A Quantitative Analysis of Trade Cooperation Over Three Decades

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Abstract

I use a quantitative general equilibrium model of trade policy to document and study changes in trade cooperation among members of the World Trade Organisation (WTO) between 1988 and 2020. The model features multiple countries and sectors, input-output linkages, and nests terms-of-trade, new trade, and political economy motives for trade policy. In this framework, noncooperative countries use import tariffs to increase domestic welfare by shifting the costs of protection onto foreign producers. I identify trade cooperation by computing the fraction of those costs that governments need to internalize in their policy decisions to align tariff predictions of the model to the data. This allows me to build a panel of cooperation parameters and political economy weights that documents three decades of cooperation inside the world trading system. Results show a sharp increase in global trade cooperation before the Great Recession in 2008. After that, growth in cooperation stopped and even reversed in some countries.

Key Words: trade cooperation; quantitative trade model; trade policy.

JEL Codes: F12, F13, O19

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1 Introduction

This paper uses a quantitative framework to document and study changes in trade policy cooperation over the last three decades. This is a period in which the extent of global cooperation was not always clear. On the one side, it includes the apex of globalization, with international trade flows reaching historically high levels and trade policy restrictions falling everywhere (Bown and Crowley, 2016; Irwin, 2022). On the other side, there is some indication that this hyper-globalization period ended with the Great Recession in 2008 (Antràs, 2021). Even though there is no broad visible retreat in trade integration, the continuous track of trade growth that followed World War II came to a standstill. Together with some notorious globalization backlashes, such as the US-China trade war and Brexit, this scenario strikes as if a new widespread protectionist wave is currently in place.

Still, some more systematic evidence of changes in global cooperation is so far missing. Providing this evidence requires me to confront the multiple dimensions through which policy measures interact with a complex global economy to affect trade partners. After all, trade restrictions are likely to impact markets beyond their original targets in non-trivial ways due to general equilibrium linkages across countries and sectors. For instance, an increase in import tariffs in a given sector may benefit all foreign exporters if it bids up domestic input prices (e.g. labor) and affects import competition in the rest of the economy. Alternatively, the same surge in the cost of domestic production may harm foreign producers that source domestic inputs via global supply chains.

Typically in the literature, long-run assessments of trade cooperation are done through a descriptive analysis of trade policy measures (e.g. Colantone et al., 2022). For all its merits, this type of analysis misses such general equilibrium responses that are key to understanding how much countries actually cooperate with each other.[1] Recently, some progress has been made by studies that evaluate specific features of the world trading system using a structural framework. This includes an assessment of the self-enforceability of observed applied tariffs (Mei, 2020) and of the concessions given and received by trading partners inside the World Trade Organisation (WTO) (Beshkar et al., 2021). Although both studies provide insights on the extent of trade policy cooper-

[1]Many recent studies have demonstrated the importance of general equilibrium considerations for understanding the consequences of trade policy, including Beshkar and Lashkaripour (2017), Costinot et al. (2015), Caliendo and Parro (2015) and Ossa (2014). With respect to the recent globalization backlashes, Caliendo and Parro (2022) show how accounting for sectoral heterogeneity and input-output linkages are important to understand the consequences of the U.S.-China trade war on the U.S. economy.

ation, none of them focus on building a comprehensive measure of it that deals simultaneously with the intricacy of modern production chains and the main motivations behind trade policy setting identified in the literature.

To deal with this complexity, I propose an analysis of trade cooperation inside the using a state-of-the-art quantitative general equilibrium model of trade policy. It features multiple countries and sectors and a rich description of the world economy, including inter and intra-industry trade in goods, global input-output networks and special interest politics. I center my analysis around the use of import tariffs, the most prevalent applied trade policy. Governments can use them to manipulate terms-of-trade, move profits away from trade partners and protect production of politically influential firms.[2]

To model cooperation, I draw on the mainstream theory on the purpose of trade agreements and on the evidence that Most-Favored-Nation (MFN) tariffs applied by WTO members are the consequence of unfinished negotiations. According to the theory, in the absence of an agreement, governments explore their market power and choose noncooperative trade policies that affect partners. An agreement can help countries to internalize the international costs of protection and choose efficient, cooperative policies instead (Johnson, 1953, Grossman, 2016).[3] A series of studies confronted these theoretical predictions with the data and showed that MFN tariffs still carry the imprint of market power. Hence, the evidence suggests that multilateral negotiations are rather inefficient as they lead only to a partial internalization of the trade externality (Ludema and Mayda, 2013; Nicita et al., 2018; Beshkar and Lee, 2022).

Motivated by this result, I model partial cooperation by allowing countries to choose tariffs internalizing only a fraction of the trade externality. To do so, they give extra weight to the welfare of WTO members in their tariff decision process. I use the quantitative framework to recover these welfare weights - henceforth cooperation parameters - following a two steps procedure. First, I compute a noncooperative counterfactual scenario in which politically-motivated importers choose

[2]As put by Bown and Crowley (2016), tariffs are the “focal point” of the trading system. Since they have been well-documented for most countries during the last three decades, they provide the ideal policy from which to measure changes in trade cooperation. Still, the focus on tariffs also means that my analysis necessarily abstracts from trade in services or different types of trade barriers.

[3]This view is compatible with different types of market structure and trade externalities. For instance, Bagwell and Staiger (1999) argue that trade agreements are meant to solve a terms-of-trade manipulation problem. In turn, Ossa (2011) emphasizes a firm-delocation effect. Overall, as summarized by Grossman (2016), a common understanding that emerges from this literature is that noncooperative trade policies lead to inferior outcomes.

a cross-sector distribution of tariffs fully exploring their market power. Second, I pin down the distribution of cooperation parameters that can move tariffs from this noncooperative benchmark back to levels observed in the data. Notice that cooperation parameters relate to the degree of the internalized trade externality implied by empirical tariffs. Hence, by backing out parameters for each importer and year, I can build a panel that portrays global changes in trade cooperation over three decades.[4]

While the use of quantitative models in the analysis of trade policy is now standard in the literature (Costinot and Rodríguez-Clare, 2014; Ossa, 2016; Caliendo and Parro, 2022), I believe that my reduced-form approach to trade negotiations is new.[5,6] It is similar, however, to the formulation of partial cooperation problems studied in different fields of Economics. A prominent example is Cyert and DeGroot (1973) who study partial cooperation in a duopoly assuming that firms internalize a share of the profits of their rivals in their utility function.[7] A recent, related study includes the analysis of partial cooperation in international environmental agreements (Colombo et al., 2022). A key assumption of this literature, also present in my analysis, is the exogeneity of the coefficient of cooperation. Although it implies abstracting from determinants of cooperation, for example in my case the structure of trade negotiations, I identify three main benefits of pursuing a similar flexible approach in a quantitative analysis.

First, it can be readily adapted to a general equilibrium model with an appealing set of micro-theoretical foundations, while still requiring modest computational effort to quantify cooperation and counterfactuals of interest. This turns feasible an analysis of global cooperation over a long period. Second, as I detail later, it provides a clear nexus between cooperation parameters and counterfactual tariffs that depends only on the size of the trade externality implied by the model and

[4] The use of static trade models to investigate changes in trade and trade policy over time is a standard procedure in the literature. For instance, it is widely used in the gravity literature (Head and Mayer, 2014). Also, it was recently employed by Lashkaripour (2021) in the context of a quantitative general equilibrium model to study changes in the prospect of a trade war over multiple years.

[5] I refer to my methodology as a "reduced-form approach" in the sense that mechanisms that shape trade cooperation identified in the literature are not explicit in the model. Still, I provide evidence that my results are consistent with many of them.

[6] To the best of my knowledge, no study on international trade uses a similar formulation of partial cooperation as the main element of its analysis. However, there are two seemingly related definitions in the literature. Saggi et al. (2018, appendix C) use it in a theoretical framework to investigate how countries optimally change their tariffs after partners form a trade agreement. Ossa (2015) uses it to line up the predictions of his quantitative model of subsidy competition to the data.

[7] Cyert and DeGroot (1973) show that this formulation captures the rational behavior of firms amid an equilibrium path that leads from noncooperation to complete cooperation.

the data. This makes it easy to back out cooperation levels with high precision by closely aligning counterfactual predictions to the data. Accordingly, the model is able to exactly match three decades of average import tariffs and approximate the corresponding cross-sector tariff distributions.

And third, the large scale of my analysis allows me to explore the country, sector and time variation of results and inspect how they articulate important mechanisms behind trade policy cooperation identified in the literature. I show that cooperation levels are associated with the free-riding problem that arises from non-discrimination requirements in the WTO, the interaction between preferential and multilateral liberalization and the emergence of global supply chain linkages. Additionally, my analysis can shed light on the long run relationship between multilateral cooperation and the political clout of industry lobbies over tariffs by relating cooperation parameters to estimated political economy weights.

I use this methodology to compute cooperation levels and political economy activity for the major trading blocs in the WTO: Australia, Brazil, Canada, China, the European Union, India, Japan, Korea, Mexico, the USA and a Rest of the World. I use data on trade, production, input-output linkages from the World Input-Output Database (WIOD, Timmer et al., 2015) and trade and tariff data from the UNCTAD (TRAINS) and the WTO for 14 manufacturing sectors between 1988 and 2020.

Results show a sharp increase in global trade cooperation in the last three decades. Between 1988 and 2020, the import-weighted average cooperation increased by 81%. This movement is observed in most trading blocs, even among developed ones, which already adopted low import tariffs in 1988. For instance, cooperation in the United States increased by 88% and in the European Union, by 136%. There are some stark differences between years, though. Before the Great Recession in 2008 overall cooperation increased fast, with an average growth rate of 3.2% per year. After 2008, a deceleration and slight reversal in this trend took place, with the average growth in cooperation in the period given by -0.01%.

Even though my results do not point towards a widespread decrease in cooperation, this is actually visible in some individual countries. For instance, cooperation in China increased after its accession to the WTO in 2001, but peaked in 2005 and decreased 47% since then. Interestingly, this happens despite a 29% decrease in average tariffs and a 56% increase in total imports capturing that the economy still became relatively more closed in the meantime. Moreover, while Brazil and

India become considerably more cooperative in the course of 33 years, reflecting their decisions to unilaterally liberalize import markets, none of this surge was observed in the past decade.

Overall, the expansion in global trade cooperation is consistent with how international trade and MFN tariffs changed in the period. Between 1988 and 2020, average MFN tariffs fell by 52% and international trade constantly grew above GDP. In the context of the quantitative model, such changes in the global economy are rationalized through a higher internalization of the trade externality. To see why, notice that, for given tariff changes, an increase in imports will enhance the trade externality because tariff-led changes in terms-of-trade and profits now apply over a larger trade volume. Moreover, for given trade volumes, lower tariffs increase the distance between non-cooperative and applied tariffs and, hence, such tariff levels can only be sustained through the internalization of a larger trade externality. Naturally, the model fully accounts for general equilibrium effects and observed changes in trade and tariffs do not translate directly into changes in cooperation, as the case of China demonstrates. Still, they are the major force behind changes in global cooperation in the past three decades. In line with that, the slowdown of trade growth after 2008 and the end of the trade liberalization agenda of the 1990s constitute the background of the stagnant cooperation levels in the last decade. I show that results are robust to accounting for participation in preferential trade agreements, treating preferential tariffs as an additional constraint to the calibration of cooperation parameters.

I explore the country and time dimensions of my results to show that they are also driven by important explanations for trade cooperation suggested by the literature that the model takes into account. I show that cooperation is associated in a theory-consistent way to the degree of concentration of WTO exporters, the distance of the average industry from final consumption ("upstreamness"), the share of domestic value added in production and the share of imports from partners inside preferential trade agreements (PTA). I also show that political economy activity is positively related to changes in cooperation, especially in developing countries. This suggests that, while developing countries do become more cooperative over time, their cross-sector tariff distributions came to reflect more political distortions.

I also present evidence on the importance of accounting for input-output linkages to compute cooperation levels. To do so, I back out parameters in a model without I-O linkages and show that it on average underestimates cooperation by 20% over the total sample period. This happens because, in the presence of I-O linkages, noncooperative countries set on average higher tariffs as the domestic costs of protection are partially passed to foreign consumers via foreign sales of upstream industries.[8] These higher tariffs in turn imply a more sizable trade externality that requires more cooperation to be internalized.

Last, I use my proposed framework to compute the welfare consequences of a moderate reversal in current cooperation levels. This scenario can be used to characterize, for instance, some of the current backlashes against globalization, which are still distant from complete noncooperation. I show that even small deviations from cooperation could imply sizable costs for trading partners. For instance, a 5% decrease in cooperation in the US in 2020 would shrink welfare in Canada and Mexico, two important trade partners, by around 5% and 3.5%, respectively.

This paper makes four main contributions to the literature. First, I add to the literature that investigates changes in trade policy cooperation over time. Colantone et al. (2022) focus on the current backlash against globalization and use descriptive evidence for multiple decades to document a protectionist shift in trade policy after 2008. This conclusion comes from the assessment of recent events, such as the US-China Trade War and Brexit, as well as data on import tariffs, new trade agreements, temporary trade barriers and the evolution of global trade. Bown and Crowley (2016) provide a detailed account of trade policy measures for the major economies over a long time span. Teti (2020) puts in place and analyzes a new dataset covering 30 years of import tariffs at the product level.

Additionally, two recent studies use quantitative models to evaluate features of the trading system providing insights into the extent of global cooperation. Mei (2020) uses a repeated game framework to evaluate the self-enforceability of observed applied tariffs by computing the minimum discount factor needed to prevent a breakdown of cooperation. Beshkar et al. (2021) measure the "concession" given by a WTO member between 1995 and 2011 as the increase in imports from each of its trading partners by restraining from levying its unilateral optimal tariffs. As in my analysis, both measures build on the welfare consequences of counterfactual tariff deviations. Still, there are important differences given their different focus. None of them provide a unified measure of cooperation with a clear interpretation, such as the welfare weights, that is tracked and compared

[8] This result is consistent with the analytical and quantitative results obtained by Lashkaripour and Beshkar (2020).

over time. Their analysis also cannot inform about the current backlash against globalization due to their shorter period of analysis. Last, neither study account for global value chains or political economy considerations, and Beshkar et al also do not incorporate any "new trade" elements in their model.

In a second contribution to the literature, my results shed new light on the ability of some of the leading models of trade policy to explain real-world tariffs. Up until now, related quantitative studies had mainly focused on counterfactual scenarios of a complete breakdown of cooperation, the suspension of PTAs, or the further expansion of the trade liberalization agenda beyond current levels (Lashkaripour and Beshkar, 2020; Lashkaripour, 2021; Ossa, 2014). Even though these are all important benchmarks, they cannot speak directly to the current state of trade policy.[9] My analysis shows that predicted tariffs can be reasonably brought in line with tariff data over multiple years by choosing plausible cooperation parameters and political economy weights. Also, I show that changes in the magnitude of the trade externality over the past years are compatible with a view of globalization that stems from the analysis of trade and tariff data.

Third, this paper contributes to the literature that studies how obstacles in the WTO negotiation process lead to inefficient trade policy setting. In a series of papers, Ludema and Mayda (2013, 2009) investigate how the non-discrimination rule at the WTO disincentive participation in negotiations creating a free-riding problem. Beshkar et al. (2015) focus on the trade-off importer's face between the flexibility allowed by higher tariff bounds and the size of the trade externality. Both explanations are empirically relevant, although Beshkar and Lee (2022) provide evidence that the flexibility-externality trade-off may be more prevalent. While I use results from this literature primarily to design my quantitative framework and investigate the plausibility of my analysis, I also show that the theoretical and empirical determinants of partial cooperation are in line with the size of the trade policy externality implied by a quantitative model.

Fourth, this paper also contributes to the emerging literature that investigates how global value chains change trade policy (Antràs, 2021; Lashkaripour and Beshkar, 2020; Blanchard et al., 2016; Caliendo et al., 2021). A unifying insight of this literature is how GVCs change the traditional

[9] A notable exception is Bagwell et al. (2021). They employ a Caliendo and Parro (2015) model to study the bargaining protocol during the Uruguay Round. They estimate bargaining parameters for seven country pairs by matching counterfactual predictions of the model to MFN tariff data in 2000. Still, while they focus on a specific round of trade negotiations, my focus is on a long run analysis, which is allowed by the parsimonious, reduced-form take on trade cooperation.

rationale for trade policy as domestic value added takes part in the production of foreign firms. I show that taking this element into account also plays a role in shaping the extent of trade cooperation in the last decades.

The remainder of this paper is organized as follows. The next section outlines the quantitative general equilibrium framework. Section 3 describes the data used to calibrate the model and how I use it to recover parameters governing the trade elasticity. Section 4 discusses the optimization procedure used to compute counterfactuals, recover cooperation parameters and political economy weights. Section 5 presents the results. Section 6 concludes.

2 Quantitative Framework

In this section, I first present a multi-country, multi-sector quantitative trade model of commercial policy. It features monopolistic competition, with products differentiated at the level of firms, as in Ossa (2014). I extend this basic framework to account for input-output linkages, as in Caliendo and Parro (2015).[10] I later detail how I define each government's objective function to take into account partial cooperation.

2.1 A static trade model

There are N countries and S sectors in the model. In what follows, subscripts denote countries, superscripts denote sectors. An ij subscript represents a flow from country i to country j. A ks superscript denote a flow from sector k to sector s.

2.1.1 Consumers

Consumer preferences are described by a Cobb-Douglas-CES utility function, which aggregates preferences over different varieties:

$$C_j = \prod_{s=1}^{S} \left(\sum_{i=1}^{N} \int_0^{M_i^s} c_{ij}^s(\omega_{is})^{\frac{\sigma_s - 1}{\sigma_s}} d\omega_{is} \right)^{\frac{\sigma_s}{\sigma_s - 1}\mu_j^s} \tag{1}$$

where c_{ij}^s is the consumption in country j of the sector s variety coming from country i, ω_{is}. M_i^s is the mass of industry s varieties produced in country i. $\sigma_s > 1$ is the sector-specific elasticity

[10] Lashkaripour (2021) employs a similar framework, but with tariffs subject to duty drawbacks.

of substitution. μ_j^s is the share of total income that consumers in j spend with sector s goods.[11] All labor income and tariff revenues accrue to them.

2.1.2 Firms

Each firm produces a unique variety and has monopoly power with respect to its own variety. The number of firms is given exogenously and firms are homogeneous within sectors. Productivity ϕ_i^s varies by country and sector and is invariant to policy. Cross-country trade is costly and subject to iceberg trade barriers ν_{ij}^s and ad-valorem tariffs t_{ij}^s. I define $\tau_{ij}^s \equiv 1 + t_{ij}^s$. Firms produce under constant returns to scale and the production technology is described by the following inverse production function:

$$\left(\frac{l_i^s}{\beta_i^{L,s}}\right)^{\beta_i^{L,s}} \prod_{k=1}^{S} \left(\frac{I_i^{k,s}}{\beta_i^{k,s}}\right)^{\beta_i^{k,s}} = \frac{1}{\phi_i^s} \sum_{j=1}^{N} c_{ij}^s \nu_{ij}^s, \tag{2}$$

where l_i^s is the labor force employed in country i and sector s and $I_i^{k,s}$ is a CES composite of sector k intermediate goods used in production in sector s and country i. $\beta_i^{L,s}$ is the share of labor in gross output. $\beta_i^{k,s}$ is the share of expenditure by sector s firms with sector k inputs in gross output. As trade costs are of the type "iceberg", country i needs to ship $c_{ij}^s \nu_{ij}^s$ units of its variety for c_{ij}^s units to arrive in country j. There is a total of $L_i = \sum_{s=1}^{S} l_i^s$ workers in country i and labor is not mobile across countries.

2.1.3 Equilibrium in Levels

Utility maximization implies that firms in industry s and country i face standard CES demands:

$$c_{ij}^s = \frac{[p_i^s \nu_{ij}^s \tau_{ij}^s]^{-\sigma_s}}{(P_j^s)^{1-\sigma_s}} E_j \mu_j^s, \tag{3}$$

where p_i^s is the ex-factory price at i, E_j is the expenditure of country j consumers and P_j^s is the CES consumption price index of industry s varieties at j.

[11] More specifically, $\mu_j^s = \sum_i \tau_{ij}^s X_{ij}^s / \sum_i \sum_t \tau_{ij}^t X_{ij}^t$

Profit maximization implies that prices are given by:

$$p_i^s = \frac{\sigma_s}{\sigma_s - 1} \frac{\omega_i^s}{\phi_i^s}, \tag{4}$$

with $\omega_i^s = (w_i)^{\beta_i^{L,s}} \prod_k (P_i^k)^{\beta_i^{k,s}}$, where w_i is the national wage. Notice that P_i^s is also the appropriate index of intermediate goods, which is given by:

$$P_j^s = \left[\sum_{i=1}^{N} M_i^s \left(\frac{\sigma_s}{\sigma_s - 1} \frac{\omega_i}{\phi_i^s} \nu_{ij}^s \tau_{ij}^s \right)^{1-\sigma_s} \right]^{\frac{1}{1-\sigma_s}}. \tag{5}$$

It aggregates in a Cobb-Douglas fashion: $P_j = \prod_s (P_j^s / \mu_j^s)^{\mu_j^s}$.

Defining $X_{ij}^s = M_i^s p_i^s \nu_{ij}^s c_{ij}^s$ as trade flows from country i to country j and using equations (3) (4), we have the following gravity equation:

$$X_{ij}^s = M_i^s \left(\frac{\omega_i^s}{\phi_i^s} \nu_{ij}^s \right)^{1-\sigma_s} (\tau_{ij}^s)^{-\sigma_s} (P_j^s)^{\sigma_s - 1} E_j \mu_j^s. \tag{6}$$

Notice that trade flows are evaluated at ex-factory prices, which are gross of iceberg costs, but net of tariffs.[12]

Sector-level profits equal a share $\frac{1}{\sigma_s}$ of value added in production. The remaining share of value added accrues to workers. The wage bill is given by:

$$w_i L_i = \left(1 - \frac{1}{\sigma_s}\right) \sum_{s=1}^{S} \sum_{n=1}^{N} \beta_i^{L,s} X_{in}^s. \tag{7}$$

In equilibrium, total expenditure is the sum of expenditure on final good and intermediates:

$$E_i = E_i^F + E_i^I. \tag{8}$$

Expenditure on final goods, equal the sum across sectors of the share $\beta_i^{L,s}$ of industry sales plus tariff revenue:

$$E_i^F = \sum_{s=1}^{S} \sum_{n=1}^{N} \beta_i^{L,s} X_{in}^s + \sum_{s=1}^{S} \sum_{m=1}^{N} t_{mi}^s X_{mi}^s. \tag{9}$$

[12] One can also define ex-factory prices net of iceberg trade costs. As those trade costs are invariable to changes, this would not affect results in the quantitative exercise.

Expenditure on intermediate inputs is given by:

$$E_i^I = \sum_{s=1}^{S} \sum_{n=1}^{N} \sum_{k=1}^{S} \beta_i^{k,s} X_{in}^s. \tag{10}$$

I define an equilibrium under policies $\{\tau_{ij}^s\}$ as a set $\{E_i, E_i^F, E_i^I, w_i, P_i^s\}_{i=1,s=1}^{N,S}$ that satisfy equilibrium conditions (8),(9), (10), (7) and (5), together with the gravity equation (6) for all i, n and s.

2.1.4 Equilibrium in Changes

In order to take the model to the data, I use Dekle et al. (2007)'s "exact hat algebra", which is now standard in the literature. This involves rewriting the equilibrium in levels in terms of changes in tariffs and all endogenous variables. In what follows, a counterfactual version of a variable x is denoted by x'. The proportional change is then given by $\hat{x} = x'/x$. Rewriting the equilibrium equations in changes yields:

$$\hat{E}_i = \frac{E_i^F}{E_i} \hat{E}_i^F + \frac{E_i^I}{E_i} \hat{E}_i^I \tag{11}$$

$$\hat{E}_i^F = \sum_{s=1}^{S} \sum_{n=1}^{N} \frac{\beta_i^{L,s} X_{ij}^s}{E_i^F} \hat{X}_{in}^s + \sum_{s=1}^{S} \sum_{m=1}^{N} \frac{X_{mi}^s}{E_i^F} t_{mi}^s \hat{X}_{mi}^s \tag{12}$$

$$\hat{E}_i^I = \sum_{n=1}^{N} \sum_{s=1}^{S} \sum_{k=1}^{S} (\beta_i^{k,s} X_{in}^s / E_i^I) \hat{X}_{in}^s \tag{13}$$

$$\hat{w}_i = \sum_{n=1}^{N} \sum_{s=1} \frac{1}{1-\sigma_s} \frac{\beta_i^{L,s} X_{in}^s}{w_i L_i} \hat{X}_{in}^s \tag{14}$$

$$\hat{X}_{ij}^s = (\hat{\omega}_i^s)^{1-\sigma_s} (\hat{\tau}_{ij}^s)^{-\sigma_s} (\hat{P}_j^s)^{\sigma_s - 1} \hat{E}_j \tag{15}$$

$$\hat{P}_j^s = \left(\sum_{i=1}^{N} \frac{\tau_{ij}^s X_{ij}^s}{\sum_{m=1}^{N} \tau_{mj}^s X_{mj}^s} (\hat{w}_i \hat{\tau}_{ij}^s)^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}} \tag{16}$$

$$\hat{\omega}_i^s = (\hat{w}_i^s)^{\beta_i^{L,s}} \prod_k (\hat{P}_i^k)^{\beta_i^{k,s}} \tag{17}$$

I define an equilibrium under policy changes $\{\hat{\tau}_{ij}^s\}$ as a set $\{\hat{E}_i, \hat{E}_i^F, \hat{E}_i^I, \hat{w}_i, \hat{P}_i^s\}_{i=1,s=1}^{N,S}$ that satisfy equilibrium conditions (11),(12), (13), (14) and (16), together with the gravity equation in changes (15) for all i, n and s.[13]

2.2 Partial Trade Cooperation

In this subsection, I detail how I define the objective function of each government to capture partial cooperation in tariffs inside the WTO together with the protection of politically influential firms. As in Ossa (2014), I start by assuming that tariff revenue is distributed to workers in each industry according to their employment share. Hence, industry-level final expenditure is given in equilibrium by:

$$E_i^{F,s} = \sum_{s=1}^{S}\sum_{n=1}^{N} \beta_i^{L,s} X_{in}^s + \frac{l_i^s}{L_i} \sum_{s=1}^{S}\sum_{m=1}^{N} t_{mi}^s X_{mi}^s. \tag{18}$$

National welfare W_i equals aggregate real income:

$$W_i = \sum_{s=1}^{S} E_i^{F,s}/P_i. \tag{19}$$

I extend the above definition of welfare to include political economy considerations. I define $\lambda_i^s \geq 0$ as the political economy weight of industry s in country i which is scaled such that $\frac{1}{S}\sum_{s=1}^{S} \lambda_{is} = 1$. I use it to define a politically augmented version of national welfare:

$$W_i^{pol} = \sum_{s=1}^{S} \lambda_i^s (E_i^{F,s}/P_i) \tag{20}$$

Different from definition W_i, W_i^{pol} captures that industry s in country i matters λ_i^s times more to the computation of national welfare than the industry obtaining average political support.

I now define each government's objective function. It aggregates political domestic welfare and

[13] In the quantification routine, I employ a more simple version of this equilibrium by using a fixed-point contraction to solve for changes in the price index and expressing the equilibrium in terms of changes in wages and expenditure levels.

the product of the political welfare of WTO partners in a Cobb-Douglas fashion. A weight $\theta_i \in [0, 1]$ is attributed to the welfare of partners and a weight $1 - \theta_i$, to domestic welfare:

$$G_i = (W_i^{pol})^{(1-\theta_i)} (\prod_{j \in \Omega_i} W_j^{pol})^{(\theta_i)} \tag{21}$$

where Ω_i is the subset of countries different from i that are also WTO members.

I adopt this definition of government preferences in the spirit of the literature that studies partial cooperation in various contexts through a similar reduced-form approach. This formulation has been used, for instance, to study partial cooperation in duopolies (Cyert and DeGroot, 1973), overlapping ownership in oligopolies (López and Vives, 2019), as well as cooperation in international environmental agreements (Colombo et al., 2022). Typically, these studies feature a cooperation parameter, the extra weight given to the welfare of partners in the agent's decision process. Often referred to as the Edgeworth (1881) coefficient of "effective sympathy", this parameter flexibly captures within its reach scenarios of full cooperation and noncooperation alongside any intermediate state in between.

In my application, this flexibility is captured by the cooperation parameter θ_i. When $\theta_i = 0$, governments will set trade policy noncooperatively. When $\theta_i > 0$, they will take the welfare of trade partners into account to some extent, leading to partial or full cooperation. This happens because tariffs are a beggar-thy-neighbor policy. Intuitively, they allow governments to increase domestic welfare by bidding up the relative price of exports (a terms-of-trade effect) and by reallocating resources toward more profitable industries (a "new trade" profit shifting effect). All this is obtained at the expense of trade partners, which observe a mirroring general equilibrium adjustment in their domestic markets and a fall in welfare.[14] If governments care about partners to some extent, they will consider these international costs of protection in their trade policy decisions and tariffs will necessarily shift away from noncooperative levels.

To make this point clear, it is useful to observe how tariff changes impact the government objective function G_i. Taking a first-order Taylor approximation around zero tariffs and defining

[14] Ossa (2016) illustrates how unilateral changes in tariffs imply adjustments through terms-of-trade and profit-shifting effects in a framework similar to the employed here, but without input-output linkages. An important difference in my setting is that both effects will be attenuated by the impact of tariffs on the price of goods produced abroad and used as inputs by domestic firms, as showed by decomposition (22).

π_i^s as the profits of industry s in country i yields:[15]

$$
\begin{aligned}
\frac{dG_i}{G_i} = (1-\theta_i) & \underbrace{\left[\frac{w_i L_i}{E_i^F}\frac{dw_i}{w_i} + \sum_{s=1}^{S} \frac{\pi_{is}}{E_i^F}\frac{d\pi_{is}}{\pi_{is}} - \sum_{l=1}^{N} \frac{X_{li}^s}{E_i}\frac{dp_l^s}{p_l^s} \right]}_{\text{Changes in own welfare}} + \\
+ (\theta_i) \sum_{j \in \Omega_i} & \underbrace{\left[\frac{w_j L_j}{E_j^F}\frac{dw_j}{w_j} + \sum_{s=1}^{S} \frac{\pi_{js}}{E_j^F}\frac{d\pi_{js}}{\pi_{js}} - \sum_{l=1}^{N} \frac{X_{lj}^s}{E_j}\frac{dp_l^s}{p_l^s} \right]}_{\text{Changes in foreign welfare}}
\end{aligned}
\tag{22}
$$

Expression (22) shows that changes in G_i are a weighted sum of changes in own and foreign welfare. The "own welfare" component captures how tariffs benefit the protectionist country if they lead to percentage changes in wages and average industry profits that are larger than changes in average prices of final goods and inputs purchased domestically and abroad.[16]

The "foreign welfare" term captures an analogous, but opposite adjustment taking place in the economies of WTO partners, with international prices linking welfare changes in importing and exporting countries in equilibrium. A relative increase in prices in the country imposing the tariff will negatively affect its trade partners. This is showed by how average price changes impact the "foreign welfare" component. The negative effect will be considered in the trade policy decision process depending on the magnitude of the cooperation parameter. The larger θ_i, the more the negative impact abroad of tariffs will be relatively taken into account, preventing its use for purely welfare-maximizing purposes to some extent.

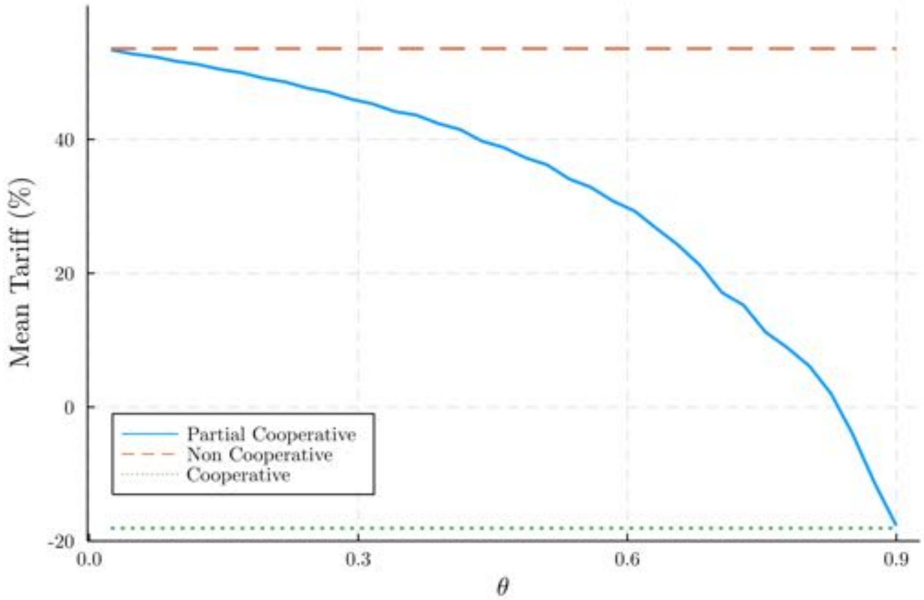
Figure 1 provides an illustration of how θ_i quantitatively determines tariffs in general equilibrium to fall between cooperative and noncooperative levels. This example uses 1988 data, the country setting the trade policy is Australia and I obtain results by computing counterfactual tariffs for different values of θ_i following the optimization routine detailed below. The blue line shows that

[15] Outside of zero tariffs, this expression would display a trade volume effect showing that governments value extra tariff revenue from changes in import volumes. Also, it would display distortions created by tariffs that are of second order when they are equal to zero. Caliendo and Parro (2015) and Ossa (2014) also present linear approximations of welfare changes promoted by tariffs.

[16] Notice that in this environment changes in prices are caused not only by changes in the wage rate but also by changes in the prices of intermediate goods used in production, as showed by the following decomposition:

$$\frac{dp_i^s}{p_i^s} = \beta_i^{L,s}\frac{dw_i}{w_i} + \sum_k \beta_i^{k,s}\frac{dP_i^k}{P_i^k}.$$

Fig. 1: Example: counterfactual tariffs and cooperation parameters



Note: Mean counterfactual cooperative, noncooperative and partially cooperative tariffs with different values of θ chosen by Australia in the first year of analysis, 1988.

average counterfactual tariffs are decreasing in θ_i, ranging from 40% to -20%. The upper bound of partially cooperative tariffs is given by average noncooperative tariffs that maximize domestic welfare W_i (when $\theta_i = 0$), depicted in the red segment. The lower bound is given by the cooperative tariff solution, depicted in green, which I compute by adopting a formulation in the spirit of a symmetric Nash bargaining protocol in which countries equally split efficiency gains among themselves.[17,18] Hence, as θ_i increases, importers take more into account the costs of protection and tariffs depart from a welfare-maximizing scenario towards full cooperation.

All things considered, formulation G_i can be viewed as a reduced-form representation of theories that study inefficiencies in trade agreements. It is true that each theory emphasizes a specific mechanism. For instance, Ludema and Mayda (2013, 2009) argue that the inefficiency is due to an MFN-driven free-riding problem. Beshkar et al. (2015), in turn, stress how governments that need to cope with uncertainties value the flexibility of higher tariffs. Still, different theories converge on

[17]This formulation is similar to the one used by Ossa (2014) to compute cooperative tariffs, which also yields a combination of import tariffs and subsidies that replicate international side payments.

[18]When it comes to individual countries, the slope of the curve of the partially cooperative solution varies depending on the extent of the trade externality, which in turn depends on the size of production and imports in each sector and how they interact with differences in sector market power. This link between country size and trade policy externality is a well-understood feature of multi-country quantitative models with terms-of-trade and profit-shifting effects (Ossa, 2014)

the conclusion that negotiating countries may not completely internalize the externalities created by importing tariffs, an implication that is confirmed by the data. My formulation focuses on this consequence and is able to provide a new measure of partial cooperation fully accounting for general equilibrium effects.

3 Data

I match the model to data on trade in manufactures, production, input-output linkages, and import tariffs for the 33 years between 1988 and 2020, 24 countries and regions aggregated into 11 trading blocs and 14 industries. I next provide a description of the data sources and how I use them to calibrate the model.

3.1 Trade and Input-Output Linkages

Data for trade in manufactures, production and input-output linkages between 1988 and 2014 come from the World Input-Output Database (WIOD). To maximize the time coverage of my analysis, I combine two datasets: the long run WIOD (Woltjer et al., 2021) and their 2016 release (Timmer et al., 2015). From the first, I obtain data between 1988 and 1999; from the second, between 2000 and 2014. To ensure consistency across regions and years, I restrict the analysis to the trade blocs that are present in both datasets. After aggregating members of the European Union into a single trade bloc,[19] I end up with 11 countries and regions.[20] To ensure consistency across years, I restrict the number of industries to the 14 manufacturing industries existent in the WIOD long run dataset, aggregating the more numerous ones in the 2016 release by their ISIC code. See table 1 for a description of the sectors.

I use input-output tables provided by the WIOD for each year to calibrate the Cobb-Douglas production parameters. I adjust the tables to reflect production of goods by cropping entries related to services and adjusting gross production for each country and sector pair accordingly. To compute

[19] The aggregation is consistent with the fact that, as an economic union, the members of the European Union adopt a unified trade policy and are able to set tariffs that explore their joint market power. See Freund and Ornelas (2010) for a review of the literature on the coordination of external trade policy inside custom unions. The definition of the European Union changes according to the number of members inside the bloc.

[20] I exclude Hong Kong and Taiwan even though they are present in both datasets since they do not present substantial tariff variation along the considered period. I also include a member of the European Union only after its accession to the bloc - before that, it is part of the Rest of the World.

the share of value added in production in each country ($\beta_i^{L,s}$), I divide total value-added in sector s by gross production in the same sector. To compute expenditure with sector-specific inputs in each country ($\beta_i^{k,s}$), I divide total purchases that sector s firms make of sector k inputs by sector s' gross production.

As the WIOD does not have data for years after 2014, I complete the dataset using sector-level bilateral trade data from the World Integrated Trade Solution (WITS) between 2015 and 2020. One problem when combining trade datasets from different sources is that they may not be consistent with each other. Inconsistencies can arise in many ways, such as, for example, from different procedures when recording trade data, measurement errors and import-export asymmetries.[21] This problem may be aggravated in the case of input-output tables as several adjustments are necessary to make sure that trade data is in line with the multi-sector description of the economy.

As the goal of the paper is to compute changes in trade cooperation over time, it is important that there are no abrupt discontinuities in trade levels from one year to the next due to the use of different sources. To avoid this problem, I proceed as follows. First, I use data from WITS to compute bilateral trade growth in each country, industry and year between 2015 and 2020 relative to 2014 levels. Second, I recover international trade flows between 2015 and 2020 by multiplying the 2014 WIOD entries by this growth rate . To recover intra-national trade flows for each country and sector between 2015 and 2020, I assume that the rate of domestic to aggregate international trade flows is the same as in 2014. I also fix $\beta_i^{L,s}$ and $\beta_i^{k,s}$ between 2015 and 2020 at 2014 levels. Naturally, the assumption on the rate of domestic to international trade flows and I-O linkages means abstracting from the further variation on these variables between 2015 and 2020. Still, the fact that this variation is remarkably stable in the years before 2014 suggests that these assumptions should not have a substantial impact on my analysis.

Figure 2 provides an overview of the import data. It displays total manufactures imports for each trading bloc between 1988 and 2020. Overall, there is an increase in international trade during the period. Still, a steep decrease in trade levels is observed in 2008 as a consequence of the Great Recession. After that, trade levels recovered, but trade growth decreased notably more in large countries with a downward trend in manufactures trade now observed in many places. Notice that

[21] The website *Our World in Data* has an interesting article explaining why aggregate numbers from the most popular sources of international trade data are not always consistent with each other. It can be accessed at: https://ourworldindata.org/trade-data-sources-discrepancies

Fig. 2: Manufactures Imports

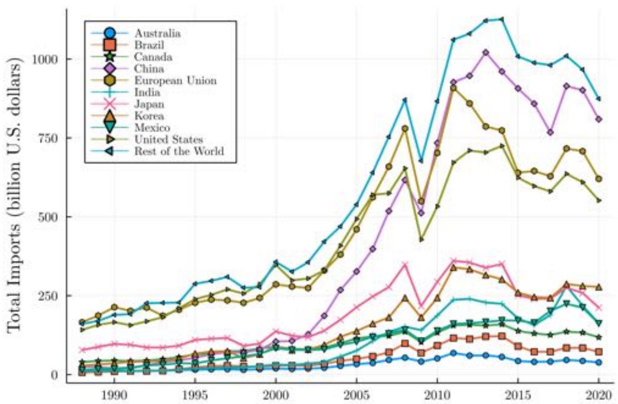
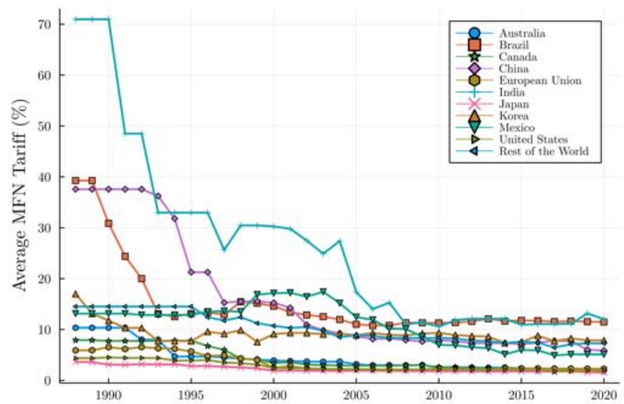


Fig. 3: Import Tariffs



Note: The source of the data is the World Input-Output Database and the World Integrated Trade Solution.

this downward trend in the later years, as well as the earlier evolution of trade levels, is consistent with other accounts of international trade in manufactures, such as the one provided by the World Bank.[22]

3.2 Trade Policy

Data for import MFN and applied tariffs at the sector-level between 1988 and 2020 is also obtained from the WITS. I compute the average MFN tariffs reported by countries that are WTO members each year. As is now standard in the literature (e.g. Bagwell et al., 2021), I fill out missing entries with the nearest year available.[23] Notice that, from the list of countries involved in the analysis, only China entered the organization after 1988 with its accession period starting in 2001. The trading block "Rest of the World" includes members and non-members of the WTO, but since the share of non-members is small and decreases over time, I treat it as a member of the organization throughout all years.

Figures 9 displays the average MFN tariffs for WTO members and average applied tariffs for non-members between 1988 and 2020. There is a sharp decrease in the world average tariff in the period, from 20% in 1988 to 5.5% in 2020. This decrease was pushed overall by developing countries. This is due to multiple events, such as efforts of unilateral trade liberalization in India and Brazil, more active participation in trade negotiations during the Uruguay Round and China's

[22]It can be accessed in https://data.worldbank.org/indicator/TM.VAL.MANF.ZS.UN.
[23]In the end, I have 14% of missing data that need to be inputed from nearby years.

accession to the WTO. For high-income nations, tariff levels were already low at the beginning of the period after decades of active participation in negotiations inside the multilateral trading system. Still, it decreased even further for some countries although at a more modest rate.

3.3 Elasticity of Substitution

I use the gravity equation implied by the model and the time-variation of the trade and tariff data to recover the elasticity of substitution σ_s, which governs the trade elasticity.[24] Shapiro (2016) and Felbermayr et al. (2022) are other studies that employ a similar strategy to recover parameters governing the trade elasticity in quantitative models using panel data.[25]

Adding a time-index to (6) and assuming a functional form to trade costs common in the literature (Head and Mayer, 2014), I obtain the following empirical gravity equation:

$$X_{ijt}^{s} = exp\left[-\sigma_s ln(1+t_{ijt}^{s}) + \nu_{jt}^{s} + \nu_{it}^{s} + \nu_{ij}^{s} \right] + \epsilon_{ijt}^{s}, \tag{23}$$

where ν_{jt}^{s} is an importer-sector-year fixed-effect, ν_{it}^{s}, an exporter-sector-year fixed-effect and ν_{ij}^{s}, an importer-exporter-sector fixed effect.

I estimate equation (23) using the PPML estimator suggested by Silva and Tenreyro (2006).[26] I use sector-level bilateral trade flows between 1988 and 2014 and bilateral tariff data (not averaged). As is well-known, the estimation of the trade elasticity is plagued by endogeneity concerns (Ossa, 2016). Given the set of fixed effects in equation (23), endogeneity problems could impact estimates of σ_s if tariff changes are correlated to bilateral time-varying shocks that affect trade flows. The MFN nature of tariffs should alleviate this concern to some extent, since they are set through multilateral tariff negotiations. Still, the aggregation level means that tariffs display heterogeneity across exporters (which I explore for identification), so this mechanism cannot be entirely ruled out. To investigate how potential differences in the elasticity of substitution impact the estimates of trade cooperation, I provide some robustness checks scaling the distribution of σ_s to match

[24] As Gros (1987) demonstrates, the classic optimal tariff formula equals the inverse of the export supply elasticity. Ossa (2016) shows that in a two country, one sector case of my framework with no input-output linkages and assuming perfect competition (that is, an Armington (1969) model), the optimal tariff of country 1 is given by $t_{21}^{'} = \frac{1}{\alpha_{22}^{'}(\sigma-1)}$, where $\alpha_{22}^{'}$ is the own-trade share of country 2 and $\alpha_{22}^{'}(\sigma-1)$ is its export supply elasticity.

[25] Caliendo and Parro (2022) provide a discussion of the different methods available to estimate trade elasticities using tariff variation.

[26] I employ the *ppml_panel_sg* Stata command used by Larch et al. (2019).

Table 1: List of sectors and elasticity of substitution (σ_s)

#	Sector	$-\sigma$	95% CI
1	Agriculture, Hunting, Forestry and Fishing	-2.05	[-6.53 ; 2.83]
2	Mining and Quarrying	-2.05	[-7.21 ; 3.11]
3	Food, Beverages and Tobacco	-0.99	[-3.38 ; 1.41]
4	Textiles, Leather and Footwear	-1.14	[-3.19 ; 0.91]
5	Pulp, Paper, Printing and Publishing	-7.97	[-15.28 ; -0.66]
6	Coke, Refined Petroleum and Nuclear Fuel	-10.19	[-16.21 ; -4.17]
7	Chemicals and Chemical Products	-6.38	[-11.26 ; -1.5]
8	Rubber and Plastics	-6.60	[-10.7 ; -2.49]
9	Other Non-Metallic Mineral	-5.66	[-12.28 ; 0.96]
10	Basic Metals and Fabricated Metal	-5.59	[-9.87 ; -1.3]
11	Machinery (not elsewhere classified)	-7.75	[-19.35 ; 3.86]
12	Electrical and Optical Equipment	-5.00	[-14.27 ; 4.28]
13	Transport Equipment	-8.29	[-13.07 ; -3.5]
14	Manufacturing (not elsewhere classified); Recycling	-5.35	[-14.29 ; 3.6]

the average distribution of equivalent parameters obtained by important related studies in the literature.

Table 1 shows the estimated σ and corresponding 95% confidence interval by sector. Estimates are in line with other studies, even though differences across samples do not allow for a straightforward comparison. Still, the average estimate of - 5.5 is in line with Head and Mayer (Head and Mayer, 2014), who summarize 32 papers and select - 5.03 as their preferred estimate. Also, it is in line with the aggregate - 4.55 estimate in Caliendo and Parro (2015).

4 Quantification

I quantify cooperation parameters θ_i and political economy weights λ_i^s by matching tariff predictions of the model to the empirical distribution of tariffs. In this section, I detail the algorithm employed in the calibration process and discuss the model fit.

I back out θ_i and λ_i^s in two separate steps. This helps to alleviate the computation intensity of the process since recovering more than five thousand parameters involves solving for the trade equilibrium thousands of times. In the first step, I estimate political economy weights that can replicate the cross-sector distribution of empirical tariffs after controlling for its mean. In the second step, I use the political weights obtained in the first step to back out cooperation parameters that align mean counterfactual tariffs to the data. The routines I adopt here build on a similar algorithm proposed by Ossa (2014) that was also recently used by Mei (2020).

Notice that the static model that I use in my application cannot rationalize trade imbalances existent in the data. To deal with this issue, I follow the suggestions in Ossa (2016), now largely adopted by the literature, and use the model structure to eliminate aggregate trade deficits from the data. To do so, I accommodate trade imbalances in the model by allowing for international transfers in each country's budget constraint and use the equilibrium in changes to compute a counterfactual scenario in which these transfers are set to zero.

In the algorithms that I describe below, I repeatedly solve for counterfactual tariffs to obtain the parameters of interest. I employ Su and Judd (2012)'s methodology of mathematical programming with equilibrium constraints (MPEC), similarly to Ossa (2014), although implemented in Julia (Bezanson et al., 2017), which allows for a faster computational time. Also, since my analysis focuses on trade cooperation inside the WTO, I restrict tariffs to be applied nondiscriminatorily.

4.1 Political Economy Weights

I back out political economy weights λ_i^s for 11 trading blocs, 14 sectors and 33 years. They are designed to capture lobbying activities that shape the cross-sector distribution of MFN tariffs. I numerically search over the λ_i^s that can match the cross-sector distribution of noncooperative counterfactual tariffs of each country and year to the tariff data after controlling for its mean. I start with a simple guess $\lambda_i^s = 1$ for each sector and solve for counterfactual tariffs that maximize political welfare changes. If the predicted sector s tariff is below the corresponding level in the data, I increase the guess for λ_i^s, repeating this procedure for all S sectors always controlling for the cross-sector mean. I iterate over this process until the mean squared residual reaches a low tolerance level.

4.2 Multilateral Cooperation

I back out the cooperation parameters θ_i for 11 trading blocs and 33 years. I design the calibration approach such that θ_i captures the degree of internalization of the trade externality, relative to a noncooperative benchmark, that is implied by real-world tariffs. This involves two steps. First, I use the model to compute a counterfactual noncooperative scenario in which each importer chooses tariffs to maximize its political welfare. Second, I pin down cooperation parameters θ_i that would move countries from this noncooperative equilibrium to one whose tariff solutions approximate the empirical distribution of tariffs.

To implement the first step, I compute a separate noncooperative benchmark for each country and year by matching the equilibrium in changes to data purged from trade imbalances and solving for the equilibrium that maximizes political welfare changes.

To implement the second step, I match the equilibrium in changes to the noncooperative trade and tariff levels obtained in the first step and then numerically search for the θ_i that yields counterfactual tariffs that approximate empirical ones. I start with a simple guess of $\theta_i = 1$ and solve for counterfactual tariffs that maximize changes in G_i. I increase θ_i if the mean counterfactual tariff is above the mean empirical one and decrease it otherwise.[27] I iterate over this process until the squared residual is minimized. Notice that I only solve for MFN tariffs and impose observed tariffs applied over exports of non-WTO members as an additional constraint to the problem.

An assumption involved in the procedure described above is that a counterfactual scenario with unilateral noncooperative tariffs is an appropriate description of the noncooperative equilibrium. Arguably, a noncooperative Nash equilibrium could provide a more precise description of a world without cooperation, as suggested by the original analysis of Johnson (1953). I choose this more simple noncooperative baseline for practical purposes, as it allows for a more parsimonious computational routine. Nonetheless, the fact that the cross-sector distribution of Nash tariffs is very close to the distribution of unilateral optimal tariffs, as showed by Ossa (2014), suggests that this assumption should play no role in my analysis.

4.3 Model Fit

The identification of cooperation levels relies on the ability of the model to match tariff data. I next provide an overview of the model fit comparing counterfactual tariffs implied by cooperation parameters and political economy weights to the data.

I start with a discussion of the fit provided by political economy weights. Recall that I estimate them by matching the cross-sector distribution of MFN tariffs after controlling for its mean. Figure 4 displays the differences between noncooperative tariffs with lobbying and the data for each country

[27] Recall that the model only admits $0 \leq \theta_i \leq 1$.

and year, with tariffs within each year sorted by the lowest to the highest noncooperative tariff. Notice that the model is overall able to replicate the distribution of tariffs in different contexts, although generally overpredicting the means.

Still, there are some relevant differences across countries and years. For the European Union, the United States and Japan, the pattern of the fit is stable over time. For other countries, the fit is more context specific. For instance, for India until 2002 and for Brazil until 1989 empirical tariffs are above noncooperative ones. For China until 1994, they are at the same level.[28] This suggests, in the first case, that tariffs were too extreme to be explained by the theory or, in the second case, that noncooperative tariffs with lobbying were a good approximation for tariffs that countries actually adopted. Another regularity are changes over time in the gap between predictions of the model and the data for multiple trading blocs. Overall, the gap widens around the years of the Great Recession, which suggests a contemporaneous change in the strength of political lobbies.

Figure A.1 in the Appendix additionally displays the resulting political economy weights. Overall, weights are highly correlated across countries, with higher levels observed in higher elasticity industries in all years. This correlation is observed because governments impose lower tariffs in higher elasticity industries and, hence, lobbying weights must balance that to match empirical tariffs.[29] This pattern resonates with political economy weights obtained by Ossa (2014). Later in section 5, I provide a discussion of how the variation on the estimates of political economy weights connects to multilateral cooperation levels.

I now turn to the model fit after accounting for political economy weights and multilateral cooperation parameters. Recall that I compute cooperation levels by matching mean cross-sector counterfactual tariffs to the data. Figure 5 shows the relationship between the two variables. Observe that the model is able to exactly match tariff means. For 96% of the observations, the difference between model predictions and the data is below 0.01%. For the remaining 4%, the model majorly underpredicts the means because they are above noncooperative levels.

Figure 6 further displays the resulting fit for each individual sector-level tariff, sorting sectors within each year from the lowest to the highest counterfactual tariff. As expected, accounting for

[28]The analysis of cooperation is restricted to WTO members. Still, I discuss the model fit for China before its accession to the WTO for completeness.

[29]Figure A.2 in the Appendix shows the distribution of non-cooperative tariffs without accounting for political economy factors.

Fig. 4: Noncooperative tariffs with lobbying - by year, country and sector ranking

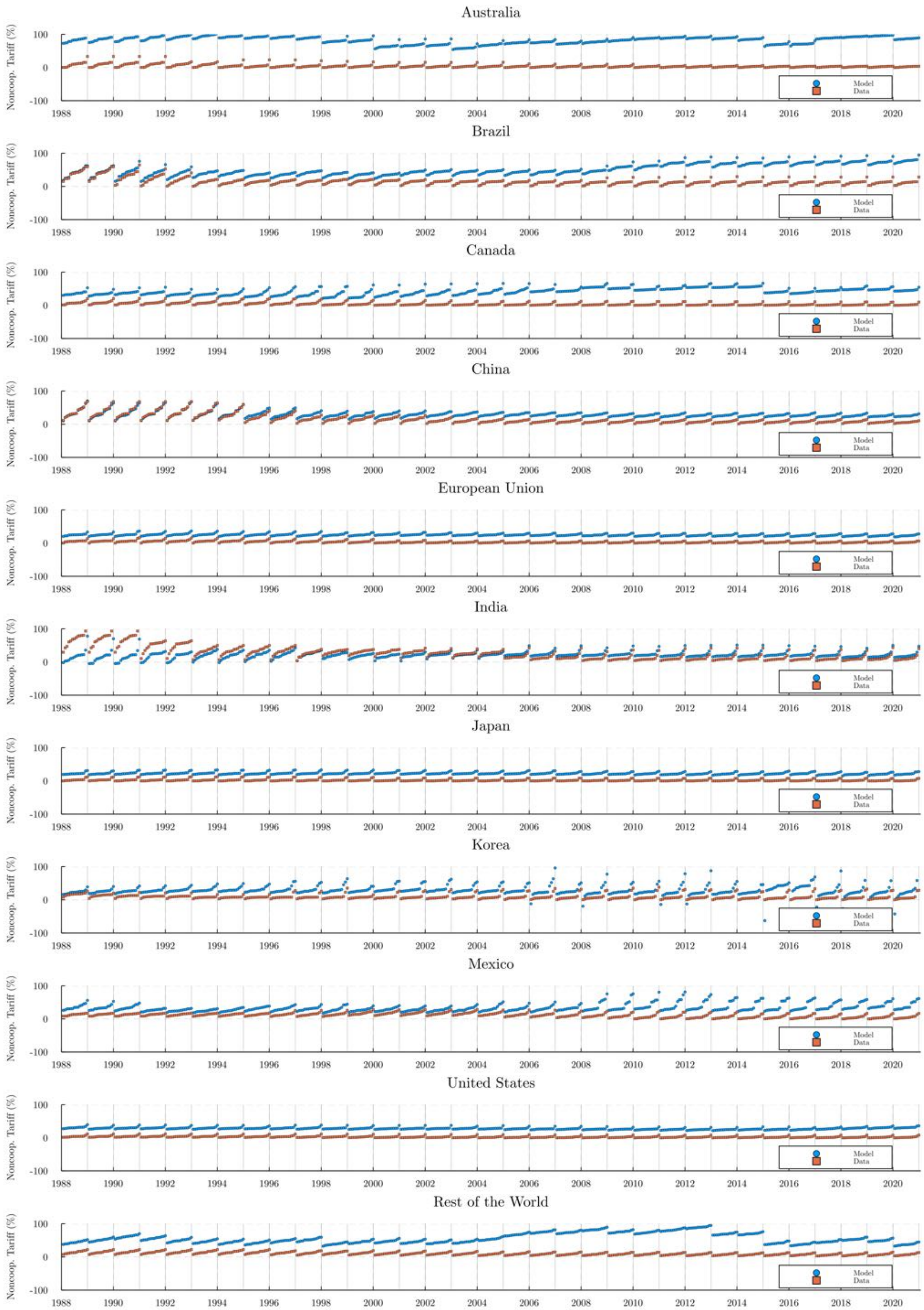
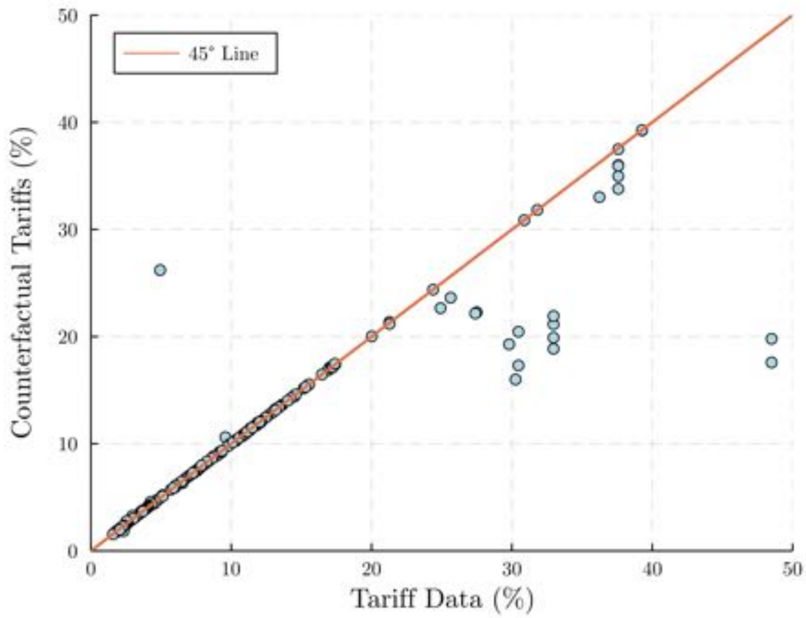


Fig. 5: Model fit - mean tariffs



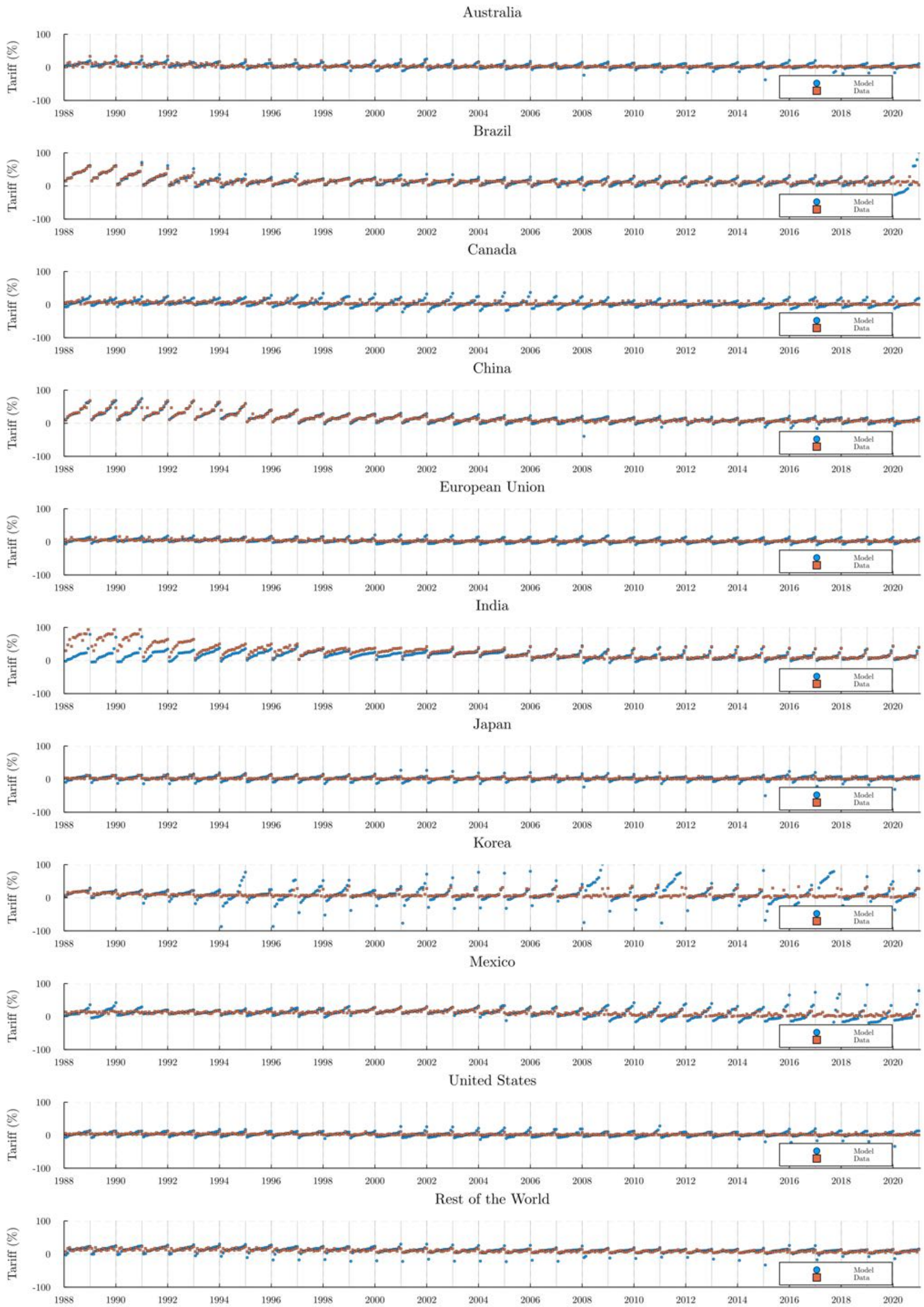
Note: The figure displays cross-sector means for tariff data and counterfactual tariffs after accounting for political economy weights and multilateral cooperation. For 96% of the observations, the difference between model predictions and the data is below 0.01%

cooperation offsets the benefits of high tariffs and brings counterfactual tariffs closer to the data for most countries and years. Also, the model usually performs better when the targeted distribution is more uniform. This is clear in the case of South Korea. Its mostly irregular fit is due to discrepant tariffs in the agriculture and food sectors, which are consistently 10 p.p. above other industries, even reaching 20 p.p. after the Great Recession. Still, such sector-level differences in tariffs are not widespread and should not affect the computation of cooperation levels.

5 Results

In this section, I present the main results starting with cooperation parameters that I back out using the methodology described above. I next investigate how the parameters relate to important determinants of trade cooperation identified in the literature, as well as to the political weights used in their background calculation. I also investigate the importance of accounting for input-output linkages and preferential liberalization and what are the welfare consequences of a potential reversal in current cooperation levels. Last, I provide sensitivity checks with respect to estimates of the elasticity of substitution.

Fig. 6: Model fit - tariffs by year, country and sector ranking



5.1 Multilateral Cooperation

Figure 7 summarizes changes in global trade cooperation between 1988 and 2020. It aggregates individual cooperation levels that I back out for each country and year using a weighted average, with weights given by countries' share of global imports in the total period.[30] The series is normalized to have a value of 1 in 1988. Results show that in the previous three decades global trade cooperation increased by 81%, with an average growth rate of 2% per year. There are some stark differences between years, though. A steep increase in trade cooperation is observed before the Great Recession in 2008, with an average growth rate in the period of 3.2% per year. After that, a deceleration and slight reversal took place. Between 2008 and 2020, the average growth in cooperation was -0.01%, with a 2% decrease in 2020 relative to 2008.

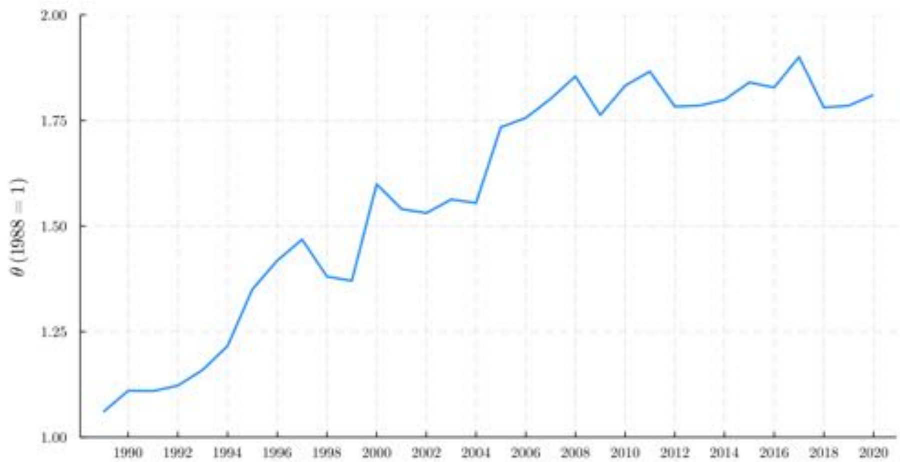
This account of changes in global trade cooperation is consistent with the simultaneous changes in trade and MFN tariffs. Between 1988 and 2020, average MFN tariffs fell by 52% and international trade constantly grew above GDP (Antràs, 2021). To see how the model rationalizes these trends, recall that cooperation is given by the degree of internalization of the trade externality. For given tariff changes, an increase in imports will increase the trade externality as tariff-led changes in terms-of-trade and profits now apply over a larger trade volume. Thus, to adopt such tariff changes, an importer would need to internalize a larger externality being relatively more cooperative. Additionally, for given trade volumes, lower tariffs increase the distance between noncooperative and applied tariffs and, hence, such tariff levels can only be sustained through the internalization of a larger trade externality. In line with that, but with an opposite effect, the slowdown of trade growth after 2008 and the end of the trade liberalization agenda of the 1990s constitute the background of the stagnant cooperation levels in the last decade.

Notice that numbers in Figure 7 also display some temporary contractions. These rather short-term reversals in cooperation are contemporaneous to major aggregate international trade shocks, as in 1997, 2000, 2008 and 2011. These shocks relate, for instance, to the Asian and Russian financial crises at the turn of the century and later to the Great Recession and its consequences.[31] Interestingly, even though downturns are followed by recoveries, subsequent cooperation levels are

[30]That is, the weight is given by: $(\sum_{t=1}^{33}\sum_{i=1}^{N}\sum_{s=1}^{S}X_{ijt}^{s})/(\sum_{t=1}^{33}\sum_{i=1}^{N}\sum_{j=1}^{N}\sum_{s=1}^{S}X_{ijt}^{s})$. Figure A.4 in the Appendix shows aggregate cooperation using a simple average instead. Qualitatively all conclusions remain the same.

[31]These shocks are visible in the country-specific manufactures imports time-series displayed in Figure 2.

Fig. 7: Global Trade Cooperation (1988 - 2020)



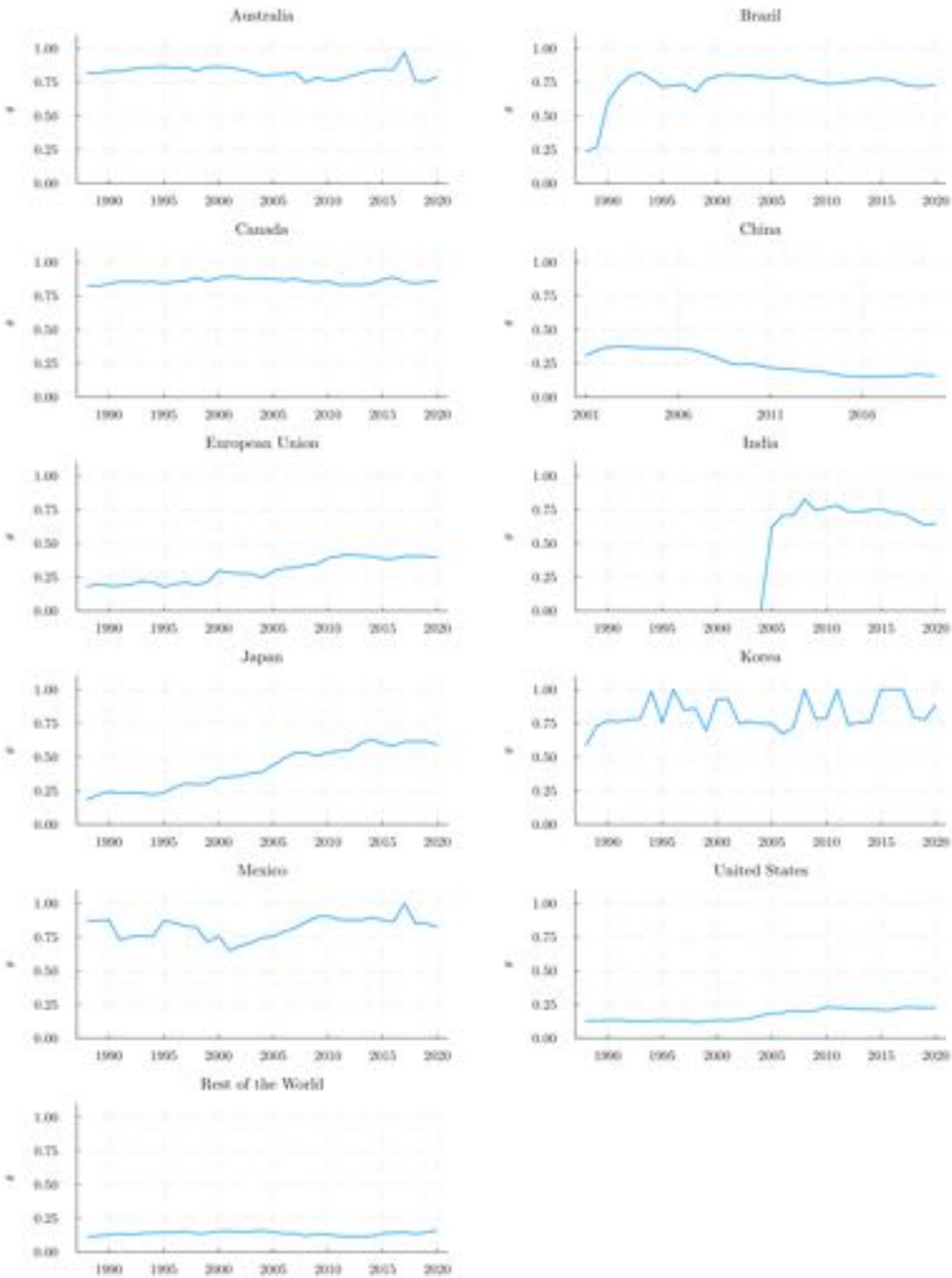
Note: Weighted average of estimated θ of all trading blocs with weights given by the import share of each country over all years.

often below what would be expected by the pre-shock trend, which gives to the curve its concave aspect. The fact that numbers do recover after a few years suggest some resilience of cooperation to macro shocks. However, the fact that it recovers to a lower growth point suggests that a more permanent component of the shocks lowers average cooperation in the long term.[32]

I now turn to country-specific levels of cooperation. Figure 8 shows the magnitude of each θ_i over time. Overall, in the first two decades cooperation in most places either increased or remained nearly stable. Cooperation increased in some high-income countries and regions, such as the European Union, Japan and the United States, even though they already adopted low tariffs in 1988 after decades of active participation in multiple rounds of trade negotiations. For instance, in the US cooperation increased 65% between 1988 and 2007, in the European Union, 125% and in Japan, 189%. Australia and Canada are exceptions to this group with near zero growth in cooperation. This happens because, even though tariffs decreased by around 70% in both countries, expenditure with foreign goods did not expand as much. As a comparison, over the 33 years the share of imports in total expenditure tripled in Japan, doubled in the USA, but only increased by half in Canada and by 30% in Australia.

[32]Measuring resilience is beyond the scope of my proposed framework, so I simply point to the suggestions in Figure 7. A permanent effect of the shock that lowers cooperation on the long run could be, for instance, policies that curb import competition in the domestic economy during the shock and that are not removed after trade flows recover to previous levels. A similar understanding of resilience based on the cumulative deviation from a trend can be found in the literature (Ringwood et al., 2019). The 2021 WTO Trade Report ((WTO, 2021)) includes a related discussion on the resilience of international trade flows to trade shocks based on ongoing research by Le Moigne et al. (2021)

Fig. 8: Trade cooperation, by country (1988 - 2020)



Note: Changes in the cooperation parameter over years. The underlying model has I-O linkages and lobbying.

Among developing countries, Brazil and India witnessed a sudden increase in cooperation in the 1990s and early 2000s, reflecting the decision to unilaterally liberalize their markets. Between 1988 and 2007, cooperation in Brazil increased 236%. India applied tariffs above noncooperative levels in the earlier years of the sample and cooperation is only observed starting from 2005, when average tariffs fell by 36% relative to the previous year. China joined the trading system in 2001, with cooperation increasing 7.2% until 2005, when it peaked. For Mexico, cooperation slightly decreased until 2005 and for the Rest of the World, it remained roughly stable. For South Korea, cooperation levels are high, but unstable due to political economy factors. As I discussed in section 4.3, this stems from strong differences in observed cross-sector tariff levels. When not accounting for lobbies, cooperation levels in the country are mostly given by 1, as showed by figure A.5 in the Appendix.

After these initial changes, cooperation stalled in general and in some places it even reversed. For instance, in China cooperation decreased 47% after 2005. Interestingly, this happens amid a 29% decrease in Chinese average tariffs and a 56% increase in its total imports. Even though such changes are in general connected to more cooperation, in this case their effect is offset by a relatively more closed economy, with a lower share of domestic expenditure on imports following a period of high economic growth.[33]

A question that arises from the numbers in Figure 8 is whether the slowdown in cooperation is due to the fact that import tariffs are already too low after years of liberalization efforts. While a quantitative analysis of the complexities surrounding current trade negotiations is beyond the scope of this paper, a simple thought experiment can shed light on the issue. I compute fully cooperative tariffs for each country and sector and compare them to applied MFN tariffs in 2020 to check the scope for further liberalization. Results show that 52% of total sector-level tariffs are still above cooperative levels, which indicates that some additional gains of cooperation are still attainable.[34]

[33] This connects to the empirical regularity in Figure 8 that larger economies are relatively less cooperative, as showed by the magnitude of θ for the EU, the USA and the Rest of the World. This happens because the trade externality is increasing in country size. Hence, for large countries a relatively smaller weight on the welfare of partners already internalizes a sizable externality and considerably brings down counterfactual tariff levels.

[34] I compute cooperative tariffs adopting a formulation in the spirit of a symmetric Nash bargaining protocol in which countries equally split efficiency gains among themselves. This formulation is similar to the one used by Ossa (2014) to compute cooperative tariffs, which also yields a combination of import tariff and subsidies that replicate international side payments. Figure A.3 in the Appendix shows the distribution of cooperative tariffs for all countries and years.

5.2 Relationship with determinants of cooperation in the literature

One of the upsides of this type of quantitative analysis is that it can provide a sense of the magnitude of important theoretical objects emphasized in the literature. However, as pointed out by Ossa (2016), it inevitably often raises doubt about how credible the numbers obtained actually are. As I indicate above, cooperation levels are primarily determined by differences between noncoperative tariffs and the data. Still, in this section I show that other elements of the model that are also important theoretical and empirical determinants of trade cooperation identified in the literature also shape the variation of parameters over time.[35]

I investigate the correlation between the cooperation parameter θ_i and a set of determinants of trade policy cooperation estimating the following equation:

$$ln(\theta_{it}) = \boldsymbol{\beta} ln(\mathbf{E_{it}}) + \nu_i + \nu_t + \epsilon_{it} \tag{24}$$

where $\boldsymbol{\beta}$ is a vector of correlations of interest, $\mathbf{E_{it}}$, a vector of explanatory variables, ν_j and ν_t, country and time fixed-effects and ϵ_{it}, an error term.

I next detail the determinants of trade cooperation included in the vector $\mathbf{E_{jt}}$. First, I investigate if cooperation relates to the concentration of import markets among WTO partners. This captures the idea that concentration determines the extent of internalization of the trade externality because the WTO non-discrimination principle creates a free-rider problem in which members only negotiate tariff cuts with principal suppliers. Hence, the more concentrated is the import market, the higher is the cooperation as importers are more aware of the costs of protection. Following Ludema and Mayda (2009, 2013), I use a Herfindahl-Hirschman Index (HHI) to capture import market concentration among WTO exporters.[36]

I also consider if changes in cooperation relate to the participation of domestic firms in global value chains. In particular, I investigate the two main insights in Blanchard et al. (2016) about the interplay between GVCs and trade policy. I first check whether the use of foreign value added by

[35] So far in the literature there are not many attempts to confront the predictions of quantitative models that feature trade policy choices made by optimizing governments with the data. One exception is the consistency of Nash tariffs with tariff levels observed in the trade war that followed the Smoot-Hawley Tariff Act of 1930 (Ossa, 2014; Lashkaripour, 2021).

[36] The index encompasses the sum of squared export shares of negotiators over all potential participants that are members of the WTO. More specifically, the degree of import market concentration is given by: $HHI_{it} = \frac{\sum_{j \in \Omega} {X^s_{ji,t}}^2}{(\sum_{j=1}^{N} X^s_{ji,t})^2}$, where Ω_j is the subset of countries different from i that are also WTO members.

domestic firms relates to more cooperation given that import tariffs transfer to foreign producers some of the benefits of protection. I also examine if the presence of more upstream domestic industries that supply inputs to foreign producers is associated with more cooperation as tariffs decrease exporter prices and, by consequence, the revenue of domestic input suppliers. To do so, I add to specification (24) the average share of domestic value added in production and a measure of "upstreamness", which captures the distance of the average industry in the economy from final consumption.[37]

Last, I investigate the correlation between cooperation and participation in preferential trade agreements. As explained by Limão (2016), conclusions of the literature on this topic depend on the settings and mechanisms investigated. Some authors argue that PTAs are a stumbling block to multilateral trade liberalization as they increase external tariffs and hamper further multilateral liberalization. Other authors argue that they are building blocks given a complementarity between preferential and multilateral tariffs. To take PTAs into account, I include in specification (24) the share of preferential imports over total imports for each country and year.[38]

Table 2 shows the results. Each column controls for a different combination of country and time fixed-effects. Notice that, as expected from the discussion above, import market concentration is positively associated with cooperation. Also, a higher share of upstream industries is on average associated with more cooperation and more domestic value added in production, with less. Coefficients of these three variables are sizable and statistically significant in most specifications. Imports of PTA partners are negatively associated with cooperation, indicating a trade-off between multilateral and preferential liberalization, although the correlation is not so strong.[39]

I further run separate regressions accounting yearly for the effect of each determinant of cooperation. Given that I also include country fixed-effects, results are obtained at the expense of some precision of the estimates, which is visible in the size of confidence intervals. Still, regressions yield some interesting insights about the yearly variation in the correlations. Figure 9 shows that the

[37] The share of value added in production corresponds to the Cobb-Douglas production parameter $\beta_i^{s,L}$. To compute upstreamness, I employ the following expression taken from the literature (Antràs and Chor, 2013; Shapiro, 2021): $U_{i,t}^s = [I - d_{ij,t} Y_{jmt}/Y_{i,t}]^{-1}\mathbf{1}$, where $U_{i,t}^s$ is a S $\times$ 1 column vector, I is the S $\times$ S identity matrix, $d_{ij,t}$ is the input-output coefficient, $Y_{i,t}^s$ is the output of industry s, and $\mathbf{1}$ is a vector of ones. To include it in specification (24), I compute the average across sectors for each country and year.

[38] Section A.1 in the Appendix includes a description of the data on preferential trade agreements that I use to compute the share of PTA imports.

[39] I later also investigate the role of PTAs on determining cooperation levels explicitly accounting for their presence in the model.

Table 2: Determinants of multilateral cooperation

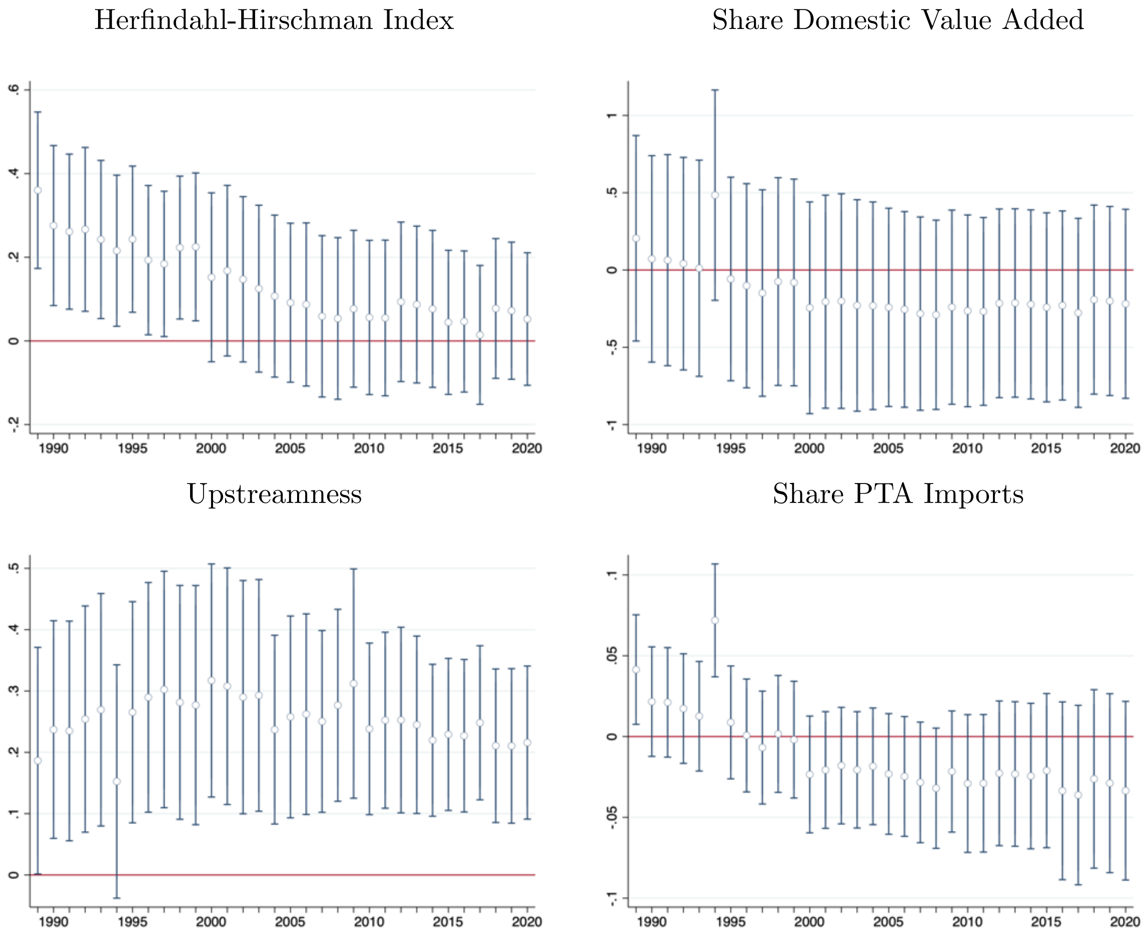
	(1)	(2)	(3)
HHI	0.157**	0.356***	0.117
	(0.069)	(0.062)	(0.081)
Share VA	-0.420*	-0.582***	-0.312
	(0.216)	(0.158)	(0.254)
Upstreamness	0.233***	0.629***	0.237***
	(0.031)	(0.019)	(0.055)
Share Imports PTA	-0.005	-0.025***	-0.021**
	(0.007)	(0.008)	(0.008)
Year FE	No	Yes	Yes
Country FE	Yes	No	Yes
Observations	332	332	332

Note: Standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively. OLS regression. The dependent variable is the cooperation parameter θ_i. HHI corresponds to a measure of import market concentration. Share VA is the average cross-industry share of domestic value added in production. Upstreamness is the distance of the average industry from final consumption. Share Imports PTA is the share of preferential imports over total imports for each country and year.

correlation with import market concentration is positive in all years, but it decreases with time in size and statistical significance. Notably, the larger and significant effects coincide with years of more intense tariff liberalization in the 1990s. The correlation with domestic value added in production varies at the beginning of the sample and remains stable after the 2000s, although it is never statistically significant. The correlation with upstreamness is continually positive, roughly stable and statistically significant. The correlation with the share of imports inside a PTA is increasing over time, as the number of PTAs increases, but it is never statistically different from zero. All in all, I take the correlations in Table 2 and Figure 9 as evidence that the levels of cooperation that I back out from the model articulate in a consistent way important empirical determinants of cooperation that are present in the model.

Next, I examine the association between political economy weights and cooperation levels. I find that political economy activity is positively related to changes in cooperation, especially in developing countries. This can be seen in Figure 10, which shows average changes in noncooperative

Fig. 9: Correlation between θ and selected variables



Note: Each chart shows yearly correlations obtained from an OLS regression which includes the interaction of the variable of interest with a time indicator, baseline levels and country fixed-effects.

tariffs with lobbying over time. Notice that political tariffs, which capture the strength of the political influence of lobbies, on average decrease during the 1990s, but increase in the 2000s, with both movements carried out by numbers in developing countries. Given that cooperation also increases over time, this implies a positive relationship with changes in cooperation, as showed by Figure 11. Recall that in the model, political weights match the cross-sector distribution of tariffs, while cooperation matches its mean. Thus, one way of rationalizing this pattern is that, while developing countries do become more cooperative over time, sector tariff distributions come to reflect more political distortions.[40]

[40] Given that political economy weights are scaled to have a mean of 1, I cannot directly compute their correlation with country-level cooperation parameters. This is why I use noncooperative tariffs implied by them instead.

Fig. 10: Changes in Tariffs w/ Lobby

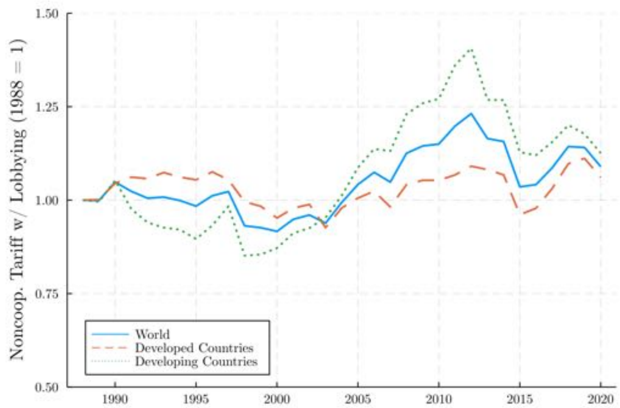
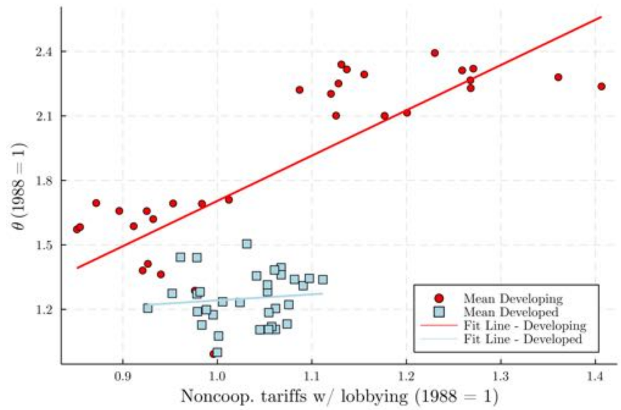


Fig. 11: Tariffs w/ Lobby and Cooperation Levels



5.3 The role of input-output linkages

I check the importance of accounting for input-output linkages in the computation of cooperation levels. To do so, I back out θ_i using a version of the model without the use of intermediates in production, that is, in which $\beta_i^{L,s} = 1$ for all s. To make for a transparent comparison, I abstract from political economy factors both in the results for the baseline model and for the version without I-O linkages.

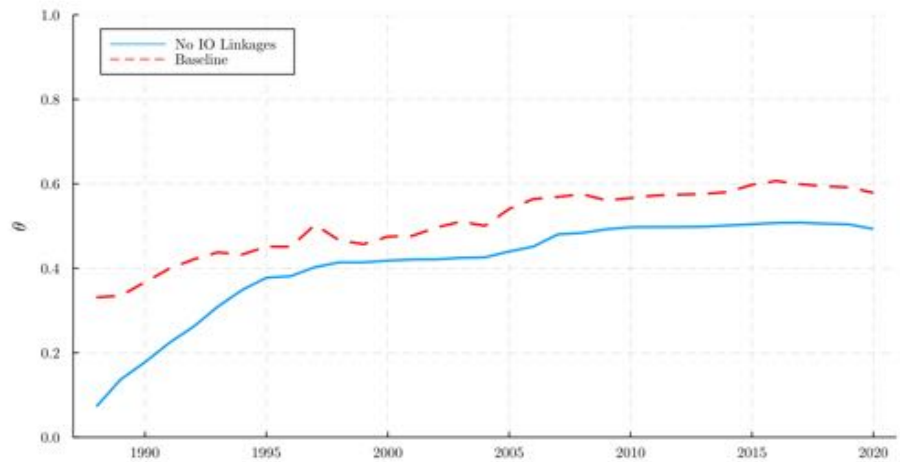
Figure 12 shows aggregate results in both cases using a weighted average as before. Notice that not accounting for I-O linkages underestimates cooperation in all years, with parameters on average 20% lower than in the baseline model. This happens because in the presence of I-O linkages countries in general set higher tariffs because costs associated with costlier domestic goods are also partially passed to foreign consumers via foreign sales of upstream industries. This increases in size the trade externalities associated with tariffs, requiring more cooperation to meet current tariff levels.[41] Figure A.6 and A.5 in the Appendix shows the θ_i used to compute aggregate numbers in Figure 12.

5.4 Preferential Trade Agreements

I also check how adjusting the size of the trade externality to take into account preferential liberalization changes the magnitude of cooperation parameters. To do so, I assume duty-free treatment

[41] This result is consistent with the analysis of Lashkaripour and Beshkar (2020), who derive analytic formulas for second-best optimal import taxes in a general equilibrium setting and find that governments impose higher tariffs on upstream industries.

Fig. 12: The role of Input-Output Linkages



Note: Weighted average of the parameter θ of all trading blocs backed out in the model with and without I-O linkages and no lobbying. Weights are given by the import share of each country over all years.

to the imports of PTA partners and impose it as an additional constraint to the optimization problem. This implies that cooperation only takes into account the impact of trade policy externalities on non-PTA partners. Section A.1 in the Appendix describes the data on PTAs that I use to calibrate the model. In the following results, I also compute cooperation parameters abstracting from political economy forces.

Figure 13 shows the results. Overall the pattern of changes in cooperation is similar to the baseline model, with an increase in cooperation in the first years and a deceleration that starts in the years around the Great Recession. The formation of PTAs enters the model as an exogenous shock that modifies the magnitude of the trade externality relative to the previous year. This explains the more abrupt changes in cooperation that are absent from the baseline results. Figure 14 further shows how accounting for PTAs changes estimates of individual θ_i for participating countries relative to the baseline model. For many countries, estimates of cooperation remain unchanged and the most affected countries are the signatories of the North American Free-Trade Agreement (NAFTA), the largest trade agreement in the sample, besides Korea and Japan. For Canada and Mexico, accounting for the PTA would require less trade cooperation, since MFN tariffs would then not apply to exports from the US, their largest trading partner. For the US, the inverse happens, and more cooperation is necessary since imports from WTO members would then be more concentrated on the EU and the Rest of the World, also large exporters.

Fig. 13: Cooperation accounting for PTAs

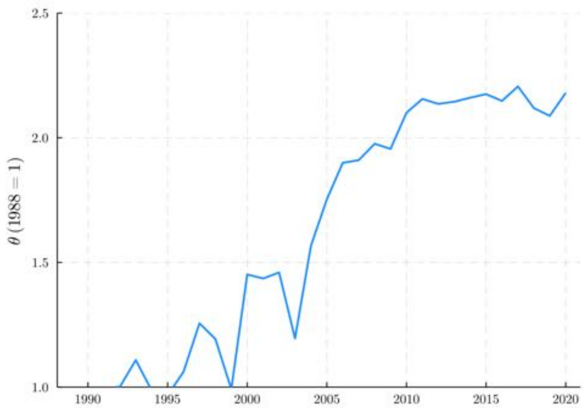
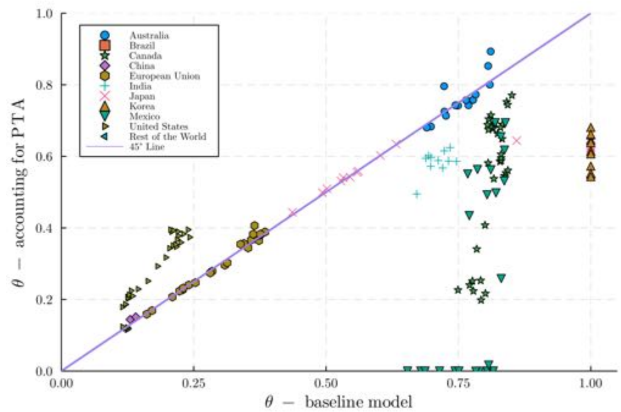


Fig. 14: Changes in θ accounting for PTAs

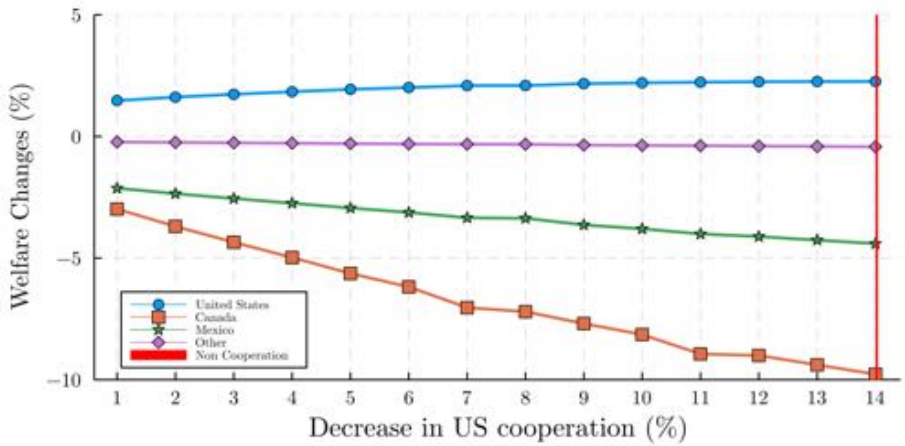


5.5 The consequences of a reversal in cooperation

In this subsection, I compute the welfare consequences of a gradual reversal in cooperation levels. Arguably, some of the current globalization backlashes, such as the trade policy restrictions adopted by the USA, can be described as a deviation from cooperation levels in the direction of some less cooperative equilibrium, although not by complete noncooperation. I use my quantitative framework to illustrate what are the welfare consequences of this type of deviation. My application focus on the United States in 2020. I compute a series of counterfactuals in which the US decreases its cooperation levels gradually up to complete noncooperation.

Figure 15 shows the results, with the x-axis displaying percentage negative changes in θ for the USA in 2020 and the y-axis the ensuing welfare changes for the US, Canada, Mexico and other countries. Observe that even a small decrease in cooperation yields welfare gains to the deviating country. Also, protectionist gains are mirrored by negative welfare effects in the economies of trade partners. It is interesting to see how the degree of the reversal in cooperation does not affect the losses of distant trade partners, but is critical to the closest ones, such as Canada and Mexico. Moreover, welfare gains of the US and the costs bore by partners change monotonically until the full noncooperation equilibrium. All in all, numbers show that even small deviations from cooperation imply sizable costs for trade partners, especially those with which the deviating country trades more intensely. Although this is just a simple thought experiment, it can help to shed light, for instance, on why trade partners promptly retaliate once a country deviates from current cooperation levels and impose higher trade barriers in return.

Fig. 15: Welfare consequences of a reversal in U.S. cooperation in 2020



Note: Decrease in US cooperation captures negative percentage changes in the parameter θ_i estimated for the USA in 2020. Welfare changes are given by the predicted differences in the economy between the observed equilibrium and this less cooperative counterfactual.

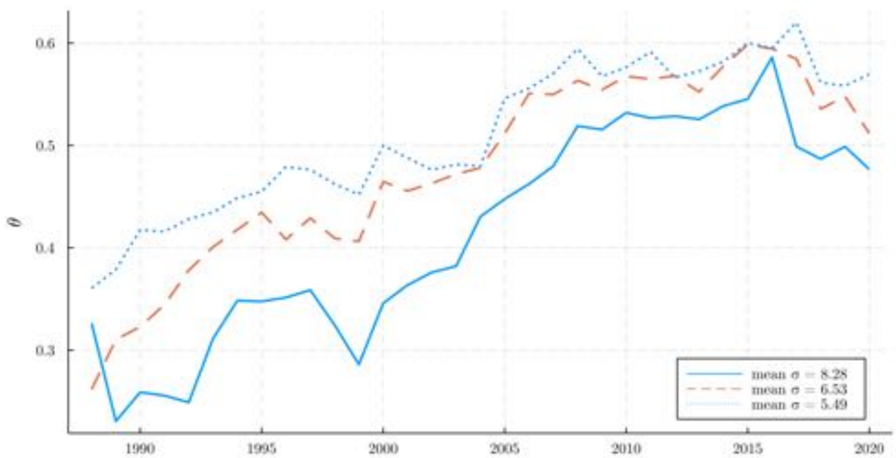
5.6 Robustness

The predictions of quantitative trade models are always conditional on the magnitude of the parameters governing the trade elasticity. Although I estimate the elasticity of substitution using the same data that I use to calibrate the model, the method is subject to endogeneity concerns, so I conduct some robustness checks to make sure that my conclusions hold with a different distribution of σ. More specifically, I scale the elasticity of substitution that I obtain from the data to match the mean trade elasticity of two important benchmarks in the literature: Eaton and Kortum (2002), with a mean elasticity of 8.28, and Costinot et al. (2012), with a mean elasticity of 6.53.[42] In each case I recalculate the political economy weights to make sure that they continue to match the distribution of empirical tariffs and obtain new cooperation parameters.

Figure 16 shows the resulting weighted average of cooperation parameters in each case, with the 5.49 mean corresponding to the baseline results. Observe that cooperation levels are decreasing in the mean σ_s. This happens because noncooperative tariffs are also decreasing in σ_s and, hence, with a higher mean elasticity of substitution countries need to internalize a smaller trade externality to meet current tariff levels. Still, notice that the trajectory of cooperation over time is the same, with a steep increase at the beginning of the sample and a deceleration observed afterward. Interestingly,

[42]Both studies employ a Ricardian framework, so the parameters they estimate are not exactly the same as the elasticity of substitution σ_s. Still, it is well understood today that different gravity models have similar predictions in equilibrium (Arkolakis et al., 2012), so I use those estimates as a reference.

Fig. 16: Robustness - elasticity of substitution



Note: Weighted average of the parameter θ of all trading blocs backed out in the model with I-O linkages and lobbying. Weights are given by the import share of each country over all years. The mean σ of 5.49 correspond to the baseline scenario; 6.53 and 8.28 correspond to the mean parameters obtained by Costinot et al. (2012) and Eaton and Kortum (2002).

a higher mean σ emphasizes the decrease in cooperation observed in the last years of the sample. Still, the main conclusions of the paper remain unchanged.

6 Concluding Remarks

This paper provides a first account of changes in global trade cooperation using a structural framework. My methodology builds on a quantitative general equilibrium trade model that includes the main motivations behind trade policy identified in the literature, as well as a theory-consistent approach to trade cooperation. I use it to compute new measures of multilateral trade cooperation and political economy weights for the largest members of the World Trade Organisation between 1988 and 2020.

I find that, after years of rapid growth in multilateral cooperation in the 1990s and early 2000s, cooperation levels stalled in the last decade and even reversed in some places. These results put numbers on two popular perceptions about recent developments in the global economy. First, that the expansion of globalization observed since the 1980s came to an end after the Great Recession in 2008. And second, that there has been no major progress in the WTO liberalization agenda recently, as suggested by the failure of the Doha Development Round. Still, given that I do not identify a widespread return to protectionism, results are also consistent with the idea that much of the value of the trading system lies in sustaining current cooperation levels. As my analysis shows, a reversal in cooperation, even at a modest rate, would entail substantial economic costs for WTO members.

This paper opens several venues for future research. It would be interesting to see how different settings change the measures of cooperation. A natural next step would be to add more countries and industries, as well as trade in services and non-trade barriers. Moreover, given its growing importance to the world economy, future research could incorporate a richer description of global supply chains, for instance accounting for sequential stages of production or tariff heterogeneity between inputs and final goods.

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A Appendix

A.1 Preferential Trade Agreements

I obtain information on the list of preferential trade agreements in each year from the latest version of the Baier and Bergstrand database (Baier et al., 2014). The Baier and Bergstrand database classify trade agreements depending on the level of trade integration they promote. I consider PTAs that promote substantial liberalization of the signatories' markets, in line with Article XXIV of the General Agreement on Tariffs and Trade (GATT). In the Baier and Bergstrand database taxonomy, this includes "free trade areas", "custom unions", "common markets" and "economic unions". Hence, I assume that whenever two countries share membership in a PTA, imports are eligible for duty-free treatment.Table A.1 shows the list of PTAs.

Table A.1: List of Preferential Trade Agreements

Starting Year	Country-Pair	
1989	Canada	United States
1994	Mexico	Canada
1994	United States	Mexico
1998	Mexico	European Union
2005	Australia	United States
2005	Mexico	Japan
2010	India	Korea
2012	Korea	European Union
2012	Korea	United States
2015	Japan	Australia
2015	Korea	Australia
2015	Canada	Korea
2016	China	Australia
2016	China	Korea
2017	Canada	European Union

Note: List of country-pairs included in the analysis that extend mutual tariff concessions inside free trade agreements. Source: *Database on Economic Integration Agreements.*

A.2 Additional Figures

Fig. A.1: Political Economy Weights

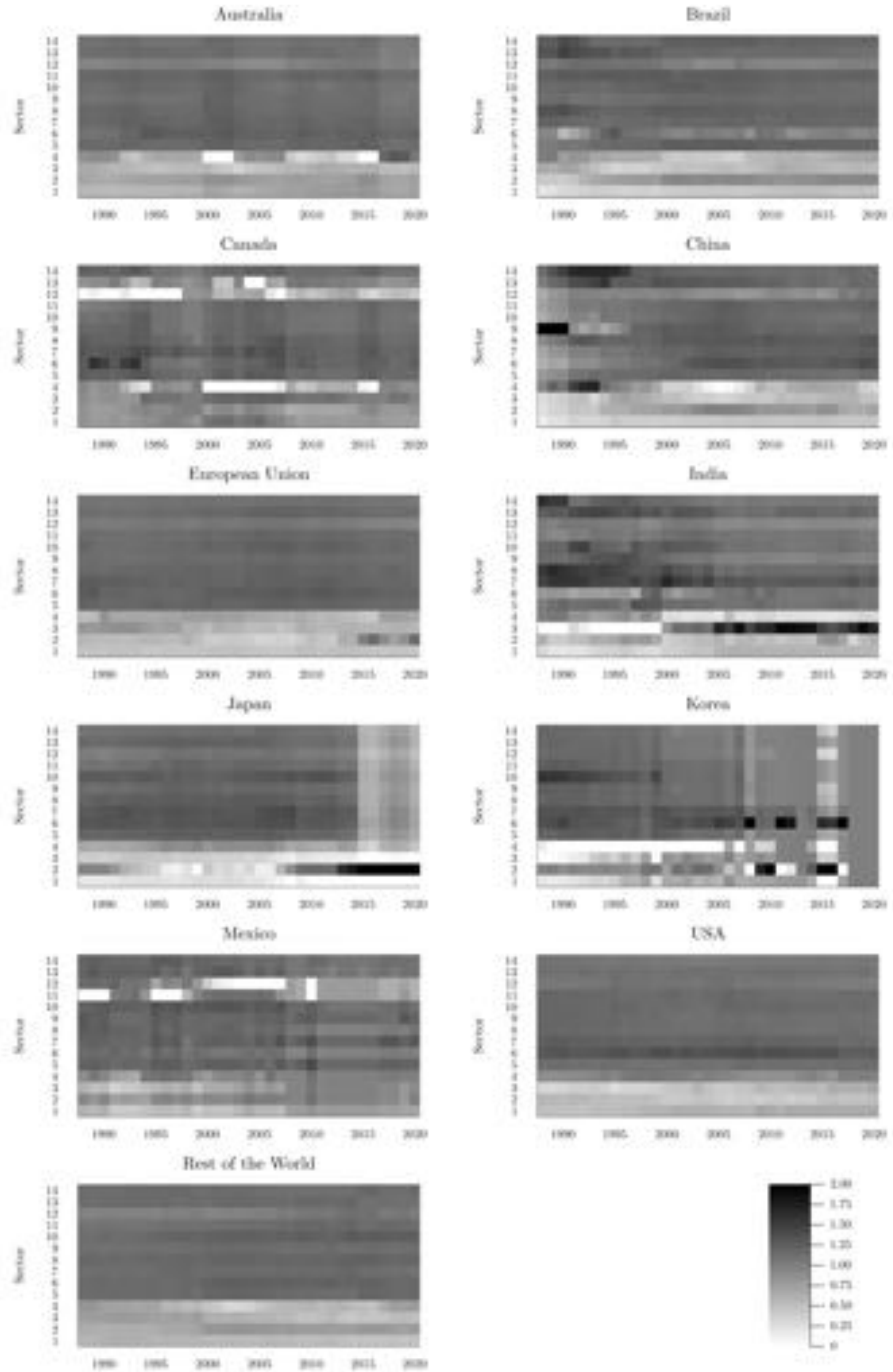


Fig. A.2: Noncooperative tariffs

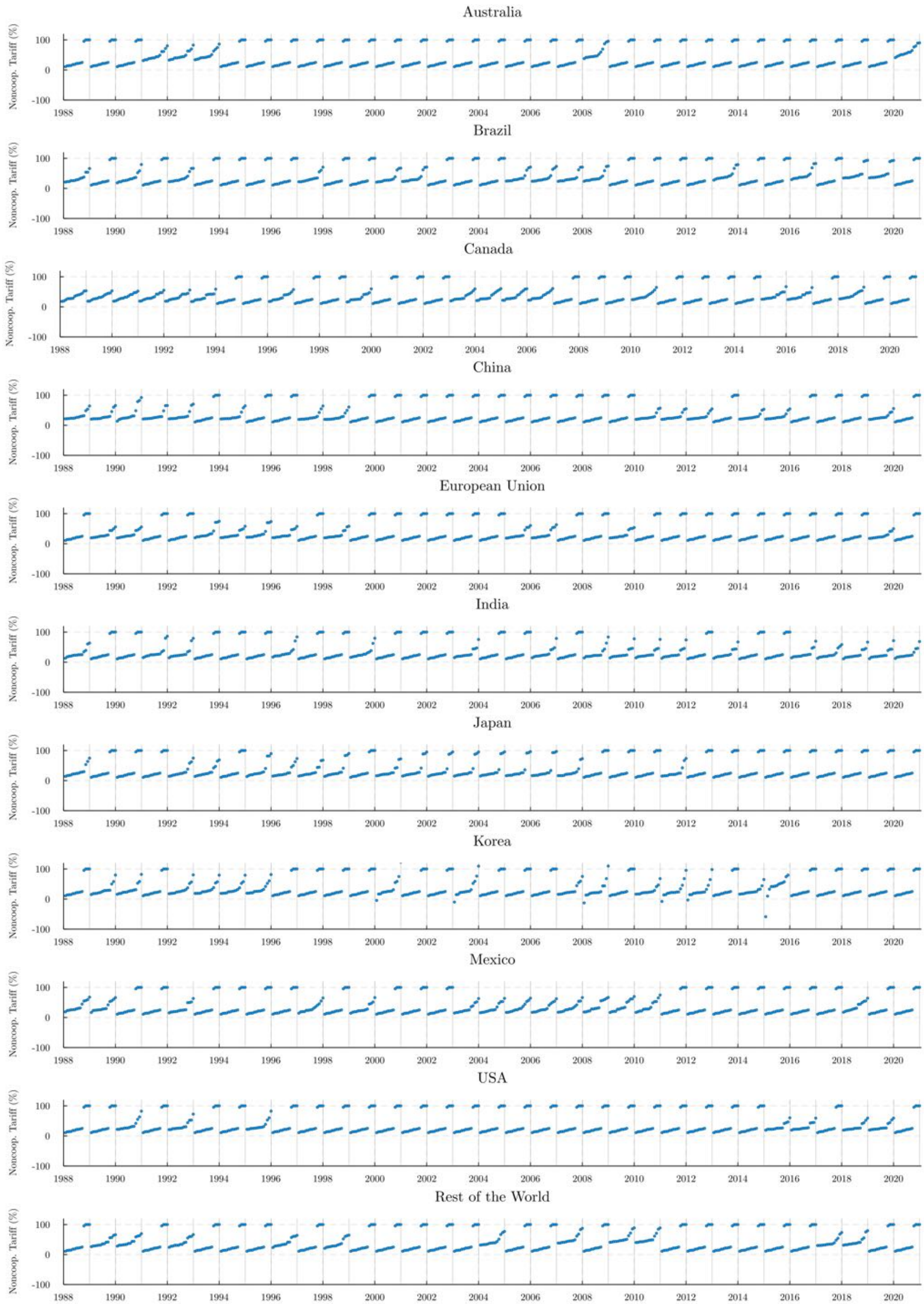


Fig. A.3: Cooperative tariffs

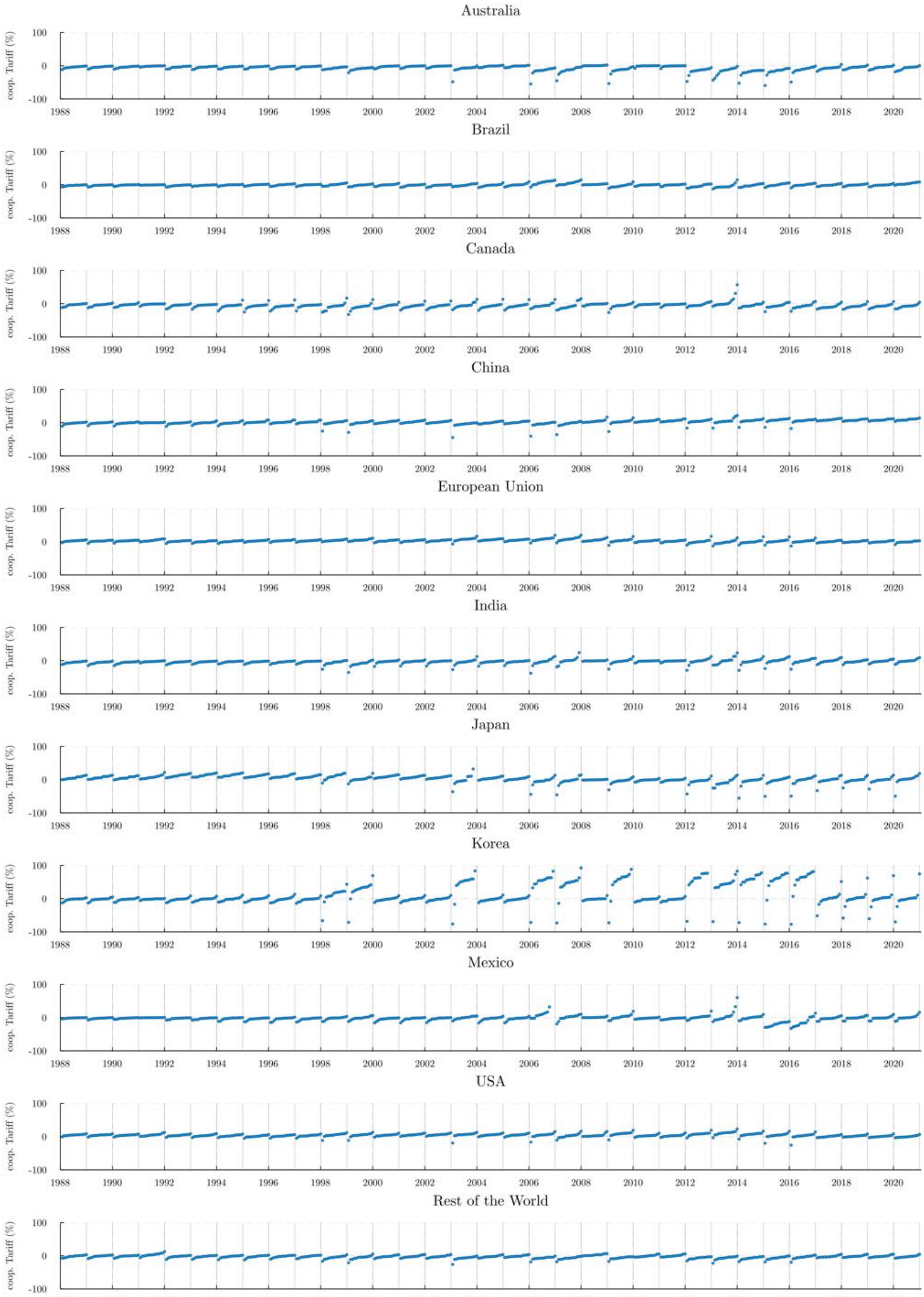
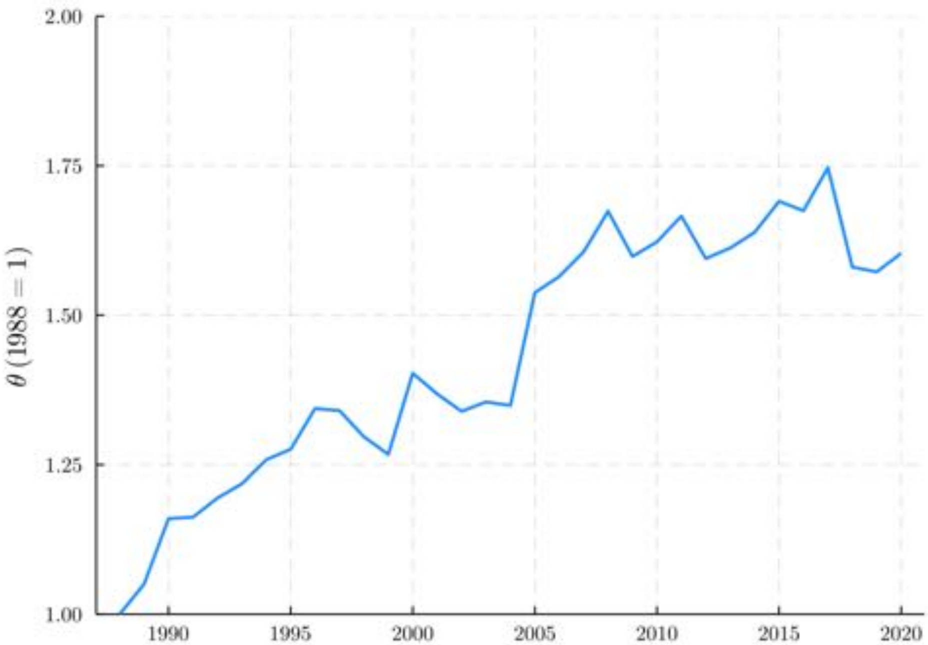


Fig. A.4: Cooperation - Simple Average



Note: Simple average of the parameter θ of all trading blocs backed out in the model with I-O linkages and lobbying. Weights are given by the import share of each country over all years.

Fig. A.5: Cooperation Paremeters without lobbying

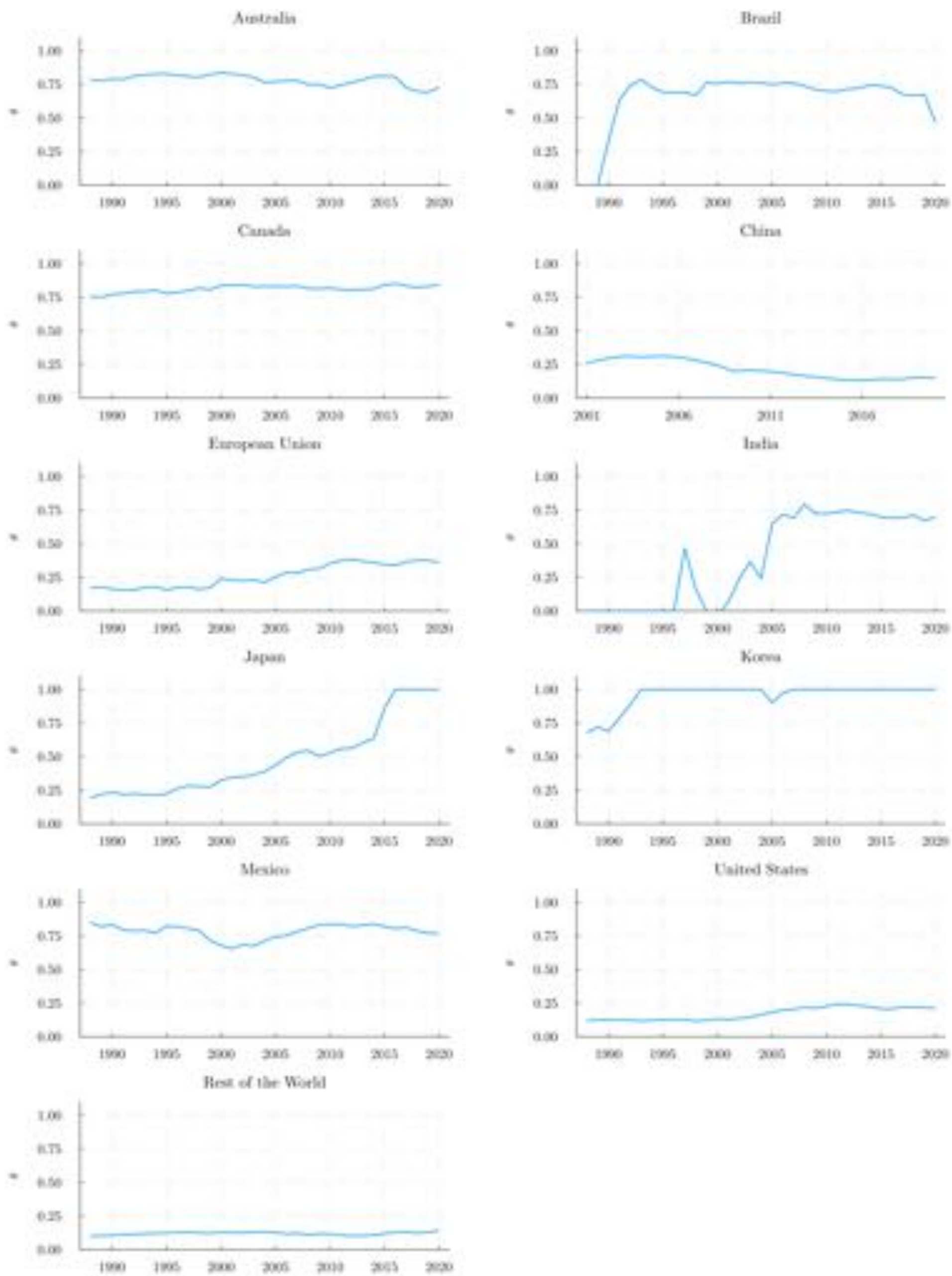


Fig. A.6: Cooperation without I-O linkages and lobbying