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Abstract

This paper sets up a model of trade, in which two countries with differing levels of technology specialize in the production of sub-stages of the global value chain. In the open economy, the technologically backward country exports intermediates in exchange for imports of a homogeneous consumption good from the technologically advanced country. This vertical specialization gives the two countries access to different policy instruments for appropriating rents in the open economy. The technologically advanced country can impose an import tariff on intermediates to lower foreign wages and increase national welfare. An import tariff is ineffective for the technologically backward economy, which can instead lower institutional quality and allow its workers to consume intermediate goods at a utility discount. In a non-cooperative policy equilibrium, the incentives to appropriate rents can be strong enough to lower welfare of the two countries to their autarky levels. This gives scope for a deep trade agreement that conditions tariff reductions on institutional quality improvements and is beneficial for both countries. Empirical evidence shows support for the main mechanisms of the model.

JEL-Codes: F120, F130, F680.

Keywords: global value chains, trade policy, institutional quality, tariffs, deep trade agreements.

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1 Introduction

Global value chains have become increasingly important over the last decades and are now a predominant factor of international trade (see Johnson and Noguera, 2017; Johnson, 2018).[1] Their wide dissemination has brought global value chains to the attention of academic research which has tried to decipher them, using advanced theoretical models (see Antràs and Chor, 2013; Costinot et al., 2013; Antràs and de Gortari, 2020). Leading to vertical patterns of trade with intermediate goods exchanged for final goods, global value chains also challenge our knowledge about the impact of trade policies, inducing Blanchard (2017) to conclude that we have to rewrite the book on how to think about these policies. Whereas such a strong conclusion may be too bold, it is a widespread concern that fragmented production along value chains is more vulnerable to policy interventions than integrated production, as nicely illustrated by the frantic appeal of UK car makers to their component suppliers that they should relocate their production from continental Europe to Britain to avoid increasing import tariffs after Brexit (see Financial Times, 2017). Despite such concerns, theoretical work on trade policy in the context of value chains is still scarce, with Antràs and Staiger (2012), Blanchard et al. (2016), and Antràs et al. (2022) as three notable exceptions.

In this paper, we build on two important insights from the small theoretical literature on global value chains and trade policy. The first one is that the incentives to use trade policy instruments may differ along the value chain (see Antràs et al., 2022) and the second one is that trade agreements involving the exchange of intermediates need to be deeper than trade agreements that are concerned with market access for final goods only (see Antràs and Staiger, 2012). We argue that these two insights are not independent and that the asymmetry in the impact of trade policy instruments along the value chain provides a rationale for modern trade agreements to condition not only on tariff and non-tariff barriers but also on institutional quality. To lay out our arguments, we build on the theory of global value chains put forward by Costinot et al. (2013). In this model, production of a single consumption good involves a continuum of stages, which are executed by a discrete number of countries, combining intermediate goods from the previous stage with local labor. Countries choose their location along the global value chain according to exogenous differences in their technologies, leading to a vertical specialization of these countries in their production patterns.

Considering only two economies, we show their differences in the incentives to use trade policy instruments. In the model of Costinot et al. (2013) the technologically advanced economy produces the later stages of the value chain, including final output. It therefore can introduce a tariff on intermediates to extract a higher share of the rents of global production. In contrast, the technologically backward economy lacks an incentive to introduce a tariff on the single consumption good and will therefore search for alternative policy instruments to counter the rent appropriation of the advanced economy. One possible,

[1] Putting numbers to the increasing importance of global value chains, Hummels et al. (2001) report that exports due to vertical specialization along the value chain accounts for almost one third of the growth of worldwide exports between 1970 and 1990. Moreover, in a decomposition exercise Johnson and Noguera (2012) show for a sample of major OECD countries in 2004 that a large part of more than one quarter of exports do typically not stay in the importer country but are redirected to other destinations, thereby highlighting the importance of global value chains.

though costly policy option is to lower institutional quality, which in our model allows workers of the technologically backward economy to consume locally produced intermediate goods at a utility discount. In a non-cooperative policy game, the incentives of countries to appropriate production rents results in a welfare loss and may ultimately eliminate all trade in the open economy. A trade agreement can help overcome the prisoner dilemma of non-cooperative trade policy. However, due to the choice of asymmetric policy instruments, a shallow contract on eliminating tariffs to improve market access is not sufficient for the implementation of a mutually beneficial trade agreement. Instead, making both countries better off and banning the incentives for non-cooperative policy intervention requires a deep trade agreement that also conditions on institutional quality. If such an agreement is successfully installed, it will generate additional trade along the global value chain, an effect that has been well documented by recent empirical research (see Orefice and Rocha, 2014; Johnson and Noguera, 2017; Osnago et al., 2017, 2019; Laget et al., 2020).[2] However, in contrast to the still widespread assumption in existing research, our theory suggests that the formation of a deep trade agreement is not exogenous but a response to too little initial trade along the global value chain, which in turn is the consequence of lacking institutional quality in the technologically backward economy.

Our theoretical analysis points to two important hypotheses, which we assess empirically. The first one is that two countries featuring stronger differences in their institutional qualities are more likely to form a deep trade agreement. The second one is that the formation of a deep trade agreement increases the imports of intermediates from the less advanced to the more advanced economy. To test these hypothesis, we build a dataset which combines information on deep trade agreements from the WTO with data on input trade from CEPII and data on country characteristics (including institutional factors) from various sources. We use this dataset to estimate in a first step the probability of two countries to form either a shallow trade agreement, which primarily deals with reductions of tariff and non-tariff barriers to improve market access, or a deep trade agreement, which additionally conditions on measures of anticorruption and property rights protection as important features of institutional quality.

Since country pairs also have the alternative of not forming a trade agreement at all, we rely on a multinomial logit estimator and consider as main covariates standard economic and political variables that have been put forward in the literature on endogenous trade agreements (see Baier and Bergstrand, 2004; Egger et al., 2008) as well as an index for the corruption of the judicial system to control for ex ante differences of the two trading partners in their institutional quality. With this approach, we find in line with our theoretical model that larger differences in the institutional quality of two trading partners increase their probability to form a deep trade agreement. In a second step, we use the outcome of the multinomial logit to predict probabilities of choosing no trade agreement, a shallow trade agreement, or a deep trade agreement, which we then employ to compute inverse probability weights in a treatment effects estimation of the impact of forming deep trade agreements on the extent of intermediate goods imports by the advanced economy. Regarding the treatment effect, we find in support of our theoretical

[2] Larch and Yotov (2022) show in a structural gravity model that deep trade agreements may also foster foreign direct investment. Relying on the theoretical model of Anderson et al. (2020) foreign investment enters the foreign capital stock, and hence their model does not directly capture trade along the value chain.

model and in line with previous empirical research a positive impact of deep trade agreements on trade along the value chain.

Since it is the main purpose of this paper to study the role of global value chains for trade policy in general and for the formation of trade agreements in particular, we choose a simple and particularly tractable theoretical model that is tailored for our analysis. This model builds on several simplifying assumptions, including the assumption of a one-sector economy. It is therefore a natural extension of our analysis to consider an outside good, whose production process is simple and does not involve a multi-stage value chain. Existence of a second consumption good gives the technologically backward economy an additional income source and reduces the incentives to lower institutional quality ceteris paribus. This is intuitive, because lowering institutional quality reduces income in the technologically advanced country with negative effects on demand for the outside good. Despite such qualifications, the main insights of the one-sector model extend in a straightforward way to a two-sector economy if labor is immobile across the two production sectors. A second restrictive assumption that we lift in an extension of our model is the assumption of costless improvements in institutional quality. Intuitively, we find that our results extend to cases where these costs are low and analyze support for the formation of deep trade agreements for different configurations of initial import tariffs in the technologically advanced economy and adjustment costs of institutional quality in the technologically backward economy.

With a focus on global value chains, our analysis is closely related to theoretical research on vertical specialization and offshoring. Prominent examples to this literature include Yi (2003), Kohler (2004), Grossman and Rossi-Hansberg (2008), and more recently Costinot et al. (2013), Antràs and Chor (2013), Antràs et al. (2017), Antràs and de Gortari (2020). Alfaro et al. (2019) develop a property-rights model of vertical production and its organization along the value chain. While their analysis is focused on the decision to integrate suppliers or not, thereby shifting firm boundaries, we analyze how changes in institutional quality affect an existing global value chain. Moreover, Zi (2020) introduces trade costs in the value chain model of Costinot et al. (2013). Whereas this extension directly relates the model to our analysis, we consider in contrast to her these trade costs to be the outcome of a Northern policy choice. With a particular emphasis on trade policy, we also contribute to a sizable literature on non-cooperative and cooperative tariff regimes. Prominent examples to this literature include Johnson (1953), Dixit (1987), Bagwell and Staiger (1997, 1999), and in models of the new trade theory Ossa (2011), Campolmo et al. (2014), Costinot et al. (2020). In contrast to these studies our focus is not primarily on the role of policy instruments for market access, but on their specific impact on production efficiency along the global value chain. More closely related to our analysis, Antràs and Staiger (2012), Blanchard et al. (2016), and Antràs et al. (2022) consider the role of value chain linkages for non-cooperative and cooperative trade policies. In difference to them, we consider asymmetries of countries along the global value chain in their access to conventional tariff instruments and analyze deficiencies in institutional quality as an alternative policy measure of technologically backward countries to secure economic rents in open economies.

Our analysis further contributes to a literature studying the effects institutional quality and the protection of property rights on international trade. Two seminal contributions in this respect are Levchenko

(2007) and Nunn (2007), who show that introducing incomplete contracts into an international trade model generates a distinct source of comparative advantage between countries with differing institutional settings. Ferguson and Formai (2013) argue that institutional quality is a less important factor of fostering exports in industries with stronger vertical integration. Stefanadis (2010) takes a different perspective and analyzes the effect of trade openness on endogenous adjustments in institutional quality. With a similar focus, Levchenko (2013) argues that countries are incentivized under free trade to improve their institutional quality if the production technologies of the trading partners are sufficiently homogeneous. Whereas this is closely related to the findings of our paper, we add an important facet to this literature by addressing the role of institutional quality in the context of global value chains.

Finally, the empirical application links our analysis to research on the endogenous formation of trade agreements and their impact on bilateral trade flows (see Baier and Bergstrand, 2004; Egger et al., 2008; Baier and Bergstrand, 2009; Egger et al., 2011). Horn et al. (2010) and Dür et al. (2014) have been the first to note that the structure of trade agreements and their impact on trade can be quite diverse, shifting the attention of empirical research towards a rigorous distinction of shallow and deep trade agreements. Distinguishing different forms of trade agreements, Egger and Tarlea (2021) have extended the two-stage estimators that are common in the literature to the case of a multivalued treatment. Similar to them, we also propose a multivalued treatment estimator to acknowledge the differences between shallow and deep trade agreements in their consequences for bilateral trade. However, we extend existing work by explicitly looking on the effect of deep trade agreements on trade along the global value chain.

The remainder of the paper is organized as follows. In Sections 2 and 3, we outline the basic model structure and study the open economy equilibrium without policy distortions. In Section 4, we extend the analysis of the open economy and allow for arbitrary levels of import tariffs in the technologically advanced economy and arbitrary levels of institutional quality in the technologically backward economy. There, we also study comparative-static effects of changing the two policy instruments, analyze a non-cooperative policy game between the two countries, and investigate the scope for trade agreements that are beneficial for both economies. In Section 5, we extend our model to one with two production sectors and in Section 6 we consider costs of improvements in the institutional quality of the technologically backward economy. Finally, Section 7 presents the empirical analysis, while Section 8 concludes with a summary of the most important results.

2 Basic model structure

We conduct our formal analysis in a production model along the lines of Costinot et al. (2013), in which a continuum of stages must be executed to produce a single consumption good. Assuming that the production stages must be executed consecutively in a predetermined order, the model describes a value chain, which we assume to have unit length. In the subsequent analysis, we capture each production stage by an index s from the unit interval. We embed this production model into a world composed of two countries, $c = 1, 2$, which are endowed with an equal mass of labor L but differ in their production technologies. Labor is immobile between countries and technology determines the Poisson rate, $\lambda_c \in (0, 1)$, at which mistakes materialize at each production stage. Whenever a mistake occurs the processed intermediate is destroyed, making labor input in all previous stages a wasteful loss. We assume that mistakes occur at a higher rate in country 1 than in country 2, i.e. $\lambda_1 > \lambda_2$. This makes country 1 the technologically backward economy (the "South") and country 2 the technologically advanced economy (the "North").

Considering a Leontief technology that combines $q(s)$ units of the intermediate produced at stage s with $q(s)ds$ units of labor to produce $q(s+ds)$ units of the consecutive stage $s+ds$, we can express the the technology of producing $q(s+ds)$ as $q(s+ds) = (1-\lambda_c ds)q(s)$. For infinitesimal ds, the production function of country c at stage s can then be written in the form of a differential equation:

$$q'(s) = -\lambda_c q(s). \tag{1}$$

Markets at all stages are perfectly competitive. The world price of intermediate good s is given by $p(s)$. The initial input at stage $s=0$ is available in perfectly elastic supply at a price $p(0)=0$. The consumer good at stage $s=1$ is chosen as our numéraire and its price is therefore normalized to one. Finally, we denote the common wage paid in country c by w_c.[3]

Making use of our technology assumption, we can write the costs of country c to produce output $q(s+ds)$ as $p(s)q(s) + w_c q(s)ds$. Substituting $q(s+ds) = (1-\lambda_c ds)q(s)$ gives the unit cost function for stage $[p(s) + w_c ds]/(1-\lambda_c ds)$. Under perfect competition, profit-maximization then establishes

$$\begin{aligned} p(s+ds) &\leq \frac{p(s) + w_c ds}{1-\lambda_c ds}, \\ p(s+ds) &= \frac{p(s) + w_c ds}{1-\lambda_c ds} \;\text{ if }\; Q_c(s') > 0 \;\text{ for all }\; s' \in (s, s+ds], \end{aligned} \tag{2}$$

where $Q_c(s)$ is economy-wide output of stage s in country c. Labor market clearing implies for country c

$$\int_0^1 Q_c(s)ds = L, \tag{3}$$

with L denoting the symmetric labor endowment in the two economies. This completes the description of the model structure.

3 The open economy without policy distortions

In this section, we investigate a baseline version of our model in the absence of policy implying that our setting reduces to a two-country variant of the model proposed by Costinot et al. (2013). For this case, the open economy equilibrium is characterized by the following lemma.

[3] To apply the solution concept of Costinot et al. (2013), we impose the additional formal condition that each firm produces a measure $\Delta > 0$ of consecutive stages. To be more specific, we assume that if a firm produces stage $s' = s + ds$, then it produces all stages $s' \in (\underline{s}, \underline{s} + \Delta]$. This implies that each unit of the consumer good is produced by a finite number of firms.

Lemma 1 *In the open economy equilibrium, there exists a unique partitioning of the unit interval of production stages into two subintervals of length S_1 and $1 - S_1$, respectively, such that $Q_1(s) > 0$ if and only if $s \in (0, S_1]$ and $Q_2(s) > 0$ if an only if $s \in (S_1, 1]$. We thereby have*

$$S_1 = -\frac{1}{\lambda_1} \ln\left(1 - \frac{\lambda_1 L}{Q_0}\right), \qquad 1 = S_1 - \frac{1}{\lambda_2} \ln\left(1 - \frac{\lambda_2 L}{Q_1}\right), \tag{4}$$

and output levels

$$Q_1 = Q_0 - \lambda_1 L, \qquad Q_2 = Q_1 - \lambda_2 L, \tag{5}$$

with $Q_0 \equiv Q_1(0)$, $Q_1 \equiv Q_1(S_1) = Q_2(S_1)$, and $Q_2 \equiv Q_2(1)$.

Proof The first part of the lemma on the vertical structure of the global value chain directly follows from the proof of Proposition 1 in Costinot et al. (2013). To derive Eqs. (4) and (5), we solve differential equation (1) at the country level and compute the general solutions $Q_1(s) = \exp[-\lambda_1 s]Q_0$ and $Q_2(s) = \exp[-\lambda_2(s - S_1)]Q_1$. Substituting these two solutions into the labor market clearing conditions of countries 1 and 2 establishes Eq. (4). Eq. (5) then follows from substituting Eq. (4) into $Q_1 = \exp[-\lambda_1 S_1]Q_0$ and $Q_2 = \exp[-\lambda_2(1 - S_1)]Q_1$.

Figure 1 gives a graphical account of the global value chain in our model. The important finding of Lemma 1 that the South executes the early stages of the global value chain, whereas the North executes the later ones is a direct consequence of our assumption that country 1 is the technologically backward economy. This is intuitive, because – as outlined above – a mistake at stage $s > 0$ destroys the production from all previously executed stages. Hence, the loss from mistakes and thus the (expected) costs of production are minimized by the vertical production structure captured by Figure 1.

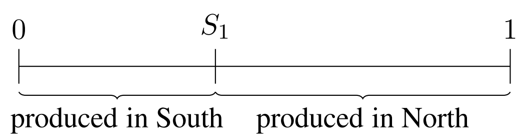


Figure 1: *The distribution of production stages across countries.*

The two equations in (4) can be combined to the global labor market clearing condition. Making use of the two auxiliary variables $x \equiv Q_0/(\lambda_1 L)$ and $\Lambda \equiv \lambda_2/\lambda_1$, we can express the global labor market clearing condition as follows

$$F(x, \Lambda) \equiv -\ln\left(\frac{x-1}{x}\right) - \frac{1}{\Lambda} \ln\left(\frac{x - 1 - \Lambda}{x - 1}\right) - \lambda_1 = 0, \tag{6}$$

where $Q_1/(\lambda_1 L) = x - 1$ has been substituted from Eq. (5). Eq. (6) implicitly determines for the open economy the level of initial input relative to Southern effective labor supply, $x = Q_0/(\lambda_1 L)$. Noting that

$\lim_{x\to 1+\Lambda} F(x,\Lambda) = \infty$, $\lim_{x\to\infty} F(x,\Lambda) = -\lambda_1$, and

$$F'_x(x,\Lambda) = -\frac{2x-1-\Lambda}{x(x-1)(x-1-\Lambda)} < 0, \tag{7}$$

it follows that that the equilibrium level of x is unique and satisfies $x > 1+\Lambda$. We can further compute

$$F'_\Lambda(x,\Lambda) = \frac{1}{\Lambda(x-1-\Lambda)}\left[1 + \frac{x-1-\Lambda}{\Lambda}\ln\left(\frac{x-1-\Lambda}{\Lambda}\right)\right] > 0. \tag{8}$$

Applying the implicit function theorem, we therefore compute

$$\frac{dx}{d\Lambda} = \frac{x}{\Lambda}\frac{x-1}{2x-1-\Lambda}\left[1 + \frac{x-1-\Lambda}{\Lambda}\ln\left(\frac{x-1-\Lambda}{\Lambda}\right)\right] > 0. \tag{9}$$

For a given mistake rate in the South (i.e., a given level of λ_1), a lower productivity disadvantage of the South, which is captured by a higher value of Λ, is associated with a larger mistake rate in the North and thus requires higher initial labor input and in consequence a decline in the fraction of production stages executed in the South to allow for full employment of workers along the global value chain.[4]

With the characterization of the open economy equilibrium at hand, we continue our analysis by determining welfare of North and South in the open economy. With the single consumer good serving as numéraire, the (uniform) wage rate paid in country c is equal to the indirect utility of consumers in country c: $v_c = w_c$. To determine welfare in the open economy equilibrium, we therefore compute the equilibrium levels of w_1 and w_2, which are jointly determined with the price of traded intermediates $p_1 \equiv p(S_1)$ by the three-equation system:

$$\begin{aligned} \lambda_1 p_1 &= \{\exp[\lambda_1 S_1] - 1\}\, w_1, \\ \lambda_1 &= \exp[\lambda_1\Lambda(1-S_1)]\lambda_1 p_1 + \{\exp[\lambda_1\Lambda(1-S_1)] - 1\}\,\frac{w_2}{\Lambda}, \\ w_2 &= w_1 + \lambda_1 p_1 (1-\Lambda). \end{aligned} \tag{10}$$

Whereas the derivation of (10) is tedious and thus deferred to the Appendix, the three equations have a straightforward economic interpretation. Making use of Lemma 1, we find that the first line corresponds to the binding budget constraint of country 1, while the second line corresponds to the binding budget constraint of country 2. The third line captures a no arbitrage condition under the profit-maximizing choice of executing stages $s \in (0, S_1]$ in country 1 and executing stages $s \in (S_1, 1]$ in country 2. Equation system (10) can be solved for

$$w_1 = \lambda_1\frac{(x-1)(x-1-\Lambda)}{2x-1-\Lambda}, \quad w_2 = \lambda_1\frac{(x-\Lambda)(x-1-\Lambda)}{2x-1-\Lambda}, \qquad p_1 = \frac{x-1-\Lambda}{2x-1-\Lambda}. \tag{11}$$

[4] With x increasing in Λ, $F(x,1) = 0$ determines an upper bound for x, denoted by $\overline{x}$, whereas $F(x,0) = 0$ gives a lower bound of x, denoted by $\underline{x}$. Evaluated at $\Lambda = 1$, Eq. (6) establishes $\overline{x} = 2\exp[\lambda_1]/\{\exp[\lambda_1] - 1\}$. Moreover, we compute $\lim_{\Lambda\to 0} F(x,\Lambda) = -\ln[(x-1)/x] + (x-1)^{-1} - \lambda_1 \equiv \bar{F}(x)$, with $\bar{F}'(x) < 0$ and $\lim_{x\to\infty}\bar{F}(x) = -\lambda_1$. Acknowledging $\bar{F}(2.79) > 1 - \lambda_1$, it follows that $\underline{x} > 2.79$ holds for all possible realizations of λ_1.

It is easily confirmed from Eq. (11) that $w_1 = w_2$ if $\Lambda = 1$, whereas $w_1 < w_2$ whenever $\Lambda < 1$. This gives the intuitive result that the technologically advanced North pays higher wages (and is therefore better off) than the technologically backward South. In the next section, we analyze how trade policy instruments affect the open economy equilibrium.

4 The open economy with policy distortions

In the subsequent analysis, we distinguish two policy instruments, namely an import tariff and institutional quality to prohibit expropriation of producers by workers. Due to the vertical production structure and the order of countries along the global value chain, the import tariff is only an effective instrument for country 2, but not for country 1.[5] We denote the (ad-valorem) import tariff of country 2 by $\tau \geq 1$. Lacking a tariff instrument, the South can still engage in rent appropriation, for instance, by allowing for institutional deficiencies. We associate institutional quality with a policy instrument and capture it by a parameter $\delta \in [0, 1]$, which measures the fraction of production output Q_1 that is actually shipped to the North for further processing. The residual fraction $1 - \delta$ of this output is consumed by Southern workers at a utility discount of $\rho(S_1) < 1$.[6] For the moment, we take the two policy instruments as given and characterize the open economy equilibrium for arbitrary $\tau > 1$ and $\delta < 1$, while postponing a discussion of non-cooperative policy setting and the potential gains from cooperation to the end of this section.

Following the analysis in Section 3, we characterize the profit-maximizing production structure in the open economy by the upper threshold for the stages produced in country 1, $\lambda_1 S_1 = \ln[(x-1)/x]$, and the global labor market clearing condition, which in the case of institutional deficiencies in the South changes to

$$\tilde{F}(x, \Lambda, \delta) \equiv -\ln\left(\frac{x-1}{x}\right) - \frac{1}{\Lambda}\ln\left(\frac{\delta(x-1)-\Lambda}{\delta(x-1)}\right) - \lambda_1 = 0. \tag{6'}$$

Derivation properties of $\tilde{F}(x, \Lambda, \delta)$ with respect to x and Λ are inherited from $F(x, \Lambda)$, implying that $dx/d\Lambda > 0$ continues to hold. Moreover, noting that $\partial\tilde{F}(\cdot)/\partial\delta < 0$, we can safely conclude that $dx/d\delta < 0$. At the same time, we have $dx/d\tau = 0$. This shows an important asymmetry in the effects of the two policy instruments. A lower institutional quality of the South – captured by a decrease in δ – decreases the fraction of Southern output of intermediate goods shipped to the North, reducing the demand for labor input there. Full employment in both countries requires adjustments of the global value chain, which are captured by an increase in the amount of initial input, $Q_0 = \lambda_1 L x$, and by a decline in the fraction of production stages executed in the South, S_1. Since the market outcome is first best if

[5] An import tariff of the South would increase the costs of the consumer good, while at the same time providing consumers with the additional means necessary to bear the higher consumption expenditures when tariff revenues are redistributed in a lump-sum fashion. This makes the import tariff an ineffective policy instrument in the South. To see this, note that if the South sets an import tariff $\tau_1 > 1$, its consumption expenditures per capita are given by c_Q^1, whereas its total income per capital equals $w_1 + (\tau_1 - 1)c_Q^1$, with $(\tau_1 - 1)c_Q^1$ as the tariff income per capita. Rearranging terms, we obtain $c_Q^1 = w_1$, irrespective of the level of τ_1.

[6] In principle, the North could also lower institutional quality and allow its workers to consume intermediates Q_1 at a utility discount. However, since the North produces the final good, it has no incentive to do so.

$\delta = 1$, the adjustments of the global value chain in response to lower Southern institutional quality are distortionary and reduce global production output of consumer good Q_2. This is different for Northern tariffs, which in our model leave the production structure and in consequence total output of consumer goods unchanged. Thus, an import tariff on intermediates is non-distortionary.

To determine the welfare effects of changes in the two policy variables, we can derive an equation system similar to (10), capturing the balanced budget constraints of the two economies and a no arbitrage condition that must hold under a profit-maximizing production structure. This equation system can then be solved for the open economy equilibrium wages, w_1, w_2, and export price, p_1. We compute[7]

$$w_1 = \frac{\lambda_1}{\tau}\frac{\delta(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda}, \quad w_2 = \lambda_1\frac{(x-\Lambda)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda}, \quad p_1 = \frac{1}{\tau}\frac{\delta(x-1)-\Lambda}{\delta(x-1)+x-\Lambda}. \quad (11')$$

A higher Northern import tariff lowers the Southern wage rate w_1, while it leaves the Northern wage rate w_2 unaffected. With the production structure unchanged, a higher import tariff on intermediates is therefore purely redistributive. This is captured by a decline in the Southern export price p_1, which improves Northern's terms of trade. In contrast, a lower institutional quality of the South is distortionary and lowers overall production output of the consumption good. As formally shown in the Appendix, this induces wages to decrease in both countries and results in a decline of the export price of intermediates. However, the price adjustment in response to lower Southern institutional quality is not decisive for the welfare effects in the open economy. On the one hand, the non-exported part of intermediates is consumed by the South at a utility discount and therefore not pure waste. On the other hand, the decrease in the export price of intermediates does not reflect a terms-of-trade improvement of the North. Instead, the lower price is the result of a decline in S_1, implying that the intermediate shipped to the North is from an earlier production stage.[8]

Similar to the baseline model in Section 3, consumers spend their entire income on the single consumption good. However, if $\delta < 1$ workers from country 1 also experience utility from the consumption of intermediate good Q_1. Denoting the utility discount from consuming Q_1 instead of Q_2 by $\rho(S_1)$, Southern welfare can be expressed by $v_1 = w_1 + (1-\delta)\rho(S_1)\lambda_1(x-1)$. Considering the specific functional form of $\rho(S_1) \equiv \{\exp[\lambda_1 S_1] - 1\}/\{\exp[\lambda_1] - 1\}$ gives a particularly tractable Southern welfare function of the following form:

$$v_1 = \frac{\lambda_1}{\tau}\frac{\delta(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda} + \frac{(1-\delta)\lambda_1}{\exp[\lambda_1]-1} \equiv \tilde{v}_1(\tau, \delta). \quad (12)$$

[7]Since the derivation of (11′) follows the derivation steps for (11), we have deferred formal details to the Online Appendix.

[8]Evaluated at the original threshold S_1, export price p_1 would increase due to the Southern wage increase. From this observation one may be tempted to conclude that factor price adjustments would give a more reliable measure for welfare changes, as suggested by the literature on factorial terms of trade (see Viner, 1937; Ghironi and Melitz, 2005). However, computing factorial terms of trade would be of limited help in our model, because it would still ignore that non-exported intermediates are consumed by the South at a utility discount. This insight accommodates the important finding of Antràs and Staiger (2012) that the welfare implications of trade policy go beyond a pure terms-of-trade effect if global value chain linkages exist.

Moreover, if $\tau > 1$, Northern welfare is increased by the tariff revenues which are distributed to workers through a lump-sum transfer of $(\tau - 1)p_1\delta Q_1/L$. Therefore, Northern welfare can be expressed as

$$v_2 = \lambda_1 \frac{(x-\Lambda)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda} + \lambda_1 \frac{\tau-1}{\tau} \frac{\delta(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda} \equiv \tilde{v}_2(\tau,\delta). \tag{13}$$

The following lemma summarizes how unilateral changes in the two policy variables affect welfare in the open economy.

Lemma 2 *An increase in the Northern import tariff increases welfare in the North and reduces welfare in the South. A decline in Southern institutional quality lowers welfare in the North, whereas the welfare effects in the South depend on the Northern import tariff and are not a priori clear. There exists a critical tariff* $\underline{\tau} > 1$ *implicitly determined by* $\partial\tilde{v}_1(\underline{\tau},1)/\partial\delta = 0$*, such that lowering Southern institutional quality decreases Southern welfare monotonically for all* $\tau \leq \underline{\tau}$*. There exists a second critical tariff* $\overline{\tau} > \underline{\tau}$ *implicitly determined by* $\partial\tilde{v}_1(\overline{\tau},0)/\partial\delta = 0$*, such that lowering Southern institutional quality increases Southern welfare monotonically for all* $\tau \geq \overline{\tau}$*. Finally, Southern welfare has a unique interior maximum at some* $\delta \in (0,1)$ *if* $\tau \in (\underline{\tau},\overline{\tau})$.

Proof See the Appendix.

Lemma 2 characterizes the best responses of the two countries in a non-cooperative policy game. The following proposition summarizes the non-cooperative equilibrium if the two governments are unconstrained in setting their policy instruments for maximizing workers' welfare in Eqs. (12) and (13).

Proposition 1 *It is a dominant strategy of the North to set the maximum possible tariff rate* $\tau = \infty$*. The optimal response of the South to* $\tau = \infty$ *is setting* $\delta = 0$*. Hence, the non-cooperative policy equilibrium of unconstrained governments is given by* $\tau = \infty$ *and* $\delta = 0$*. This establishes*

$$\lim_{\tau\to\infty} \tilde{v}_1(\tau,0) = \frac{\lambda_1}{\exp[\lambda_1]-1} \equiv v_1^{nc}, \quad \lim_{\tau\to\infty} \tilde{v}_2(\tau,0) = \frac{\lambda_2}{\exp[\lambda_2]-1} \equiv v_2^{nc} \tag{14}$$

Proof The proposition follows from Eqs. (12), (13), and Lemma 2.

Non-cooperative policies of unconstrained governments establish an outcome with $\lim_{\delta\to 0} S_1 = 0$, implying that country 2 hosts the entire global value chain. As a consequence, non-cooperative policy setting puts the North into an autarky equilibrium. This is intuitive, because the North sets a prohibitive import tariff, and this implies that $v_2^{nc} = v_2^a$, with superscript a referring to autarky. With its wages going to zero, the South cannot afford the final output produced by the North and is compelled to consume the initial input $Q_0 = \lambda_1 Lx$, which gives a maximum utility discount but is available in unlimited amount at a price of zero. Due to the chosen functional form of the discount factor $\rho(S_1)$, our model has the nice property that welfare in the South also converges to the autarky level if δ goes to zero, establishing $v_1^{nc} = v_1^a$.

An immediate question regarding the non-cooperative policy outcome is whether cooperation gains can be achieved simultaneously for both countries. To tackle this question, we contrast the non-cooperative welfare levels in Proposition 1 with the welfare levels that could be achieved if the two countries coordinated on free trade with perfect institutional quality, $\delta = \tau = 1$. The results from this comparison are summarized in Proposition 2.

Proposition 2 *Policy coordination on $\tau = \delta = 1$ increases welfare in both countries relative to the non-cooperative case in Proposition 1.*

Proof See the Appendix.

Propositions 1 and 2 provide an important insight. In a trade model with vertical specialization of two countries along the global value chain and with intermediate goods produced in the South exchanged against the consumption good produced in the North, a trade agreement can be beneficial for both countries only if tariff reductions of the North are accompanied by improvements in Southern institutional quality. The expansion of offshoring and intermediate goods imports from the South may therefore provide an explanation for the increasing importance of deep trade agreements as an attempt to enforce better institutional quality in countries executing comparably early stages of the value chain (see Laget et al., 2020).

Of course, the results from Propositions 1 and 2 should not be seen as an argument that deep trade agreements are always beneficial for both trading partners. Whereas our analysis above considers the case of unconstrained governments, the possibility of countries to impose high tariffs is in general constrained by WTO rules, rendering an import tariff of $\tau = \infty$ an unrealistic outcome. We therefore ask in a further step, how our previous insights change if we consider an upper tariff bound of τ_{max}. The following proposition summarizes our results.

Proposition 3 *If Northern import tariffs are constrained by an upper bound τ_{max}, a trade agreement that imposes $\tau = \delta = 1$ is beneficial for both countries only if τ_{max} is sufficiently high. If τ_{max} is too low, a trade agreement on $\tau = \delta = 1$ is not beneficial for the North.*

Proof Analysis in the text.

From Lemma 2, we know that $\tau = \tau_{max}$ and $\delta = 0$ are best-response policies of the North and the South, respectively, if $\tau_{max} \geq \overline{\tau}$. In this case, cooperation on $\tau = \delta = 1$ is beneficial for both countries in line with Proposition 2. If $\tau_{max} \leq \underline{\tau}$, the non-cooperative equilibrium is characterized by $\tau = \tau_{max}$ and $\delta = 1$. In this case, cooperation on $\tau = \delta = 1$ is to the benefit of the South but to the detriment of the North. This is because the import tariff is purely redistributive in our model. By an argument of continuity, existence of a mutually beneficial trade agreement extends to tariff bounds τ_{max} lower than but close to $\overline{\tau}$, whereas absence of a mutually beneficial trade agreement extends to tariff bounds τ_{max} higher than but close to $\underline{\tau}$.

5 A two-sector model

In our analysis so far, we have considered a single sector of production. Whereas a one-sector economy is particularly attractive from the perspective of analytical tractability, it may overemphasize the role of the considered policy instruments and thus limit the practical relevance of our results. For this reason, we now extend our model to a two-sector economy, with a multi-stage production process for good Q_2 and a one-stage production process for an outside good Y. Each unit of good Y requires the input of one unit of labor. We assume labor to be immobile between sectors and set the exogenous labor supply in each sector equal to $L/2$. Moreover, to facilitate our analysis, we assume that good Y is only consumed in the North, where preferences are represented by a Cobb-Douglas utility function of the following (direct) form: $u_2 = \left(c_Q^2\right)^{\alpha}\left(c_Y^2\right)^{1-\alpha}$, with c_Q^2, c_Y^2 denoting per-capita Northern consumption of Q_2 and Y, respectively, and with $\alpha \in (0,1)$ as the Northern expenditure share for consumption good Q_2. Southern households only consume Q_2 from the North.[9]

In this simple extension of our model, the solution for the optimal production structure of Q_2 remains to be characterized by $\lambda_1 S_1 = \ln[(x-1)/x]$ and Eq. (6′), with the important difference that x is now given by $2Q_0/(\lambda_1 L)$. The change in the definition of x reflects that less labor input is available for the production of good Q_2 in the two-sector model without labor mobility. Moreover, open economy equilibrium wages and prices continue to be given by Eq. (11′). Restricting our analysis of the non-cooperative policy game to the same set of instruments as in the baseline model and assuming therefore that trade of good Y is not subject to any impediments,[10] we can make use of the market-clearing conditions for the two consumer goods to solve for the uniform wage paid by North and South in the outside sector. As formally shown in the Appendix, we compute

$$w_Y = \frac{1-\alpha}{1+\alpha}\lambda_1\left\{\frac{(x-\Lambda)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda} + \frac{\tau-1}{\tau}\frac{\delta(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda}\right\}. \tag{15}$$

Noting the close resemblance between $\tilde{v}_2(\tau,\delta)$ in Eq. (13) and w_Y in Eq. (15), it is immediate that $dw_Y/d\tau > 0$ and $w_Y/d\delta < 0$ (see the proof of Lemma 2). Noting that in the open economy equilibrium we have $c_Q^2 = [\alpha/(1-\alpha)]w_Y$, $c_Y^2 = 1$, we can express welfare of the North (in per-capita terms) as $v_2 = [\alpha w_Y/(1-\alpha)]^{\alpha}$, implying that the properties of v_2 from Section 4 extend in a straightforward way to the two-sector economy considered here.

Making use of $v_1 = [w_1 + w_Y + (1-\delta)\rho(S_1)\lambda_1(x-1)]/2$, we can moreover express Southern welfare as follows:

$$v_1 = \frac{\lambda_1}{2}\left\{[\delta(x-1)-\Lambda]\left[\frac{1-\alpha}{1+\alpha} + \frac{2\alpha}{1+\alpha}\frac{1}{\tau}\frac{\delta(x-1)}{\delta(x-1)+x-\Lambda}\right] + \frac{1-\delta}{\exp[\lambda_1]-1}\right\}. \tag{16}$$

[9]Due to this assumption the important insight from our one-sector model that import tariffs of the South are ineffective extends to the two sector model.

[10]Considering a homogeneous outside good that is freely tradable at zero costs is common practice in the literature on non-cooperative and cooperative trade policies (see Ossa, 2011; Antràs and Staiger, 2012; Campolmo et al., 2014; Blanchard et al., 2016, for recent examples).

Similar to v_2, v_1 inherits important properties of the one-sector economy. For instance, welfare in the South decreases monotonically in τ. Moreover, lowering institutional quality δ reduces welfare through a reduction of labor income and increases welfare due to higher consumption of intermediates at production stage S_1. However, the strength in the effect of the two policy instruments on Southern welfare changes in the two-sector model. On the one hand, the negative consequences of a higher level of τ on Southern welfare are reduced in the two sector model. Higher tariff revenues increase Northern income and thus worldwide demand for good Y. The resulting increase in w_Y exerts a positive welfare effect on the South. On the other hand, a lower level of δ reduces income in the North with negative consequences on Southern income in Sector Y. We show in the Appendix that acknowledging these additional effects makes $\delta = 0$ not necessarily the optimal Southern response to $\tau \to \infty$. Despite such qualifications, the main insight from our analysis of the one-sector model that a trade agreement with $\tau = \delta = 1$ increases global value chain trade and can therefore be beneficial for both countries continues to hold in the two-sector model. In particular, for high levels of α and thus a high Northern expenditure share for good Q_2, the results from the baseline model with a single production sector extend unchanged to the two-sector economy considered here.

As a byproduct of our analysis of the two-sector model, we can express the value share of intermediate goods imported by the North as

$$share_2 \equiv \frac{\lambda_1 p_1 \delta(x-1)}{\lambda_1 p_1 \delta(x-1) + w_Y}. \tag{17}$$

Making use of Eqs. (6′), (11′), and (15) we show in the Appendix the intuitive result that this share decreases in τ, while it increases in δ. A higher import tariff has two effects. It lowers the price of intermediates and thus its value share in Northern imports. At the same time, a higher tariff increases Northern income and, through higher demand for good Y, it also increases wage rate w_Y. As a consequence, final goods imports of the North become more expensive, further lowering the value share of intermediates. An increase in the institutional quality exerts two counteracting effects on the value share of intermediate imports. It increases both the price and the quantity of imported intermediates, which are now intermediates from a latter stage of production. However, through higher Northern income and the induced increase in w_Y it also increases the value of Northern imports of final good Y. In our model, it is the first effect that dominates, implying that the Northern value share of imported intermediates increases with better institutional quality in the South.[11]

[11]For the analysis in this section, we have assumed that labor is immobile between sectors. If labor were mobile across sectors the analysis would be considerably more complicated. Whereas the assumption of a Leontief technology in value chain production makes the import tariff purely redistributive in our baseline model, this tractable feature would be lost with intersectoral labor mobility. Relying on numerical methods, we show in the Online Appendix to this manuscript that there is still a case for deep trade agreements that allow for positive import tariffs if labor is fully mobile across sectors. At a more general level, we expect the main results from our analysis in this section to extend to a two-sector model with constrained labor mobility.

6 Trade agreements if improving institutional quality is costly

In Sections 4 and 5, we have shown that a bilateral agreement on lowering tariffs in the North and improving institutional quality in the South can foster mutually beneficial trade along the value chain. Thereby, a trade stimulus from the agreement materializes in our model only if institutional deficiencies in the South exist in the non-cooperative case and if the gains from improving institutional quality compensate the North for (potential) losses in tariff revenues. As pointed out by Proposition 3 both of these conditions are violated if initial tariffs are sufficiently low. The analysis so far has neglected, however, that improvements of institutional quality may be costly for the South. In this section, we consider such costs and, to keep things simple, model them as an expenditure that is independent of how much the institutional quality improves. We illustrate the outcome of the thus extended model in Figure 2, relying on a specific parameter configuration. Focusing on the two sector model from Section 5, we choose for the expenditure share of good Q_2 a relatively high level of $\alpha = 0.9$ and consider sizable differences in the productivity of the two economies, by setting $\lambda_1 = 0.95$ and $\lambda_2 = 0.05$.[12]

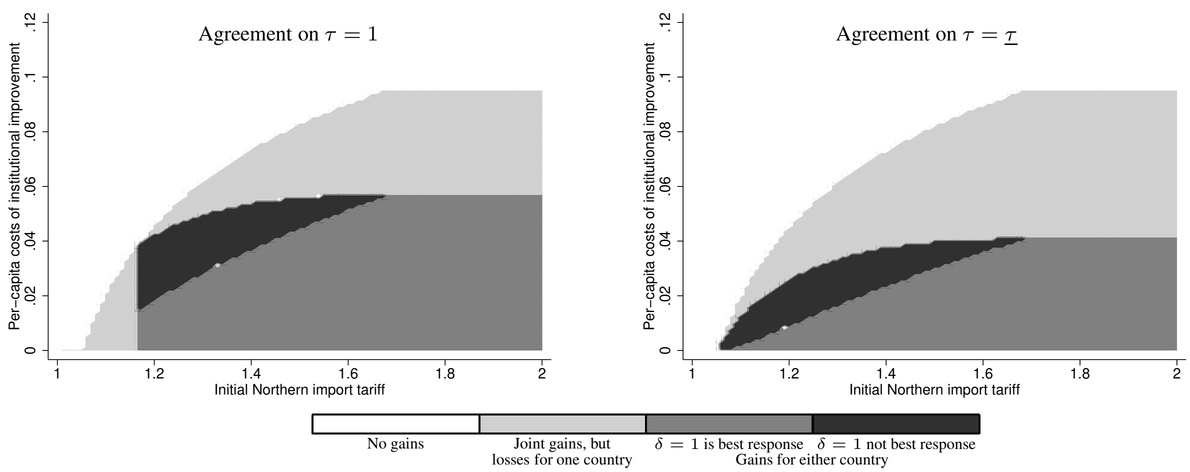


Figure 2: *Welfare effects of trade agreement (two sectors, $\lambda_1 = 0.95, \lambda_2 = 0.05$, $\alpha = 0.9$)*

In the left panel of Figure 2, we depict the welfare effects of a trade agreement imposing $\tau = \delta = 1$ for different levels of initial (non-cooperative) Northern import tariffs, τ_{max}, and different cost levels for improving institutional quality in the South. These costs are given in units of consumption good Q_2, reported at a per-capita level, and denoted by f. We distinguish four different outcomes. The white region indicates combinations of initial tariffs τ_{max} and institutional costs f that eliminate welfare gains from trade agreements. From Proposition 3 we know that if $\tau_{max} \leq \underline{\tau}$ the South's best response is $\delta = 1$, and in this case global welfare is already maximized in the absence of a trade agreement. Moreover, for $\tau_{max} > \underline{\tau}$ a trade agreement that imposes $\delta = 1$ would lower global welfare if the costs of improving institutional quality are excessive. The light gray region refers to combinations of τ_{max} and f for which joint welfare gains exist, but one of the two countries loses from the formation of a trade agreement.

[12]Since the results for the one-sector economy are similar to those for the two-sector model, we do not elaborate on them here.

Losses of the North are possible, for instance, if a comparably strong reduction of tariffs (and thus a considerable drop in tariff revenues) is met by a comparably small improvement of Southern institutional quality. According to our analysis from Section 4, this is possible if τ_{max} is higher than but close to $\underline{\tau}$, while, at the same time, a small level of f rules out joint losses from the trade agreement. Losses of the South are possible despite joint gains if a comparably small δ has been the best Southern response to a comparably high initial τ_{max} in the non-cooperative equilibrium and, at the same time, the costs of institutional improvements, f, are of intermediate size.

The remaining two regions refer to combinations of τ_{max} and f, for which trade agreements are beneficial for both countries. This materializes in our model under two conditions, namely if *(i.)* a high initial tariff induces the South to choose low institutional quality in the non-cooperative policy equilibrium and if *(ii.)* the cost of improving institutional quality is not too high. In the figure, we distinguish two possible cases. In the first one, improving institutional quality is the unilateral best response of the South to eliminating the import tariff in the North (dark gray region). In the second one, the South would prefer keeping the low institutional quality, if the trade agreement were not enforcing the institutional improvement (black region). This challenges the view held by many that even in the absence of binding contracts trade will provide sufficient incentives for developing countries to improve institutional quality in their self-interest (see Rodrik, 2002; IMF, 2005, for a discussion).

In the right panel of Figure 2, we consider formation of a trade agreement with a tariff equal to $\underline{\tau} > 1$. We consider this case, for two reasons. First, preferential treatment of developing countries is one of the few exceptions from the most-favored nations principle of the WTO. Second, it has been established by previous research that setting zero tariffs is not necessarily welfare-optimal for members of a bilateral trade agreement (see Saggi et al., 2019, 2022). From Figure 2, we conclude that forming a trade agreement with a positive import tariff, reduces potential welfare gains for the South and therefore makes the formation of a mutually beneficial agreement less likely. However, the main insights from our previous analysis remain intact, when extending our analysis to trade agreements with positive import tariffs.

7 Empirical analysis

In this section, we provide evidence for the main insights from our theoretical analysis by testing two hypothesis that are specific to our model. These are

H1: Countries that differ more strongly in the quality of their judicial institutions are more likely to form a deep trade agreement, which lowers tariffs and improves institutional quality. As a qualification to this important insight, our formal analysis shows that formation of a deep trade agreement is less likely, ceteris paribus, if initial Northern tariff rates have been small.

H2: Formation of a deep trade agreement increases imports of intermediates from the less advanced to the more advanced economy and thus trade along the value chain.

To tackle these two hypotheses, we build on a sizable literature dealing with the endogenous formation of trade agreements (TAs) when estimating their trade effects (cf. Egger et al., 2008; Baier and Bergstrand, 2009; Egger et al., 2011). As put forward by Horn et al. (2010), Dür et al. (2014), and others, the design of TAs and their impact on trade can be quite diverse. We take this diversity into account and distinguish two different types of TAs, namely *shallow trade agreements* that abolish tariffs or non-tariff barriers to improve market access and *deep trade agreements* that additionally condition on institutional quality by introducing measures of anticorruption and property rights protection. Comprehensive information on trade agreements is available from the Gravity Database of the Centre d'Études Prospectives et d'Informations Internationales (CEPII), while details on the design of these agreements are provided by the World Bank's database on Deep Trade Agreements (see Conte et al., 2021; Hofmann et al., 2017, for further details).

For any two countries i and j our TA indicator can then have the following three mutually exclusive states (values) in year t:

$$TA_{ijt} = \begin{cases} 0 & \text{if no bilateral TA exists between } i \text{ and } j \text{ in } t \\ 1 & \text{if a shallow TA exists between } i \text{ and } j \text{ in } t \\ 2 & \text{if a deep TA exists between } i \text{ and } j \text{ in } t \end{cases} . \tag{18}$$

Suppressing time indices, we can express the probabilities of two countries i and j having a TA of state $k = 0, 1, 2$ as

$$\Pr\left(TA_{ij} = k \middle| \mathbf{X}_{ij}\right) = \frac{\exp\left[\mathbf{X}'_{ij}\beta_k\right]}{\sum_k \exp\left[\mathbf{X}'_{ij}\beta_k\right]}, \tag{19}$$

where $\mathbf{X}_{ij}$ is a vector of bilateral covariates, and β_k the corresponding vector of state-specific coefficients. We can now estimate the probabilities for the two states $k = 1$ (shallow TA) and $k = 2$ (deep TA) – with the alternative of $k = 0$ (no TA) as the control state – using a multinomial logit model (see Greene, 2012, Ch.18, for a discussion). More specifically, we estimate for country pairs without a TA in period $t-1$, the probability of forming a *new* type-1 (shallow) or type-2 (deep) TA between periods $t-1$ and t. We then use this information in a second step to determine the causal effect of TA formation on the share of intermediate imports by the technologically advanced economy, which is the country with the higher total factor productivity.

To select the covariates explaining bilateral formation of different forms of TAs, we follow Baier and Bergstrand (2004) and Egger et al. (2008).[13] A first set of covariates captures common economic determinants that are widely accepted to influence bilateral trade flows. This includes total bilateral (log) real GDP and the similarities of countries in real GDP, factor endowments, and total factor productivity as well as bilateral trade costs. These variables are constructed using information from the World Development Indicators, the Penn World Tables, OECD's International Trade by Commodity Statistics, and

[13] An overview of the covariates, their definitions, and data sources is given in the Appendix.

CEPII's International Trade Database at the Product-Level (BACI). A second set of covariates captures important political factors. Following Frye and Mansfield (2004) and Biglaiser and Brown (2005), we control for fractionalization of legislature and regime durability due to missing events of recent political change as important determinants of trade liberalization and thus TA formation. We use information from the Quality of Government Standard Dataset to construct these variables (see Teorell et al., 2022).

The third set of covariates, while not considered in the literature so far, is motivated by our theoretical model. According to our analysis, the asymmetry of countries in the quality of their judicial institutions should be an important factor for explaining the formation of deep TAs. To capture the quality of judicial institutions, we rely on survey information regarding the perceived *corruption of the judicial system* from the Varieties of Democracy Institute (see Pemstein et al., 2022). In an extension, we consider as an alternative the *rule of law index* from the Worldwide Governance Indicators (Kaufmann et al., 2010), which has been used for explaining the level and structure of bilateral trade flows in previous research (see Levchenko, 2007; Nunn, 2007; Ferguson and Formai, 2013). Beyond that, we also control for the share of preferential duty lines on inputs granted by the importer country to capture in a simple way the degree of bilateral integration prior to the formation of a TA, thereby acknowledging the qualification of our first hypothesis (see above). To construct this variable, we use information from the World Integrated Trade Solution on bilateral preferential tariffs at the industry level.

The estimation results for the multinomial logit regressions are reported in Table 1. There, we distinguish seven different models. Model 1 presents a parsimonious specification, in which we explain two countries' TA formation by the asymmetry in the quality of their judicial system as well as a set of common bilateral economic covariates. Availability of these covariates restricts our sample to 15,484 country pairs forming 619 new trade agreements (158 shallow and 461 deep TAs) over the period 1997 to 2015.[14] The positive coefficient of asymmetry in the quality of judicial systems in the regression for deep trade agreements appears to be well in line with our theoretical model. However its magnitude has to be interpreted with care, as the estimated coefficient refers to the impact of our variable of interest on the log of the relative probability (odds ratio) of forming a deep trade agreement rather than forming no TA at all. To obtain intuition on how important the asymmetry in the quality of judicial systems potentially is for the formation of deep trade agreements, we can note that increasing asymmetry in the quality of judicial institutions from the 25th to the 75th percentile in our sample increases the probability to form a deep trade agreement by more than 80 percent. This is much larger in magnitude, for instance, than the (negative) impact of increasing total bilateral (real) GDP from the 25th to the 75th percentile on the probability to form a deep trade agreement.

Although the focus of our analysis is on the probability of forming deep trade agreements, parameter estimates for shallow trade agreements are added as well to provide a comprehensive picture of how institutional factors impact the formation of different types of TAs. In the parsimonious specification of Model 1, the negative coefficient for the asymmetry in the quality of judicial institutions on the probability to form a shallow trade agreement is small and statistically insignificant. This is surprising, because

[14] For a clean distinction of treatment and control units, we eliminate all countries from the control group, which are also part of the treatment group in the respective observation year.

Table 1: *The probability of forming a shallow or deep trade agreement.*

	M1	M2	M3	M4	M5	M6	M7
			Shallow trade agreements ($TA_{ij} = 1$)				
Asymmetry in the quality of judicial institutions	-0.010	-0.199°	-0.439^{**}	-0.168	-0.182	-0.099	-0.441°
	(0.094)	(0.108)	(0.125)	(0.134)	(0.132)	(0.140)	(0.247)
Share of preferential duty lines for inputs							-7.918^{**}
							(1.663)
			Deep trade agreements ($TA_{ij} = 2$)				
Asymmetry in the quality of judicial institutions	0.499^{**}	0.455^{**}	0.332^{**}	0.467^{**}	0.430^{**}	0.468^{**}	0.397^{**}
	(0.054)	(0.064)	(0.079)	(0.082)	(0.083)	(0.082)	(0.121)
Share of preferential duty lines for inputs							-6.111^{**}
							(0.857)
Specification details							
Bilateral econ. controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bilateral pol. controls	No	Yes	Yes	Yes	Yes	Yes	Yes
Third-country controls	No	No	Yes	Yes	Yes	Yes	Yes
5-year fixed effects	No	No	No	Yes	Yes	Yes	Yes
Lagged controls ($t - 2$)	No	No	No	No	Yes	No	No
CUs and FTAs only	No	No	No	No	No	Yes	No
Pseudo R^2	0.081	0.144	0.269	0.324	0.297	0.336	0.518
Wald χ^2-Test	567.10	841.35	1,250.13	1,132.58	1,101.20	1,228.43	6,339.24
Prob $> \chi^2$	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	15,484	12,949	12,949	12,949	11,737	12,949	3,135

Notes: Data sources: CEPII, World Bank, WTO, and others listed in the Appendix. The estimation method in all models is multinomial logit. Bilateral economic controls are total log (real) GDP, similarities of the two countries in (real) GDP, the capital-labor ratio, the high-skilled labor share, total factor productivity, and log bilateral trade costs. Bilateral political controls are the similarity in legislative fractionalization as well as regime durability in the two countries. Third country controls are inverse-distance weighted averages of total log real GDP and the similarities in real GDP, the capital-labor ratio, the skilled to unskilled labor ratio as well as total factor productivity. A constant is estimated but not reported. Robust standard errors in parentheses: ** $p < 0.01$, * $p < 0.05$, and $^{\circ}$ $p < 0.1$.

existing research suggests that low institutional quality as well as asymmetry in institutional quality are important barriers to trade (see Anderson and Marcouiller, 2002; de Groot and Linders, 2004; Helble et al., 2009; Francois and Manchin, 2013). To the extent that the factors explaining shallow TAs are the same factors that explain bilateral trade flows, as suggested by Baier and Bergstrand (2004), we would therefore expect that a larger asymmetry in the quality of judicial institutions lowers the probability to form a shallow TA. Our results do not provide strong support for such an effect.

In Models 2 to 4, we consider additional controls that have shown to be important by previous research on TA formation. In Model 2, we add political controls for the fractionalization of legislature and the durability of the political system, whereas in Model 3 we consider inverse distance-weighted third market controls for total bilateral real GDP and symmetry in real GDP, factor endowments and total factor productivities. These covariates are added to acknowledge that any two countries forming a TA do so in a multilateral trade environment. In Model 4, we include dummies for five year intervals to capture overall time trends. We consider Models 3 and 4 as the main specifications of our analysis, because the comparably high Pseudo-R^2 indicates a very good fit of our model with the data. Models 5 to 6 provide extensions for these specifications. For instance, in Model 5, we consider lagged controls to reduce the potential impact of anticipation effects. We therefore regress the probability of two countries to form a new TA membership between period $t-1$ and t on covariates from period $t-2$. In Model 6, we confine TA formation to new membership in a customs union or free trade agreement. It turns out that the main result from Models 3 and 4 regarding the positive impact of higher asymmetry in the quality of judicial institutions on the formation of deep TAs remains unchanged by the modifications of Models 5 to 6.[15]

Overall, the results from Models 1 to 6 provide clear evidence for our hypothesis that stronger asymmetry in the quality of judicial institutions makes the formation of a deep TA more likely. In Model 7, we go one step further and elaborate on the additional insight from our model that lower initial tariffs on the import of intermediates make formation of deep trade agreements less likely. We compute the share of preferential duty lines for inputs in the importing country as a proxy for the ex ante bilateral tariff regime. Since information for preferential tariffs is not available for all country pairs, including this covariate as an additional control lowers our sample size significantly. However, the main insight of our analysis regarding a positive impact of higher asymmetry in institutional quality on the likelihood of forming a deep trade agreement remains unchanged for the now smaller country sample. Moreover, we take the significant negative coefficient of the number of preferential duty lines as support for our theoretical insight that lower initial import tariffs on intermediates reduce the probability of forming a deep TA.

In a next step, we use the outcome of the multinomial logit regression for predicting inverse probabilities of country pairs in our dataset to form a new shallow or deep TA. We employ these inverse probabilities as weights in a difference-in-difference estimation to determine the causal contemporaneous treatment effect of TA formation on the share of intermediate to overall imports by the technologically advanced country (see Eq. (17) of the two-sector model in Section 5). To construct the import data, we rely on trade flows from CEPII's BACI trade database and compute shares instead of levels for two reasons. First, shares make the estimates easier comparable between considerably heterogeneous country pairs and, second, they do not require constructing import price deflators for the nominal trade flows reported by BACI. Since considering shares would imply that the left-hand side variable is bounded, we estimate the causal effect of new TA formation on logit-transformed shares of intermediate imports in a linear regression model. Thereby, a logit transformation of the left-hand side variable appears unproblematic, because the observed intermediate import shares in our sample lie strictly between zero and one (see Papke and Wooldridge, 1996; Baum, 2008, for a discussion).

It is well established in the literature that the proposed two-step procedure eliminates selection bias and allows to estimate a causal effect of TAs on trade (see Egger et al., 2008; Baier and Bergstrand, 2009, for two early contributions).[16] Using this method, we can estimate two different treatment effects of

[15] In the Appendix, we present additional robustness checks, considering alternative measures for the quality of institutions and bilateral trade costs, changing the set of covariates, and looking at a longer sample period.

[16] An important assumption for a causal interpretation of the treatment effect is that conditional on observables the treat-

TA membership, namely an *average treatment effect* (ATE), determining the effect of TA formation for randomly selected country pairs, and the *average treatment effect on the treated* (ATT), determining the effect of TA membership on those actually treated. In observational studies, ATE and ATT are unlikely identical, and Baier and Bergstrand (2009) emphasize that in this case the treatment effect on the treated is the more important one, as it provides the relevant information for policy makers deciding upon TA formation. In our application, a complication arises because the treatment is multivalued, as TAs can be shallow or deep. Unlike nearest-neighbor matching, inverse probability weighting allows us to deal with multivalued treatments (see Imbens, 2000 and Wooldridge, 2010, Ch. 21.6.2, for a general discussion and Egger and Tarlea, 2021 for an application in the context of TAs).

For estimating the treatment effect, we distinguish three specifications. In specification 1, we formulate a parsimonious outcome model, explaining the (logit transformed) share of intermediate imports in the technologically advanced economy by time-invariant country-pair fixed effects, a time dummy, taking a value of 0 for the pre-treatment period and a value of 1 for the post-treatment period, our multivalued TA indicator, and an interaction term between the time dummy and the TA indicator. In specification 2, we follow a similar approach but add other time-variant controls, which are motivated by the gravity literature. These are total bilateral (real) GDP, bilateral trade costs, country-specific real GDP per capita, and applied duties of the exporting and importing country.[17] In both of these specifications, we assume that the assignment of treatment follows Model 1 in Table 1 and consider a small set of matching covariates for predicting the inverse-probability weights. In specification 3, we consider the broader set of matching covariates from Model 3 of Table 1, and adopt the difference-in-difference model from specification 2. As pointed out by Egger et al. (2008) accounting for third-country controls in the treatment model may help eliminating problems of interdependence between the treatment and control group.[18]

The results from the three alternative specifications reported in Table 2 show clear evidence for Hypothesis 2 that formation of a deep trade agreement increases the imports of intermediates from the less advanced to the more advanced economy. Thereby, a positive treatment effect exists for both randomly picked country pairs as well as for country pairs actually treated.[19] In Table 2, we report the ATT for those country pairs forming a deep TA and compare the impact of their treatment to the alternative of not forming any TA. For our analysis, this is the main treatment effect of interest. However, with the multi-

ment is random. A quasi-randomization of the treatment can be achieved by inverse-probability weighting if the balancing on observables is sufficiently strong.

[17]We apply a regression-adjustment estimator that can correct for covariate discrepancies between treatment and control units (see Imbens and Wooldridge, 2009; Aichele and Felbermayr, 2013). As pointed out by Imbens and Wooldridge (2009, p. 38-39), combining regression adjustment and (inverse) propensity score weighting results in a doubly-robust estimator "by both removing the correlation between the omitted covariates, and by reducing the correlation between the omitted and included variables." As a consequence, the respective treatment estimator is consistent when either the outcome or the treatment model is correctly specified.

[18]To reduce the likelihood of anticipation effects, we consider lagged covariates and predict the probability of forming a shallow or deep TA between periods $t-1$ and t by observables in period $t-2$ (see above). In the Appendix, we show robustness of our results, when using matching covariates from period $t-1$ instead of period $t-2$, considering only TAs in the form of customs unions and free trade agreements, and choosing a less restrictive definition of import shares.

[19]Note that the observation numbers between the ATE and the ATT effects can differ in Table 2, because the overlap assumption requires that each country pair has a positive probability for either treatment. We set a tolerance level of 1e-5 for this probability and eliminate country pairs which show a probability lower than this threshold.

Table 2: *The treatment effects of new TAs on intermediate import shares by the relatively advanced economy.*

	Specification 1		Specification 2		Specification 3	
	ATE	ATT	ATE	ATT	ATE	ATT
Shallow vs. no TA	-0.119	-0.129	-0.028	-0.059	-0.196^{*}	-0.115
	(0.131)	(0.109)	(0.134)	(0.115)	(0.081)	(0.096)
Deep vs. no TA	0.088	0.204^{**}	0.313^{*}	0.217^{**}	0.222°	0.249^{**}
	(0.082)	(0.070)	(0.123)	(0.076)	(0.120)	(0.083)
Add. controls in outcome model	No	No	Yes	Yes	Yes	Yes
Add. controls in treatment model	No	No	No	No	Yes	Yes
New shallow TAs	117	117	109	109	100	100
New deep TAs	374	374	319	319	300	316
Observations	7,482	7,482	4,709	4,711	3,837	4,014

Notes: Data sources: CEPII, World Bank, WTO, and others listed in the Appendix. Outcome model: Difference-in-difference estimation of new TA formation on the intermediate import share in technologically advanced country, using inverse probability weights from propensity score matching. Treatment model: Multinomial logit estimation of propensity score of forming shallow or deep TAs. Specifications 1 and 2 associate the treatment assignment with Model 1 and specification 3 with Model 3 of Table 1. Treatment covariates are lagged by one period: Covariates from $t-2$ predict probability of new shallow or deep TA between $t-1$ and t. Specification 1 uses a parsimonious outcome model with time-invariant country-pair fixed effects, a time dummy, with value 0 in the pre-treatment and value 1 in the post-treatment period, the multivalued TA indicator, and an interaction term between the time dummy and the TA indicator as covariates. The outcome model in specifications 2 and 3 additionally controls for total bilateral (real) GDP, bilateral trade costs, country-specific real GDP per capita, and applied duties of the exporting and importing country, and it make use of regression adjustment procedures. Robust standard errors in parentheses: ** $p < 0.01$, * $p < 0.05$, and $^{\circ}$ $p < 0.1$.

valued treatment, one can compute alternative ATTs. For instance, one can also determine the treatment effect of forming a deep TA compared to the alternative of forming a shallow TA for countries actually forming a deep TA. Whereas this treatment effect would also be positive in all our specifications, we do not further elaborate on it, because its relationship to our theoretical model is not immediate.[20]

8 Conclusions

This paper sets up a trade model with vertical specialization of two countries along the global value chain. We show that in the open economy equilibrium, the global value chain is partitioned into two subintervals, with a technologically backward South specializing on early production stages and a technologically advanced North executing the later ones. As a consequence of the vertical specialization of countries, the South exports intermediates in exchange for the import of a homogeneous consumption good from the North. In the open economy, the Northern country can use an import tariff to appropriate rents from the South. The import tariff lowers the wage received by Southern workers, but it does not change the equilibrium production structure and leaves the partitioning of the global value chain between the

[20] For a similar reason, we also do not discuss the impact of other covariates in the outcome model under specifications 2 and 3. The coefficients of these covariates are insignificant in many instances, which we take as evidence that dropping gravity controls would not lead to a severe omitted variable bias when estimating the impact of TAs on the share of intermediate imports.

two trading partners unchanged. As a consequence, Northern welfare increases and Southern welfare decreases with a higher import tariff.

Since the South imports a single consumption good, it cannot appropriate rents from the North by imposing an import tariff. However, it can lower the institutional quality and allow its workers to consume locally produced intermediates at a utility discount. A lower institutional quality lowers welfare of the North and it may increase or decrease welfare in the South. In contrast to the import tariff of the North, institutional deficiencies lower production efficiency along the global value chain. This is reflected by a reduction in the production stages executed in the South and an expansion of the production stages executed in the North.

In a non-cooperative policy game, the North will choose a prohibitive tariff and the South will choose the minimum institutional quality if government policy is unconstrained. This reduces welfare of both countries to their respective autarky levels. In this case, an agreement of the two countries that implements free trade and eliminates institutional deficiencies in the South is beneficial for both economies. If the maximum tariff of the North is constrained by an upper bound, such a trade agreement can be detrimental for one of the two countries and thus not be implemented. In particular, if the upper bound for the tariff is low, it may be in the self-interest of the South to choose the maximum possible level of institutional quality without cooperation. In this case, the South has nothing to offer to make further tariff reductions attractive for the North. The main insights from our analysis remain unchanged when extending our framework to one with two production sectors and when considering improvements of Southern institutional quality to be costly.

In an empirical application of our analysis, we bring two important hypotheses from our model to the data. The first one is that larger differences in institutional quality increase the probability of two countries to form a deep trade agreement. The second one is that the formation of a deep trade agreement fosters trade along the value chain and thus the import of intermediates from less advanced countries by more advanced economies. Relying on multinomial logit to estimate the probability of forming different types of trade agreements and employing a multivalued treatment estimator to derive causal inference regarding the impact of deep trade agreements on trade along the value chain, we find strong evidence for our two theoretical hypotheses.

Our formal analysis builds on a parsimonious two-country model of the global value chain, which lacks important features for analyzing coexistence of shallow and deep trade agreements and for studying third-country effects of such agreements. Extending the analysis to a multi-country, multi-sector framework that is suited for studying these issues is beyond the scope of this paper. However, such an extension would be a fruitful avenue for conducting theoretical research and guiding empirical work on trade policies along the value chain in the future.

References

AICHELE, R. AND G. FELBERMAYR (2013): "Estimating the Effects of Kyoto on Bilateral Trade Flows Using Matching Econometrics," *World Economy*, 36, 303–330.

ALFARO, L., P. ANTRÀS, D. CHOR, AND P. CONCONI (2019): "Internalizing Global Value Chains: A Firm-Level Analysis," *Journal of Political Economy*, 127, 508–559.

ANDERSON, J. E., M. LARCH, AND Y. V. YOTOV (2020): "Transitional Growth and Trade with Frictions: A Structural Estimation Framework," *Economic Journal*, 130, 1583–1607.

ANDERSON, J. E. AND D. MARCOUILLER (2002): "Insecurity and the Pattern of Trade: An Empirical Investigation," *Review of Economics and Statistics*, 84, 342–352.

ANTRÀS, P. AND D. CHOR (2013): "Organizing the Global Value Chain," *Econometrica*, 81, 2127–2204.

ANTRÀS, P. AND A. DE GORTARI (2020): "On the Geography of Global Value Chains," *Econometrica*, 88, 1553–1598.

ANTRÀS, P., T. C. FORT, A. GUTIÈRREZ, AND F. TINTELNOT (2022): "Trade Policy and Global Sourcing: A Rationale for Tariff Escalation," NBER Working Paper No. 30225.

ANTRÀS, P., T. C. FORT, AND F. TINTELNOT (2017): "The Margins of Global Sourcing: Theory and Evidence from U.S. Firms," *American Economic Review*, 107, 2514–2564.

ANTRÀS, P. AND R. W. STAIGER (2012): "Offshoring and the Role of Trade Agreements," *American Economic Review*, 102, 3140–83.

BAGWELL, K. AND R. W. STAIGER (1997): "Multilateral Tariff Cooperation during the Formation of Customs Unions," *Journal of International Economics*, 42, 91–123.

——— (1999): "An Economic Theory of GATT," *American Economic Review*, 89, 215–248.

BAIER, S. L. AND J. H. BERGSTRAND (2004): "Economic Determinants of Free Trade Agreements," *Journal of International Economics*, 64, 29–63.

——— (2009): "Estimating the Effects of Free Trade Agreements on International Trade Flows Using Matching Econometrics," *Journal of International Economics*, 77(1).

BAUM, C. F. (2008): "Stata Tip 63: Modeling Proportions," *The Stata Journal*, 8, 299–303.

BIGLAISER, G. AND D. S. BROWN (2005): "The Determinants of Economic Liberalization in Latin America," *Political Research Quarterly*, 58, 671–680.

BLANCHARD, E. J. (2017): "Renegotiating NAFTA: The Role of Global Supply Chains," in *Economics and Policy in the Age of Trump*, ed. by C. P. Bown, CEPR Press, 175–183.

Blanchard, E. J., C. P. Bown, and R. C. Johnson (2016): “Global Value Chains and Trade Policy,” *NBER Working Paper No. 21883*.

Campolmo, A., H. Fadinger, and C. Forlatti (2014): “Trade Policy: Home Market Effect versus Terms-of-Trade Externality,” *Journal of International Economics*, 93, 92–107.

Conte, M., P. Cotterlaz, and T. Mayer (2021): “The CEPII Gravity Database,” online available under http://www.cepii.fr/DATA_DOWNLOAD/gravity/doc/Gravity_documentation.pdf.

Costinot, A., A. Rodríguez-Clare, and I. Werning (2020): “Micro to Macro: Optimal Trade Policy with Firm Heterogeneity,” *Econometrica*, 88, 2739–2776.

Costinot, A., J. Vogel, and S. Wang (2013): “An Elementary Theory of Global Supply Chains,” *Review of Economic Studies*, 80, 109–144.

de Groot, H. L. F. and G.-J. Linders (2004): “The Institutional Determinants of Bilateral Trade Patterns,” *Kyklos*, 57, 103–124.

Dixit, A. (1987): “Strategic Aspects of Trade Policy,” in *Advances in Economic Theory: Fifth World Congress*, ed. by T. F. Bewley, Cambridge: Cambridge University Press, 329–362.

Dür, A., L. Baccini, and M. Elsig (2014): “The Design of International Trade Agreements: Introducing a New Dataset,” *Review of International Organizations*, 9, 353–375.

Egger, H., P. Egger, and D. Grrenaway (2008): “The Trade Structure Effects of Endogenous Regional Trade Agreements,” *Journal of International Economics*, 74, 278–298.

Egger, P., M. Larch, and R. Winkelmann (2011): “The Trade Effects of Endogenous Preferential Trade Agreements,” *American Economic Journal: Economic Policy*, 3, 113–143.

Egger, P. and F. Tarlea (2021): “Comparing Apples to Apples: Estimating Consistent Partial Effects of Preferential Economic Integration Agreements,” *Economica*, 88, 456–473.

Ferguson, S. and S. Formai (2013): “Institution-Driven Comparative Advantage and Organizational Choice,” *Journal of International Economics*, 90, 193–200.

Francois, J. and M. Manchin (2013): “Institutions, Infrastructure, and Trade,” *World Development*, 46, 165–175.

Frye, T. and E. D. Mansfield (2004): “Timing is Everything: Elections and Trade Liberalization in the Postcommunist World,” *Comparative Political Studies*, 37, 371–398.

Gaulier, G. and S. Zignago (2010): “BACI: International Trade Database at the Product-level The 1994-2007 Version,” CEPII WP No. 2010 – 23.

GHIRONI, F. AND M. J. MELITZ (2005): "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *Quarterly Journal of Economics*, 120, 865–915.

GREENE, W. H. (2012): *Econometric Analysis*, Prentice Hall, 7th ed.

GROSSMAN, G. M. AND E. ROSSI-HANSBERG (2008): "Trading Tasks: A Simple Theory of Offshoring," *American Economic Review*, 98, 1978–1997.

HEAD, K. AND T. MAYER (2014): "Gravity Equations: Workhorse, Toolkit, and Cookbook," in *Handbook of International Economics*, ed. by K. R. Gita Gopinath, Elhanan Helpman, Elsevier, vol. 4, chap. 3.

HELBLE, M., B. SHPHERD, AND J. S. WILSON (2009): "Transparency and Regional Integration in the Asia Pacific," *World Economy*, 32, 479–508.

HOFMANN, C., A. OSNAGO, AND M. RUTA (2017): "Horizontal Depth: A New Database on the Content of Preferential Trade Agreements," Policy Research Working Paper No. WPS 7981.

HORN, H., P. C. MAVROIDIS, AND A. SAPIR (2010): "Beyond the WTO? An Anatomy of EU and US Preferential Trade Agreements," *World Economy*, 33, 1565–1588.

HUMMELS, D., J. ISHII, AND K.-M. YI (2001): "The Nature and Growth of Vertical Specialization in World Trade," *Journal of International Economics*, 54, 75–96.

IMBENS, G. (2000): "The Role of the Propensity Score in Estimating Dose-Response Functions," *Biometrika*, 87, 706–710.

IMBENS, G. AND J. M. WOOLDRIDGE (2009): "Recent Developments in the Econometrics of Program Evaluation," *Journal of Economic Literature*, 47, 5–86.

IMBENS, G. W. AND D. B. RUBIN (2015): *Causal Inference for Statistics, Social and Biomedical Sciences*, Cambirdge University Press.

INTERNATIONAL MONETARY FUND (2005): *World Economic Outlook*, IMF.

JOHNSON, H. G. (1953): "Optimum Tariffs and Retaliation," *Review of Economic Studies*, 21, 142–153.

JOHNSON, R. C. (2018): "Measuring Global Value Chains," *Annual Review of Economics*, 10.

JOHNSON, R. C. AND G. NOGUERA (2012): "Accounting for Intermediates: Production Sharing and Trade in Value Added," *Journal of International Economics*, 86, 224–236.

——— (2017): "A Portrait of Trade in Value-Added over Four Decades," *Review of Economics and Statistics*, 99, 896–911.

KAUFMANN, D., A. KRAAY, AND M. MASTRUZZI (2010): "The Worldwide Governance Indicators: Methodology and Analytical Issues," World Bank Policy Research Working Paper No. 5430.

KOHLER, W. (2004): "International Outsourcing and Factor Prices with Multistage Production," *The Economic Journal*, 114, 166–185.

LAGET, E., A. OSNAGO, N. ROCHA, AND M. RUTA (2020): "Deep Trade Agreements and Global Value Chains," *Review of Industrial Organization*, 57, 379–410.

LARCH, M. AND Y. V. YOTOV (2022): "Deep Trade Agreements and FDI in Partial and General Equilibrium: A Structural Estimation Framework," CESifo Working Paper No. 9985.

LEVCHENKO, A. A. (2007): "Institutional Quality and International Trade," *Review of Economic Studies*, 74, 791–819.

——— (2013): "International Trade and Institutional Change," *Journal of Law, Economics, & Organization*, 29, 1145–1181.

NOVY, D. (2013): "Gravity Redux: Measuring International Trade costs with Panel Data," *Economic Inquiry*, 51, 101–121.

NUNN, N. (2007): "Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade," *Quarterly Journal of Economics*, 122, 569–600.

OREFICE, G. AND N. ROCHA (2014): "Deep Integration and Production Networks: An Empirical Analysis," *World Economy*, 37, 106–136.

OSNAGO, A., N. ROCHA, AND M. RUTA (2017): "Do Deep Trade Agreements Boost Vertical FDI?" *World Bank Economic Review*, 30, S119–S125.

——— (2019): "Deep Trade Agreements and Vertical FDI: The Devil is in the Details," *Canadian Journal of Economics*, 52, 1558–1599.

OSSA, R. (2011): "A New Trade Theory of GATT/WTO Negotiations," *Journal of Political Economy*, 119, 122–152.

PAPKE, L. E. AND J. M. WOOLDRIDGE (1996): "Econometric Methods for Fractional Response Variables with an Application to 401(K) Plan Participation Rates," *Journal of Applied Econometrics*, 11, 619–632.

PEMSTEIN, D., K. L. MARQUARDT, E. TZELGOV, Y.-T. WANG, J. MEDZIHORSKY, J. KRUSELL, F. MIRI, AND J. VON RÖMER (2022): "The V-Dem Measurement Model: Latent Variable Analysis for Cross-National and Cross-Temporal Expert-Coded Data," V-Dem Working Paper No. 21. University of Gothenburg: Varieties of Democracy Institute.

RODRIK, D. (2002): "Trade Policy Reform as Institutional Reform," in *Development, Trade, and the WTO: A Handbook*, ed. by B. M. Hoekman, P. English, and A. Mattoo, World Bank.

Saggi, K., W. F. Wong, and H. M. Yildiz (2019): "Should the WTO Require Free Trade Agreements to Eliminate Internal Tariffs?" *Journal of International Economics*, 118, 316–330.

——— (2022): "The Role of Non-discrimination in a World of Discriminatory Preferential Trade Agreements," *Canadian Journal of Economics*, 55, 174–212.

Stefanadis, C. (2010): "Appropriation, Property Rights Institutions, and International Trade," *American Economic Journal: Economic Policy*, 2, 148–72.

Teorell, J., A. Sundström, S. Holmberg, B. Rothstein, P. N. A., and C. M. Dalli (2022): "The Quality of Government Standard Dataset," V. 22. University of Gothenburg: The Quality of Government Institute.

Viner, J. (1937): *Studies in the Theory of International Trade*, Routledge.

Wooldridge, J. M. (2010): *Econometric Analysis of Cross Section and Panel Data*, MIT Press, 2nd ed.

Yi, K.-M. (2003): "Can Vertical Specialization Explain the Growth of World Trade?" *Journal of Political Economy*, 111, 52–102.

Zi, Y. (2020): "Trade Costs, Global Value Chains and Economic Development," *Journal of Economic Geography*, 20, 249–291.

A Theoretical appendix

A.1 Derivation of equation system (10)

From Eq. (2), we know that $[p(s+ds)-p(s)]/ds = [p(s)\lambda_c+w_c]/(1-\lambda_c ds)$ holds whenever $Q_c(s') > 0$ for all $s' \in (s, s+ds]$. Taking the limit of $ds \to 0$ gives the differential equation $p'(s) = p(s)\lambda_c+w_c$. We can now solve this differential equation for the general solution $p(s) = -w_c/\lambda_c + B_c \exp[\lambda_c s]$. Making use of the equilibrium production structure from Lemma 1, we compute $p(0) = -w_1/\lambda_1 + B_1 = 0$ and thus $B_1 = w_1/\lambda_1$. This establishes $p(s) = \{\exp[\lambda_1 s]-1\}w_1/\lambda_1$ for all $s \in (0, S_1]$ and thus the first line in system (10) when setting $s = S_1$ and $p(S_1) = p_1$. Moreover, evaluating $p(s) = -w_2/\lambda_2+B_2 \exp[\lambda_2 s]$ at $s = S_1$, we compute $B_2 = [p_1 + w_2/\lambda_2]\exp[-\lambda_2 S_1]$, which establishes $p(s) = p_1 \exp[\lambda_2(s-S_1)] + (w_2/\lambda_2)\{\exp[\lambda_2(s-S_1)]-1\}$. Evaluated at $s = 1$ and $p(1) = 1$, this gives the second line of equation system (10).

In a final step, we acknowledge that a profit-maximizing choice of executing stages $s > S_1$ in country 2 and executing stages $s < S_1$ in country 1 requires

$$\begin{aligned} p(S_1+ds) - \frac{p(S_1)+w_2 ds}{1-\lambda_2 ds} &\geq p(S_1+ds) - \frac{p(S_1)+w_1 ds}{1-\lambda_1 ds}, \\ p(S_1) - \frac{p(S_1-ds)+w_1 ds}{1-\lambda_1 ds} &\geq p(S_1) - \frac{p(S_1-ds)+w_2 ds}{1-\lambda_2 ds} \end{aligned}$$

to simultaneously hold according to Eq. (2). Making use of standard mathematical manipulation and setting $p(S_1) = p_1$, we can reformulate the two conditions for the limiting case of $ds \to 0$

$$p_1(\lambda_1-\lambda_2) \geq w_2 - w_1, \qquad w_2 - w_1 \geq p_1(\lambda_1-\lambda_2),$$

which jointly establish the third line of equation system (10). This completes the proof.

A.2 Proof of Lemma 2

Noting $dx/d\tau = 0$ from Eq. (6′), $\partial\tilde{v}_1(\cdot)/\partial\tau < 0$ and $\partial\tilde{v}_2(\cdot)/\partial\tau > 0$ directly follow from Eqs. (12) and (13), respectively. Moreover, applying the implicit function theorem to Eq. (6′), we obtain

$$\frac{dx}{d\delta} = -\frac{x}{\delta}\frac{x-1}{\delta(x-1)+x-\Lambda}, \qquad \frac{d[\delta(x-1)]}{d\delta} = \frac{(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda}. \tag{A.1}$$

Then, differentiating $\tilde{v}_1(\tau,\delta)$ with respect to δ, we compute

$$\begin{aligned} \frac{\partial\tilde{v}_1(\cdot)}{\partial\delta} &= \frac{\lambda_1}{\tau}\frac{(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda}\left[1-\frac{x(1-\Lambda)}{[\delta(x-1)+x-\Lambda]^2}\right] - \frac{\lambda_1}{\exp[\lambda_1]-1} \\ &= \frac{w_1}{\delta}\left[1-\frac{x(1-\Lambda)}{[\delta(x-1)+x-\Lambda]^2}\right] - \frac{\lambda_1}{\exp[\lambda_1]-1}, \end{aligned} \tag{A.2}$$

where the second equality sign follows from Eq. (11′). The second partial derivative is given by

$$\frac{\partial^2 \tilde{v}_1(\cdot)}{\partial \delta^2} = -\frac{w_1}{\delta^2}\frac{x(1-\Lambda)}{[\delta(x-1)+x-\Lambda]^2}\left\{\frac{\delta(x-1)}{\delta(x-1)+x-\Lambda} + \frac{(1-\Lambda)[\delta(x-1)-\Lambda]}{[\delta(x-1)+x-\Lambda]^2} + 2\frac{(x-1)[x+\delta\Lambda-\delta^2(x-1)]}{[\delta(x-1)+x-\Lambda]^2}\right\} < 0.$$

This implies that if $\tilde{v}_1(\cdot)$ has an extremum in δ on the unit interval, it must be a maximum.

Acknowledging $\partial^2\tilde{v}_1(\cdot)/\partial\delta\partial\tau < 0$ and

$$\lim_{\delta\to 0}\frac{\partial \tilde{v}_1(\cdot)}{\partial \delta} = \frac{1}{\tau}\frac{\lambda_2}{\exp[\lambda_2]-1} - \frac{\lambda_1}{\exp[\lambda_1]-1}, \tag{A.3}$$

we can determine a critical $\overline{\tau}$ by setting $\partial\tilde{v}_1(\overline{\tau},0)/\partial\delta = 0$.[21] It is then immediate that $\partial\tilde{v}_1(\tau,0)/\partial\delta >,=,< 0$ if $\overline{\tau} >,=,< \tau$. In view of $\partial^2\tilde{v}_1(\cdot)/\partial\delta^2 < 0$ it follows that the welfare maximizing level of δ is larger than zero if $\tau < \overline{\tau}$. We can compute a second critical $\underline{\tau}$ by setting $\partial\tilde{v}_1(\underline{\tau},1)/\partial\delta = 0$. Due to $\partial^2\tilde{v}_1(\cdot)/\partial\delta\partial\tau < 0$, it is then immediate that $\partial\tilde{v}_1(\tau,1)/\partial\delta >,=,< 0$ if $\underline{\tau} >,=,< \tau$. In view of $\partial^2\tilde{v}_1(\cdot)/\partial\delta^2 < 0$, it follows that the welfare maximizing level of δ is smaller than one if $\tau > \underline{\tau}$. Setting $\partial\tilde{v}_1/d\delta = 0$ determines τ as implicit function of δ, which we denote by $\hat{\tau}(\delta)$. Making use of $\partial^2\tilde{v}_1/\partial\delta^2 < 0$, $\partial^2\tilde{v}_1/\partial\delta\partial\tau < 0$, we have $\hat{\tau}'(\delta) < 0$, which establishes $\underline{\tau} < \overline{\tau}$. Moreover, we can show that $\underline{\tau} > 1$. Since the formal proof for this result is tedious, we have deferred it to the Online Appendix to this manuscript.

We now turn to the impact of changes in parameter δ on welfare in the North. For this purpose, we differentiate Eq. (13) with respect to δ. This gives

$$\begin{aligned}\frac{\partial \tilde{v}_2(\cdot)}{\partial \delta} &= \lambda_1\frac{(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda}\frac{x(1-\Lambda)}{[\delta(x-1)+x-\Lambda]^2} \\ &\quad + \lambda_1\frac{\tau-1}{\tau}\frac{(x-1)[\delta(x-1)-\Lambda]}{\delta(x-1)+x-\Lambda}\left[1-\frac{x(1-\Lambda)}{[\delta(x-1)+x-\Lambda]^2}\right] \\ &= \tau\frac{w_1}{\delta}\frac{x(1-\Lambda)}{[\delta(x-1)+x-\Lambda]^2} + (\tau-1)\frac{w_1}{\delta}\left[1-\frac{x(1-\Lambda)}{[\delta(x-1)+x-\Lambda]^2}\right] > 0,\end{aligned}$$

where the second equality sign follows from Eq. (11′). This establishes $\partial\tilde{v}_2(\cdot)/\partial\delta > 0$ and completes the proof.

A.3 Proof of Proposition 2

We consider $\tau = \delta = 1$. Then, setting $\Lambda = 1$ establishes $x = 2\exp[\lambda_1]/\{\exp[\lambda_1]-1\}$ according to Footnote 4. In this case, we have $\tilde{v}_1(1,1) = \lambda_1/\{\exp[\lambda_1]-1\}$ and thus $\tilde{v}_1(1,1) = v_1^{nc}$, according to

[21] From Eq. (A.3), we can compute the explicit solution $\overline{\tau} = \frac{\lambda_2}{\lambda_1}\frac{\exp[\lambda_1]-1}{\exp[\lambda_2]-1} > 1$.

Eqs. (12) and (14). Totally differentiating $\tilde{v}_1(1,1)$ with respect to λ_2 further establishes

$$\frac{d\tilde{v}_1(1,1)}{d\lambda_2} = \lambda_1 \frac{2x(x-1-\Lambda)+\Lambda(1+\Lambda)}{(2x-1-\Lambda)^2}\frac{dx}{d\Lambda}\frac{d\Lambda}{d\lambda_2} - \lambda_1 \frac{x(x-1)}{(2x-1-\Lambda)}\frac{d\Lambda}{d\lambda_1}.$$

Substituting $dx/d\Lambda$ from Eq. (9) and $d\Lambda/d\lambda_2 = 1/\lambda_1$, we compute

$$\frac{d\tilde{v}_1(1,1)}{d\lambda_2} = \frac{x(x-1)}{(2x-1-\Lambda)^2}\left\{\frac{2x(x-1-\Lambda)+\Lambda(1+\Lambda)}{\Lambda(2x-1-\Lambda)}\left[1+\frac{x-1-\Lambda}{\Lambda}\ln\left(\frac{x-1-\Lambda}{x-1}\right)\right]-1\right\}.$$

From the properties of the natural logarithm it is well known that, for $y>0$, we have $\ln y \leq y-1$. This implies $\ln\left[(x-1-\Lambda)/(x-1)\right] \leq -\Lambda/(x-1)$ and thus

$$\frac{d\tilde{v}_1(1,1)}{d\lambda_2} \leq -\frac{x[(2x-1-\Lambda)\Lambda+(x-1)(1+\Lambda)]}{(2x-1-\Lambda)^3} < 0.$$

This is sufficient for $\tilde{v}_1(1,1) > v_1^{nc}$ to hold for all $\Lambda < 1$ and thus $\lambda_2 < \lambda_1$.

To determine the ranking of $\tilde{v}_2(1,1)$ and v_2^{nc}, we first rewrite Eq. (6) as follows

$$\hat{F}(x,\Lambda) \equiv -\Lambda \ln\left(\frac{x-1}{x}\right) - \ln\left(\frac{x-1-\Lambda}{x-1}\right) - \lambda_2 = 0. \tag{A.4}$$

Applying the implicit function theorem, we compute

$$\frac{dx}{d\Lambda} = \frac{x}{\Lambda}\frac{x-1}{2x-1-\Lambda}\left[1-(x-1-\Lambda)\ln\left(\frac{x-1}{x}\right)\right] > 0. \tag{A.5}$$

For a given mistake rate in the North (i.e. for a given level of λ_2), x increases in Λ. Setting $\Lambda = 1$ gives $\lambda_1 = \lambda_2$, $x = 2\exp[\lambda_2]/\{\exp[\lambda_2]-1\}$, and $\tilde{v}_2(1,1) = \lambda_2/\{\exp[\lambda_2]-1\}$. This establishes $\tilde{v}_2(1,1) = v_2^{nc}$. Totally differentiating $\tilde{v}_2(1,1)$ with respect to λ_1 gives

$$\frac{d\tilde{v}_2(1,1)}{d\lambda_1} = \lambda_1 \frac{2x(x-1-\Lambda)+1+\Lambda}{(2x-1-\Lambda)^2}\frac{dx}{d\Lambda}\frac{d\Lambda}{d\lambda_1} - \lambda_1 \frac{(2x-1-\Lambda)(x-1-\Lambda)+x(x-\Lambda)}{(2x-1-\Lambda)^2}\frac{d\Lambda}{d\lambda_1} + \frac{(x-\Lambda)(x-1-\Lambda)}{2x-1-\Lambda}.$$

Substituting $dx/d\Lambda$ from Eq. (A.5) and $d\Lambda/d\lambda_1 = -\Lambda/\lambda_1$, we compute

$$\frac{d\tilde{v}_2(1,1)}{d\lambda_1} = -\frac{2x(x-1-\Lambda)+1+\Lambda}{(2x-1-\Lambda)^2}\frac{x(x-1)}{2x-1-\Lambda}\left[1-(x-1-\Lambda)\ln\left(\frac{x-1}{x}\right)\right] + \frac{\Lambda x(x-\Lambda)}{(2x-1-\Lambda)^2} + \frac{x(x-1-\Lambda)}{2x-1-\Lambda}.$$

Rearranging terms, we obtain $d\tilde{v}_2(1,1)/d\lambda_1 = x(x-1)(x-1-\Lambda)[2x(x-1-\Lambda)]+1+\Lambda](2x-1-$

$\Lambda)^{-3}\hat{f}(x,\lambda)$, with

$$\hat{f}(x,\Lambda) = \frac{2(x-\Lambda)}{2x(x-1-\Lambda)+1+\Lambda} + \ln\left(\frac{x-1}{x}\right).$$

Partially differentiating $\hat{f}(x,\Lambda)$ with respect to Λ gives $\hat{f}'_\Lambda(x,\Lambda) = 2(x-1)[2x(x-1-\Lambda)+1+\Lambda]^{-2} > 0$ and thus $\hat{f}(x,\Lambda) > \hat{f}(x,0)$. Moreover, differentiating $\hat{f}(x,0)$ with respect to x, we obtain

$$\hat{f}'_x(x,0) = -\frac{(4x-6)x(x-1)-1}{x(x-1)[2x(x-1)+1]^2}.$$

Since $\hat{f}'_x(x,0) < 0$ holds for all $x > 2$ and since $x > 2$ is imposed by Footnote 4, we can safely conclude that $\hat{f}(x,\Lambda) > \hat{f}(x,0) > \lim_{x\to\infty}\hat{f}(x,0) = 0$. This is sufficient for $\tilde{v}_2(1,1) > v_2^{nc}$ to hold for all $\Lambda < 1$ and thus $\lambda_1 > \lambda_2$, which completes the proof.

A.4 Derivation details for the analysis in Section 5

We first note that per-capita income in countries 1 and 2 can be expressed as $(w_Y + w_1)/2$ and $[w_Y + w_2 + (\tau-1)w_1]/2$, respectively, with $w_1 = \lambda_1 p_1 \delta(x-1)$ as the (per-capita) value of intermediate imports by country 2. Given the Cobb-Douglas preferences, consumers of country 2 spend constant fractions of their income on the two consumer goods: a fraction α on Q_2 and a fraction $1-\alpha$ on $w_Y Y$. Accordingly, the global market clearing conditions for the two goods can be written as

$$\alpha\left[(w_Y + w_2) + (\tau-1)w_1\right] + (w_Y + w_1) = \lambda_1[\delta(x-1) - \Lambda], \tag{A.6}$$

$$(1-\alpha)\left[(w_Y + w_2) + (\tau-1)w_1\right] = 2w_Y. \tag{A.7}$$

Solving Eq. (A.7) for $(w_Y+w_2)+(\tau-1)w_1 = 2w_Y/(1-\alpha)$, substituting this expression into Eq. (A.6), and replacing w_1 by Eq. (11′), we can solve for Eq. (15).

In a next step, we make use of $(w_Y+w_2)+(\tau-1)w_1 = 2w_Y/(1-\alpha)$ to compute $c_Q^2 = [\alpha/(1-\alpha)]w_Y$ and $c_Y^2 = 1$. Substitution into $u_2 = (c_Q^2)^\alpha (c_Y^2)^{1-\alpha}$ establishes indirect utility $v_2 = [\alpha w_Y/(1-\alpha)]^\alpha$. To determine the impact of changes in τ and δ on v_2, we need to determine their impact on w_Y. Introducing the auxiliary expression $X_1(\delta) \equiv \delta(x-1)$ and $X_2(\delta) = x - \Lambda$, we rewrite Eq. (15) as follows

$$w_Y = \lambda_1 \frac{1-\alpha}{1+\alpha}[X_1(\delta) - \Lambda]\left[1 - \frac{1}{\tau}\frac{X_1(\delta)}{X_1(\delta)+X_2(\delta)}\right]. \tag{A.8}$$

Acknowledging $dX_1(\delta)/d\tau = dX_2(\delta)/d\tau = 0$ from Eq. (6′), it follows that $dw_Y/d\tau > 0$. Moreover, making use of Eq. (A.1), we compute

$$X_1'(\delta) = \frac{1}{\delta}\frac{X_1(\delta)[X_1(\delta)-\Lambda]}{X_1(\delta)+X_2(\delta)} > 0, \qquad X_2'(\delta) = -\frac{1}{\delta}\frac{X_2(\delta)+\Lambda}{X_1(\delta)-\Lambda}X_1'(\delta) < 0. \tag{A.9}$$

This allows us to determine

$$\frac{dw_Y}{d\delta} = \frac{1-\alpha}{1+\alpha}\frac{X_1'(\delta)}{L}\left\{1-\frac{1}{\tau}\left[1-\frac{X_2(\delta)+\lambda_2 L}{X_1(\delta)+X_2(\delta)}\frac{(\lambda_1-\lambda_2)L}{X_1(\delta)+X_2(\delta)}\right]\right\} > 0.$$

Putting together, we can safely conclude that $dv_2/d\tau > 0$ and $dv_2/d\delta > 0$.

Let us now turn to welfare in the South, which is given by Eq. (16). Using auxiliary variables $X_1(\delta)$, $X_2(\delta)$, we can express v_1 in a more compact form as

$$v_1 = \frac{\lambda_1}{2}\left\{[X_1(\delta)-\Lambda]\left[\frac{1-\alpha}{1+\alpha}+\frac{2\alpha}{1+\alpha}\frac{1}{\tau}\frac{X_1(\delta)}{X_1(\delta)+X_2(\delta)}\right]+\frac{1-\delta}{\exp[\lambda_1]-1}\right\}, \tag{A.10}$$

with $dv_1/d\tau < 0$ following form $dX_1(\delta)/d\tau = dX_2(\delta)/d\tau = 0$. Differentiating v_1 with respect to δ gives

$$\frac{\partial v_1}{\partial\delta} = \frac{\lambda_1}{2}\left\{X_1'(\delta)\left[\frac{1-\alpha}{1+\alpha}+\frac{2\alpha}{1+\alpha}\frac{1}{\tau}\left(1-\frac{X_2(\delta)+\lambda_2 L}{X_1(\delta)+X_2(\delta)}\frac{(\lambda_1-\lambda_2)L}{X_1(\delta)+X_2(\delta)}\right)\right]-\frac{1}{\exp[\lambda_1]-1}\right\}.$$

Noting that

$$X_1''(\delta) = -\frac{X_1'(\delta)}{\delta}\frac{X_2(\delta)+\Lambda}{X_1(\delta)+X_2(\delta)}\frac{(1-\Lambda)}{X_1(\delta)+X_2(\delta)} < 0. \tag{A.11}$$

and that $X_1'(\delta)+X_2'(\delta) < 0$, it follows that $d^2v_1/d\delta^2 < 0$. This implies that if v_1 has an extremum in δ on the unit interval, the extremum must be a maximum. Noting further that $\lim_{\delta\to 0} X_1(\delta) = \lim_{\delta\to 0}\delta X_2(\delta) = \Lambda\exp[\lambda_2]/\{\exp[\lambda_2]-1\}$ and $\lim_{\delta\to 0} X_2(\delta) = \infty$, we compute $\lim_{\delta\to 0} X_1'(\delta) = \Lambda/\{\exp[\lambda_2]-1\}$ and

$$\lim_{\delta\to 0}\frac{dv_1}{d\delta} = \frac{1}{2}\left[\left(\frac{1-\alpha}{1+\alpha}+\frac{2\alpha}{1+\alpha}\frac{1}{\tau}\right)\frac{\lambda_2}{\exp[\lambda_2]-1}-\frac{\lambda_1}{\exp[\lambda_1]-1}\right]. \tag{A.12}$$

Hence, for $\lim_{\delta\to 0} dv_1/d\delta < 0$ to hold if $\tau\to\infty$, α must be sufficiently large in the two-sector model.

In a final step, we make use of the two auxiliary variables $X_1(\delta)$ and $X_2(\delta)$ to rewrite Eq. (17)

$$share_2 = \frac{1}{1+Z(\delta)}, \quad \text{with} \quad Z(\delta) \equiv \frac{w_Y}{\lambda_1 p_1\delta(x-1)} = \frac{1-\alpha}{1+\alpha}\left[\tau-1+\tau\frac{X_2(\delta)}{X_1(\delta)}\right]. \tag{A.13}$$

Noting that $dZ(\delta)/d\tau > 0$ and $Z'(\delta) < 0$, we can thus safely conclude that $dshare_2/d\tau < 0$, while $dshare_2/d\delta > 0$. This completes the proof.

B Empirical appendix

In this Appendix, we provide descriptives and report the data sources for the main variables used in our empirical analysis in Section 7. Moreover, we present some robustness checks for the empirical results in the main text and discuss balancing properties and regression results for the matching model underlying specification 2 of Table 2.

B.1 Descriptives and data sources

An overview of the descriptives for our variables and details on their construction are given in Table B.1, while their data sources are listed in Table B.2. For the TA indicator, we rely on a broad definition, considering all forms of trade agreements that are reported by the WTO. For the sample period 1996 to 2015, we observe 619 new trade agreements covering 158 shallow agreements and 461 deep agreements, which additionally implement anticorruption rules and measures of property rights protection.[22] Since for our analysis, we need to observe country pairs one year before a new agreement is formed, we observe the first new TA for 1997. A list of all TAs considered for our analysis is reported in the Online Appendix to this manuscript. To construct the share of intermediate imports, we use product-level trade data from BACI , which is available at the 6-digit level for the Harmonized System 1996 (HS96) nomenclature. This dataset has two advantages over available alternatives. First, the Statistical Division of the UN provides an m:1 crosswalk to the classification of Broad Economic Categories (BEC, v. 4), which we employ to distinguish trade of intermediate, capital, and consumption goods according to standard procedures.[23] Second, BACI gives consistent free-on-board trade flows, which we prefer to cost, insurance, and freight inclusive import data in order to isolate changes in the volume of trade from changes in trade costs (see Gaulier and Zignago, 2010, for further details). A disadvantage of the dataset is that trade flows are only available for 1996 and consecutive years.

For the main covariates of our analysis we find considerable heterogeneity between the country pairs in our sample. This is not overly surprising because our sample covers a rich set of 113 developed and developing countries. For an interpretation of the similarity indices, it is notable that by construction the maximum level of this index is -0.693 (see the formula in the footnote of Table 1). In contrast, asymmetry in the quality of judicial institutions is measured by its standard deviation for a country pair and must therefore have a positive real value. Whereas most covariates reported in Table 1 are widely used in the literature (see Baier and Bergstrand, 2004; Egger et al., 2008; Baier and Bergstrand, 2009), there are three variables that deserve further discussion. First, we use information on tertiary education from the World Development Indicators to obtain a proxy for the skilled to unskilled labor ratio. This variable is available for many years but only a restricted number of countries. Below, we show robustness of our results when dropping this covariate. Second, to construct a measure of trade costs, we rely on the International Trade by Commodity Statistics, which provide information on international transport and insurance costs. This data is available from the OECD for 1995 onwards and has been aggregated from the industry to the aggregate, economy-wide level using the previously mentioned BACI trade flow data. In various robustness checks, we consider alternative measures of trade costs. Third, the share of preferential duty lines is available for a comparably small country sample. Whereas we could set the preferential duties to zero for all country pairs reporting a custom union or a free trade agreement, this

[22] 601 of these agreements are classified as custom unions or free trade agreements.

[23] The BEC categories 321 (motor spirit), 51 (passenger motor cars), and 7 (goods not elsewhere specified) cannot be assigned to a unique type of trade flow and are therefore dropped from our analysis.

Table B.1: *Descriptive statistics.*

	Obs.	Mean	STD.	Min.	Max
			Outcome variables		
TA indicator	15,484	0.070	0.353	0.000	2.000
Intermediate import share	9,159	0.603	0.311	0.000	1.000
			Bilateral covariates		
Total log real GDP	15,484	23.527	2.378	17.303	32.480
Similarity real GDP	15,484	−2.037	1.263	−7.522	−0.693
Similarity skilled to unskilled labor	15,484	−1.201	0.640	−4.350	−0.693
Similarity in capital labor ratio	15,484	−1.339	0.738	−4.595	−0.693
Similarity in total factor productivity	15,484	−0.789	0.119	−1.608	−0.693
Log bilateral trade costs	15,484	1.080	0.501	−0.693	2.257
Asymmetry judicial quality	15,484	1.163	0.878	0.001	4.487
Similarity legislature fractionalization	12,957	−0.856	0.404	−3.243	−0.693
			Unilateral covariates		
Log real GDP p.c. exporter	15,484	8.594	1.011	6.562	12.031
Log real GDP p.c. importer	15,484	9.669	0.941	6.562	12.031
Log applied tariff exporter	12,490	1.847	0.728	-2.408	3.512
Log applied tariff importer	13,499	1.470	0.773	-2.408	3.512
Share preferential tariff lines importer	3,472	0.877	0.132	0.002	1.000
Maximum bilateral durability	15,471	35.945	30.99267	0.000	166.000
Minimum bilateral durability	15,471	11.722	13.50654	0.000	163.000

Notes: The variables are constructed combining different datasets that are listed in Table B.2. Similarity of countries i and j for variable X is defined as $S = \log\left(1 - \left[\frac{X_i}{X_i+X_j}\right]^2 - \left[\frac{X_j}{X_i+X_j}\right]^2\right)$. Asymmetry of variable X is measured by its standard deviation for a country pair.

would be of limited help, because these country pairs are eliminated from the control group. Due to the data limitations, we do not use preferential tariff information in our preferred specifications.

Table B.2: *Data sources.*

TA indicator	CEPII's Gravity Database and WTO Database on Deep Trade Agreements
Import data	CEPII's International Trade Database at the Product-Level (BACI)
Skill ratio (tertiary education)	World Development Indicators
Capital-labor ratio	Penn World Tables
Total factor productivity	Penn World Tables
Bilateral trade costs	International Trade by Commodity Statistics (OECD)
Quality of judicial Institutions	The Varieties of Democracy Dataset
Legislative fractionalization	The Quality of the Government Institute Standard Dataset
Log real GDP per capita	Penn World Tables
Applied tariffs (weighted)	World Development Indicators
Preferential tariff lines	World Integrated Trade Solution
Durability of political system	The Quality of the Government Institute Dataset

B.2 Robustness checks

In Table B.3, we report the results from several robustness checks regarding the impact of asymmetry in the quality of judicial institutions on the probability to form shallow or deep trade agreements. Thereby, we rely on a similar specification as in Model 4 of Table 1. In Models 8 and 9, we consider alternative measures for the quality of (judicial) institutions. In Model 8, we rely on the rules of law index from the World Governance Indicators, which has been used by previous research as a proxy for the quality of judicial institutions in general and contract enforcement as well as the security of property rights in particular (see Levchenko, 2007; Nunn, 2007; Ferguson and Formai, 2013). Compared to our preferred measure, this variable has lower coverage of countries as well as time periods. Using this alternative control also gives a positive estimate for the asymmetry in the quality of judicial institutions on the probability of forming a deep TA. However the strong positive estimate for asymmetry in judicial quality on the probability to form a shallow TA is surprising and in contradiction to the idea that differences in institutional quality are a barrier to international trade (see de Groot and Linders, 2004). In Model 9, we consider differences in legislative corruption from the Varieties of Democracy Standard Database as an alternative measure for the asymmetry in the quality of institutions and find our results from Table 1 confirmed by this robustness check.

Table B.3: *The probability of forming a shallow or deep trade agreement – robustness.*

	M8	M9	M10	M11	M12	M13	M14
	Shallow trade agreements ($TA_{ij} = 1$)						
Asymmetry in the quality of (judicial) institutions	0.858^{**} (0.223)	0.055 (0.114)	-0.387^{*} (0.155)	-0.215° (0.128)	-0.375^{**} (0.106)	-0.387^{**} (0.078)	-0.135° (0.076)
	Deep trade agreements ($TA_{ij} = 2$)						
Asymmetry in the quality of (judicial) institutions	0.678° (0.152)	0.419^{**} (0.076)	0.366^{**} (0.091)	0.350^{**} (0.080)	0.226^{**} (0.054)	0.199^{**} (0.053)	0.307^{**} (0.055)
Pseudo R^2	0.373	0.322	0.328	0.329	0.237	0.296	
Wald χ^2-Test	1,044.15	1,117.85	1,029.75	1,278.65	2,199.52	3,302.02	909.35
Prob > χ^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	10,991	12,669	10,214	16,803	41,308	65,503	12,949

Notes: Data sources: see Tables B.1 and B.2 and the discussion in the text. The estimated specifications are similar to Model 4 of Table 1, with the following differences. In Models 8 and 9, we consider a rule of law index from the Worldwide Governance indicators and the corruption in legislative procedures from the Varieties of Democracy Institute as alternative measures of institutional quality. In Models 10 and 11 we use estimates from the World Bank's ESCAP database and the log bilateral distance as well as an indicator for common official language from CEPII as alternative proxies for bilateral trade costs. In Models 12 and 13, we use log bilateral distance as well as an indicator for common official language to proxy for bilateral trade costs and drop the similarity in the relative skill endowment from the set of regressors. In Model 13, we additionally extend the sample period to cover new TA formations between 1981 to 2015. Finally, in Model 14, we estimate the specification from Model 4 using multinomial probit. Robust standard errors in parentheses: ** $p < 0.01$, * $p < 0.05$, and $^{\circ}$ $p < 0.1$.

In Models 10 and 11, we consider alternative proxies for bilateral trade costs. In Model 10, we rely on the trade costs reported by World Bank's ESCAP database. These trade costs are constructed from observed trade flows, using the gravity model (see Novy, 2013). Similar to our preferred trade cost variable, this alternative measure is available for 1995 onwards but for a smaller country sample. Using this alternative trade cost measure does not change our results qualitatively. In Model 11, we consider log bilateral distance and an indicator for common official language from CEPII's gravity database as alternative (time-invariant) proxies for trade costs that are widely used in the gravity literature (see Head and Mayer, 2014). Compared to other trade cost measures, these proxies have the advantage to be available for a longer time horizon and a larger country sample. Using them in our estimation does not change the results in an important way. In Models 12 and 13, we use the alternative trade cost proxies from Model 11 and additionally drop the control for similarity in the relative skill endowment. This increases the country sample considerably (Model 12) and allows us to expand the sample period to the years 1980 to 2015 (Model 13). Both of these extensions leave the main insights from our analysis unchanged. Finally, in Model 14, we estimate our preferred specification from Model 4 using multinomial probit instead of multinomial logit. For this alternative estimation method, a Pseudo R^2 is not reported. However, the main insights from Table 1 are robust to estimating our model with multinomial logit or multinomial probit.

Table B.4: *The treatment effects of new TAs on intermediate import shares – robustness.*

	Specification 4		Specification 5		Specification 6	
	ATE	ATT	ATE	ATT	ATE	ATT
Shallow vs. no TA	0.004	-0.092	0.024	-0.032	0.047	-0.072
	(0.151)	(0.096)	(0.139)	(0.107)	(0.126)	(0.118)
Deep vs. no TA	0.034	0.138^{*}	0.292^{**}	0.222^{**}	0.324^{*}	0.177^{*}
	(0.096)	(0.070)	(0.111)	(0.074)	(0.159)	(0.084)
Add. controls in outcome model	No	No	Yes	Yes	Yes	Yes
Add. controls in treatment model	No	No	No	No	Yes	Yes
New shallow TAs	123	123	104	104	123	123
New deep TAs	340	340	328	328	352	352
Observations	5,129	5,130	5,546	5,547	6,175	6181

Notes: Treatment and outcome models are the same as in specification 2 of Table 1. In specification 4, matching covariates are from period $t-1$ instead of period $t-2$. Specification 5 restricts TAs to custom unions and free trade agreements. Specification 6 uses a broader definition of total imports, which does not require that both imports of consumption goods as well imports of capital goods are not missing. Robust standard errors in parentheses: ** $p < 0.01$, * $p < 0.05$, and $^{\circ}$ $p < 0.1$.

In Table B.4, we report robustness of our treatment effects estimator, considering three alternatives to our preferred specification 2 in Table 2. In specification 4, we consider covariates from period $t-1$ instead of period $t-2$ to estimate the probability of a new TA formation (shallow or deep) between periods $t-1$ and t in the treatment model. This increases sample size but lowers preciseness of our estimates. By and large the estimation results from Table 2 are robust to this modification. Specification 5 restricts TAs to custom unions and free trade agreements. This lowers the size of the treatment group but increases the size of the control group, from which we eliminate all country pairs reporting an existing TA. Since the latter effect dominates, sample size slightly increases. Using a more restrictive measure of

TAs allows us to estimate the treatment effects more precisely and makes the ATE and ATT effects more similar than in our preferred specification 2. Finally, in specification 6, we use a slightly less restrictive criterion for measuring intermediate import shares. In Table 2, we require non-missing information for the imports of capital and consumption goods for a country pair to be included in our sample. Lifting this constraint does not change our estimates in an important way.

B.3 Balancing test and estimation results for the treatment model

In Table B.5, we show the estimation outcome of the treatment model underlying specification 2 in Table 2. A comparison of the estimation results confirms that the treatment model is the same for the AFTE and the ATT estimator and it shows that the loss of two observations from the control group in the ATE estimation – after eliminating country pairs with a probability of receiving either treatment level smaller than 1e-5 – has no effect on the outcome of propensity score matching.

Table B.5: *Treatment model for specification 2 of Table 2.*

	ATE		ATT	
	Shallow TA	Deep TA	Shallow TA	Deep TA
Total log real GDP	-0.140^{**}	-0.144^{**}	-0.140^{**}	-0.144^{**}
	(0.045)	(0.026)	(0.045)	(0.026)
Similarity real GDP	0.152°	0.208^{**}	0.152°	0.208^{**}
	(0.084)	(0.056)	(0.084)	(0.056)
Similarity skilled to unskilled labor	1.274^{**}	1.636^{**}	1.274^{**}	1.636^{**}
	(0.283)	(0.237)	(0.283)	(0.237)
Similarity capital-labor ratio	-0.501^{**}	0.012	-0.501^{**}	0.012
	(0.182)	(0.162)	(0.182)	(0.162)
Similarity total factor productivity	3.338^{*}	8.162^{**}	3.338^{*}	8.162^{**}
	(1.670)	(1.020)	(1.670)	(1.020)
Log bilateral trade costs	0.304	0.3228^{**}	0.304	0.3228^{**}
	(0.211)	(0.122)	(0.211)	(0.122)
Asymmetry judicial quality	-0.042	0.508^{**}	-0.042	0.508^{**}
	(0.133)	(0.074)	(0.133)	(0.074)
Observations	4,709	4,709	4,711	4,711

Notes: Treatment model outcome for the preferred specification 2 in 1. A constant is estimated but not reported. Robust standard errors in parentheses: ** $p < 0.01$, * $p < 0.05$, and $^{\circ}$ $p < 0.1$.

In Table B.6 we report how inverse propensity score weighting improves the balancing of our covariates. Following Imbens and Wooldridge (2009) and Imbens and Rubin (2015), we thereby report the standardized differences of covariates between treatment and control group, separately for shallow and deep TAs. Using the rule-of-thumb criterion of Imbens and Rubin (2015) and considering a variable as balanced if its standardized difference between the control and treatment group is not larger than one quarter, we find that the inverse probability weighting successfully balances covariates in most instances and shows a particularly good performance in the case of our preferred ATT estimator.

Table B.6: *Covariate balancing due to inverse propensity score weighting for specification 2 of Table 2*

	ATE				ATT			
	Shallow TA		Deep TA		Shallow TA		Deep TA	
	Raw	Weighted	Raw	Weighted	Raw	Weighted	Raw	Weighted
Total log real GDP	−0.322	0.072	−0.313	−0.092	−0.323	0.052	−0.313	0.017
Similarity real GDP	0.289	0.057	0.386	0.141	0.290	−0.023	0.387	−0.001
Similarity skilled to unskilled labor	0.382	−0.039	0.538	0.292	0.384	0.237	0.538	0.003
Similarity capital-labor ratio	0.122	−0.251	0.313	0.086	0.123	0.241	0.314	0.021
Similarity total factor productivity	0.279	−0.117	0.496	0.279	0.280	0.322	0.497	0.003
Log bilateral trade costs	0.164	0.074	0.127	0.040	0.165	0.081	0.128	−0.007
Asymmetry judicial quality	−0.134	0.011	0.144	0.126	−0.135	0.006	0.144	−0.011
Obs. no TA	4,281	1,648.6	4,281	1,648.6	4,283	1,527.4	4,283	1,527.4
Obs. shallow TA	109	1,659.0	109	1,659.0	109	1,660.7	109	1,660.7
Obs. deep TA	319	1,401.4	319	1,401.4	319	1,522.9	319	1,522.9
Total observations	4,709	4,709	4,709	4,709	4,711	4,711	4,711	4,711

Notes: Reported numbers refer to standardized differences before (raw) and after weighting.

Online Appendix for

Trade Policy along the Global Value Chain:
A Rationale for the Evolution of Deep Trade Agreements

— Hartmut Egger, Christian Fischer-Thöne —

In this Online Appendix, we present further derivation details for the one-sector model outlined in Sections 3 and 4. Moreover, we provide further discussion of the two-sector model outlined in Section 5, considering the limiting case of perfect inter-sectoral labor mobility. Finally, we also list the shallow and deep trade agreements covered by our empirical analysis in Section 7.

S.1 Derivation of w_1, w_2, and p_1 in $(11')$

The derivation steps have the same order as in Appendix A.1. Starting point is differential equation $p_c'(s) = p_c(s)\lambda_c + w_c$, where a country index is attached to the price, because $\delta < 1$ drives a wedge between the price per produced and the price per shipped unit and because $\tau > 1$ drives a wedge between the export and the import price. The differential equation has the general solution $p_c(s) = -w_c/\lambda_c + B_c \exp[\lambda_c s]$. In view of $p_1(0) = -w_1/\lambda_1 + B_1 = 0$, we get $B_1 = w_1/\lambda_1$. This establishes $p_1(s) = \{\exp[\lambda_1 s] - 1\} w_1/\lambda_1$ for all $s \in (0, S_1]$. Acknowledging $\delta p_1 = p_1(S_1)$ then gives for $s = S_1$:

$$\delta p_1 = \{\exp[\lambda_1 S_1] - 1\} \frac{w_1}{\lambda_1}. \tag{S.14}$$

Moreover, evaluating $p_2(s) = -w_2/\lambda_2 + B_2 \exp[\lambda_2 s]$ at $s = S_1$, we compute, using $p_2(S_1) = \tau p_1$, $B_2 = [\tau p_1 + w_2/\lambda_2] \exp[-\lambda_2 S_1]$. This establishes $p_2(s) = \tau p_1 \exp[\lambda_2(s - S_1)] + (w_2/\lambda_2)\{\exp[\lambda_2(s - S_1)] - 1\}$, which evaluated at $s = 1$ and setting $p_2(1) = 1$ gives

$$1 = \exp[\lambda_2(1 - S_1)]\tau p_1 + \{\exp[\lambda_2(1 - S_1)] - 1\} \frac{w_2}{\lambda_2}. \tag{S.15}$$

Finally, acknowledging that a profit-maximizing choice of executing stages $s > S_1$ in country 2 and executing stages $s < S_1$ in country 1 requires

$$p_2(S_1 + ds) - \frac{p_2(S_1) + w_2 ds}{1 - \lambda_2 ds} \geq p_2(S_1 + ds) - \frac{\tau}{\delta} \frac{p_1(S_1) + w_1 ds}{1 - \lambda_1 ds},$$
$$p_2(S_1) - \frac{\tau}{\delta} \frac{p_1(S_1 - ds) + w_1 ds}{1 - \lambda_1 ds} \geq p_2(S_1) - \frac{p_2(S_1 - ds) + w_2 ds}{1 - \lambda_2 ds}$$

to simultaneously hold according to Eq. (2). Making use of standard mathematical manipulation and setting $p_1(S_1) = \delta p_1$, $p_2(S_1) = \tau p_1$, we can reformulate the two conditions for the limiting case of $ds \to 0$ as follows

$$\tau p_1(\lambda_1 - \lambda_2) \geq w_2 - \tau\delta^{-1} w_1, \qquad w_2 - \tau\delta^{-1} w_1 \geq \tau p_1(\lambda_1 - \lambda_2),$$

which jointly establish

$$\delta w_2 = \tau w_1 + \tau\delta p_1(\lambda_1 - \lambda_2). \tag{S.16}$$

We can combine Eqs. (S.14)-(S.16) to determine the explicit solutions for w_1, w_2 and p_1 in Eq. (11′). This completes the proof.

S.2 Further derivation details for Lemma 2

In Appendix A.2, we argue that $\underline{\tau} > 1$. A sufficient condition for this is that $\partial\tilde{v}_1(1,1)/\partial\delta > 0$ holds. Evaluating the derivative in Eq. (A.2) at $\tau = \delta = 1$, we obtain

$$\frac{\partial\tilde{v}_1(1,1)}{\partial\delta} = \lambda_1\left[f(\Lambda) - \frac{1}{\exp[\lambda_1] - 1}\right], \tag{S.17}$$

with

$$f(\Lambda) \equiv \frac{(x-1)(x-1-\Lambda)}{2x-1-\Lambda}\left[1 - \frac{x(1-\Lambda)}{(2x-1-\Lambda)^2}\right] \tag{S.18}$$

and x given as implicit function of Λ by Eq. (6). To proceed, we differentiate $f(\Lambda)$ and obtain

$$f'(\Lambda) = \frac{x(x-1)}{(2x-1-\Lambda)^5}\frac{x-1-\Lambda}{\Lambda^2}H(x,\Lambda), \tag{S.19}$$

with

$$\begin{aligned} H(x,\Lambda) = {} & [2x(x-1-\Lambda) + \Lambda(1+\Lambda)]\left[(2x-1-\Lambda)^2 - x(1-\Lambda)\right]\left[\frac{\Lambda}{x-1-\Lambda} + \ln\left(\frac{x-1-\Lambda}{x-1}\right)\right] \\ & + (x-1)(x-1-\Lambda)(2x{+}1+\Lambda)(1-\Lambda)\left[\frac{\Lambda}{x-1-\Lambda} + \ln\left(\frac{x-1-\Lambda}{x-1}\right)\right] \\ & - 2\left[x(x-1) + (x-1-\Lambda)(1-\Lambda)\right]\frac{\Lambda^2(2x-1-\Lambda)}{x-1-\Lambda}. \end{aligned}$$

It follows that $H(x,\Lambda) >,=,< 0$ if and only if $\hat{H}(x,\Lambda) >,=,< 0$, with

$$\hat{H}(x,\Lambda) \equiv \ln\left(\frac{x-1-\Lambda}{x-1}\right) + \frac{\Lambda}{x-1-\Lambda} - 2\frac{\Omega_1(x,\Lambda)}{\Omega_2(x,\Lambda)}\frac{\Lambda^2(2x-1-\Lambda)}{x-1-\Lambda}, \tag{S.20}$$

$\Omega_1(x,\Lambda) \equiv x(x-1) + (x-1-\Lambda)(1-\Lambda) > 0$, and

$$\begin{aligned} \Omega_2(x,\Lambda) \equiv {} & [2x(x-1-\Lambda) + \Lambda(1+\Lambda)]\left[(2x-1-\Lambda)^2 - x(1-\Lambda)\right] \\ & + (x-1)(x-1-\Lambda)(2x{+}1+\Lambda)(1-\Lambda) > 0. \end{aligned}$$

To determine the sign of $\hat{H}(x,\Lambda)$, we differentiate it with respect to x. This gives

$$\hat{H}'_x(x,\Lambda) = \frac{\Lambda^2\Omega_2(x,\Lambda)^{-2}}{(x-1)(x-1-\Lambda)^2}\Bigg\{2\Omega_1(x,\Lambda)\Omega_2(x,\Lambda)(1+\Lambda)(x-1) - \Omega_2(x,\Lambda)^2 - 2\left[\frac{\partial\Omega_1'(\cdot)}{\partial x}\Omega_2(x,\Lambda) - \frac{\partial\Omega_2'(\cdot)}{\partial x}\Omega_1(x,\Lambda)\right](2x-1-\Lambda)(x-1-\Lambda)(x-1)\Bigg\}.$$

Expanding this derivative, we compute

$$\hat{H}'_x(x,\Lambda) = \frac{\Lambda^2\Omega_2(x,\Lambda)^{-2}}{(x-1)}\frac{2x-1-\Lambda}{x-1-\Lambda}h(x,\Lambda),$$

with

$$\begin{aligned} h(x,\Lambda) \equiv\; & 8x^5(3+\Lambda) - 4x^4(27+18\Lambda-5\Lambda^2) + x^3(183+207\Lambda-27\Lambda^2-43\Lambda^3) \\ & - x^2(1+\Lambda)(141+115\Lambda-77\Lambda^2-19\Lambda^3) + x(1+\Lambda)(45+94\Lambda-18\Lambda^2-42\Lambda^3+\Lambda^4) \\ & - 3 - 26\Lambda - 31\Lambda^2 + 8\Lambda^3 + 19\Lambda^4 + 2\Lambda^5 - \Lambda^6. \end{aligned}$$

To make progress in the determination of the sign of $h(x,\Lambda)$, we compute its higher derivatives as[24]

$$\begin{aligned} h'_x(x,\Lambda) =\; & 40x^4(3+\Lambda) - 16x^3(27+18\Lambda-5\Lambda^2) + 3x^2(183+207\Lambda-27\Lambda^2-43\Lambda^3) \\ & - 2x(1+\Lambda)(141+115\Lambda-77\Lambda^2-19\Lambda^3) + (1+\Lambda)(45+94\Lambda-18\Lambda^2-42\Lambda^3+\Lambda^4) \end{aligned}$$

$$\begin{aligned} h''_x(x,\Lambda) = 2\big[& 80x^3(3+\Lambda) - 24x^2(27+18\Lambda-5\Lambda^2) + 3x(183+207\Lambda-27\Lambda^2-43\Lambda^3) \\ & -(1+\Lambda)(141+115\Lambda-77\Lambda^2-19\Lambda^3)\big] \end{aligned}$$

$$h'''_x(x,\Lambda) = 6\left[80x^2(3+\Lambda) - 16x(27+18\Lambda-5\Lambda^2) + 183 + 207\Lambda - 27\Lambda^2 - 43\Lambda^3\right]$$

$$h^{iv}_x(x,\Lambda) = 96\left[10x(3+\Lambda) - 27 - 18\Lambda + 5\Lambda^2\right]$$

Noting $h^{iv}_x(x,\Lambda) > 0$ holds for all $x > 2.79$, it follows that $h'''_x(x,\Lambda) > h'''_x(2.79,\Lambda) > 5{,}075 + 157\Lambda + 1{,}177\Lambda^2 - 259\Lambda^3 > 0$. As a consequence, we have $h''_x(x,\Lambda) > h''_x(2.79,\Lambda) > 3{,}117 - 298\Lambda + 1{,}340\Lambda^2 - 528\Lambda^3 + 38\Lambda^4 > 0$, establishing $h'_x(x,\Lambda) > h'_x(2.79,\Lambda) > 1{,}420 - 287\Lambda + 970\Lambda^2 - 529\Lambda^3 + 65\Lambda^4 + \Lambda^5 > 0$. We can thus safely conclude that $h(x,\Lambda) > h(2.79,\Lambda) > 512 - 146\Lambda + 510\Lambda^2 - 346\Lambda^3 + 52\Lambda^4 + 4\Lambda^5 - \Lambda^6 > 0$ and thus $\hat{H}'_x(x,\Lambda) > 0$. Noting that $\lim_{x\to\infty}\hat{H}(x,\Lambda) = 0$, we finally conclude that $\hat{H}(x,\Lambda) < 0$ and thus $f'(\Lambda) < 0$. In view of Eq. (S.17), this establishes

$$\frac{\partial\tilde{v}_1(1,1)}{\partial\delta} > \lambda_1 L\left[f(1) - \frac{1}{\exp[\lambda_1]-1}\right]. \tag{S.21}$$

[24] Alternatively, one can make use of mathematical software packages to confirm that $h(x,\Lambda) < 0$ if $x > 2.79$ and $0 < \Lambda \leq 1$

Making use of Eq. (6), we further note that $\lim_{\Lambda \to 1} x = 2\exp[\lambda_1]/\{\exp(\lambda_1] - 1\}$. Substituting into Eq. (S.18), we compute $f(1) = 1/\{\exp[\lambda_1] - 1\}$. This implies that the right-hand side of Eq. (S.21) is equal to zero, which is sufficient for $\partial\tilde{v}_1(1,1)/\partial\delta > 0$ to hold for all $\Lambda < 1$ and completes the proof.

S.3 A two-sector model with perfect labor mobility

To elaborate on the importance of restricting inter-sectoral labor mobility for the theoretical results in Section 5, we keep the main assumptions from there but consider the polar case of perfect inter-sectoral labor mobility Then, diversification of a country's production structure requires that wages are equalized across sectors. There are only two possible outcomes that are consistent with global value chain trade, namely *(i.)* $w_Y = w_1 < w_2$ with diversified production only in country 1 and *(ii.)* $w_1 < w_2 = w_Y$ with diversified production only in country 2.[25] Noting further that case *(ii.)* is ruled out by our assumption that the two countries share the same technology in the production of good Y, we can focus in the remaining analysis on an outcome with $w_Y = w_1 < w_2$, and we analyze whether for this case diversified production is possible.

We first note that with diversified production in the South, we can characterize the profit-maximizing production structure in the open economy by the upper threshold for the production stages conducted in the South, $\lambda_1 S_1 = -\ln[(x-\mu)/x]$, and the global labor market clearing condition in sector Q:

$$\bar{F}(x, \Lambda, \delta, \mu) \equiv -\ln\left(\frac{x-\mu}{x}\right) - \frac{1}{\Lambda}\ln\left(\frac{\delta(x-\mu)-\Lambda}{\delta(x-\mu)}\right) - \lambda_1 = 0, \tag{S.22}$$

with $\mu \in [0,1]$ as the share of Southern labor used in the production of Q_1 and $1-\mu$ as the share of Southern labor used in the production of good Y. It is easily confirmed that $\bar{F}'_x(\cdot) < 0$, whereas $\bar{F}'_\mu(\cdot) > 0$. This establishes the intuitive result that

$$\frac{dx}{d\mu} = \frac{x}{\mu}\frac{\mu\delta(x-\mu) + \mu(1-\Lambda)}{\mu\delta(x-\mu) + x - \mu\Lambda} > 0. \tag{S.23}$$

Higher Southern labor input in the production of good Q increases the amount of initial production input $Q_0 = \lambda_1 L x$. Moreover, provided that $\mu > 0$, we can make use of equation system (S.14)-(S.16) to determine sector Q wages of the two countries as follows[26]

$$w_1 = \frac{\lambda_1}{\tau}\frac{\delta(x-\mu)[\delta(x-\mu)-\Lambda]}{\mu\delta(x-\mu) + x - \mu\Lambda}, \qquad w_2 = \lambda_1\frac{(x-\mu\Lambda)[\delta(x-\mu)-\Lambda]}{\mu\delta(x-\mu) + x - \mu\Lambda}. \tag{S.24}$$

The wage paid by the South in sector Y is given by $w_Y = w_1$ (see above). Following the derivation steps

[25] From the analysis in Section 3 we know that for $\lambda_1 > \lambda_2$ vertical specialization in the production of good Q_2 requires $w_1 < w_2$.

[26] The Southern export price of good Q_1 is given by $p_1 = (\mu/\tau)[\delta(x-\mu)-\Lambda]/[\mu\delta(x-\mu) + x - \mu\Lambda]$.

in Appendix A.4 we can express the global market-clearing conditions for goods Q_2 and Y as

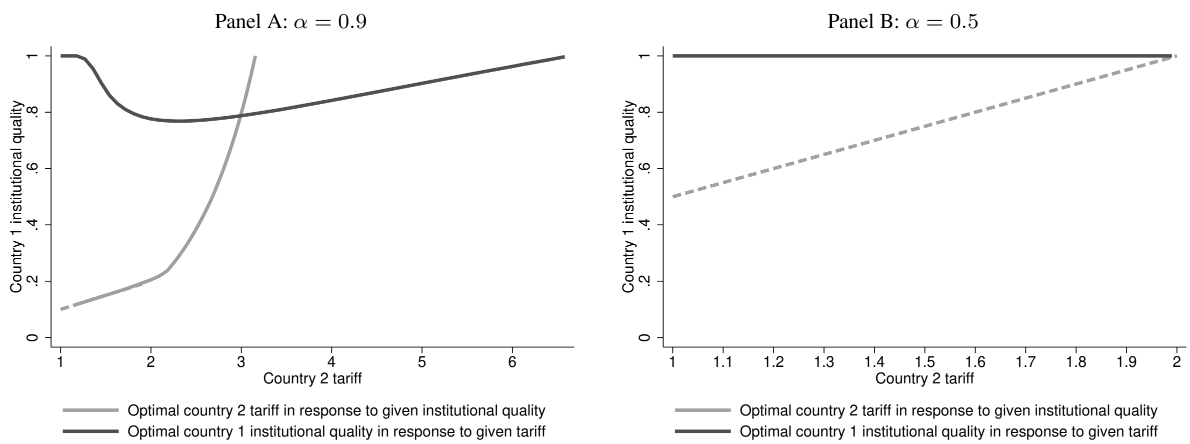
$$\alpha \left[w_2 + \mu(\tau - 1)w_1\right] + w_1 = \lambda_1[\delta(x - \mu) - \Lambda], \tag{S.25}$$

$$(1 - \alpha) \left[w_2 + \mu(\tau - 1)w_1\right] = (1 - \mu)w_1, \tag{S.26}$$

and rewrite Eq. (S.26) to solve for $w_2 + \mu(\tau - 1)w_1 = [(1 - \mu)/(1 - \alpha)]w_1$. Substituting into Eq. (S.25) and making use of w_1, we compute

$$\frac{1 - \mu}{1 - \alpha} - \mu(\tau - 1) = \frac{\tau}{\delta} \frac{x - \mu\Lambda}{x - \mu}. \tag{S.27}$$

From Eq. (S.23) we can infer that in an interior solution with $\mu \in (0, 1)$, we have $dx/d\mu \times \mu/x < 1$. This is sufficient for the right-hand side of Eq. (S.27) to increase in μ. Since the left-hand side decreases in μ, it follows that, under the sufficient condition of $\tau/\delta < 1/(1 - \alpha)$, μ has a unique interior solution on the unit interval. Two conclusions are immediate. First, a free trade equilibrium with $\tau = \delta = 1$ is characterized by diversified production in the South and full specialization of the North on the production of good Q_2. Second, labor mobility constrains the scope of policy intervention of the two countries in that setting $\tau \geq \delta/(1 - \alpha)$ leads to $\mu = 0$ and hence makes further increases in Northern tariffs or a further deterioration of institutional quality in the South ineffective.



Notes: A dashed line means a lower bound of Northern tariff $\tau \geq \delta(1 - \alpha)$, leading to $\mu = 0$.

Figure S.1: *Best-response policy choices of the two countries for* $\lambda_1 = 0.95$ *and* $\lambda_2 = 0.05$

The parameter condition $\tau/\delta < 1/(1 - \alpha)$ is suggestive for the conclusion that labor mobility constrains the countries' policy choices less severely if the expenditures share for good Q_2 is higher. Hence, we expect our results from Section 5 to extend to a model variant with inter-sectoral labor mobility if α is sufficiently large. To see whether this conjecture is valid, we display in Figure S.1 the best (welfare-maximizing) response of the South (δ) and the North (τ) for a given policy parameter of the other economy.[27] Thereby, we consider sizable technology differences and distinguish two scenarios, one with a

[27] Making use of $w_Y c_Y^2 = (1 - \alpha)[w_2 + \mu(\tau - 1)w_1]$ and $c_Q^2 = \alpha L[w_2 + \mu(\tau - 1)w_1]$, we can express welfare in the

large value of $\alpha = 0.9$ in Panel A and one with a comparably small value of $\alpha = 0.5$ in Panel B. In the former case, there exists an interior best-response equilibrium with $\tau > 1$, $\delta < 1$, and $\mu > 0$. In the latter case, the South has an incentive to minimize its employment in Sector Y by setting $\delta = 1$, whereas the North has an incentive to maximize Southern employment in Sector Y by setting $\tau \geq \delta(1-\alpha)$, thereby enforcing $\mu = 0$. The reason for this outcome is intuitive. For low levels of α the North benefits more strongly from an improvement in its terms of trading final goods (through lowering w_Y) which for a sufficiently low expenditure share for Q_2 dominates its losses of tariff revenues and its share of welfare gains from vertical specialization.

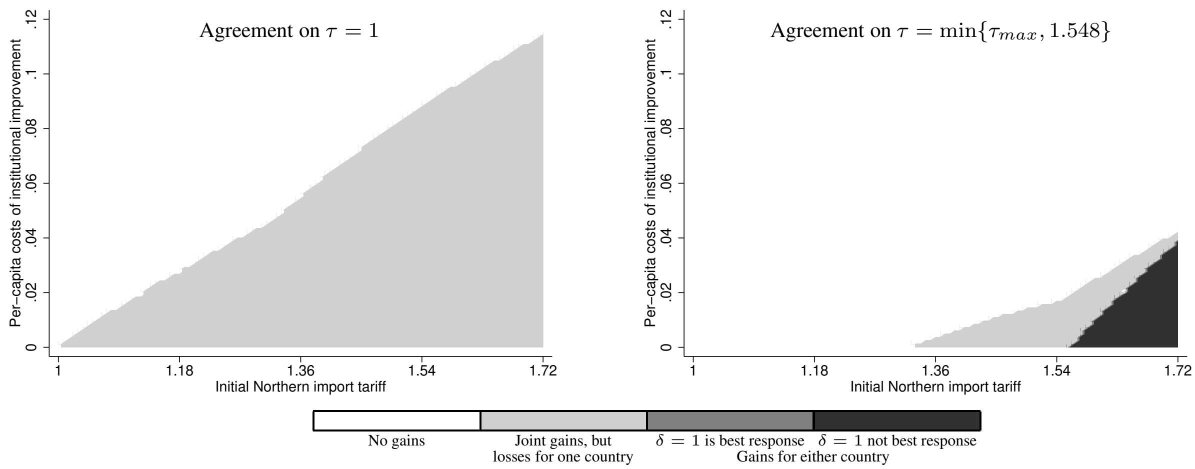


Figure S.2: *Welfare effects of trade agreement if labor is mobile between sectors (two sectors, $\lambda_1 = 0.95, \lambda_2 = 0.05$, $\alpha = 0.75$)*

In Figure.S.2, we study the scope for mutually beneficial trade agreements for the two sector model with full labor mobility between sectors. We thereby choose the same parameter values as in the left panel of Figure S.1, acknowledging that in this case there would exist a non-cooperative policy equilibrium with $\tau > 1$ and $\delta < 1$ if governments were unconstrained. We take this as a starting point and compute for initial tariffs $\tau_{max} \leq 1.72$ the welfare effects of a North-South trade agreement that implements $\tau = \delta = 1$.[28] We see from Figure 2 that for the considered parameter values a trade agreement may increase joint welfare of both countries, but induces a welfare loss for one of the two trading partners. In the right panel, we consider an alternative agreement that lowers tariffs to $\min\{\tau_{max}, 1.548\}$ and establishes $\delta = 1$. We find that such an agreement may indeed be mutually beneficial for the two countries.

S.4 New trade agreements between 1997 and 2015

North as $v_2 = (1-\mu)[\alpha w_Y/(1-\alpha)]^\alpha$, which reduces to $v_2 = [\alpha\lambda_2/\{\exp(\lambda_2)-1\}]^\alpha$ if $\tau \geq \delta/(1-\alpha)$ and thus $\mu = 0$. Similarly, we compute $v_1 = w_Y + \mu(1-\delta)\lambda_1/[\exp(\lambda_1)-1]$, which reduces to $v_1 = w_Y = (1-\alpha)\lambda_2/[\exp(\lambda_2)-1]$ if $\delta \leq \tau(1-\alpha)$ establishes $\mu = 0$. Making use of $w_Y = w_1$ from Eq. (S.24) gives the relevant welfare criteria for determining the best-response function in Figure S.1.

[28]The upper bound for the initial tariff is chosen to ensure that for any non-cooperative δ the North sets the maximum possible τ.

Table S.1: *List of new bilateral TAs and their types.*

Year	Country 1	Country 2	Type	Year	Country 1	Country 2	Type
1997	Bulgaria	Slovenia	shallow	2008	Barbados	Slovenia	deep
1997	Canada	Chile	shallow	2008	Barbados	Spain	deep
1997	Canada	Israel	shallow	2008	Barbados	Sweden	deep
1997	Czech Republic	Israel	shallow	2008	Barbados	United Kingdom	deep
1997	Czech Republic	Latvia	shallow	2008	Botswana	Norway	deep
1997	Czech Republic	Lithuania	shallow	2008	Botswana	Switzerland	deep
1997	Estonia	Slovenia	shallow	2008	Chile	Panama	deep
1997	Hungary	Romania	shallow	2009	Argentina	India	shallow
1997	Israel	Slovakia	shallow	2009	Brazil	India	shallow
1997	Lithuania	Poland	shallow	2009	Canada	Iceland	shallow
1997	Lithuania	Slovenia	shallow	2009	Canada	Norway	shallow
1997	Poland	Romania	shallow	2009	Canada	Switzerland	shallow
1997	Romania	Slovenia	shallow	2009	Honduras	Panama	deep
1998	Austria	Tunisia	deep	2009	India	Paraguay	shallow
1998	Croatia	Slovenia	shallow	2009	India	Uruguay	shallow
1998	Czech Republic	Estonia	shallow	2010	Austria	Serbia	deep
1998	Czech Republic	Turkey	shallow	2010	Belgium	Serbia	deep
1998	Estonia	Slovakia	shallow	2010	Cyprus	Serbia	deep
1998	Estonia	Turkey	shallow	2010	Czech Republic	Serbia	deep
1998	Finland	Tunisia	deep	2010	Denmark	Serbia	deep
1998	Greece	Tunisia	deep	2010	Estonia	Serbia	deep
1998	Hungary	Turkey	shallow	2010	Finland	Serbia	deep
1998	Lithuania	Turkey	shallow	2010	France	Serbia	deep
1998	Mexico	Nicaragua	shallow	2010	Hungary	Serbia	deep
1998	Slovakia	Turkey	shallow	2010	India	Indonesia	deep
1998	Spain	Tunisia	deep	2010	India	Malaysia	deep
1998	Sweden	Tunisia	deep	2010	India	Philippines	deep
1999	Bulgaria	Hungary	shallow	2010	Indonesia	South Korea	deep
1999	Bulgaria	Poland	shallow	2010	Ireland	Serbia	deep
1999	Bulgaria	Romania	shallow	2010	Italy	Serbia	deep
1999	Bulgaria	Turkey	shallow	2010	Latvia	Serbia	deep
1999	Iceland	Morocco	deep	2010	Lithuania	Serbia	deep
1999	Latvia	Poland	shallow	2010	Malaysia	South Korea	deep
1999	Morocco	Norway	deep	2010	Malta	Serbia	deep
1999	Morocco	Switzerland	deep	2010	Netherlands	Serbia	deep
2000	Belgium	Mexico	deep	2010	Poland	Serbia	deep
2000	Belgium	Morocco	deep	2010	Portugal	Serbia	deep
2000	Denmark	Mexico	deep	2010	Serbia	Slovakia	deep
2000	Denmark	Morocco	deep	2010	Serbia	Slovenia	deep
2000	Finland	Israel	deep	2010	Serbia	Spain	deep
2000	Finland	Mexico	deep	2010	Serbia	Sweden	deep
2000	Finland	Morocco	deep	2010	Serbia	United Kingdom	deep
2000	France	Mexico	deep	2010	South Korea	Thailand	deep
2000	France	Morocco	deep	2011	Austria	South Korea	deep
2000	Greece	Israel	deep	2011	Belgium	South Korea	deep
2000	Greece	Mexico	deep	2011	Bulgaria	South Korea	deep
2000	Greece	Morocco	deep	2011	Canada	Colombia	shallow
2000	Hungary	Latvia	shallow	2011	Colombia	Switzerland	deep
2000	Hungary	Lithuania	shallow	2011	Cyprus	South Korea	deep
2000	Ireland	Mexico	deep	2011	Czech Republic	South Korea	deep
2000	Ireland	Morocco	deep	2011	Denmark	South Korea	deep
2000	Israel	Portugal	deep	2011	Estonia	South Korea	deep

2000	Israel	Spain	deep	2011	Finland	South Korea	deep
2000	Israel	Sweden	deep	2011	France	South Korea	deep
2000	Italy	Mexico	deep	2011	Greece	South Korea	deep
2000	Italy	Morocco	deep	2011	Hungary	South Korea	deep
2000	Latvia	Turkey	shallow	2011	Iceland	Serbia	deep
2000	Luxembourg	Mexico	deep	2011	Ireland	South Korea	deep
2000	Luxembourg	Morocco	deep	2011	Italy	South Korea	deep
2000	Mauritius	Mozambique	deep	2011	Latvia	South Korea	deep
2000	Mexico	Netherlands	deep	2011	Lithuania	South Korea	deep
2000	Mexico	Portugal	deep	2011	Luxembourg	South Korea	deep
2000	Mexico	Spain	deep	2011	Malta	South Korea	deep
2000	Mexico	Sweden	deep	2011	Netherlands	South Korea	deep
2000	Mexico	United Kingdom	deep	2011	Norway	Serbia	deep
2000	Morocco	Netherlands	deep	2011	Poland	South Korea	deep
2000	Morocco	Portugal	deep	2011	Portugal	South Korea	deep
2000	Morocco	Spain	deep	2011	Romania	South Korea	deep
2000	Morocco	Sweden	deep	2011	Serbia	Switzerland	deep
2000	Morocco	United Kingdom	deep	2011	Slovakia	South Korea	deep
2000	Mozambique	Tanzania	deep	2011	Slovenia	South Korea	deep
2000	Mozambique	Zambia	deep	2011	South Korea	Spain	deep
2000	Poland	Turkey	shallow	2011	South Korea	Sweden	deep
2000	Slovenia	Turkey	shallow	2011	South Korea	United Kingdom	deep
2001	Estonia	Hungary	shallow	2012	Argentina	Israel	shallow
2001	Honduras	Mexico	shallow	2012	Austria	Mauritius	shallow
2001	Iceland	Mexico	deep	2012	Austria	Zimbabwe	shallow
2001	Mexico	Norway	deep	2012	Belgium	Mauritius	shallow
2001	Mexico	Switzerland	deep	2012	Belgium	Zimbabwe	shallow
2002	Bulgaria	Estonia	shallow	2012	Bulgaria	Mauritius	shallow
2002	Bulgaria	Israel	shallow	2012	Bulgaria	Zimbabwe	shallow
2002	Bulgaria	Lithuania	shallow	2012	Canada	Jordan	deep
2002	China	India	shallow	2012	Chile	Nicaragua	shallow
2002	China	Laos	shallow	2012	Cyprus	Mauritius	shallow
2002	China	South Korea	shallow	2012	Cyprus	Zimbabwe	shallow
2002	Croatia	Iceland	shallow	2012	Czech Republic	Mauritius	shallow
2002	Croatia	Norway	shallow	2012	Czech Republic	Zimbabwe	shallow
2002	Croatia	Switzerland	shallow	2012	Denmark	Mauritius	shallow
2003	Belgium	Chile	deep	2012	Denmark	Zimbabwe	shallow
2003	Bulgaria	Croatia	shallow	2012	Estonia	Mauritius	shallow
2003	Bulgaria	Latvia	shallow	2012	Estonia	Zimbabwe	shallow
2003	Chile	Denmark	deep	2012	Finland	Mauritius	shallow
2003	Chile	Finland	deep	2012	Finland	Zimbabwe	shallow
2003	Chile	France	deep	2012	France	Mauritius	shallow
2003	Chile	Greece	deep	2012	France	Zimbabwe	shallow
2003	Chile	Ireland	deep	2012	Greece	Mauritius	shallow
2003	Chile	Italy	deep	2012	Greece	Zimbabwe	shallow
2003	Chile	Luxembourg	deep	2012	Hong Kong	Iceland	deep
2003	Chile	Netherlands	deep	2012	Hong Kong	Switzerland	deep
2003	Chile	Portugal	deep	2012	Hungary	Mauritius	shallow
2003	Chile	Spain	deep	2012	Hungary	Zimbabwe	shallow
2003	Chile	Sweden	deep	2012	Iceland	Ukraine	deep
2003	Chile	United Kingdom	deep	2012	Ireland	Mauritius	shallow
2003	Croatia	Czech Republic	shallow	2012	Ireland	Zimbabwe	shallow
2003	Croatia	Hungary	shallow	2012	Italy	Mauritius	shallow
2003	Croatia	Poland	shallow	2012	Italy	Zimbabwe	shallow
2003	Croatia	Romania	shallow	2012	Latvia	Mauritius	shallow

2003	Croatia	Slovakia	shallow	2012	Latvia	Zimbabwe	shallow
2004	Chile	Cyprus	deep	2012	Lithuania	Mauritius	shallow
2004	Chile	Czech Republic	deep	2012	Lithuania	Zimbabwe	shallow
2004	Chile	Estonia	deep	2012	Malta	Mauritius	shallow
2004	Chile	Hungary	deep	2012	Malta	Zimbabwe	shallow
2004	Chile	Iceland	deep	2012	Mauritius	Netherlands	shallow
2004	Chile	Latvia	deep	2012	Mauritius	Poland	shallow
2004	Chile	Lithuania	deep	2012	Mauritius	Portugal	shallow
2004	Chile	Malta	deep	2012	Mauritius	Romania	shallow
2004	Chile	Norway	deep	2012	Mauritius	Slovakia	shallow
2004	Chile	Poland	deep	2012	Mauritius	Slovenia	shallow
2004	Chile	Slovakia	deep	2012	Mauritius	Spain	shallow
2004	Chile	Slovenia	deep	2012	Mauritius	Sweden	shallow
2004	Chile	Switzerland	deep	2012	Mauritius	United Kingdom	shallow
2004	Cyprus	Czech Republic	deep	2012	Netherlands	Zimbabwe	shallow
2004	Cyprus	Egypt	deep	2012	Norway	Ukraine	deep
2004	Cyprus	Estonia	deep	2012	Poland	Zimbabwe	shallow
2004	Cyprus	Finland	deep	2012	Portugal	Zimbabwe	shallow
2004	Cyprus	Greece	deep	2012	Romania	Zimbabwe	shallow
2004	Cyprus	Hungary	deep	2012	Slovakia	Zimbabwe	shallow
2004	Cyprus	Iceland	deep	2012	Slovenia	Zimbabwe	shallow
2004	Cyprus	Israel	deep	2012	Spain	Zimbabwe	shallow
2004	Cyprus	Jordan	deep	2012	Sweden	Zimbabwe	shallow
2004	Cyprus	Latvia	deep	2012	Switzerland	Ukraine	deep
2004	Cyprus	Lithuania	deep	2012	United Kingdom	Zimbabwe	shallow
2004	Cyprus	Malta	deep	2013	Austria	Costa Rica	deep
2004	Cyprus	Mexico	deep	2013	Austria	Honduras	deep
2004	Cyprus	Morocco	deep	2013	Austria	Nicaragua	deep
2004	Cyprus	Norway	deep	2013	Austria	Panama	shallow
2004	Cyprus	Poland	deep	2013	Belgium	Costa Rica	deep
2004	Cyprus	Portugal	deep	2013	Belgium	Honduras	deep
2004	Cyprus	Slovakia	deep	2013	Belgium	Nicaragua	deep
2004	Cyprus	Slovenia	deep	2013	Belgium	Panama	shallow
2004	Cyprus	Spain	deep	2013	Bulgaria	Costa Rica	deep
2004	Cyprus	Sweden	deep	2013	Bulgaria	Honduras	deep
2004	Cyprus	Switzerland	deep	2013	Bulgaria	Nicaragua	deep
2004	Cyprus	Tunisia	deep	2013	Bulgaria	Panama	shallow
2004	Czech Republic	Egypt	deep	2013	Canada	Panama	deep
2004	Czech Republic	Iceland	deep	2013	Chile	Croatia	deep
2004	Czech Republic	Jordan	deep	2013	Costa Rica	Croatia	deep
2004	Czech Republic	Malta	deep	2013	Costa Rica	Cyprus	deep
2004	Czech Republic	Mexico	deep	2013	Costa Rica	Czech Republic	deep
2004	Czech Republic	Morocco	deep	2013	Costa Rica	Denmark	deep
2004	Czech Republic	Norway	deep	2013	Costa Rica	Estonia	deep
2004	Czech Republic	Switzerland	deep	2013	Costa Rica	Finland	deep
2004	Czech Republic	Tunisia	deep	2013	Costa Rica	France	deep
2004	Denmark	Malta	deep	2013	Costa Rica	Greece	deep
2004	Egypt	Estonia	deep	2013	Costa Rica	Hungary	deep
2004	Egypt	Finland	deep	2013	Costa Rica	Ireland	deep
2004	Egypt	Greece	deep	2013	Costa Rica	Italy	deep
2004	Egypt	Hungary	deep	2013	Costa Rica	Latvia	deep
2004	Egypt	Latvia	deep	2013	Costa Rica	Lithuania	deep
2004	Egypt	Lithuania	deep	2013	Costa Rica	Luxembourg	deep
2004	Egypt	Malta	deep	2013	Costa Rica	Malta	deep
2004	Egypt	Poland	deep	2013	Costa Rica	Netherlands	deep

2004	Egypt	Portugal	deep	2013	Costa Rica	Poland	deep
2004	Egypt	Slovakia	deep	2013	Costa Rica	Portugal	deep
2004	Egypt	Slovenia	deep	2013	Costa Rica	Romania	deep
2004	Egypt	Spain	deep	2013	Costa Rica	Slovakia	deep
2004	Egypt	Sweden	deep	2013	Costa Rica	Slovenia	deep
2004	Estonia	Finland	deep	2013	Costa Rica	Spain	deep
2004	Estonia	Israel	deep	2013	Costa Rica	Sweden	deep
2004	Estonia	Jordan	deep	2013	Costa Rica	United Kingdom	deep
2004	Estonia	Malta	deep	2013	Croatia	Dominican Republic	deep
2004	Estonia	Mexico	deep	2013	Croatia	Egypt	deep
2004	Estonia	Morocco	deep	2013	Croatia	Honduras	deep
2004	Estonia	Norway	deep	2013	Croatia	Israel	deep
2004	Estonia	Poland	deep	2013	Croatia	Jamaica	deep
2004	Estonia	Sweden	deep	2013	Croatia	Jordan	deep
2004	Estonia	Switzerland	deep	2013	Croatia	Mauritius	shallow
2004	Estonia	Tunisia	deep	2013	Croatia	Mexico	deep
2004	Finland	Latvia	deep	2013	Croatia	Morocco	deep
2004	Finland	Lithuania	deep	2013	Croatia	Nicaragua	deep
2004	Finland	Malta	deep	2013	Croatia	Panama	shallow
2004	Finland	Slovakia	deep	2013	Croatia	South Africa	deep
2004	Finland	Slovenia	deep	2013	Croatia	South Korea	deep
2004	Greece	Malta	deep	2013	Croatia	Tunisia	deep
2004	Hungary	Jordan	deep	2013	Croatia	Zimbabwe	shallow
2004	Hungary	Malta	deep	2013	Cyprus	Honduras	deep
2004	Hungary	Mexico	deep	2013	Cyprus	Nicaragua	deep
2004	Hungary	Morocco	deep	2013	Cyprus	Panama	shallow
2004	Hungary	Tunisia	deep	2013	Czech Republic	Honduras	deep
2004	Iceland	Malta	deep	2013	Czech Republic	Nicaragua	deep
2004	Iceland	Slovakia	deep	2013	Czech Republic	Panama	shallow
2004	India	Thailand	shallow	2013	Denmark	Honduras	deep
2004	Ireland	Malta	deep	2013	Denmark	Nicaragua	deep
2004	Israel	Latvia	deep	2013	Denmark	Panama	shallow
2004	Israel	Lithuania	deep	2013	Estonia	Honduras	deep
2004	Israel	Malta	deep	2013	Estonia	Nicaragua	deep
2004	Jordan	Latvia	deep	2013	Estonia	Panama	shallow
2004	Jordan	Lithuania	deep	2013	Finland	Honduras	deep
2004	Jordan	Malta	deep	2013	Finland	Nicaragua	deep
2004	Jordan	Poland	deep	2013	Finland	Panama	shallow
2004	Jordan	Slovakia	deep	2013	France	Honduras	deep
2004	Jordan	Slovenia	deep	2013	France	Nicaragua	deep
2004	Latvia	Malta	deep	2013	France	Panama	shallow
2004	Latvia	Mexico	deep	2013	Greece	Honduras	deep
2004	Latvia	Morocco	deep	2013	Greece	Nicaragua	deep
2004	Latvia	Sweden	deep	2013	Greece	Panama	shallow
2004	Latvia	Tunisia	deep	2013	Honduras	Hungary	deep
2004	Lithuania	Malta	deep	2013	Honduras	Ireland	deep
2004	Lithuania	Mexico	deep	2013	Honduras	Italy	deep
2004	Lithuania	Morocco	deep	2013	Honduras	Latvia	deep
2004	Lithuania	Sweden	deep	2013	Honduras	Lithuania	deep
2004	Lithuania	Tunisia	deep	2013	Honduras	Luxembourg	deep
2004	Malta	Mexico	deep	2013	Honduras	Malta	deep
2004	Malta	Morocco	deep	2013	Honduras	Netherlands	deep
2004	Malta	Norway	deep	2013	Honduras	Poland	deep
2004	Malta	Poland	deep	2013	Honduras	Portugal	deep
2004	Malta	Portugal	deep	2013	Honduras	Romania	deep

2004	Malta	Slovakia	deep	2013	Honduras	Slovakia	deep
2004	Malta	Slovenia	deep	2013	Honduras	Slovenia	deep
2004	Malta	Spain	deep	2013	Honduras	Spain	deep
2004	Malta	Sweden	deep	2013	Honduras	Sweden	deep
2004	Malta	Switzerland	deep	2013	Honduras	United Kingdom	deep
2004	Malta	Tunisia	deep	2013	Hong Kong	Norway	deep
2004	Malta	United Kingdom	deep	2013	Hungary	Nicaragua	deep
2004	Mexico	Poland	deep	2013	Hungary	Panama	shallow
2004	Mexico	Slovakia	deep	2013	Ireland	Nicaragua	deep
2004	Mexico	Slovenia	deep	2013	Ireland	Panama	shallow
2004	Morocco	Poland	deep	2013	Italy	Nicaragua	deep
2004	Morocco	Slovakia	deep	2013	Italy	Panama	shallow
2004	Morocco	Slovenia	deep	2013	Latvia	Nicaragua	deep
2004	Norway	Slovakia	deep	2013	Latvia	Panama	shallow
2004	Poland	Tunisia	deep	2013	Lithuania	Nicaragua	deep
2004	Slovakia	Sweden	deep	2013	Lithuania	Panama	shallow
2004	Slovakia	Switzerland	deep	2013	Luxembourg	Nicaragua	deep
2004	Slovakia	Tunisia	deep	2013	Luxembourg	Panama	shallow
2004	Slovenia	Sweden	deep	2013	Malta	Nicaragua	deep
2004	Slovenia	Tunisia	deep	2013	Malta	Panama	shallow
2005	Belgium	Croatia	deep	2013	Mexico	Nicaragua	deep
2005	China	Indonesia	shallow	2013	Netherlands	Nicaragua	deep
2005	China	Malaysia	shallow	2013	Netherlands	Panama	shallow
2005	China	Philippines	shallow	2013	Nicaragua	Poland	deep
2005	China	Thailand	shallow	2013	Nicaragua	Portugal	deep
2005	Croatia	Cyprus	deep	2013	Nicaragua	Romania	deep
2005	Croatia	Denmark	deep	2013	Nicaragua	Slovakia	deep
2005	Croatia	Estonia	deep	2013	Nicaragua	Slovenia	deep
2005	Croatia	Finland	deep	2013	Nicaragua	Spain	deep
2005	Croatia	France	deep	2013	Nicaragua	Sweden	deep
2005	Croatia	Greece	deep	2013	Nicaragua	United Kingdom	deep
2005	Croatia	Ireland	deep	2013	Panama	Poland	shallow
2005	Croatia	Italy	deep	2013	Panama	Portugal	shallow
2005	Croatia	Latvia	deep	2013	Panama	Romania	shallow
2005	Croatia	Lithuania	deep	2013	Panama	Slovakia	shallow
2005	Croatia	Malta	deep	2013	Panama	Slovenia	shallow
2005	Croatia	Netherlands	deep	2013	Panama	Spain	shallow
2005	Croatia	Portugal	deep	2013	Panama	Sweden	shallow
2005	Croatia	Spain	deep	2013	Panama	United Kingdom	shallow
2005	Croatia	Sweden	deep	2014	Austria	Cameroon	deep
2005	Croatia	United Kingdom	deep	2014	Bahrain	Iceland	shallow
2005	Iceland	Tunisia	deep	2014	Bahrain	Norway	shallow
2005	Norway	Tunisia	deep	2014	Bahrain	Switzerland	shallow
2005	Switzerland	Tunisia	deep	2014	Belgium	Cameroon	deep
2006	Bahrain	United States of America	deep	2014	Bulgaria	Cameroon	deep
2006	Chile	China	deep	2014	Cameroon	Croatia	deep
2006	Morocco	United States of America	deep	2014	Cameroon	Cyprus	deep
2006	Norway	South Korea	deep	2014	Cameroon	Czech Republic	deep
2006	South Korea	Switzerland	deep	2014	Cameroon	Denmark	deep
2007	Bulgaria	Chile	deep	2014	Cameroon	Estonia	deep
2007	Bulgaria	Cyprus	deep	2014	Cameroon	Finland	deep
2007	Bulgaria	Egypt	deep	2014	Cameroon	France	deep
2007	Bulgaria	Estonia	deep	2014	Cameroon	Germany	deep
2007	Bulgaria	Jordan	deep	2014	Cameroon	Greece	deep
2007	Bulgaria	Latvia	deep	2014	Cameroon	Hungary	deep

2007	Bulgaria	Lithuania	deep	2014	Cameroon	Ireland	deep
2007	Bulgaria	Malta	deep	2014	Cameroon	Italy	deep
2007	Bulgaria	Mexico	deep	2014	Cameroon	Latvia	deep
2007	Bulgaria	Morocco	deep	2014	Cameroon	Lithuania	deep
2007	Bulgaria	Tunisia	deep	2014	Cameroon	Malta	deep
2007	Chile	India	shallow	2014	Cameroon	Poland	deep
2007	Cyprus	Romania	deep	2014	Cameroon	Portugal	deep
2007	Egypt	Iceland	deep	2014	Cameroon	Romania	deep
2007	Egypt	Norway	deep	2014	Cameroon	Slovakia	deep
2007	Egypt	Switzerland	deep	2014	Cameroon	Slovenia	deep
2007	Estonia	Romania	deep	2014	Cameroon	Spain	deep
2007	Iceland	South Korea	deep	2014	Cameroon	Sweden	deep
2007	Jordan	Romania	deep	2014	Cameroon	United Kingdom	deep
2007	Latvia	Romania	deep	2014	Canada	Honduras	deep
2007	Lithuania	Romania	deep	2014	Chile	Hong Kong	shallow
2007	Malta	Romania	deep	2014	China	Iceland	deep
2007	Morocco	Romania	deep	2014	China	Switzerland	deep
2008	Austria	Barbados	deep	2014	Costa Rica	Mexico	deep
2008	Barbados	Belgium	deep	2014	Guatemala	Mexico	deep
2008	Barbados	Bulgaria	deep	2014	Iceland	Qatar	shallow
2008	Barbados	Cyprus	deep	2014	Iceland	Saudi Arabia	shallow
2008	Barbados	Czech Republic	deep	2014	Norway	Qatar	shallow
2008	Barbados	Denmark	deep	2014	Norway	Saudi Arabia	shallow
2008	Barbados	Estonia	deep	2014	Qatar	Switzerland	shallow
2008	Barbados	Finland	deep	2014	Saudi Arabia	Switzerland	shallow
2008	Barbados	France	deep	2015	Canada	South Korea	deep
2008	Barbados	Greece	deep	2015	Chile	Thailand	shallow
2008	Barbados	Hungary	deep	2015	Colombia	Iceland	deep
2008	Barbados	Ireland	deep	2015	Colombia	Norway	deep
2008	Barbados	Italy	deep	2015	Costa Rica	Iceland	deep
2008	Barbados	Latvia	deep	2015	Costa Rica	Norway	deep
2008	Barbados	Lithuania	deep	2015	Costa Rica	Switzerland	deep
2008	Barbados	Malta	deep	2015	Iceland	Panama	deep
2008	Barbados	Netherlands	deep	2015	Mexico	Panama	shallow
2008	Barbados	Poland	deep	2015	New Zealand	South Korea	shallow
2008	Barbados	Portugal	deep	2015	Norway	Panama	deep
2008	Barbados	Romania	deep	2015	Panama	Switzerland	deep
2008	Barbados	Slovakia	deep				