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Tariff Troubles: Repercussions of Protectionist Policies on US Agriculture and the Trade Deficit

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ABSTRACT

The United States has increased protectionist measures since 2018 and has remained notably passive while other nations have pursued trade agreements. This change, coupled with the potential for future increased import tariffs, suggests impending changes in trade dynamics between the United States and the rest of the world. This study employs a recursive dynamic computable general equilibrium model to examine the economy-wide and sector-specific effects of potential future US protectionist measures, with an emphasis on agricultural sectors. We simulate the impact of US exclusion from new trade agreements and the effects of implementing a 10% import tariff on all goods and final consumption goods only, with and without retaliation from other countries. Findings reveal that import tariffs do not reduce the trade deficit because of the negative impacts on US exports, even if there is no retaliation from trade partners. Agricultural sectors are generally adversely affected, although findings show differentiated sectoral impacts that vary across policies.

1 | Introduction

Since 2017, 90 regional trade agreements have been notified to the WTO and entered into force. Only one of them included the United States (US), which was the US–Mexico–Canada Agreement (USMCA), the renegotiated North American Free Trade Agreement (NAFTA) between the US, Canada and Mexico. Given the rise in sentiments against multilateralism and the bipartisan reluctance regarding the potential for new US preferential trade agreements, the future of US trade policy could bring about a cancellation of existing trade agreements and an increase in import tariffs beyond current levels, potentially provoking retaliation and a new trade policy landscape that further threatens the multilateral trading system and has important implications for agriculture. Factors fuelling these changes are the persistent US trade deficit, offshoring of US manufacturing, concerns regarding production and trade practices in China, other geopolitical tensions and dissatisfaction with the general state of the US economy. The campaign of President-elect Trump included threats of punitive tariffs of up to 60% against China, as well as general tariffs of 10% to 20% on all imports entering the US that would further remove the US from liberalisation efforts (POLITICO 2024). Among economy-wide analyses, there is agreement that the decline in multilateralism has a detrimental effect on growth and welfare (Baldwin 2016; Bhagwati 1992). This includes not only the effects of actively implemented new tariffs but also passive protectionism demonstrated by the reluctance to pursue new trade agreements while liberalisation takes place in other parts of the world.

In 2017, the US had a comparably low average import tariff on all imports equal to approximately 1.27% (Figure 1), while facing a moderate average tariff equal to approximately 2.79% on exports (Figure 2). Furthermore, 90 free trade agreements have been concluded between regions in the rest of the world during a time when the US has been reluctant to take part in new liberalisation ambitions. Therefore, even though there has been a stalemate in multilateral trade liberalisation through the World Trade Organization since 2001, nations have pursued liberalisation efforts with each other. Figure 1 shows that through these trade agreements, import barriers were not drastically lowered for most regions in the world, while Figure 2 shows that several regions improved their own access to foreign markets. Thus, while the US is not alone in current sentiments to protect the domestic market, other countries have been more successful in achieving market access by negotiating trade agreements.

This prompts the question of whether the US economy took a competitive disadvantage by staying outside of liberalising ambitions for the last several years. Potentially, other countries were able to form trade connections and substitute US products with relatively more affordable options from other trade partners due to trade liberalisation. Also, it is possible that innovative and affordable products did not reach US consumers as they could have because while average US import tariffs are relatively low, there are noteworthy import barriers that prevail when considering protection on more disaggregated products. Discussions

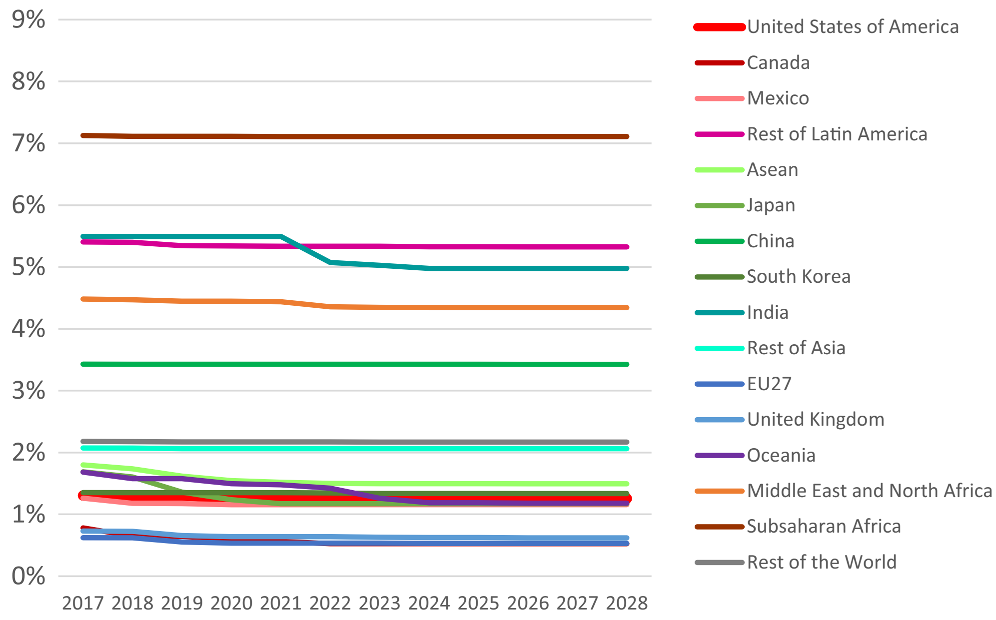

FIGURE 1 | Simulated average import tariffs imposed by different regions around the world. *Source:* TASTE output. [Colour figure can be viewed at wileyonlinelibrary.com]

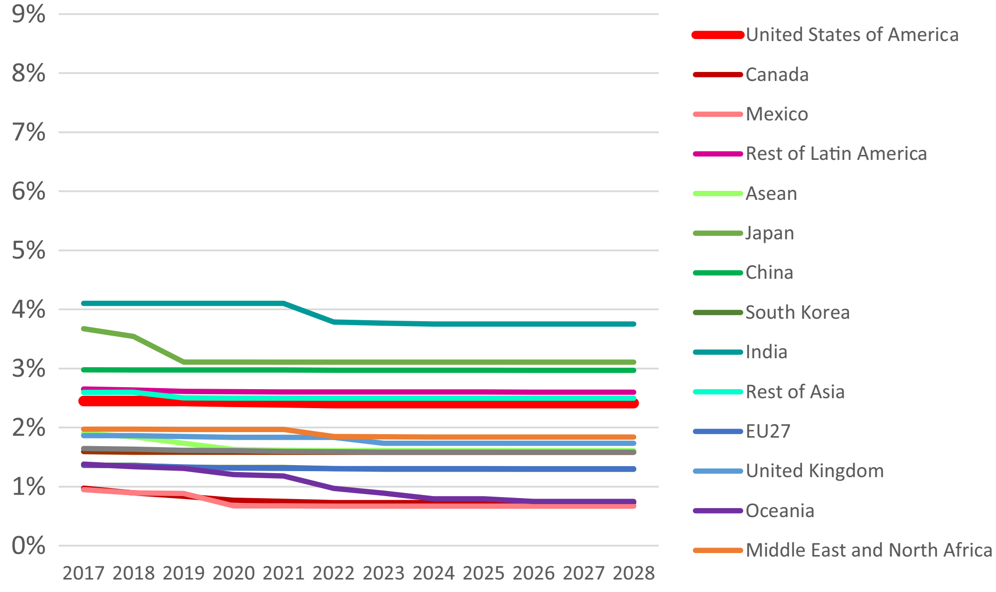

FIGURE 2 | Simulated trade-weighted average import tariffs faced by exports from different regions. *Source:* TASTE output. [Colour figure can be viewed at wileyonlinelibrary.com]

of a potential minimum US import tariff across products could protect domestic industry from import competition but would come at the cost of higher import prices for intermediate inputs into production that harm domestic producers and lead to higher prices for final goods that negatively impact US consumers. Furthermore, this could lead to decreased competitiveness of the US economy in the world, which negatively affects industries that rely on exports, including agriculture.

Economic modelling is an attempt to quantify the effect of policies in a complex nexus of economic interactions. In computable general equilibrium (CGE) models, consumers and producers in different regions adjust import volumes according to relative price levels, which depend on tariff rates and other factors in the market. The behavioural equations in the CGE model and the corresponding database account for upstream and downstream effects. Purchasing power enters the model through price and income changes. Reductions in output affect economic agents through changes in factor incomes, which in turn affect demand. CGE models allow for the comprehensive analysis of policy shocks that affect the global economy from different angles.

The objective of this research is to understand the economy-wide effects of potential changes in US trade policy and the sector-specific impacts on agriculture. We use the Global Trade Analysis Project (GTAP)-based CGEbox, a modular framework for CGE analysis (Britz 2022) and the G-RDEM module for baseline generation and counterfactual analysis (Britz and Roson 2019). We employ version 11 of the GTAP database and update tariff rates based on regional trade agreements that have been notified to the WTO since 2017, implementing tariff reform under the assumptions of broad tariff eliminations. We analyse how other countries' increased market access from trade agreements that have come into force in other parts of the world affects US trade, production, prices, and wages and investigate three different counterfactual scenarios based on potential future changes in US trade policy. First, we simulate a broad 10% increase in US import tariffs across all sectors and trade partners. Second, we consider how these effects differ for a more targeted scenario that includes import tariff increases on US imports of goods for final consumption from all trade partners while tariffs remain unchanged for goods primarily used as intermediates. Finally, we determine how policy effects differ if there is retaliation from other countries. We show results for both aggregate economic effects and more detailed, sector-specific effects for US agriculture. We also investigate the wage effects for workers of different skill levels, the movement of agricultural labour and unskilled workers across industries and identify modelling limitations in terms of labour mobility between agricultural and nonagricultural sectors. While agricultural sectors comprise a small share of the total US economy, they are more vulnerable to protectionist trade policy measures in relative terms. Findings for agricultural sectors show that the passive protectionism of not joining FTAs may be most harmful to beef and other meat products, while newly implemented 10% import tariffs may have the largest negative impacts on certain crops.

This research contributes to the existing literature by providing a more general understanding of the economic implications of potential future US protectionist policies, including the more passive reluctance to engage in free trade negotiations and active protectionism through potential tariff increases for US imports. Furthermore, we provide perspective on whether the US may improve the trade deficit through protectionist policies and shed light on the sectoral effects of protection, particularly in agricultural sectors. The following section provides background on the US trade deficit and addresses how the trade deficit is connected to the US Dollar's role as a global currency and the high demand for US government securities and other investments connected to the trade deficit, which also affects the modelling assumptions employed. The third section provides a review of the literature of comparable studies that analyse the effects of US protectionist trade policies, followed by the methodology and data used for this study in sections four and five, respectively. We then discuss results for the trade balance, GDP, detailed sector-specific effects and changes in consumer prices, and finalise our study with concluding remarks.

2 | Background on the US Trade Deficit

The US trade deficit is neither a recent development nor is it necessarily a sign of domestic mismanagement or unfair trading practices of trade partners. Figure 3 shows how the US trade deficit has persisted and grown for the past five decades. An overview of the trade balance across different sectors shows that the US currently has a trade deficit in all sectors except energy-related products (Figure 4), and the largest trade deficit is in electronic products. The US also has a trade deficit with almost all of its major trading partners except Brazil (Figure 5).

Apart from trade policy, several factors can affect the trade balance. For instance, having larger growth than trade partners can result in an increased ability to consume domestic and imported goods. Relatively slower economic growth in other countries may prevent a similar increase in imports, which results in a trade deficit for the growing country (Papaioannou and Yi 2001). Furthermore, a trade deficit can be a sign of a strong economy that is actively engaged in the global market when coupled with both relatively large export and import flows, as is the case for the US. Figure 3 shows that US exports grew at a similar rate to imports (see blue and green bars), and the US had a trade surplus in services (green line). Considering that US imports and exports were much more balanced throughout the 1960s and then increased from 1971 onwards, Reinbold and Wen (2018) attribute a large part of the US trade deficit to the collapse of the Bretton Woods System. During the Bretton Woods system, exchange rates were fixed and the US dollar served as an international reserve currency backed by gold. When President Nixon ended the Bretton Woods system in 1971, the dollar retained its dominant position as an international medium of exchange and store of value, and US government securities became the most demanded foreign reserve in the world (Reinbold and Wen 2018). This capital inflow enabled both trade and fiscal deficits in the US (Reinbold and Wen 2018). Similarly, capital flows that will allow a current account deficit can also be fostered by an above-average growth rate corresponding with above-average interest rates (Bekkers et al. 2020). This close relationship between foreign

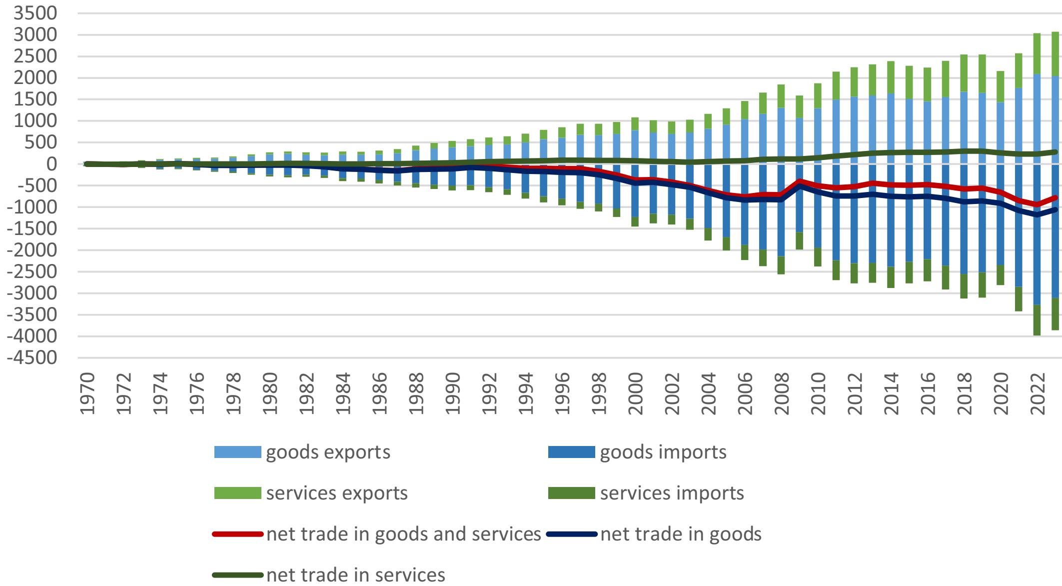

FIGURE 3 | Historic trade balance of the United States (red) and its composition of trade in goods (blue) and services (green) in billion USD. *Source:* World Bank Open Data (2024b, 2024c, 2024d, 2024i) and authors' calculations. [Colour figure can be viewed at wileyonlinelibrary.com]

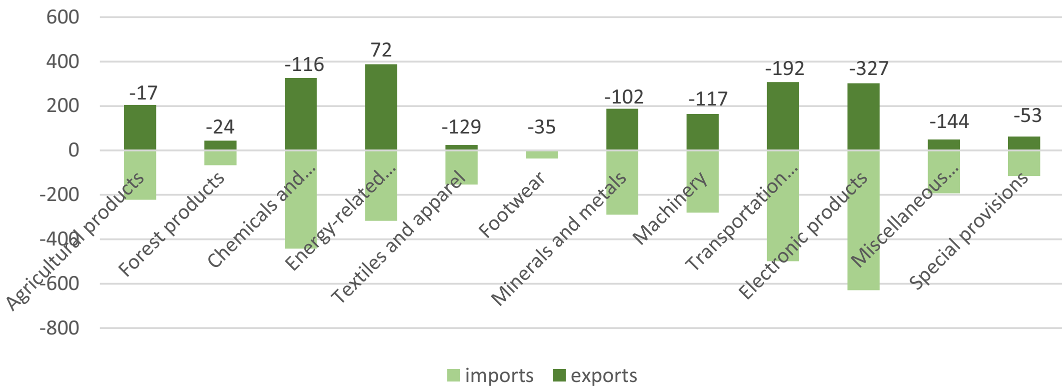

FIGURE 4 | 2022 US trade balance by sector in billion USD. *Source:* USITC (2024). [Colour figure can be viewed at wileyonlinelibrary.com]

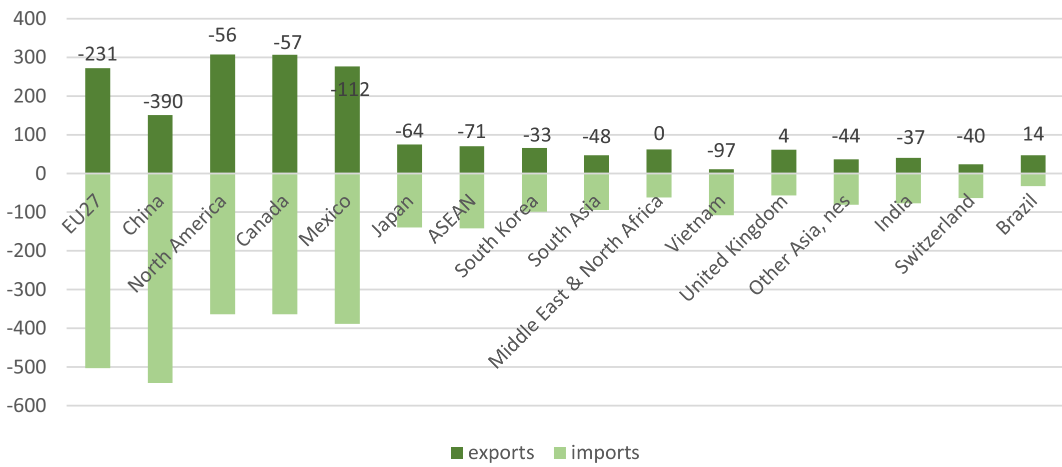

FIGURE 5 | 2021 US trade balance by trade partner regions in billion USD. *Source:* WITS (2024). [Colour figure can be viewed at wileyonlinelibrary.com]

capital inflows and the trade deficit can also be seen in the US balance of payments. Figure 6 shows that the financial account (which includes foreign investments) and the current account (which includes the trade balance) are balanced, while the capital account plays a minor role.

The composition of both the financial account (FA) and the current account (CA) is shown in Figure 7. The current account comprises net income from abroad (such as salaries from foreign employers), net current transfers from abroad (such as remittances) and net trade in goods and services (i.e., the trade balance). Among these, net trade in goods and services is the largest account and shows more absolute fluctuations. The financial account, on the other hand, comprises reserve assets (i.e., holding of foreign exchange) and various investments (direct investments, portfolio investments and other investments). For the sake of clarity, the types of investment are not distinguished in the graph. Investments make up the bulk of the financial account and show noteworthy fluctuations. Capital inflows through investments and trade deficits tend to counter each other. This does not mean that one directly causes the other but shows how the US trade deficit is financed. In recent years, however, the US trade deficit has been a central focus and has spurred concerns that led to justification for protectionist policies, with widespread opposition to trade policy liberalisation. The resulting protectionist policies, however, are unlikely to reduce the trade deficit if there are no changes in capital inflows.

3 | Literature Review

Trade protectionism in the US is a long-standing and extensively studied topic. Numerous studies have analysed the economic costs of US protectionist policies, particularly in industries such as automotive, steel, textiles and agriculture. Given the substantial influence of the US market on global trade, researchers have consistently found significant deadweight losses associated with protectionism, affecting both domestic and foreign economies (McGee 1992; Krugman 1997; Feenstra 1992). Notably, Feenstra (1992) and Krugman (1997) employ trade models to quantify these costs. The literature presents a nuanced debate on the merits and drawbacks of protectionism (Abboushi 2010; McGee 1992). On one hand, protectionist measures aim to support nascent industries, safeguard domestic jobs and foster economic self-sufficiency. However, critics argue that protectionism can have heterogeneous effects across industries, benefiting some sectors while harming others. While import restrictions may preserve jobs in protected industries, the subsequent reduction in exports can lead to job losses in export-oriented sectors (McGee 1992). Therefore, assessing the impact of trade protectionism both within and across sectors is crucial

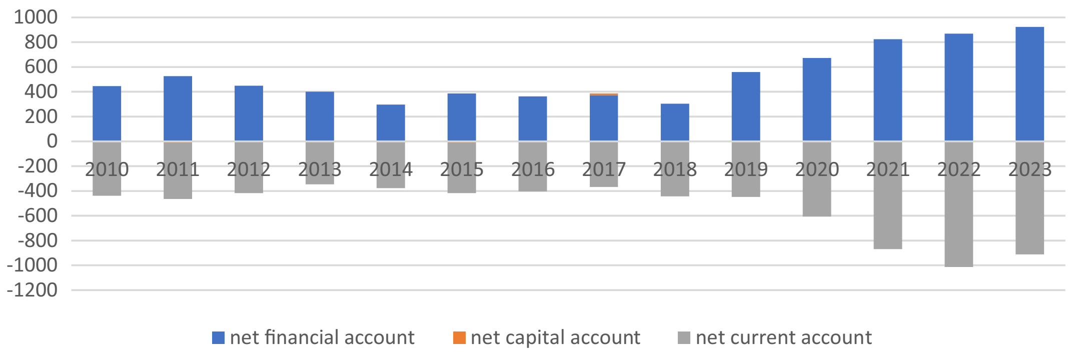

FIGURE 6 | Composition of the balance of payments in the US over time in billion USD. *Source:* World Bank Open Data (2024a, 2024e, 2024f). [Colour figure can be viewed at wileyonlinelibrary.com]

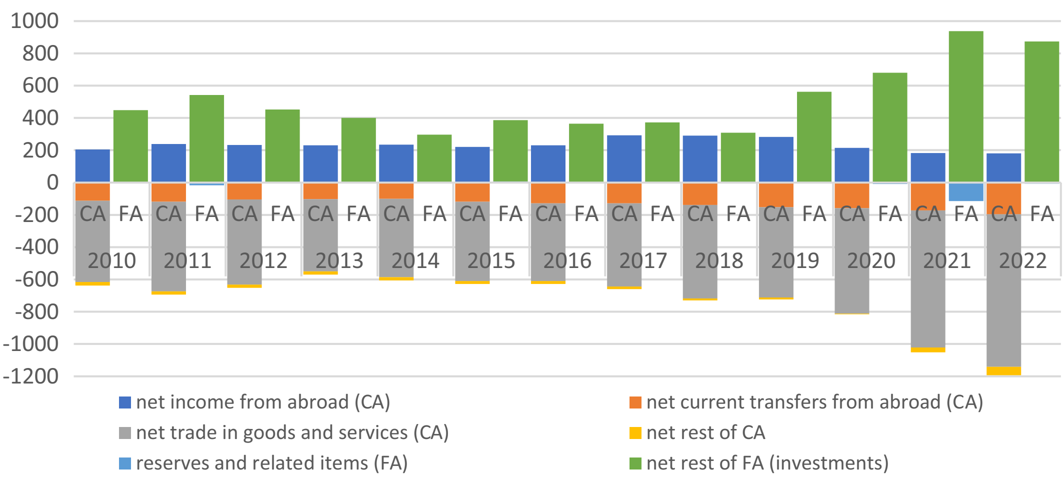

FIGURE 7 | Composition of the US current account (CA) and financial account (FA) over time in billions USD. *Source:* World Bank Open Data (2024a, 2024f, 2024g, 2024h, 2024i, 2024j). [Colour figure can be viewed at wileyonlinelibrary.com]

for a comprehensive understanding of the implications of trade policy reform.

While the economic implications of US trade protectionism have been extensively researched over the years, the topic has gained a renewed interest, particularly since the 2016 election of President Trump. The trade war that erupted in 2018, marked by escalating tariffs and retaliatory measures between the US and its major trading partners, has led to many studies investigating how these protectionist measures impacted different areas of the economy. Several studies have estimated the effects of US import tariffs and corresponding retaliatory tariffs, specifically those imposed on the US by China.

The tariffs introduced by the Trump administration in 2018 have sparked a growing body of literature examining their economic impact (Flaaen and Pierce 2019; Benguria and Saffie 2020; Amiti et al. 2019; Cavallo et al. 2021; Fajgelbaum et al. 2020). These studies found substantial welfare costs and indicated that the costs induced by US import tariffs were almost entirely passed through to domestic prices during the trade war. Amiti et al. (2019) show that the import tariffs applied by the US in 2018 led to a monthly increase of \$3.2 billion in tax burdens for US consumers and firms relying on foreign goods, exacerbated by an additional \$1.4 billion monthly in welfare losses. Similarly, Fajgelbaum et al. (2020) reveal that the tariffs and retaliatory tariffs implemented in 2018 led to a 0.27% US GDP loss. Additionally, results from a CGE model with estimated elasticities of substitution across origins highlight the potential heterogeneous effects of tariffs across sectors and regions (Fajgelbaum et al. 2020). In addition, Benguria and Saffie (2020) find that US import tariffs have negatively impacted local labour markets. Indeed, the unemployment rate rose in regions and sectors exposed to retaliatory tariffs, particularly in agriculture. The US import tariffs negatively affected labour primarily through input–output linkages, leading to a decline in the employment share in the manufacturing sector and a decrease in regional earnings. Although the US import tariffs did boost regional earnings in regions and sectors that had protection, they ultimately reduced overall earnings as the higher costs of imported materials and components outweighed this small benefit (Benguria and Saffie 2020). Flaaen and Pierce (2019) corroborate these findings, noting that any positive employment effects from US import protection through tariffs were offset by retaliatory tariffs and increased costs of inputs. While these studies examine the overall and cross-sector impacts of US protectionist measures, we extend this important work and focus on the effects of tariffs on agricultural sectors.

Although the aforementioned studies primarily employ econometric methods, another strand of the literature, which is of particular interest, relies on CGE modelling to simulate the effects of US protectionism. These analyses specifically focus on the economic impacts of increased tariffs imposed during the trade war and quantify the cost of protectionism for both the US and all affected countries, such as China. Table A1 in Appendix A provides a comparative overview of several CGE analyses that investigate the effects of US trade protection. Most of the CGE studies employ the GTAP modelling framework (Kawasaki 2018; Tsutsumi 2019; Li and Whalley 2021; Rosyadi and Widodo 2018; Carvalho et al. 2019). Other approaches include work by Li et al. (2018), who use a general equilibrium model with a noncooperative and cooperative Nash equilibrium tariff war, Bollen and Rojas-Romagosa (2018), who use a WorldScan CGE model developed by the Netherlands Bureau for Economic Policy Analysis, and Guo et al. (2018) who use a general equilibrium model introduced by Eaton and Kortum (2022). Despite model differences, all studies simulate the effects of increased US import tariffs on the US economy and its trading partners. Studies focus on changes in GDP, welfare, trade volumes/values, domestic production, wages and employment under various tariff increase scenarios, including retaliatory tariffs from trade partners.

While the scenario design for simulated tariff changes varies between studies, they generally represent those implemented during the US–China trade war, primarily affecting steel and aluminium. However, there are some exceptions. Rosyadi and Widodo (2018) simulated import tariffs applied on all goods. Similarly, Kawasaki (2018) models scenarios with US import tariffs specifically on Chinese goods, as well as tariffs applied to goods from all countries.

Furthermore, several studies have explored the impact of the US-China trade war on agricultural markets, which were particularly affected by the conflict. Li et al. (2020) used a CGE model with the GTAP database to analyse the consequences of retaliatory tariffs on the agricultural sector. Their findings indicated welfare losses for both the US and China, with soybeans and meat products being especially impacted. Grant et al. (2021) supported these conclusions through a gravity model analysis, estimating that trade retaliation resulted in export losses for the US agricultural sector amounting to \$13.5 billion to \$18.7 billion. They also noted minimal reorientation of exports to nonretaliating markets, suggesting that the negative effects were widespread and challenging to offset. Carter and Steinbach (2020) further supported these observations by identifying two primary effects: trade destruction, which consisted of reduced exports of targeted agricultural products to retaliatory markets and trade deflection, where exports shifted to nonretaliatory markets. Their study found that the overall losses from trade with retaliatory countries surpassed the gains from trade with other markets by more than \$14.4 billion, using an oligopolistic trade model and export supply curve estimates for the US and nonretaliatory markets.

Soybeans and meat products were consistently highlighted as the most affected sectors from the trade conflict. China's 25% tariff on US soybean exports significantly disrupted the market. Adjemian et al. (2021) employed the relative price of a substitute (RPS) method and observed that US soybean prices at the Gulf export location dropped by \$0.74/bu over 5 months. Although the US government responded with trade aid payments amounting to \$8.5 billion, their analysis showed that this support exceeded the estimated tariff damage by approximately \$5.4 billion. Expanding on this, Baryshpolets et al. (2022) developed a theoretical spatial equilibrium model to examine the effects of removing both the Market Facilitation Program (MFP) and Chinese tariffs on soybeans. Their research concluded that eliminating these measures would result in a net gain for US welfare. Building on this, our paper provides a timely contribution by examining various tariff scenarios and potential retaliatory responses that could come into effect under the new US administration, analysing their impact on the trade balance and the US agricultural sector.

One overall takeaway from the literature is that US trade protectionism measures, through the increase in tariffs, lead to negative effects on the US economy, resulting in an overall decline in GDP and welfare, as well as a decrease in imports within protected sectors. These findings are consistent across different studies and scenarios, although the magnitude of the effects varies due to differences in the scenarios simulated in each study. Another significant finding is that import tariffs have heterogeneous effects across different sectors of the economy. The sector-specific impacts vary depending on the tariff scenario, with sectors directly targeted by tariffs often experiencing a decrease in imports and an increase in domestic production. For instance, manufacturing, metal and aluminium and electronic sectors tend to have simulated increased domestic production (Guo et al. 2018; Tsutsumi 2019; Carvalho et al. 2019). Conversely, sectors such as agriculture, processed food, motor vehicles and parts and transport equipment often have declines in production (Tsutsumi 2019). These results align with the findings from the econometric studies mentioned earlier. Finally, some studies also focus on the effects of tariffs on employment, where Bollen and Rojas-Romagosa (2018) and Guo et al. (2018) find a decline in real wages, and Li and Whalley (2021) find a reduction in manufacturing employment.

Although the aforementioned research primarily focuses on the trade war between the US and China and other trade partners, it examines the economic consequences of US trade protectionism on various economic outcomes. Our study similarly investigates the effects of US trade protectionism by simulating the impact of an overall tariff increase on imports from different countries. However, our approach differs in a few key aspects. First, while previous studies simulated the effects of import tariffs contextual to the US–China trade war, often targeting sectors such as steel and aluminium, our work expands the literature by simulating the effect of a future potential 10% increase in US import tariffs across other sectors and trade partners given discussion in the US to consider implementing such measures. This approach allows us to assess the impact of more general protectionist measures while investigating the consequences of potential future policies on various economic outcomes.

In addition, we not only simulate the effect of additional tariffs, but also examine protectionism through the lens of US nonparticipation in trade agreements while the rest of the world continues to liberalise. We therefore evaluate the cost of protectionism in two ways: first, by remaining passive in trade agreements and not engaging in new agreements with other countries, and second, by imposing trade restrictions through import tariffs.

4 | Methodology

4.1 | Modelling Framework

For the analysis, we employ CGEbox, a modular code basis that is based on the GTAP 11 database with extensions to include other CGE modelling features (Britz 2022). Using CGEbox, we employ the G-RDEM module to create a baseline and simulate trade policy scenarios in a recursive dynamic variation of the GTAP model (Britz and Roson 2019). The GTAP 11 Database is a consistent representation of the world economy, which accounts for economic activities in 65 different sectors in 160 countries and regions (Aguiar et al. 2022). We aggregate the database to include 16 regions and 24 sectors focused on agricultural products as described in Tables A3 and A4 in Appendix C. The GTAP model includes behavioural equations based on microeconomic theory and accounting relationships, ensuring that the receipts and expenditures of every agent in the economy are balanced (Brockmeier 2001). An example of a behavioural equation in the GTAP model is the nested demand structure for private demand. An example of an accounting equation is the equality between import demand and export supply between two countries.

The production process is described by a nested Constant Elasticity of Transformation function, containing a nest for intermediates (i.e., intermediate inputs used in the production process) and a value-added nest for factors (capital, land, different forms of labour and natural resources). To align total factor productivity to the expected growth path for each country, the G-RDEM module endogenises a factor-specific shifter in the value-added nest and solves the model with exogenously given population and GDP trends. All counterfactuals that build upon this baseline then maintain the estimated levels for the productivity parameters while national income is endogenously computed (Britz 2022).

The demand for commodities, whether from firms that require intermediates, the government or final consumers, also follows a nested demand structure. In its first nest, consumers choose between different commodities via a Constant-Difference-of-Elasticities (CDE) function; in the second nest, consumers choose between imports and domestic supply via an Armington constant elasticity of substitution (CES) function. Finally, in the third nest, imports are selected from different source countries with another Armington CES function (Corong et al. 2017). This nested Armington structure has several advantages compared to models that assume homogenous products. Consumers and producers can differentiate between commodities from different origins and view them as imperfect substitutes. If prices of foreign varieties change, as in this study's tariff scenarios, the demand side will not immediately shift its entire demand to the cheapest supplier but rather react to price changes in accordance with their preferences. This helps gain more realistic results for outcomes that we see in real trade data, such as intra-industry trade. The CGEbox specification employed for this work deviates from the standard GTAP structure for this dynamic analysis by using a Modified AIDADS (MAIDADS, with AIDADS standing for An Implicit, Directly Additive Demand System) instead of the first nest CDE function. This accounts for Engel curves, where the budget shares of certain goods, such as food, depend on income. While this is usually not necessary to consider in comparative static models with a short time horizon and limited income changes, it becomes relevant in model exercises that simulate economies over longer time horizons or that may have considerable impacts on incomes.

While there are several possible choices for the economic modelling of the effects of trade policy, such as partial equilibrium models or gravity models, a global model with several disaggregated, interacting regions and sectors is in this case not only a useful but necessary choice. Considering that this study investigates the effects of tariff changes among non-US regions on the US economy, the model needs to account for tariff changes from trade agreements in other parts of the world to simulate their direct and indirect effects. The CGE modelling framework we employ allows us to investigate the effects of tariff changes throughout the US economy. The GTAP database provides the necessary foundation for multiregion, multisector analysis with a focus on international trade and is the most common database employed for this type of analysis. The CGEbox framework allows for several customisations for the baseline generation and the MAIDADS adaptation of the demand structure within the recursive dynamic CGE model for this work.

4.2 | Baseline and Scenarios

The baseline serves several purposes. On one hand, general trends and developments that occur "in the background" are incorporated into the policy analysis. On the other hand, a baseline allows us to display results net of some of the shocks in the global economy that we do not explicitly model. For instance, neither recent monetary policies, COVID-19, nor the war in Ukraine are part of this study. The price trends in the baseline, thereby, do not give a realistic picture of the real inflation trends over recent years, and even additional modelling work may not include all factors affecting the global economy. While this is not ideal, the baseline allows us to find the model's pathway without any additional shocks. By showing results as changes from the baseline, we present the results of our policy scenarios net of these modelling-specific trends.

For the scenarios, we implement all tariff reform from trade agreements notified to the WTO over the last 10 years in a simplified fashion focusing on the entailed tariff changes. Details on this can be found in Appendix B (Table A2). For the policy scenarios, all trade agreements, including those with future effects, are included. The tariff changes are aggregated to GTAP sectors with the TASTE program (Horridge and Laborde 2008). The regional disaggregation we adopt for the database leaves the most important US trade partners disaggregated. We leave GTAP database sectors disaggregated except for a few raw agricultural products and most services sectors, which are typically not the primary focus of tariff liberalisations. This allows us to investigate the sector-specific effects of changes in trade policy. This research considers four trade policy scenarios as follows:

- 'Trade Agreements': Global tariff changes resulting from current preferential trade agreement commitments.
- 'U.S. 10': Trade Agreements plus a minimum import tariff of 10% imposed by the US on all imports from all trade partners.
- "U.S. Cons 10": Trade Agreements plus a minimum import tariff of 10% imposed by the US on all trade partners, but only on commodities for final consumption.
- "Trade War": Trade Agreements plus a US trade war, where a minimum import tariff of 10% is imposed by the US on other countries and by other countries on imports from the US, both only on commodities for final consumption.

Our first scenario includes only the trade agreements in the rest of the world and thus depicts the effects of the current reluctance of the US to engage in trade liberalisation. Our second scenario follows US Presidential campaign rhetoric considering a general 10% import tariff on all commodities (Stein 2023). Such an import tariff might not only increase consumption prices but also face some resistance by industry since US producers would be required to import intermediate inputs at considerably higher prices, which lowers their competitiveness. Thus, the third scenario differentiates between imports that are more likely to be directed to final consumption and imports that are more likely to serve as intermediate inputs. The 'U.S. Cons 10' scenario only imposes an import tariff increase on goods intended for final consumption, essentially shielding US industry from the negative effects of a tariff increase on imports of intermediates for use in production. Finally, the fourth scenario depicts a trade war where the entire world retaliates with a 10% minimum tariff on all final consumption goods imported from the US. For the third and fourth scenarios, we differentiate between commodities that are more likely to be for final consumption and commodities that are more likely to be used as intermediate inputs.

4.3 | Model Closure

In general, model closures specify which variables are exogenous and which are endogenously varied to achieve market clearing in the CGE model. Thus, the closure defines which variables can be exogenously changed to simulate economic shocks and directly influence simulation results and interpretation. Over different time periods or circumstances, different closure assumptions may be appropriate.

Critical closure decisions of GTAP-based models are labour and capital mobility. Our work assumes that labour and capital are fully mobile, which implies that labour and capital markets readily adapt to new circumstances. Our results should thus be considered optimistic regarding labour market frictions, as real-world situations are likely to entail transition costs such as retraining, relocation or temporary unemployment that we do not consider. In addition, capital, to the extent that it is not depreciated, can be specialised and thus difficult to transfer to another sector in certain instances.

Another critical closure decision concerns the allocation of global foreign investments. In the standard GTAP model, countries' access to foreign investments depends on the rate of return on investments, corrected by risk parameters. This assumption and perfect capital mobility have been analysed and questioned in the empirical literature (Apergis and Tsoumas 2009). In Section 2, we explained why the US is a strong attractor for foreign capital in ways that are not connected to the rate of return and how this enables a persistent trade deficit. To reflect this, the closure for this research is adapted so that countries receive a fixed share of global foreign investment.

There are challenges related to closure assumptions when comparing observed data to the model baseline. For example, we do not adopt closure assumptions that relate to the COVID-19 pandemic or the war in Ukraine that dramatically affected markets. To consider the impact of the COVID-19 pandemic, for example, additional closure modifications could be employed, such as exogenously limiting consumption. However, this would likely yield unintended changes in model dynamics, including changes in savings and other important macroeconomic variables for the full study period. Accordingly, we adopt standard closure assumptions apart from fixing international investments. While the model baseline does not match perfectly with historical data for GDP, baseline results are very close to observed values for trade flows, which is the focus of this analysis, and is described in the results section.

5 | Data

CGEbox (Britz 2022) is based on the GTAP 11 Database (Aguiar et al. 2022) and includes the G-RDEM baseline generation module (Britz and Roson 2019). The baseline population and GDP growth projections are based on the 'Middle of the Road' shared Socioeconomic Pathway (SSP2), which are drawn from the OECD Env-Growth Model, see Dellink et al. (2017). Additionally, crop yield and crop land expansion across regions for the baseline are from the Food and Agriculture Organisation (FAO 2018). Based on this, the baseline endogenously estimates changes in total factor productivity while accounting for debt accumulation and productivity growth differences by sector.

To generate the tariff reform for trade agreements in all scenarios, we considered all trade agreements that were notified to the WTO since 2015 (WTO 2024). We list trade agreements together with their respective GTAP regions in Appendix B, Table A2. Each trade agreement is then implemented over the course of 3 years from the start of each agreement, granting the often-sensitive agricultural commodities a longer term for their tariff abolition as described in Table 1.

Furthermore, the withdrawal of the United Kingdom from the European Union caused some long-term tariff changes, which we also include in our analysis. Details on this are in Table A2. The resulting tariff changes were compiled using the TASTE program (Horridge and Laborde 2008), which has been regularly updated by Pelikan et al. (2020) with MAcMap Data (Guimbard et al. 2012, ITC 2020). For the baseline, only tariff changes until 2017 are included. For all policy scenarios, all tariff changes from trade agreements are included.

For the third and the fourth scenarios, we distinguish between commodities intended for final consumption and intermediate input demand. While most imports are not differentiated by use at the border, the classification of Broad Economic Categories (BEC) is a three-digit classification that groups transportable goods according to their main end use (United Nations 2018). By using concordance tables from the United Nations Statistics Division (2024), we translate between the Harmonised System (HS) and the BEC classification and assign end uses to each six-digit HS code.

In terms of tariff changes, it makes a major difference whether only final consumption commodities are affected or whether intermediates are also targeted (Figure 8). Metals, chemicals and energy-related sectors such as fuels and gas, wheat, plant-based fibres, oilseeds and live ruminants are examples of products used as intermediate inputs or are subject to further processing before they meet the end consumer. Consequently, tariff changes for these sectors are much smaller when only final demand imports are targeted. On the other hand, fruits and vegetables, processed food, meat, textiles and paper hardly see exemptions from a new potential US minimum tariff since they are considered final consumption goods.

Figure 9 depicts import tariffs imposed on US exports across scenarios. US trade partners already apply relatively high tariffs for several agri-food sectors, including processed rice, cereal grains and meat products. Additionally, several crops are considered intermediate inputs, including plant-based fibres and live animals, whereby they would be excluded from retaliation during a trade war according to our scenarios. Horticultural commodities, some animal products, processed food and energy-related sectors such as fuels and gas go through a noticeable increase in tariffs under a trade war scenario.

6 | Results and Discussion

6.1 | Baseline Comparisons to Observed Data

In Figure 10, we include a baseline with a standard closure that includes equal returns to capital alongside the modified baseline used for this work that includes a fixed global allocation of investment and compare both baselines to historic US trade balance data. The model-simulated baselines are more optimistic about the ability of the US to improve its trade balance compared to observed data. The closure adaptation we employ for

TABLE 1 | Tariff implementation schedule for all policy scenarios.

	Year 1	Year 2	Year 3
Agricultural commodities	Linear cut by 33%	Linear cut by 66%	Abolished
All others	Tariffs abolished	Tariffs abolished	Tariffs abolished

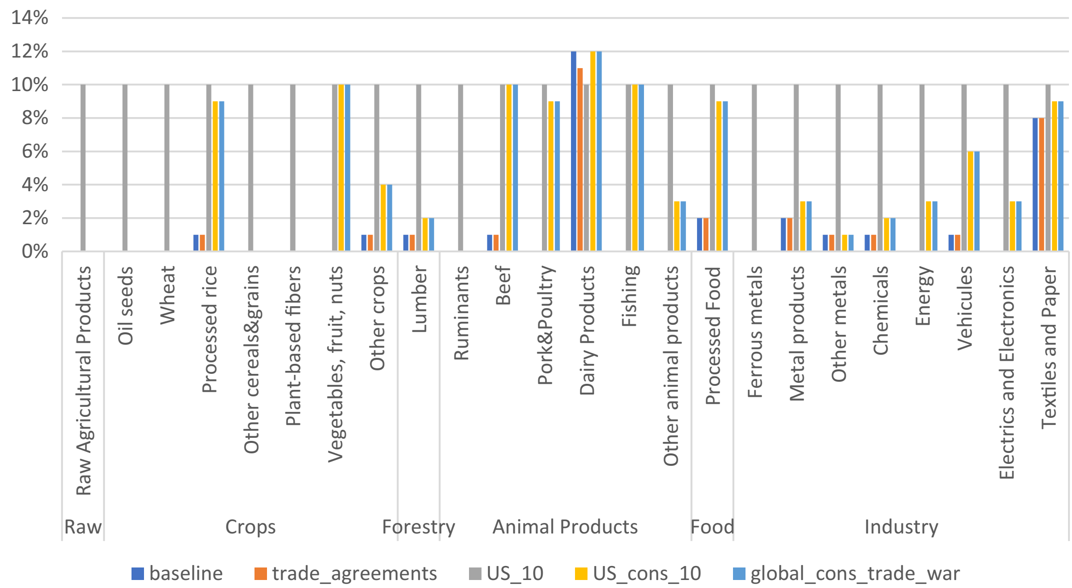

FIGURE 8 | US import tariffs on goods for different scenarios, trade-weighted average. *Source:* Authors' calculations based on TASTE output. [Colour figure can be viewed at wileyonlinelibrary.com]

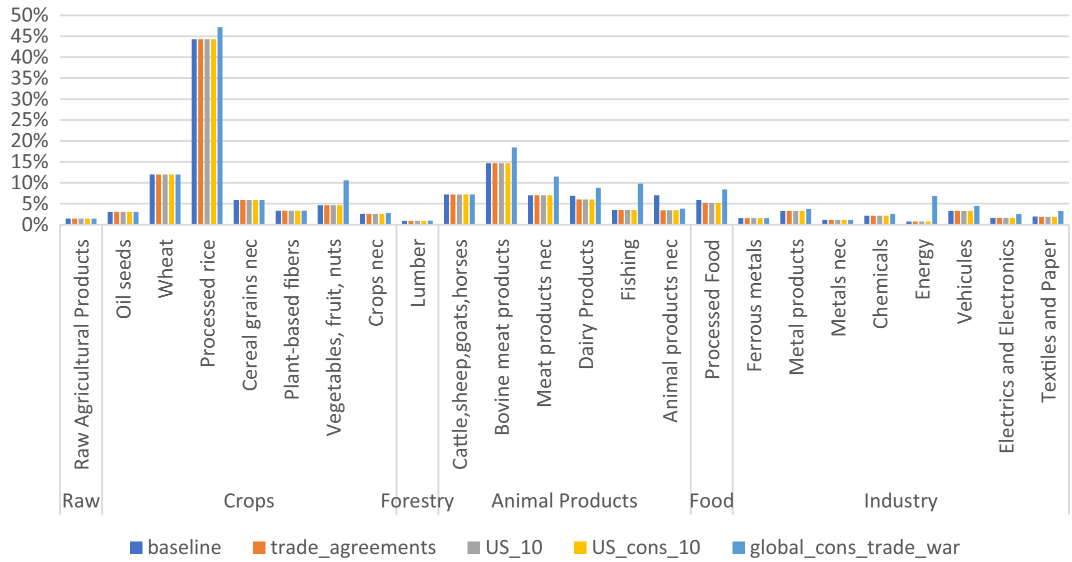

FIGURE 9 | Import tariffs that other countries impose on goods coming from the United States. *Source:* Authors' calculations based on TASTE output. [Colour figure can be viewed at wileyonlinelibrary.com]

our analysis clearly results in a more realistic trend for the trade balance, which confirms the closure choice that includes fixed investment shares as described in Subsection 4.3. Yet, there are still trend deviations, particularly from 2020.

Figure 10 also displays the trade agreements scenario employed in tandem with both baselines. They yield very similar trade balance values as the respective baselines, indicating that not including trade agreements in the baseline assumptions is not the reason for the strong deviation from historical data. In Subsection 4.3, we explained that while a closer alignment with historical values would be ideal, we refrain from adding model assumptions that aim to consider the numerous economic developments that have defined recent years. Although the overall trade balance, which includes exports and imports, appears to be disconnected from historical values, a comparison of historical export and import values with the model results included in the next subsection (Figure 11) as well as historical GDP per capita values compared to model results (Figure 12) indicates that the model shows consistent trends in relevant macroeconomic measures.

6.2 | Effects on Trade

Figure 11 shows that, according to the baseline in which no trade agreements were in place, both imports and exports show an increasing trend over recent years. Despite some fluctuations,

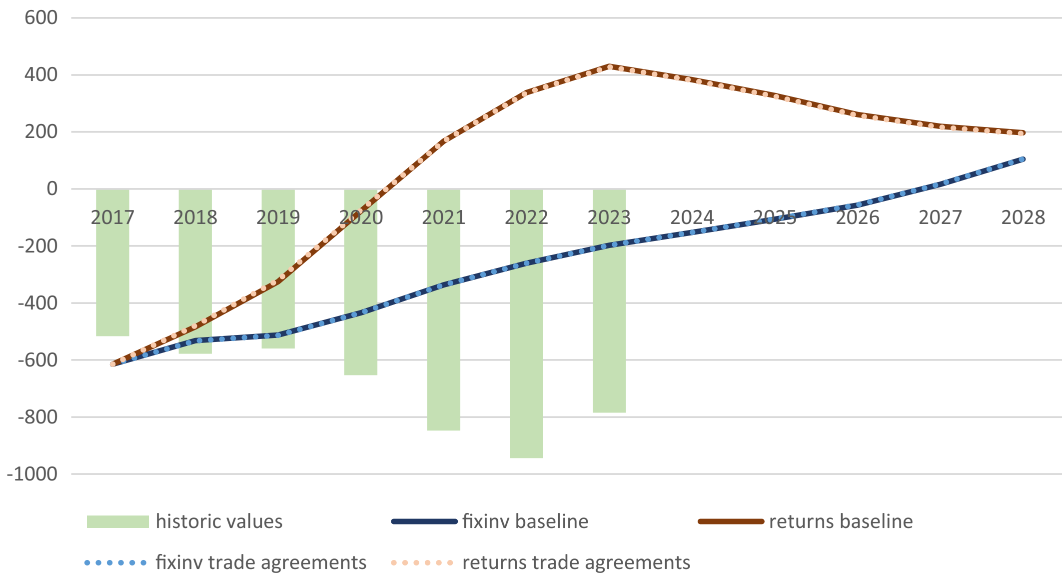

FIGURE 10 | Observed US trade balance and simulated values for a baseline with standard CGE closure ('returns baseline'), the modified baseline employed for scenarios with fixed global allocation of investment ('fixinv baseline'), and the respective trade agreements scenarios. *Source:* Authors' simulations and historic data from World Bank Open Data (2024b, 2024i). [Colour figure can be viewed at wileyonlinelibrary.com]

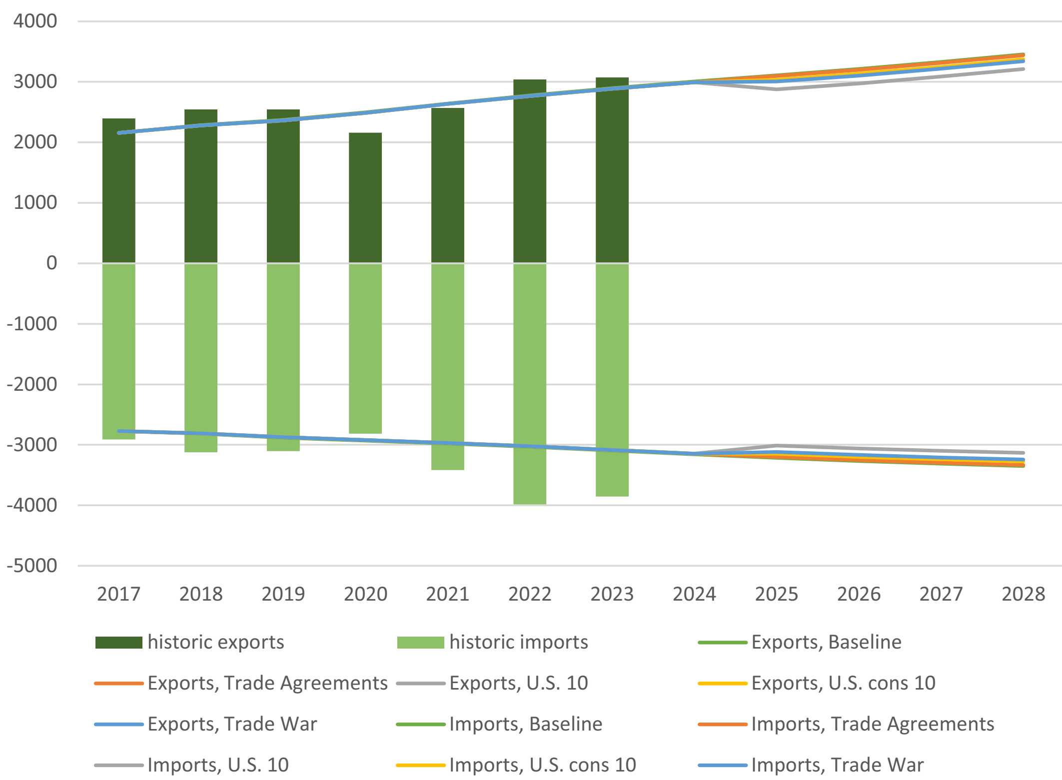

FIGURE 11 | Exports (positive) and imports (negative) for different scenarios in billion USD. *Source:* Authors' simulations and historical data from World Bank Open Data (2024b, 2024i). [Colour figure can be viewed at wileyonlinelibrary.com]

this trend roughly aligns with historical import and export data from the same years. We can then compare deviations for the four scenarios in 2025 (see Table A5):

- Trade Agreements: Once the trade agreements that entered into force in other regions of the world are accounted for, both US imports and US exports decrease. In 2025, US imports and exports are each 0.4% lower than the baseline. This reflects how refraining from liberalisation reduced US trade activity, leading to diminished integration into global trade, albeit with a relatively minor effect on the trade balance.
- US 10: A minimum import tariff of 10% strongly diminishes US integration into world trade by decreasing imports by

6.3% and exports by 7.5%, resulting in a further expansion of the trade deficit by USD 30.5 billion compared to the baseline.

- US Cons 10: If the additional tariffs are limited to final consumption commodities, the effects on overall trade have the same sign as the US 10 scenario but are of smaller magnitudes. In 2025, imports are 2.1% below the baseline and exports are 2.4% below the baseline. The trade deficit expands by $9.2 billion relative to the baseline, which is lower than the US 10 scenario.
- Trade War: Finally, retaliation in response to US import tariffs on final consumption goods would further enhance the disintegration of the US in world trade, lowering imports 3% below the baseline and exports 3.4% below the baseline in 2025. In the Trade War scenario, the trade deficit is USD 8.5 billion larger than the baseline.

In sum, the protectionist stance to refrain from entering trade agreements has hurt US competitiveness, and while tariffs may reduce imports, they also hurt exports. Several economic interactions across policy regimes affect US trade and domestic production. First, US producers rely on both domestic and imported intermediate inputs, and tariffs on imported intermediates increase production costs and reduce the ability to produce competitively. Second, consumers facing higher prices for imported goods may substitute domestic products, which, given limited production capacity, reduces the share of domestic production that can be exported. Third, capital inflows to the US are also affected. Since investments are fixed in the closure employed, investments into the US will not decrease if imports decline. Accordingly, other items in the balance of payments will adjust in the model, primarily the trade balance. In reality, potential US domestic policies could be implemented to further affect the trade balance and capital inflows, such as a lowered government deficit.

6.3 | Effects on GDP and Output

The impacts on per capita GDP are negligible across scenarios relative to the baseline. Even a 10% minimum tariff on all goods only has a minor negative effect, decreasing per capita GDP 0.1% below

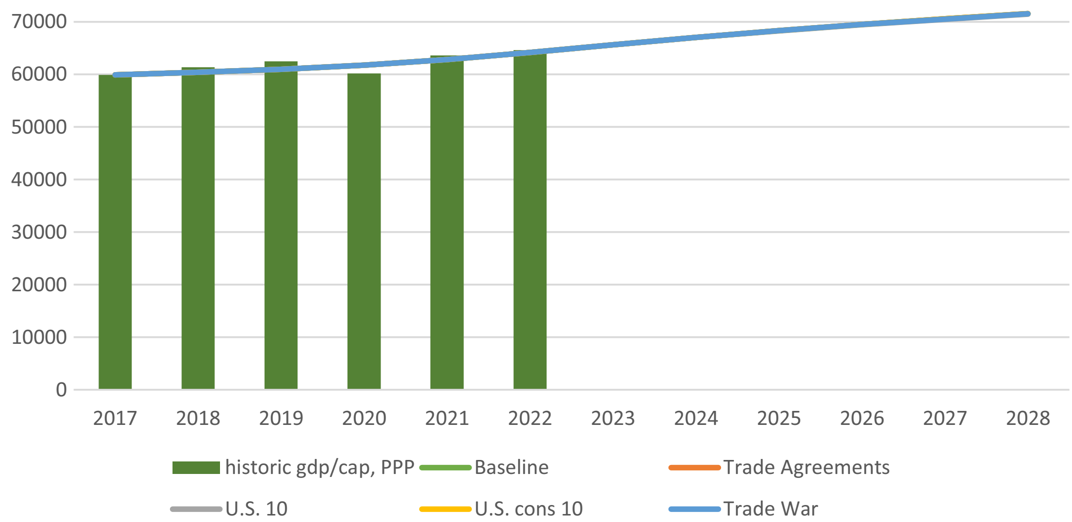

FIGURE 12 | GDP per capita in different scenarios and in real values. *Source:* Authors' simulations and World Bank (2024). [Colour figure can be viewed at wileyonlinelibrary.com]

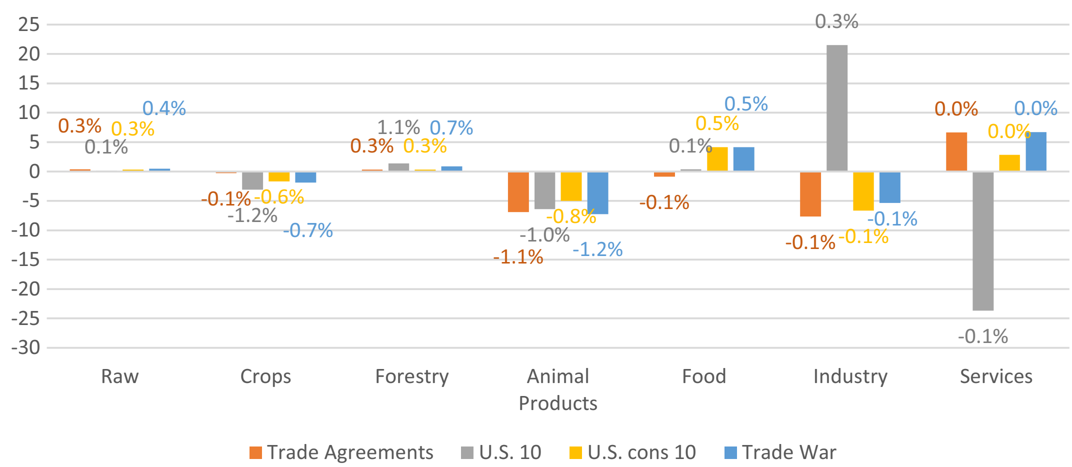

FIGURE 13 | Absolute output volume changes for different sector groups in billion USD compared to baseline values. Relative sectoral changes are also indicated by percentage changes. *Source:* Authors' simulations. [Colour figure can be viewed at wileyonlinelibrary.com]

baseline levels in the years following the policy implementation (Figure 12). However, there are important implications when considering the impacts on the various sectors contributing to GDP. For example, if a 10% minimum tariff is imposed, industrial sector output volume increases by USD 20 billion, while services sector output volume decreases by USD 20 billion (Figure 13).[1] Thus, despite the small impact on overall GDP, tariffs can have a transformative effect on the US economy, causing numerous changes in output, wages and prices at a more disaggregated level.

In terms of their contribution to GDP, the agricultural sectors play a minor role in the overall picture. According to the 2025 baseline output volumes, 73.5% of total US output is generated in the services sectors, 21.7% in the industrial sectors, and only 2.8% in the agricultural sectors (including related primary production such as fishing and forestry), plus another 1.9% when food processing is included. Figure 13, however, shows that while their absolute changes are not large in levels, the impacts are noteworthy in relative, percentage change terms. Accordingly, we further describe the trade policy effects across agricultural sectors.

6.4 | Effects on Agricultural Production

In Figure 14, the agri-food sectors from Figure 13 are depicted in more detail. For the group of crops, the changes from the tariff agreement scenario are minor. Even with a 10% tariff, the output changes are mostly negative, but still small in relative and absolute terms (less than 3% and less than USD 1 billion respectively), except for losses of up to 8% in the relatively small US rice sector and losses of up to 11% or USD 1.6 billion in the other crops sector. For most crops (except horticultural products) a 10% tariff is noticeably worse than the mere enforcement of trade agreements in other parts of the world. In the group of animal products, the effects are also mostly negative, except for in dairy, where tariffs are currently already high without any tariff changes (see Figure 8). Particularly, beef and pork & poultry production stand out as relatively large primary agricultural sectors in the US. In contrast to crops, the simulated changes for animal products are larger under the trade agreements scenario and smaller under the US 10 scenario. This means that animal products have suffered from the long-term protectionist stance, while a 10% import tariff manages to mitigate these effects to some extent. This is also the case for forestry and food processing. Food processing stands out because of its absolute size relative to other agricultural sectors and because it reacts differently to different scenarios. Trade agreements in the rest of the world have a minor negative impact on processed food output (less than −1%), which is mitigated by a 10% tariff on all US imports. However, a targeted import tariff that only applies to final goods leads to minor output gains of approximately 1% for processed food. This is because food processing relies on crops and other imports as intermediate inputs, and sparing imported intermediate inputs from a tariff increase allows this sector to continue to benefit from relatively lower costs for imported varieties in its production.

By differentiating between workers with different skills, one can track the development of agricultural and unskilled labour in relation to other professions (Figure 15). While the implementation of trade agreements in the rest of the world had a very small negative effect on wages for all skillsets, this is more than offset by tariff increases. Workers in agricultural or unskilled labour follow the general trend of the other professions in most scenarios—only in the case of a 10% minimum tariff does their path deviate from other professions, showing a slightly higher increase in wages.

Employment effects can be further explained by considering the factor use of agricultural and unskilled labour and worker movement across sectors (Figure 16). Notably, worker professions are not exclusively linked or fixed to sectors. For example, nonagricultural sectors employ labour that is in the agricultural and

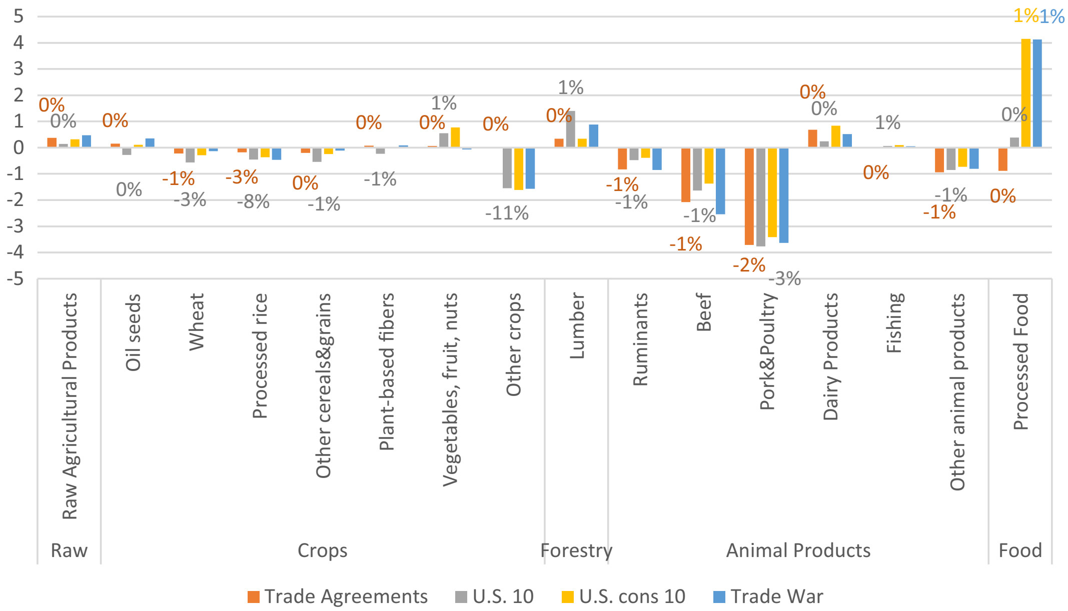

FIGURE 14 | Absolute changes in sectoral output volumes in billion USD compared to baseline values. For the scenario trade agreements and US10, sector changes are also depicted in relative (percentage change) terms. *Source:* Authors' simulations. [Colour figure can be viewed at wileyonlinelibrary.com]

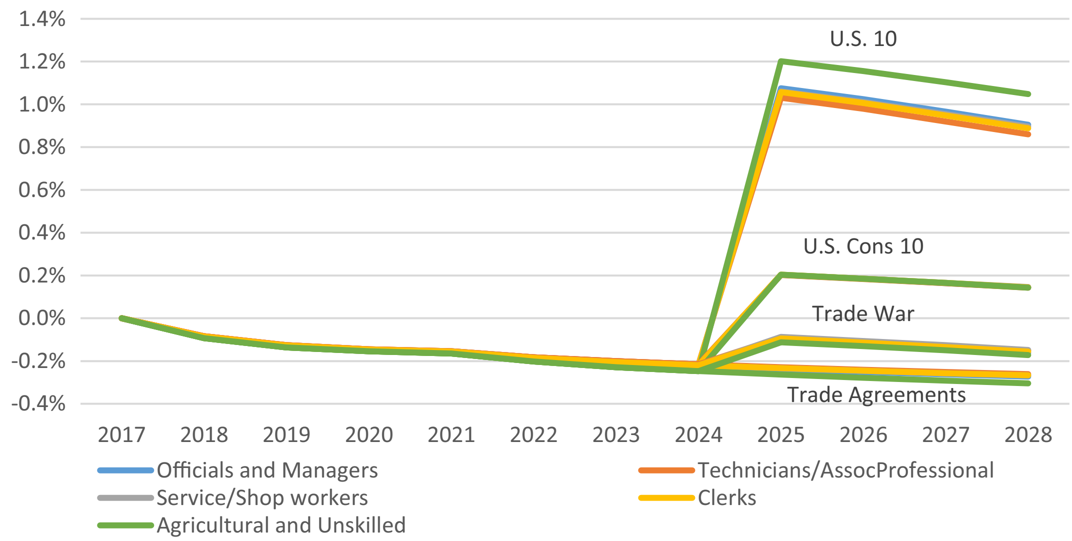

FIGURE 15 | Wages in comparison with baseline levels. *Source:* Authors' simulations. [Colour figure can be viewed at wileyonlinelibrary.com]

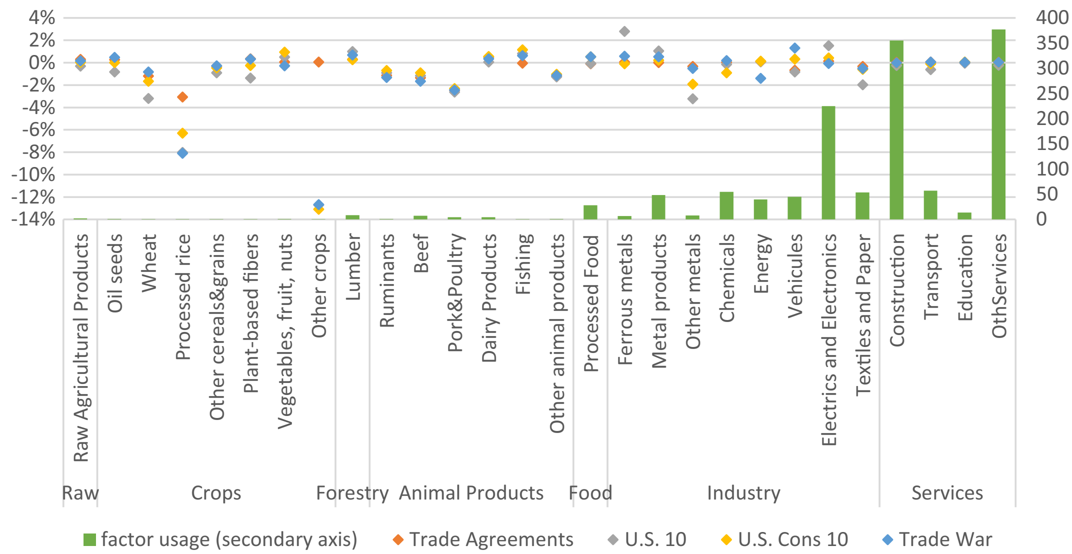

FIGURE 16 | Employment and movement of agricultural and unskilled labour across sectors. The bar graph shows the baseline employment of agricultural and unskilled labour in billion USD (see footnote 1 for units of measurement), while the dots show the increases and decreases in employment across sectors for all scenarios for the year 2025. *Source:* Authors' simulations. [Colour figure can be viewed at wileyonlinelibrary.com]

unskilled professions, and agricultural sectors employ labour from other professions. Additionally, professions are mobile across different economic sectors. Because of this, workers with different skillsets can leave the agricultural sector and move to sectors that benefit from the tariff increases. While we model labour as perfectly mobile, we acknowledge that labour markets may have frictions related to mobility that we do not account for. There is empirical evidence suggesting that workers employed in agriculture may not be able to leave rural employment easily and that modelling a factor market segregation between agricultural and nonagricultural sectors may yield a more realistic depiction of rural employment (Keeney and Hertel 2005). Real-world effects may therefore result in a decline in agricultural wages or a rise in rural unemployment that our model does not depict.

6.5 | Effects on Consumers

Figure 17 shows the baseline decline in the real consumer price index. This should not be confused with nominal inflation, which is not part of our model. Nominal inflation reflects changes in the price of a basket of goods and is driven by the relationship between the supply of goods and the supply of money. With the disruption of consumption during the COVID pandemic and the oil price shock of the Ukrainian war, nominal inflation in the US experienced a spike that is not included in our model, and all prices are expressed in real terms, with the world factor price index and the model's numeraire. According to the real consumer price index, US consumption becomes cheaper in the baseline. While trade agreements in the rest of the world lead to slightly lower prices faced by US consumers,

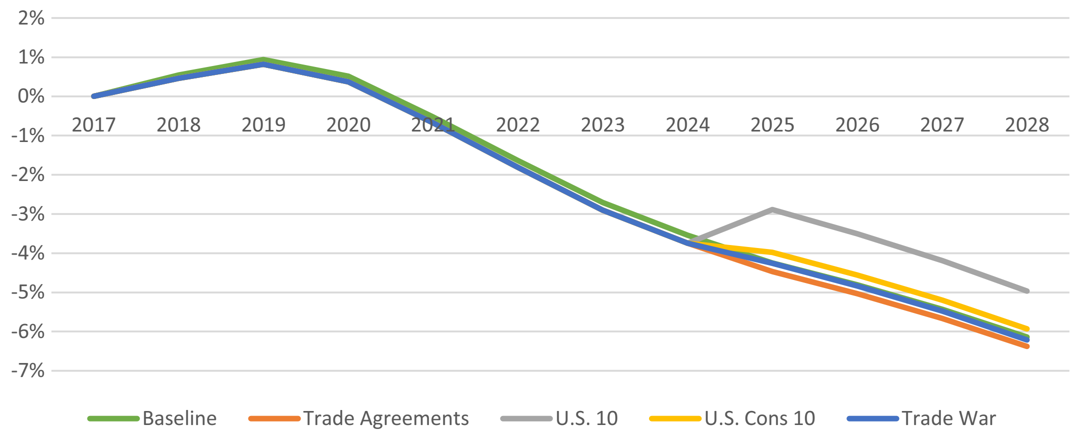

FIGURE 17 | US real consumer price index changes in comparison with 2017 values. *Source:* Authors' simulations. [Colour figure can be viewed at wileyonlinelibrary.com]

tariff increases raise consumer prices above the baseline level. It is worth noting that tariffs imposed on intermediate and final goods amplify impacts on consumer prices compared to tariffs imposed only on final goods, as domestic producers pass on the increased costs of intermediate goods and domestic consumers have less flexibility to substitute relatively more expensive imports for less expensive domestically produced goods.

This consumer price index change also puts wage changes into perspective. The positive effects of wage increases on US workers are eroded entirely by increased price levels, resulting in a slightly negative effect on overall purchasing power (Table 2). The increase in the consumer price index also negatively affects potential losses of nonlabour incomes. Recipients of land rents, who are among the winners of a baseline scenario, lose part of this income with all protectionist scenarios and have purchasing power reductions of up to 5% in the 10% tariff scenario. Capital rent recipients can generate minor gains in the 10% tariff scenario, which are entirely eroded when expressed in terms of purchasing power. Recipients of rents from natural resources slightly lose in the 10% tariff scenario, and more so in the trade war scenario with a loss of purchasing power of up to 4% compared to the baseline.

7 | Conclusion

The protectionist rhetoric of US politics has engendered criticism from economists, supported by several studies that illustrate the negative economic effects of protectionism (Amiti et al. 2019; Bollen and Rojas-Romagosa 2018; Carvalho et al. 2019; Fajgelbaum et al. 2020; Guo et al. 2018; Kawasaki 2018; Rosyadi and Widodo 2018; Tsutsumi 2019). Most research has found that additional US import tariffs lead to negative effects on the US economy, resulting in an overall decline in GDP and welfare, as well as a decrease in imports within protected sectors (Bollen and Rojas-Romagosa 2018; Carvalho et al. 2019; Guo et al. 2018; Kawasaki 2018; Rosyadi and Widodo 2018; Tsutsumi 2019). However, these effects can be unevenly distributed across affected sectors.

Indeed, when tariff levels across global regions are compared for the term of the last two American presidencies, plotting the effects of the trade agreements that took place in the rest of the world quickly shows that other regions were able to improve their access to foreign markets, while often not even drastically reducing their own import tariffs. This could leave the US in an unfavourable position. Compared to other regions, the US has a relatively low trade-weighted import tariff of about 1.3% but faces a relatively higher, though still low, tariff barriers for its own exports of about 2.8%. By not being part of the liberalising ambitions of other countries, the US may see an increasing discrepancy between its own export potential and the export potential of competitors. Also, spillover effects and other productivity gains due to exposure to trade may pass by US firms.

On top of the reluctance to participate in trade agreements, there is some advocacy for increasing US import tariffs, including a proposed minimum 10% tariff on all imports. The logic of raising tariffs may seem appealing at first: by discouraging domestic consumers from buying imported goods and domestic producers from importing inputs, one could encourage local production and reduce overall imports. Such a tariff increase may, however, not only harm domestic consumers and contribute to inflation but also harm domestic producers that depend on imported intermediates and lose their competitiveness. An attenuated variation of a 10% minimum tariff applied to all US imports may, therefore, lie in a 10% minimum tariff on final consumption commodities while protecting US firms from increased tariffs for intermediate inputs.

To quantitatively analyse these potential policies, we simulate the effects of the free trade agreements that came into force during the last two US presidential terms and compare them with a hypothetical baseline in which these developments did not occur. For the coming presidential term, we simulate the continuation of recently concluded trade agreements in addition to scenarios that include a minimum 10% tariff on all imported goods, a minimum 10% tariff on all final consumption commodities and a trade war scenario where the rest of the world retaliates with a 10% tariff on all consumption commodities from the US.

The US reluctance to pursue trade agreements, while the rest of the world continued to liberalise, did not affect the trade balance in a clearly negative fashion, according to our simulations. Even

TABLE 2 | Percentage change in the purchasing power of US workers and recipients of other factor incomes, difference from baseline. Purchasing power expressed as wages (or rents) to consumer price index ratio.

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Trade agreements	Officials and Managers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Technicians/ Assoc. Professional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Service/Shop workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Clerks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Agricultural and Unskilled	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Natural Resources	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.7	0.3
	Capital	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	−1.0	0.2	0.2	0.3
	Land	0.0	−1.6	−1.4	−1.2	−1.0	−0.9	−1.2	−1.0	−0.8	−1.0	−1.1	−0.7
US 10	Officials and Managers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.3	−0.3	−0.3	−0.3
	Technicians/ Assoc. Professional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.4	−0.4	−0.4	−0.4
	Service/Shop workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.4	−0.4	−0.4	−0.3
	Clerks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.4	−0.4	−0.4	−0.4
	Agricultural and Unskilled	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.2	−0.2	−0.2	−0.2
	Natural Resources	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	−1.4	−1.4	−1.3	−1.7
	Capital	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	−1.4	−0.1	0.0	0.1
	Land	0.0	−1.6	−1.4	−1.2	−1.0	−0.9	−1.2	−1.0	−5.1	−4.9	−4.7	−4.3
US Cons 10	Officials and Managers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Technicians/ Assoc. Professional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Service/Shop workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Clerks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Agricultural and Unskilled	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Natural Resources	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	−0.3	−0.3	0.3	−0.2
	Capital	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	−0.3	−0.3	−0.2	−0.2
	Land	0.0	−1.6	−1.4	−1.2	−1.0	−0.9	−1.2	−1.0	−3.0	−3.0	−2.9	−2.6

(Continues)

TABLE 2 | (Continued)

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Trade war	Officials and Managers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Technicians/ Assoc. Professional	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Service/Shop workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Clerks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Agricultural and Unskilled	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.1	−0.1	−0.1
	Natural Resources	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	−4.0	−4.3	−3.9	−4.1
	Capital	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	−1.2	0.0	0.1	0.1
	Land	0.0	−1.6	−1.4	−1.2	−1.0	−0.9	−1.2	−1.0	−3.1	−3.3	−3.1	−2.8

Source: Authors' simulations.

with the comparably ambitious assumption that all concluded trade agreements gradually abolish all tariffs, the US could elevate its trade balance above the baseline scenario in some years since the protectionism of the US discouraged both imports and exports.

This negative effect on not only imports but also exports is much more drastic in the case of a 10% tariff on all imports into the US, resulting in an overall expansion of the trade deficit by USD 30.5 billion. Implementing a minimum tariff only for final goods makes these trade deficit effects less pronounced. If other countries retaliate by also applying a minimum tariff of 10% on final goods, this further decreases exports and imports with an overall small negative effect on the US trade deficit, which expands by USD 8.5 billion relative to the baseline. For GDP, minimum US tariffs as well as a trade war scenario have simulated negative effects, but they are not very pronounced. Three effects are likely to cause this persistence of the trade deficit: first, US producers rely on imports for inputs. When these inputs become more expensive due to tariffs, this harms the competitiveness of US exports. Second, consumers react to increased import prices by switching to domestically produced alternatives. If domestic production is not able to expand enough to compensate for this increased demand, this will relocate former exports into the domestic market. Third, the US benefits from high foreign investment in the private sector, government securities, and the US Dollar. As described in the background section, these investments directly relate to the trade balance and are unlikely to decrease under lowered imports. Thus, in reality, reduced imports are likely to lead to an adaptation in exports via exchange rate changes if the US government does not implement corresponding policies on the side of foreign investments, such as a reduced public deficit.

At the same time, while the overall trade balance would be harmed by the tariff increases and overall GDP per capita shows little change, a few industrial sectors can benefit from increased tariffs, according to our analysis. However, agricultural sectors overall tend to decrease output under protectionism, although results vary across agricultural sectors upon closer inspection. Many crop sectors are hardly affected by trade agreements that take place in the rest of the world, while a 10% tariff leads to production declines of several percent. The other crops sector is particularly affected, with a decline of 11% or 1.5 billion dollars if the US imposes a 10% tariff on imports. Animal products, on the other hand, are harmed by trade agreements in the rest of the world, with production declines of up to 2% or USD 3.7 billion for pork and poultry, followed by production declines of 1% or USD 2.1 billion for beef. A 10% import tariff does not exacerbate losses for animal products in a noteworthy manner.

We considered US workers to be immobile across skill groups, but mobile across sectors, meaning that workers within a skill group may flexibly change employment across sectors under wage differences. Therefore, even workers in sectors with decreasing sectoral output can benefit from protectionism by switching to an industry that gains from protectionism if they are able. From a consumer perspective, import tariff increases and the trade war scenario lead to higher prices and fewer affordable options in the supermarket. Even under the best-case assumption of mobile factors, our analysis shows that wage increases are not sufficient to offset the consumer price increases. When wages are put in relation to consumer prices, we can see that the purchasing power of US workers decreases under all forms of protectionism, and even the purchasing power of recipients of nonlabour income is mostly negatively affected by the tariff increases.

This research provides important insights into the implications of past and potential future trade policy considering increased US protectionism with a particular focus on impacts on agricultural sectors. This work also finds that the US trade deficit widens when the US refrains from trade liberalisation and when protectionist policies are implemented. There are important limitations of this analysis. First, there have been several important economic developments globally that we do not explicitly model in the baseline, including the COVID-19 pandemic and the war in Ukraine, which are outside of the scope of this analysis. Second, trade agreements have nuanced specifications and tariff schedules that we implement in a simplified manner. Third, we only consider import tariff reform and do not account for nontariff measures included in trade agreements across scenarios. There is a robust literature that investigates the effects of changes in nontariff measures that we do not consider in this work (Kinzius et al. 2019; Grundke and Moser 2019; Orefice 2017; Chen et al. 2022). Given that global tariffs are relatively low, resulting from previous trade reform, and recent trade agreements focus on deeper integration across economies, further research is warranted to investigate the potential economy-wide effects of the deeper integration within trade agreements beyond the changes in tariffs that we investigate in this study.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the Global Trade Analysis Project as cited in text and in References.

ENDNOTE

[1] GTAP-based models measure output volume in terms of value at the calibration point, with the price being initially normalised to 1 and able to change over time, whereby relative price changes can be considered. Without this approach, it would be challenging to aggregate the vastly different units of measurement for different outputs. This can be interpreted as the output volume measured at 2017 prices.

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Appendix A

Literature Summary of Comparable Studies and Their Main Outcomes

TABLE A1 | Literature for trade protectionism using CGE models.

Authors	Method	Data	Simulated scenario	GDP/welfare	Exports/imports	Production	Wages/ employment
Kenichi Kawasaki (2018)	Static CGE modelling using GTAP	GTAP database version 10	2 scenarios: import tariff hike of 25% worldwide on all metal and metal products; 10% tariff on US imports of all goods from all countries	0.2% decrease in global GDP, and with a 10% tariff US real GDP decrease by 0.7%	Improvement in US trade balance by 1.3 billion (for all sectors).	NA	NA
Li et al. (2018)	GE model, with an endogenous trade imbalance structure	2013 as the benchmark year	Mutual tariff war with 45% import tariff rate between Chian and US	GDP in the US increases by 0.007%	Negative effects on trade	US manufacturing production decrease with Chinese tariff retaliation	Negative effect on employment
Guo et al. (2018)	GE model of Eaton and Kortum (2022)	OECD Inter-Country Input–Output database (ICIO) 2015 edition	Four scenarios: Increase in import tariff by 45% to China (US/CHINA), and to the ROW (US/ROW), and retaliation scenarios from both parties	US experience a welfare loss of 0.66% (US/CHINA) and 1.74% (US/ROW)	US experiences a decrease of 73% of imports from China (US/CHINA). Global total imports drop by 10.73% (US/ROW)	US Domestic production increases by more than 20% in the computer, textiles, and electrical equipment sectors (US/CHINA) US/ROW: textiles sector doubles production followed by the computer sector with an 80% increase and electrical sector with a 70% increase	US/Row: real wages in the US will decline by around 2%
Tsutsumi (2019)	GTAP models, with an additional equation to link trade openness and technological changes	GTAP database version 9	Simulate the tariffs imposed by the US on China in 2018	Decrease of GDP by 0.1%, and by 1.6% if consider capital deepening and technological spillover	Decrease in export by 3.61%	Light manufacturing sector, and electronic and machinery equipment sector expand, while the agriculture and processed food sector and motor vehicles, transport equipment sector decrease	NA

(Continues)

TABLE A1 | (Continued)

Authors	Method	Data	Simulated scenario	GDP/welfare	Exports/imports	Production	Wages/ employment
Bollen and Rojas-Romagosa (2018)	WorldScan CGE model developed by the Netherlands Bureau for Economic Policy Analysis	GTAP database version 9	Five scenarios: US unilateral steel (25%) and aluminium (S&A, 10%) tariffs; Retaliation over US steel and aluminium tariffs; US-China trade sanctions; US tariffs on motor vehicles; Additional Scenarios: Trade war escalations	GDP in the US falls by around 0.3% (in the last three scenarios, remain unchanged in the first scenario)	Terms of trade changes by 0.4, −0.4%, −0.6%, −0.5% (respectively in each scenario)	Changes in the production of specific sectors	Real average wage change, changes by 0, −0.3, −0.1, and 0 (respectively in each scenario)
Chunding Li John Whalley (2021)	Global GE model with endogenous trade imbalance, using GTAP	2013 as a base year, World bank WDI database, UN Comtrade, WTO statistic database	Tariff rates of 15%, 30%, 45%, and 60% against trade partners (such as China, EU, Canada and Mexico), with retaliation scenarios	NA	NA	NA	Reduction of manufacturing employment in the US
Rosyadi and Widodo (2018)	CGE model with GTAP	GTAP Database version 9	Two scenarios: US imposes 45% import tariff on all products from China, and China retaliates by imposing similar % point of tariff increase; US imposes 45% import tariff on manufacturing commodities and China retaliates by imposing similar tariff rate	Scenario 1: −0.92% change US GDP Scenario 2: −0.66% change US GDP	Scenario 1: change in US trade balance of 108203.75 Scenario 2: change in US trade balance of 92,742.91	NA	NA
Carvalho et al. (2019)	CGE model with GTAP	GTAP version 9	Two scenarios: unilateral imposition of US import tariffs on products from China and other countries; Retaliation from China (25% tariff on the US products listed by China)	US welfare loss (−19.266 billion dollars from scenario 1 and −23.598 from scenario 2)	Decrease in US trade deficit, decrease in US imports from China (on products where tariffs where applied)	Increase in production of iron & steel (5.71%), electronic equipment (5.78%), and aluminium (2.88%) in the US, except for motor vehicles and parts (−0.47%) and other transport equipment (−1.29%).	NA

Appendix B

Tariff Changes Through FTAs and Brexit

The trade agreements listed by the WTO since 2015 are listed in Table 2—but they were not the only reason for long-term tariff changes: As a consequence of the withdrawal of the United Kingdom from the European Union ('Brexit') and the resulting loss of favourable trade terms from EU trade agreements from January 2021 onwards, the UK government sought to reach UK-only agreements with many of the same countries—the so-called rollover agreements (UK in a changing Europe 2021). Thus, new UK trade agreements that included the same partners as pre-existent EU trade agreements (European Commission 2024) were marked as rollover agreements '(ro)' and not implemented in the form of tariff changes, as their tariff protection is likely to be similar. This is, however, not the case for the agreements with South Korea and Australia, which are still under negotiation for the EU, and the agreement with New Zealand, which the EU concluded only after the withdrawal of the United Kingdom. However, some EU trade agreements did not receive a UK rollover—namely Algeria, Armenia, Azerbaijan, Kazakhstan, and Madagascar—so the tariff level for all trade between the UK and these countries was set back to the most favoured nation (MFN) tariff (to be precise, it was set to the MFN for the GTAP regions ARM, AZE, KAZ and MDG. Tariffs between the UK and Algeria were not adjusted, as the latter is aggregated into the GTAP region XNF, which also includes Libya and West Sahara).

TABLE A2 | Trade agreements listed by the WTO since 2017.

	RTA name	Coverage (goods/services)	Date of entry into force	Status	Implementation
1	ASEAN Trade in Services Agreement (ATISA)	S	05 Apr 21	In force for at least one Party	–[a]
2	Korea, Republic of—Israel	G&S	01 Dec 2022	In Force	KOR, ISR
3	EU—New Zealand	G&S	01 May 2024	In Force	EU27, NZL
4	Kazakhstan—Serbia	G	10 Jan 2012	In Force	–[b]
5	Kazakhstan—Uzbekistan	G	16 May 1998	In Force	—
6	Kazakhstan—Azerbaijan	G	20 Jul 99	In Force	—
7	Türkiye—Bolivarian Republic of Venezuela	G	21 Aug 20	In Force	TUR, VEN
8	China—Cambodia	G&S	01 Jan 22	In Force	CHN, KHM
9	China—Nicaragua	G&S	01 Jan 24	In Force	CHN, NIC
10	United Kingdom—Australia	G&S	31 Mai 23	In Force	GBR, AUS
11	United Kingdom—New Zealand	G&S	31 Mai 23	In Force	GBR, NZL
12	Indonesia—Korea, Republic of	G&S	01 Jan 23	In Force	IDN, KOR
13	India—Australia	G&S	29 Dez 22	In Force	IND, AUS
14	Korea, Republic of—Cambodia	G	01 Dez 22	In Force	KOR, KHM
15	Mozambique—Indonesia	G	06 Jun 22	In Force	MOZ, IDN
16	India—United Arab Emirates	G&S	01 Mai 22	In Force	IND, ARE
17	China—Cambodia	G&S	01 Jan 22	In Force	CHN, KHM
18	United Kingdom—Iceland, Liechtenstein and Norway	G&S	01 Dez 21	In Force	GBR, XEF, NOR (ro)
19	EFTA—Indonesia	G&S	01 Nov 21	In Force	CHE, IDN, XEF, NOR
20	EFTA—Türkiye	G&S	01 Okt 21	In Force	CHE, TUR, XEF, NOR
21	Türkiye—Bosnia and Herzegovina	G&S	01 Aug 21	In Force	TUR, XER
22	Eurasian Economic Union (EAEU)—Serbia	G	10 Jul 21	In Force	ARM, XER, BLR, KAZ, KGZ, RUS
23	United Kingdom—Mexico	G&S	01 Jun 21	In Force	GBR, MEX (ro)
24	United Kingdom—Serbia	G&S	20 Mai 21	In Force	GBR, XER (ro)
25	United Kingdom—Albania	G&S	03 Mai 21	In Force	GBR, ALB (ro)
26	United Kingdom—Jordan	G	01 Mai 21	In Force	GBR, JOR (ro)
27	India—Mauritius	G&S	01 Apr 21	In Force	IND, MUS (ro)

(Continues)

TABLE A2 | (Continued)

	RTA name	Coverage (goods/services)	Date of entry into force	Status	Implementation
28	United Kingdom—Ghana	G	05 Mrz 21	In Force	GBR, GHA (ro)
29	United Kingdom—Kosovo	G	01 Jan 21	In Force	GBR, XER (ro)
30	United Kingdom—Lebanon	G	01 Jan 21	In Force	GBR, XWS (ro)
31	United Kingdom—Morocco	G	01 Jan 21	In Force	GBR, MAR (ro)
32	United Kingdom—Pacific States	G	01 Jan 21	In Force	GBR, XOC (ro)
33	United Kingdom—Palestine	G	01 Jan 21	In Force	GBR, XWS (ro)
34	United Kingdom—Korea, Republic of	G&S	01 Jan 21	In Force	GBR, KOR (ro)
35	United Kingdom—SACU and Mozambique	G	01 Jan 21	In Force	GBR, BWA, XSC, NAM, ZAF, MOZ (ro)
36	United Kingdom—Switzerland—Liechtenstein	G	01 Jan 21	In Force	GBR, CHE, XEF (ro)
37	United Kingdom—Tunisia	G	01 Jan 21	In Force	GBR, TUN (ro)
38	United Kingdom—Ukraine	G&S	01 Jan 21	In Force	GBR, UKR (ro)
39	United Kingdom—Colombia, Ecuador and Peru	G&S	01 Jan 21	In Force	GBR, COL, ECU, PER (ro)
40	United Kingdom—CARIFORUM States	G&S	01 Jan 21	In Force	GBR, XCB, XCA, XSM, JAM, TTO, DOM (ro)
41	United Kingdom—Central America	G&S	01 Jan 21	In Force	GBR, CRI, SLV, GTM, HND, NIC, PAN (ro)
42	United Kingdom—Chile	G&S	01 Jan 21	In Force	GBR, CHL (ro)
43	United Kingdom—Côte d'Ivoire	G	01 Jan 21	In Force	GBR, CIV (ro)
44	United Kingdom—Eastern and Southern Africa States	G	01 Jan 21	In Force	GBR, MUS, XEC, ZWE (ro)
45	United Kingdom—Faeroe Islands	G	01 Jan 21	In Force	GBR, XER (ro)
46	United Kingdom—Georgia	G&S	01 Jan 21	In Force	GBR, GEO (ro)
47	United Kingdom—Israel	G	01 Jan 21	In Force	GBR, ISR (ro)
48	United Kingdom—Cameroon	G	01 Jan 21	In Force	GBR, CMR (ro)
49	United Kingdom—Egypt	G	01 Jan 21	In Force	GBR, EGY (ro)
50	United Kingdom—Moldova, Republic of	G&S	01 Jan 21	In Force	GBR, XEE (ro)
51	United Kingdom—North Macedonia	G&S	01 Jan 21	In Force	GBR, XER (ro)
52	United Kingdom—Japan	G&S	01 Jan 21	In Force	GBR, JPN (ro)
53	United Kingdom—Singapore	G&S	01 Jan 21	In Force	GBR, SGP (ro)
54	United Kingdom—Türkiye	G	01 Jan 21	In Force	GBR, TUR (ro)
55	United Kingdom—Viet Nam	G&S	01 Jan 21	In Force	GBR, VNM (ro)
56	United Kingdom—Canada	G&S	01 Jan 2021(G)	In Force	GBR, CAN (ro)
			01 Apr 2021(S)		
57	United Kingdom—Kenya	G	01 Jan 21	In Force	GBR, KEN
58	EU—United Kingdom	G&S	01 Jan 21	In Force	EU27, GBR
59	Ukraine—Israel	G	01 Jan 21	In Force	UKR, ISR

(Continues)

TABLE A2 | (Continued)

	RTA name	Coverage (goods/services)	Date of entry into force	Status	Implementation
60	China—Mauritius	G&S	01 Jan 21	In Force	CHN, MUS
61	Pacific Agreement on Closer Economic Relations Plus (PACER Plus)	G&S	13 Dez 20	In force for at least one Party	AUS, NZL, XOC
62	EFTA—Ecuador	G&S	01 Nov 20	In Force	CHE, ECU, XEF, NOR
63	Türkiye—Bolivarian Republic of Venezuela	G	21 Aug 20	In Force	TUR, VEN
64	Colombia—Israel	G&S	11 Aug 20	In Force	COL, ISR
65	EU—Viet Nam	G&S	01 Aug 20	In Force	EU27, VNM
66	Indonesia—Australia	G&S	05 Jul 20	In Force	IDN, AUS
67	United States–Mexico–Canada Agreement (USMCA/CUSMA/T-MEC)	G&S	01 Jul 20	In Force	MEX, CAN, USA
68	Peru—Australia	G&S	11 Feb 20	In Force	PER, AUS
69	Hong Kong, China—Australia	G&S	17 Jan 20	In Force	HKG, AUS
70	EU—Singapore	G&S	21 Nov 19	In Force	EU27, SGP
71	Eurasian Economic Union (EAEU)—Iran	G	27 Okt 19	In Force	ARM, IRN, BLR, KAZ, KGZ, RUS
72	Korea, Republic of—Central America	G&S	01 Okt 19	In Force	KOR, SLV, CRI, HND, NIC, PAN
73	Türkiye—Kosovo	G	01 Sep 19	In Force	TUR, XER
74	Chile—Indonesia	G	10 Aug 19	In Force	CHL, IDN
75	ASEAN—Hong Kong, China	G&S	11 Jun 19	In Force	BRN, HKG, KHM, IDN, LAO, MYS, XSE, PHL, SGP, THA, VNM
76	Hong Kong, China—Georgia	G&S	13 Feb 19	In Force	HKG, GEO
77	EU—Japan	G&S	01 Feb 19	In Force	EU27, JPN
78	Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)	G&S	30 Dez 18	In Force	AUS, BRN, CAN, CHL, JPN, MYS, MEX, NZL, PER, SGP, VNM
79	EU—Armenia	Services	01 Jun 18	In Force	EU27, ARM
80	EFTA—Philippines	G&S	01 Jun 18	In Force	CHE, PHL, XEF, NOR
81	China—Georgia	G&S	01 Jan 18	In Force	CHN, GEO
82	El Salvador—Ecuador	G	16 Nov 17	In Force	SLV, ECU
83	Hong Kong, China—Macao, China	G&S	27 Okt 17	In Force	HKG, XEA
84	Türkiye—Singapore	G&S	01 Okt 17	In Force	TUR, SGP
85	Türkiye—Faeroe Islands	G	01 Okt 17	In Force	TUR, XER
86	EU—Canada	G&S	21 Sep 17	In Force	EU27, CAN
87	Southern Common Market (MERCOSUR)—Egypt	G	01 Sep 17	In Force	ARG, EGY, BRA, URY, PRY
88	EFTA—Georgia	G&S	01 Sep 17	In Force	CHE, GEO, XEF, NOR
89	Canada—Ukraine	G	01 Aug 17	In Force	CAN, UKR
90	Peru—Honduras	G&S	01 Jan 17	In Force	PER, HND

[a]The ATISA agreement was not implemented as it applies to services, and we focus our analysis on tariffs on goods.
[b]Despite only being notified to the WTO in 2024, Kazakhstan's agreements with Serbia, Uzbekistan and Azerbaijan were already in force since 1998–2012 and do therefore not create any tariff changes in our analysis period.
Source: WTO 2024. Rollover agreements of the United Kingdom are marked with '(ro)'.

Appendix C

Aggregation

TABLE A3 | Regional aggregation.

GTAP region	GTAP region description	Aggregate region
usa	United States of America	usa
can	Canada	can
mex	Mexico	mex
brn	Brunei Darussalam	ASEAN
khm	Cambodia	ASEAN
idn	Indonesia	ASEAN
lao	Lao People's Democratic Republic	ASEAN
mys	Malaysia	ASEAN
phl	Philippines	ASEAN
sgp	Singapore	ASEAN
tha	Thailand	ASEAN
vnm	Viet Nam	ASEAN
afg	Afghanistan	ASEAN
xsa	Rest of South Asia	ASEAN
jpn	Japan	jpn
chn	China	chn
aut	Austria	EU_27
bel	Belgium	EU_27
bgr	Bulgaria	EU_27
hrv	Croatia	EU_27
cyp	Cyprus	EU_27
cze	Czechia	EU_27
dnk	Denmark	EU_27
est	Estonia	EU_27
fin	Finland	EU_27
fra	France	EU_27
deu	Germany	EU_27
grc	Greece	EU_27
hun	Hungary	EU_27
irl	Ireland	EU_27
ita	Italy	EU_27
lva	Latvia	EU_27
ltu	Lithuania	EU_27
lux	Luxembourg	EU_27
mlt	Malta	EU_27
nld	Netherlands	EU_27
pol	Poland	EU_27
prt	Portugal	EU_27
rou	Romania	EU_27
svk	Slovakia	EU_27
svn	Slovenia	EU_27
esp	Spain	EU_27
swe	Sweden	EU_27
kor	Republic of Korea	kor
gbr	United Kingdom of Great Britain	gbr
ind	India	ind
xna	Rest of North America	LatinAmer
arg	Argentina	LatinAmer
bol	Bolivia (Plurinational State of)	LatinAmer
bra	Brazil	LatinAmer
chl	Chile	LatinAmer
col	Colombia	LatinAmer
ecu	Ecuador	LatinAmer
pry	Paraguay	LatinAmer
per	Peru	LatinAmer
ury	Uruguay	LatinAmer
ven	Venezuela (Bolivarian Republic o	LatinAmer
xsm	Rest of South America	LatinAmer
cri	Costa Rica	LatinAmer
gtm	Guatemala	LatinAmer
hnd	Honduras	LatinAmer
nic	Nicaragua	LatinAmer
pan	Panama	LatinAmer
slv	El Salvador	LatinAmer
xca	Rest of Central America	LatinAmer
dom	Dominican Republic	LatinAmer
jam	Jamaica	LatinAmer
hti	Haiti	LatinAmer
pri	Puerto Rico	LatinAmer
tto	Trinidad and Tobago	LatinAmer
xcb	Rest of Caribbean	LatinAmer
bhr	Bahrain	MENA
irn	Iran (Islamic Republic of)	MENA

(Continues)

TABLE A3 | (Continued)

GTAP region	GTAP region description	Aggregate region
irq	Iraq	MENA
isr	Israel	MENA
jor	Jordan	MENA
kwt	Kuwait	MENA
lbn	Lebanon	MENA
omn	Oman	MENA
pse	Palestine	MENA
qat	Qatar	MENA
sau	Saudi Arabia	MENA
syr	Syrian Arab Republic	MENA
tur	Türkiye	MENA
are	United Arab Emirates	MENA
xws	Rest of Western Asia	MENA
dza	Algeria	MENA
egy	Egypt	MENA
mar	Morocco	MENA
tun	Tunisia	MENA
xnf	Rest of North Africa	MENA
aus	Australia	Oceania
nzl	New Zealand	Oceania
xoc	Rest of Oceania	Oceania
hkg	China, Hong Kong SAR	RoAsia
mng	Mongolia	RoAsia
twn	Taiwan Province of China	RoAsia
xea	Rest of East Asia	RoAsia
xse	Rest of Southeast Asia	RoAsia
bgd	Bangladesh	RoAsia
npl	Nepal	RoAsia
pak	Pakistan	RoAsia
lka	Sri Lanka	RoAsia
ben	Benin	SSA
bfa	Burkina Faso	SSA
cmr	Cameroon	SSA
civ	Côte d'Ivoire	SSA
gha	Ghana	SSA
gin	Guinea	SSA
mli	Mali	SSA
ner	Niger	SSA
nga	Nigeria	SSA

(Continues)

TABLE A3 | (Continued)

GTAP region	GTAP region description	Aggregate region
sen	Senegal	SSA
tgo	Togo	SSA
xwf	Rest of Western Africa	SSA
caf	Central African Republic	SSA
tcd	Chad	SSA
cog	Congo	SSA
cod	Democratic Republic of the Congo	SSA
gnq	Equatorial Guinea	SSA
gab	Gabon	SSA
xac	South-Central Africa	SSA
com	Comoros	SSA
eth	Ethiopia	SSA
ken	Kenya	SSA
mdg	Madagascar	SSA
mwi	Malawi	SSA
mus	Mauritius	SSA
moz	Mozambique	SSA
rwa	Rwanda	SSA
sdn	Sudan	SSA
tza	United Republic of Tanzania	SSA
uga	Uganda	SSA
zmb	Zambia	SSA
zwe	Zimbabwe	SSA
xec	Rest of Eastern Africa	SSA
bwa	Botswana	SSA
swz	Eswatini	SSA
nam	Namibia	SSA
zaf	South Africa	SSA
xsc	Rest of Southern African Customs	SSA
nor	Norway	RestofWorld
che	Switzerland	RestofWorld
xef	Rest of EFTA	RestofWorld
alb	Albania	RestofWorld
srb	Serbia	RestofWorld
blr	Belarus	RestofWorld
rus	Russian Federation	RestofWorld
ukr	Ukraine	RestofWorld

(Continues)

TABLE A3 | (Continued)

GTAP region	GTAP region description	Aggregate region
xee	Rest of Eastern Europe	RestofWorld
xer	Rest of Europe	RestofWorld
kaz	Kazakhstan	RestofWorld
kgz	Kyrgyzstan	RestofWorld
tjk	Tajikistan	RestofWorld
uzb	Uzbekistan	RestofWorld
xsu	Rest of Former Soviet Union	RestofWorld
arm	Armenia	RestofWorld
aze	Azerbaijan	RestofWorld
geo	Georgia	RestofWorld
xtw	Rest of the World	RestofWorld

TABLE A4 | Sectoral aggregation.

GTAP sector	GTAP sector description	Aggregate, as modelled	Sector group[a]
rmk	Raw milk	Raw Agricultural Products	Raw
pdr	Paddy rice	Raw Agricultural Products	Raw
c_b	Sugar cane, sugar beet	Raw Agricultural Products	Raw
frs	Forestry	Raw Agricultural Products	Raw
osd	Oil seeds	Oil seeds	Crops
wht	Wheat	Wheat	Crops
pcr	Processed rice	Processed rice	Crops
gro	Cereal grains nec	Other cereals and grains	Crops
pfb	Plant-based fibres	Plant-based fibres	Crops
v_f	Vegetables, fruit, nuts	Vegetables, fruit, nuts	Crops
ocr	Crops nec	Other crops	Crops
lum	Wood products	Lumber	Forestry
ctl	Cattle, sheep, goats, horses	Ruminants	Animal Products
cmt	Bovine meat products	Beef	Animal Products
omt	Other meat nec	Pork and Poultry	Animal Products
mil	Dairy products	Dairy	Animal Products

(Continues)

TABLE A4 | (Continued)

GTAP sector	GTAP sector description	Aggregate, as modelled	Sector group[a]
fsh	Fishing	Fishing	Animal Products
oap	Animal products nec	Other Animal products	Animal Products
sgr	Sugar	Processed Food	Food
ofd	Food products nec	Processed Food	Food
b_t	Beverages and tobacco products	Processed Food	Food
vol	Vegetable oils and fats	Processed Food	Food
i_s	Ferrous metals	Ferrous metals	Industry
fmp	Metal products	Metal products	Industry
nfm	Metals nec	Other metals	Industry
chm	Chemical products	Chemicals	Industry
bph	Basic pharmaceutical products	Chemicals	Industry
nmm	Mineral products nec	Chemicals	Industry
rpp	Rubber and plastic products	Chemicals	Industry
oil	Oil	Energy	Industry
coa	Coal	Energy	Industry
ely	Electricity	Energy	Industry
p_c	Petroleum, coal products	Energy	Industry
gas	Gas	Energy	Industry
gdt	Gas manufacture, distribution	Energy	Industry
mvh	Motor vehicles and parts	Vehicles	Industry
otn	Transport equipment nec	Vehicles	Industry
eeq	Electrical equipment	Electrics and Electronics	Industry
ele	Computer, electronic, optical prod	Electrics and Electronics	Industry
ome	Machinery and equipment nec	Electrics and Electronics	Industry
omf	Manufactures nec	Electrics and Electronics	Industry
oxt	Other Extraction (former omn)	Textiles and Paper	Industry
lea	Leather products	Textiles and Paper	Industry

(Continues)

TABLE A4 | (Continued)

GTAP sector	GTAP sector description	Aggregate, as modelled	Sector group[a]
ppp	Paper products, publishing	Textiles and Paper	Industry
tex	Textiles	Textiles and Paper	Industry
wap	Wearing apparel	Textiles and Paper	Industry
wol	Wool, silk-worm cocoons	Textiles and Paper	Industry
cns	Construction	Construction	Services
otp	Transport nec	Transport	Services
wtp	Water transport	Transport	Services
atp	Air transport	Transport	Services
whs	Warehousing, support activities	OthServices	Services
ofi	Financial services nec	OthServices	Services
ins	Insurance (formerly isr)	OthServices	Services
obs	Business services nec	OthServices	Services
ros	Recreational and other serv	OthServices	Services
osg	Public Administration, defence	OthServices	Services
rsa	Real estate activities	OthServices	Services
dwe	Dwellings	OthServices	Services
hht	Human health, Social work act	OthServices	Services
cmn	Communication	OthServices	Services
wtr	Water	OthServices	Services
trd	Trade	OthServices	Services
afs	Accommodation, food, service act	OthServices	Services
edu	Education	Education	Services

[a]The sector group is not an aggregation that is relevant to the modelling, but for some graphs, such as Figure 13, we aggregated our model results and for others, such as Figure 14, we displayed sector groupings along with our aggregates.

Appendix D

Trade Changes

TABLE A5 | Model simulated exports, imports and trade balance values in 2025.

	Exports			Imports			Trade balance		
		Change from baseline			Change from baseline			Change from baseline	
	Level	Abs	%	Level	Abs	%	Level	Abs	%
Baseline	3110			3216			−106		
Trade Agreements	3097	−13.0	−0.4%	3202	−13.3	−0.4%	−106	0.4	−0.3%
US 10	2876	−233.9	−7.5%	3012	−203.4	−6.3%	−136	−30.5	28.8%
US cons 10	3035	−75.2	−2.4%	3150	−66.0	−2.1%	−115	−9.2	8.7%
Trade War	3005	−104.3	−3.4%	3120	−95.8	−3.0%	−114	−8.5	8.0%

Note: Table A5 provides model simulated total exports, total imports and trade balance values for year 2025 in all scenarios in billion USD levels (shown in Figure 11), as well as their absolute (abs) and relative (%) changes from the baseline.
Source: Authors' simulations.