs. All results refer to the case of bi-directional tariffs between China and the US. The red dashed line indicates the baseline scenario (i.e. China → US + US → China). The blue and green dashed lines deviate from the baseline by either shutting off the production network completely (green) or setting the tariff on imported production inputs to zero (blue).

Appendix E: Impacts of tariffs in a model with market entry and exit

To assess the implications of monopolistic competition and endogenous markups, we extend the model to include endogenous market entry and exit. In doing so, we follow Jaimovich and Floetotto (2008). The main idea is that the number of firms in each sector is endogenous, with firm entry being associated with entry costs. As long as the expected firm value (defined as the discounted sum of expected firm profits) exceeds the entry cost, firms enter the market. As in Cavallari (2015), each firm observes a random scrap value at the beginning of each period. If this scrap value exceeds the expected continuation value, the firm exits the market (see also Röhe and Stähler, 2020 for a detailed discussion). Hinterlang et al. (2025) provide a formal derivation of this model in the EMuSe setting, which is closely related to the framework used here. As Figure E.1 shows, monopolistic competition and endogenous markups indeed amplify the effects induced by tariffs; however, the qualitative results remain unchanged.

Figure E.1: Implications of tariffs in a model with antry and exit

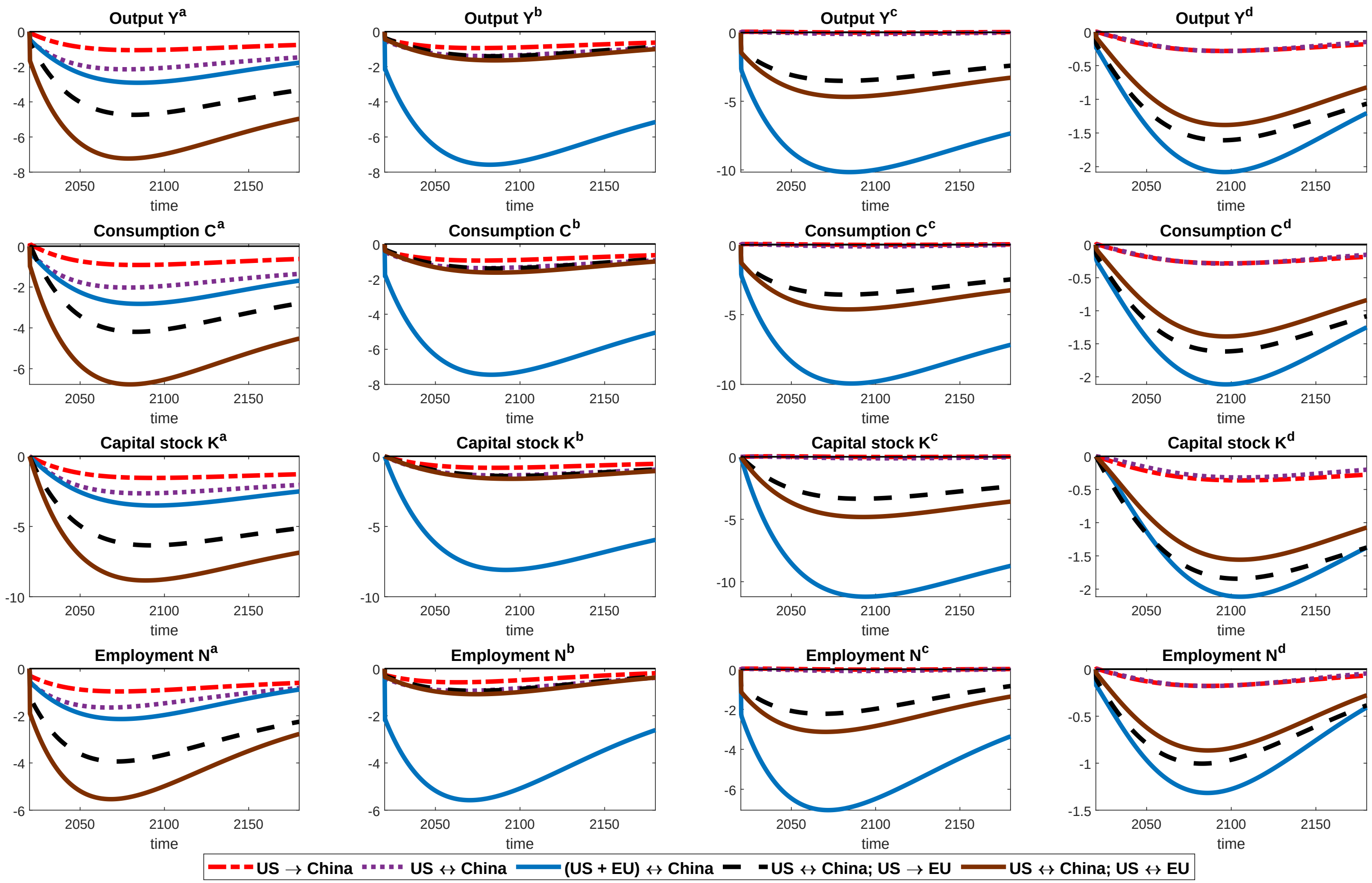


Notes: Figure plots (projected) implications of tariffs for selected key macroeconomic variables in percentage deviation from initial steady state. In the red dashed line scenario, the US levies import tariffs on China, China retaliates in the purple-dotted scenario. The blue straight line presents bi-directional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

Appendix F: Impacts of tariffs when trade elasticities are high

In this appendix, we show the results of simulating the model with higher trade elasticities (set to 3). Figure F.1 shows that the results are qualitatively similar. However, the positive effects for the tariff-imposing region are weakened. As domestically produced goods become more expensive with rising intermediate input prices, the incentive to buy these goods decreases, since they can more easily be substituted for by goods produced in other regions. These regions, in turn, experience a slightly smaller downturn relative to our baseline simulations. Nevertheless, the differences are small.

Figure F.1: Implications of tariffs in a model with antry and exit



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 bi-directional tariffs between the West and China. The dashed black line denotes bi-directional tariffs between the US and China and the US levying import tariffs on the EU.The straight brown line denotes bi-directional tariffs between the US and China as well as the US and the EU. We assume endogenous entry and exit and, thereby, markups here.

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