Interdependence, Sectoral Linkages, and the Costs and Benefits of Negotiating Free-Trade Agreements

Shubhi Agarwal
University of Florida

Hamid Firooz
University of Rochester

Gunnar Heins
University of Florida

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Abstract

The last decades have seen a substantial increase in the number of free trade agreements (FTAs). The vast majority of these agreements, however, have been signed between richer economies with only limited participation by developing countries. This paper studies the reasons for and consequences of this trend and develops a model to quantify the costs and benefits of FTAs in the presence of intermediate goods, input-output linkages, sectoral heterogeneity, and interdependence across FTAs, when countries endogenously negotiate FTAs with each other. In light of challenges regarding the dimensionality of the problem, we adapt the approach developed by Jia (2008) to the present setting and quantify the importance of falling negotiating costs, welfare gains, cross-country heterogeneity, and cross-FTA complementarities in the recent rise in the number of new FTAs. Our estimates imply that heterogeneity in the potential gains and costs from FTAs is the main reason why FTAs are primarily negotiated between rich economies and that these FTAs may increase rather than decrease the probability of developing countries participating in FTAs in the future.

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1 Introduction

The last decades have seen a substantial increase in the number of regional free trade agreements (FTAs). While predominantly signed between neighbors and geographically close countries, such agreements recently also included cases in which countries from different continents agreed on free trade among themselves, for example in the context of the recently signed *Comprehensive and Progressive Agreement for Trans-Pacific Partnership* (CPTPP).

However, not all countries have been part of this trend to an equal extent. While most rich countries have managed to negotiate FTAs with a wide range of trade partners, the degree of trade relationships across developing countries is considerably less pronounced, especially for countries which only recently became globally important in terms of trade volume.[1] This is a concern for at least two reasons. First, as for example pointed out by Freund (2000), countries which signed FTAs earlier with each other may have a lasting first-mover advantage in terms of involvement in the international trade of goods. Given the often-documented positive relationship between trade and growth (see, e.g., Frankel and Romer (1999)), such historical advantages may therefore potentially translate into permanent income differences across countries. Second, since pre-existing FTAs tend to affect the benefit of future ones, the rising number of FTAs signed between richer countries may reduce incentives to sign FTAs with developing countries further.

There are several candidate explanations for the recent rise in trade agreements. First, the amount of trade has increased over the last decades, which may have direct implications for the benefit of FTAs. Second, trade in intermediate goods and sectoral linkages have become more important over time and have been shown to magnify the impact of tariffs (see, e.g., Caliendo and Parro (2015)). Third, the relationships and ease with which countries can negotiate may have changed over time. Lastly, there may be complementarities between FTAs: An FTA signed with one country may for example change the welfare benefits of other FTAs in the future, or experience in drafting and negotiating one FTA may facilitate this process for subsequent FTAs.

This paper develops a quantitative model in which countries endogenously sign free-trade agreements with each other that captures these channels and disentangles the importance of each one for the overall growth in FTAs and for why countries are so differently involved

[1] Only about 13% of signatories are low or lower-middle income countries.

in free trade agreements. Specifically, we quantify the costs and benefits of free-trade agreements in the presence of intermediate goods, input-output linkages, sectoral heterogeneity, and interdependence across FTAs. We focus on three different determinants of successful negotiations of free-trade agreements: (1) Varying welfare effects; (2) Differences in the ease with which a particular country pair can engage in negotiations; and (3) Varying incentives over time. Especially interdependence across FTAs makes this a challenging problem since past signed agreements can affect the benefits of future ones in various ways. On the one hand, if signed FTAs have a strongly negative impact on the marginal benefit of potential future ones, there can be multiple equilibria giving an advantage to countries who "move" first. On the other hand, if FTAs raise the benefit of future agreements, for example through input complementarities or learning-by-doing/increasing returns to scale in terms of negotiating or setting up agreements, one would expect a rising number of FTAs being signed over time, consistent with what has been the case in recent decades.

To understand how such interdependence between FTAs and the resulting heterogeneity shape trade negotiations and the distribution of signed FTAs across time and country pairs, we explicitly model the decision of each country to sign FTAs with each other over 3 decades. Specifically, in our model, countries can negotiate FTAs with other countries which result in potential welfare gains or losses for both partners. However, countries also face a negotiation cost, which is allowed to vary with country-pair characteristics such as geographical distance, a common border, or a common language, as well as with the country's history in terms of negotiating other FTAs.

In this setting, signing an FTA has several direct and indirect effects: On the one hand, it directly affects current welfare through a lower tariff between a country and its trade partner. On the other hand, however, it also affects the marginal benefit of signing other FTAs, since lowers tariffs towards other countries may change the attractiveness of further tariffs reductions and since past experience in signing FTAs may alter the negotiation cost. These latter channels significantly complicate the analysis and create interdependence across trade agreements. In particular, as is common for discrete choice models with interdependence, a main challenge when determining the optimal set of chosen FTAs is the dimensionality of the problem. In the present setting, for example, a country can sign a free-trade agreement with 43 other countries, resulting in about 9 quadrillion (2^{43}) country-pair combinations in each time period. Further, the choice set is equally large for every country which complicates

the analysis even further.

In principle, when solving the model, one could employ the method developed by Jia (2008) if FTAs are known to be compliments ex ante or on recent work by Arkolakis, Eckert and Shi (2021) if they are substitutes. In the present case however, whether or not FTAs are complements or substitutes is not clear ex ante and may also depend on the specific country pair. There are two reasons for this ambiguity: On the one hand, two countries signing an FTA with each other has an ex ante ambiguous effect on welfare of a third country which is to a large extent due to the fact that tariff reductions that countries commit to are generally not the same, especially when countries differ in the initial level of tariffs. In addition, one does also not know ex ante if signing an FTA lowers or increases the negotiation cost of other agreements.

For those reasons, we modify the approach developed by Jia (2008) by calibrating the model first for the parameter region in which FTAs are complements, that is, when experience in signing an FTA lowers the negotiation cost by more than the marginal welfare gain of other FTAs declines. We then update the parameters depending on the difference in predicted and actual moments until the model matches each of the targeted moments. We found that in practice, for several iterations in the estimation, not all FTAs are complements anymore. However, since such cases are the exception in practice, it is feasible to manually resolve decisions for such cases.

As is the case in Jia (2008), using a starting point at which other countries sign only FTAs that increase the marginal benefit of a country's FTAs allows us to determine the largest set of FTAs that a country may optimally want to sign. On the other hand, a starting point at which other countries sign FTAs that lower the marginal benefit delivers the smallest set. As is the case in many applications, these two sets effectively bound the possible set of FTAs that will be optimally signed and reduce the choice set to a manageable size. We estimate the parameters of the model via the simulated method of moments and target five key moments: (1) The fraction of FTAs that are signed overall, (2) The fraction of FTAs that are signed with neighboring countries, (3) The fraction of FTAs that are signed with countries that share a common language, (4) The fraction of FTAs that are signed with large countries that exceed the median GDP in the data, and (5) the fraction of countries that sign more than 10 FTAs.

Our parameter estimates suggest that a common border and a common language lower

negotiation costs between countries, while they sharply increase with distance and country size. Consequently, for most countries, a neighbor will typically be the partner country for which it is easiest to successfully negotiate an FTA, conditional on the predicted change in welfare. For example, Australia would find it easiest to negotiate with New Zealand due to a common language and close proximity and the same holds true for the U.S. and Canada. On the other hand, countries face the largest friction when negotiating with large countries and the vast majority of partner countries with the highest negotiation costs are large. Interestingly, the model predicts that China's negotiation costs are highest versus the U.S. and those for the U.S. highest when negotiating with China.

Further, our estimates imply that past experience in signing an FTA noticeably lowers the cost of negotiating other FTAs. Primarily due to this channel, we find that in practice, most agreements are compliments to each other and hence that the reduction in the negotiation cost is quantitatively more relevant than other sources of interdependence. This finding is consistent with the observation that a country is more likely to sign an additional FTA if it has already signed more FTAs with others in the past (see also Baier, Bergstrand and Mariutto (2014)) and is in line with anecdotal evidence regarding learning-by-doing and increasing returns to scale in negotiating, setting up, and monitoring compliance within FTAs.

The ability to solve the model allows us to evaluate the importance of counterfactual changes in negotiation costs and other parameters of the model. In particular, we evaluate four main questions counterfactually. First, we ask to what extent IO linkages, intermediate goods, and sectoral heterogeneity matters. These channels can be readily shut down in the model and since these channels result in more interdependencies between countries, they are particularly relevant in the present context. We find that the number of FTAs that countries sign would be about 12.9% lower in the absence of input-output linkages due to generally lower predicted welfare effects of FTAs (see Caliendo and Parro (2015)). The rising importance of intermediate-good trade hence appears to be a moderate contributor to the rise in FTAs since the 1990s.

Second, we evaluate the quantitative importance of interdependence across FTAs. In order to assess to what extent interdependence across agreements is important, we consider an alternative scenario in which prior FTAs lower the negotiation cost of other FTAs only a little and compare the number of predicted FTAs with those in the baseline case. We find

that about 25% fewer FTAs would be signed. Further, we find that signing an FTA with the U.S. makes a country more likely to sign other FTAs as well with an increase in the average number by 11.6%. Hence, our results suggest a rather moderate risk for countries to be "left out" when other countries sign FTAs. In fact, the model predicts that a general rise in FTAs will translate into a higher probability of signing FTAs with other countries as well, including developing economies.

Third, we find that "gravity" variables such as a common language and differences in country size are both important determinants of FTA negotiations. If country size did not matter, the ratio of FTAs signed by large countries relative to small ones would increase by 10.6%. Without language barriers, countries would sign on average 5.0% more FTAs compared to the baseline scenario. Hence, such frictions contribute both to the share of FTAs that are signed each year as well as to differences in terms of which partner countries are more likely to successfully negotiate such agreements.

Lastly, we find that the recent rise in FTAs can be primarily explained by a combination of falling negotiation costs and an increasing importance of non-tariff related benefits of FTAs. To come to this conclusion, we disentangle the negotiation cost from the welfare benefits of reductions in non-tariff barriers, by estimating the model separately for FTAs that were mainly focused on tariff reductions and those that were not. We find that both components contributed to recent trends, with reductions in non-tariff barriers being particularly important in the 2010s.

Related literature. This paper makes four main contributions to the existing literature. First, we propose an approach to estimate the effective cost of negotiating free-trade agreements over time and across trade partners which takes into account both factual and counterfactual welfare changes. We overcome the dimensionality of the problem by proposing an extension of the approach developed by Jia (2008), which allows us to perform counterfactuals and to study quantitatively to what extent changes in the negotiation cost over time and across trade partners can explain the recent rise in newly signed FTAs. We contribute to the large literature studying the motives and consequences of trade agreements (Freund, 2000; Baier and Bergstrand, 2004; Freund and Ornelas, 2010; Bown and Crowley, 2013; Baier, Bergstrand and Mariutto, 2014; Maggi, 2014; Limão, 2016; Rodrik, 2018; Crowley, Han and Prayer, 2021, 2024) by embedding each country's decision to sign FTAs into a structural quantitative Ricardian multi-sector, multi-country model that allows for interdependence

and sectoral linkages. This paper also complements the existing literature on the political economy of tariffs (e.g., Grossman and Helpman, 1994; Bagwell and Staiger, 1999; Goldberg and Maggi, 1999; Maggi and Rodriguez-Clare, 2007; Ossa, 2014). In contrast to these papers, we focus on discrete changes in tariffs through FTAs, as well as on explaining the recent rise in FTAs.

Second, we contribute to the growing literature on large-scale discrete choice problems (e.g., Jia (2008), Antràs, Fort and Tintelnot (2017), Arkolakis, Eckert and Shi (2021), Alfaro-Ureña et al. (2024), and Liu (2023)). Our main methodological contribution is to propose a method of solving discrete-choice games under large choice sets in which a player's actions can either increase or lower another player's payoffs and when this interdependence is not known a priori. This setting is motivated by our findings that two countries signing an FTA with each other has an ex ante ambiguous effect on welfare of a third-country and hence contrasts with Jia (2008) or Antràs, Fort and Tintelnot (2017) in which one player's payoffs is affected by others in the same direction or with Arkolakis, Eckert and Shi (2021), where the presence of compliments or substitutes is known ex ante. Further, in contrast to Jia (2008) and related work, we estimate a large-scale discrete choice problem in which marginal benefits are derived from a complex structural general equilibrium model. These outcomes are hence micro-founded, which has the benefit that one can study the impact of changes for example in transport cost or sectoral linkages on the decision to sign an FTA.

Third, this paper provides novel quantitative estimates of the effective cost that countries face when signing regional agreements as well as the degree of interdependence both on the cost and benefit side. To the best of our knowledge, this is the first paper that provides explicit estimates on negotiation costs across county pairs. Our estimates imply that FTAs are largely complements through past agreements lowering the negotiation cost in future ones. This implication complements findings by Egger and Larch (2008), Baldwin and Jaimovich (2012), and Baier, Bergstrand and Mariutto (2014) and suggests a rather moderate risk for developing countries to be "left out" when developed countries sign FTAs, and our estimates imply that heterogeneity in the potential gains from FTAs are the main reason for why FTAs are mainly negotiated between richer economies.

Fourth, to the best of our knowledge, this is the first paper that provides quantitative predictions regarding the welfare consequences for the universe of signed as well as a large set of about 60,000 potential free-trade agreements in the presence of intermediate goods,

input-output linkages, and sectoral heterogeneity. This approach allows us to document a range of novel facts in terms of how these welfare benefits change over time, how factual and counterfactual agreements compare, as well as how individual FTAs interact. We believe that these estimates, in addition to informing the model in the estimation and the counterfactual analysis, are of interest in their own right and can at the very least provide useful insights for future research.

The remainder of the paper is structured as follows. Section 2 describes the theoretical model. Section 3 describes the data and our approach to estimation. Section 4 presents the parameter estimates as well as the resulting negotiation costs across country pairs. Section 5 summarizes the results of several counterfactual exercises while Section 6 concludes.

2 The Quantitative Model

To quantify the welfare consequences of free trade agreements, we adopt a multi-country, multi-sector general equilibrium framework which is similar to the one developed by Caliendo and Parro (2015). In this setting, firms in each sector use labor and inputs made by other firms to produce final goods. Trade is costly and subject to both tariffs and an iceberg cost and both good and factor markets are perfectly competitive. In the empirical application in Section 3, we allow the fundamentals and the outcomes of the model to vary over time t, however, in this part, we do not explicitly state time subscripts for notational convenience.

2.1 Preferences

There are N countries and J sectors in the economy. Country n is populated by L_n households who consume C_n^j final goods from sector j and obtain a utility over sectors:

$$u(C_n) = \prod_{j=1}^{J} (C_n^j)^{\alpha_n^j}. \tag{1}$$

Under this assumption, consumers hence spend a constant fraction of their income on varieties of sector j.

2.2 Technology

A continuum of intermediate varieties $\omega^j \in [0,1]$ is produced in each sector j and sold in a perfectly competitive market. Country n produces ω^j with the following technology:

$$q_n^j(\omega^j) = z_n^j(\omega^j) \left[l_n^j(\omega^j)\right]^{\gamma_n^j} \prod_{k=1}^{J} \left[m_n^{k,j}(\omega^j)\right]^{\gamma_n^{k,j}} \tag{2}$$

where $\gamma_n^{k,j}$ denotes the share of materials from sector k used in the production of ω^j. Given this production function, we can write a firm's marginal cost as

$$c_n^j = \Upsilon_n^j \left(w_n\right)^{\gamma_n^j} \prod_{k=1}^{J} \left(P_n^k\right)^{\gamma_n^{k,j}}, \tag{3}$$

where the price index P_n^k will be defined below.

In each country n and sector j, there are producers of a composite intermediate good Q_n^j who buy varieties ω^j from the lowest-cost producer across the world, and produce according to the following production technology:

$$Q_n^j = \left[\int \left(r_n^j(\omega^j)\right)^{(\sigma^j-1)/\sigma^j} d\omega^j\right]^{\sigma^j/(\sigma^j-1)}, \tag{4}$$

where $r_n^j(\omega^j)$ is the quantity of variety ω^j bought by this producer, and σ^j denotes the elasticity of substitution across varieties. The price index P_n^j therefore equals

$$P_n^j = \left[\int p_n^j(\omega^j)^{1-\sigma^j} d\omega^j\right]^{1/(1-\sigma^j)}. \tag{5}$$

Trade costs for shipping goods from country i to n in sector j consist of both an iceberg component d_{ni}^j and tariffs τ_{ni}^j such that

$$\kappa_{ni}^j = \tilde{\tau}_{ni}^j \cdot d_{ni}^j \tag{6}$$

with $\tilde{\tau}_{ni}^j = 1 + \tau_{ni}^j$. We assume that the triangle inequality holds: $\kappa_{nm}^j \kappa_{mi}^j \geq \kappa_{ni}^j$. Under these

assumptions, the price that country n pays for variety ω^j equals

$$p_n^j(\omega^j) = \min_i \frac{c_i^j \kappa_{ni}^j}{z_i^j(\omega^j)}. \tag{7}$$

Under the assumption that the productivity distribution in country i in sector j follows a Frećhet distribution with location parameter λ_i^j and scale parameter θ^j, the price index can be shown to equal

$$P_n^j = A^j \left[\sum_{i=1}^{N} \lambda_i^j (c_i^j \kappa_{ni}^j)^{-\theta^j} \right]^{-1/\theta^j}, \tag{8}$$

where A^j is a constant. The fraction of country n's expenditure spent on intermediates from i can then be written as

$$\pi_{ni}^j = \frac{\lambda_i^j [c_i^j \kappa_{ni}^j]^{-\theta^j}}{\sum_{h=1}^{N} \lambda_h^j [c_h^j \kappa_{nh}^j]^{-\theta^j}}. \tag{9}$$

2.3 Equilibrium

Given Fréchet location and shape parameters, λ_i^j and θ^j, Cobb-Douglas shares α_i^j, value added shares γ_i^j and Input-Output intermediate shares $\gamma_i^{k,j}$, labor endowments L_n, iceberg trade costs d_{in}^j, and ad valorem tariffs τ_{in}^j, an equilibrium is characterized by a set of wages $\{w_n\}_{n=1}^N$ that satisfies the following equilibrium conditions:

1. Cost of the input bundle
$$c_n^j = \Upsilon_n^j \left(w_n\right)^{\gamma_n^j} \prod_{k=1}^{J} \left(P_n^k\right)^{\gamma_n^{k,j}} \tag{10}$$

2. Sectoral price index
$$P_n^j = A^j \left[\sum_{i=1}^{N} \lambda_i^j (c_i^j \kappa_{ni}^j)^{-\theta^j} \right]^{-1/\theta^j} \tag{11}$$

3. Trade shares
$$\pi_{ni}^j = \frac{\lambda_i^j [c_i^j \kappa_{ni}^j]^{-\theta^j}}{\sum_{h=1}^{N} \lambda_h^j [c_h^j \kappa_{nh}^j]^{-\theta^j}} \tag{12}$$

4. Total expenditure in country n:
$$I_n = w_n L_n + R_n + D_n \tag{13}$$

where $R_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\tau_{in}^k}{1+\tau_{in}^k} \pi_{in}^k X_n^j$ and D_n are country n' tariff revenue and trade

deficit, respectively;

5. Total expenditure on country n's sector j:

$$X_n^j = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N} X_i^k \frac{\pi_{in}^k}{1+\tau_{in}^k} + \alpha_n^j I_n \tag{14}$$

6. Trade deficit D_n equals total imports net of total exports:

$$\sum_{j=1}^{J}\sum_{i=1}^{N} X_n^j \frac{\pi_{in}^k}{1+\tau_{in}^k} - D_n = \sum_{j=1}^{J}\sum_{i=1}^{N} X_i^j \frac{\pi_{in}^k}{1+\tau_{in}^k}. \tag{15}$$

The last equation implies that labor markets clear. To facilitate solving the model we follow the exact hat algebra in Dekle, Eaton and Kortum (2008) and write the equilibrium equations of the model in changes, $\hat{x} = \frac{x'}{x}$, where x' denotes the counterfactual value of x and x the factual one. In this case, the equilibrium can be characterized by the following set of equations:

1. Cost of input bundles:

$$\hat{c}_n^j = \hat{w}_n^{\gamma_n^j} \prod_{k=1}^{J} (\hat{P}_n^k)^{\gamma_n^{k,j}} \tag{16}$$

2. Price index

$$\hat{P}_n^j = \left[\sum_{i=1}^{N} \pi_{ni}^j (\hat{c}_i^j \hat{\kappa}_{ni}^j)^{-\theta^j} \right]^{-1/\theta^j} \tag{17}$$

3. Trade shares

$$\hat{\pi}_{in} = \frac{(\hat{c}_i^j \hat{\kappa}_{ni}^j)}{\hat{P}_n^j} \tag{18}$$

4. Total expenditure in country n:

$$I_n' = \hat{w}_n w_n L_n + R_n' + D_n \tag{19}$$

where $R_n' = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\tau_{in}'^k}{1+\tau_{in}'^k} \pi_{in}'^k X_n'^j$ and we assume trade deficits remain unchanged;

5. Total expenditure on country n's sector j:

$$X_n'^j = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N} X_i'^k \frac{\pi_{in}'^k}{1+\tau_{in}'^k} + \alpha_n^j I_n' \tag{20}$$

6. Trade deficit D_n:

$$\sum_{j=1}^{J}\sum_{i=1}^{N} X_n'^j \frac{\pi_{in}'^k}{1+\tau_{in}'^k} - D_n = \sum_{j=1}^{J}\sum_{i=1}^{N} X_i'^j \frac{\pi_{in}'^k}{1+\tau_{in}'^k}. \tag{21}$$

This approach has the advantage that we can bring the model to the data with relatively moderate data requirements and only require explicit information on trade shares, value added, input-output linkages, as well as estimates of the trade elasticity θ^j.

We follow the approach by Dekle, Eaton and Kortum (2008), Ossa (2014), and Caliendo and Parro (2015), among others, and eliminate trade deficits, that is, we first set D_n to zero and then calibrate the model to the observed trade data. We assume that trade deficits remain equal to zero in all counterfactual exercises.

2.4 Negotiating Free-Trade Agreements

In each period $t = 1, ..., T$, countries can decide to negotiate potential free trade agreements between each other. In order to sign an agreement, countries face a negotiation cost s_{int} which might vary depending on the country pair (i, n) as well as over time. We assume that this cost has to be paid in each period for every country with which an FTA was agreed on. Hence, in each period, countries can decide anew whether or not they want to, for example, sign or renew an agreement or not, which implies that at time t, country n would want to sign an agreement with i if the expected welfare benefit exceeds the negotiation cost, which suggests the following decision rule:

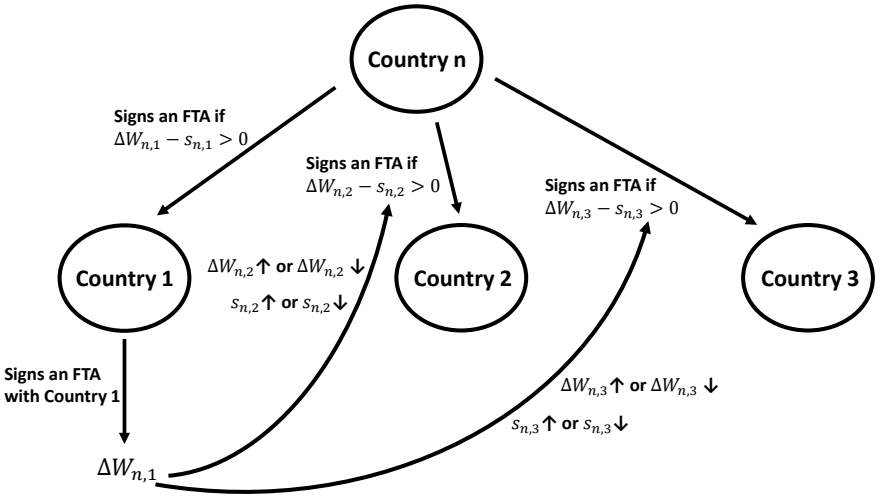
$$D_{int} = 1\{ \underbrace{\hat{W}_{nt}|(\Delta D_{int} = 1, \mathbf{D})}_{\text{Welfare Gain from FTA with country i}} - s_{int}(\mathbf{D}) > 0\}. \tag{22}$$

where D_{int} as a dummy variable that equals 1 if there is an FTA between countries n and i in place at time t and $\mathbf{D}$ denotes the set of all FTAs that are in place. We assume that an agreement is only signed if the net welfare gain from an FTA is positive for both countries.

For the empirical application of the model, we assume that the negotiation cost depends on a set of variables that plausibly shape the ease with which countries n and i can negotiate an agreement. In particular, we assume that

$$s_{int} = s(\text{Dist}_{in}, \text{Bord}_{in}, \text{Lang}_{in}, \text{GDP}_{it}, \text{GDP}_{nt}, \sum_{i' \neq i} FTA_{i'nt}) \tag{23}$$

Figure 1: Interdependence in Negotiating FTAs



Notes: The figure visualizes each country's decision making in the presence of interdependence in an example case with 3 other countries. ΔW_{ni} denotes the welfare change associated with signing an FTA with country i and s_{ni} the corresponding negotiation cost. For notational convenience, we drop time subscripts in this plot.

where Dist_{in} denotes the bilateral distance between countries n and i, Bord_{in} denotes whether or not both countries share a border, Lang_{in} denotes whether or not i and n speak the same language, and GDP_{it} denotes country i's gross domestic product at time t. Lastly, as discussed in detail below, we allow the negotiation cost to vary depending on the set of other FTAs that are in place. Specifically, the term $\sum_{i' \neq i} FTA_{i'nt}$ describes the number of other FTAs that country n has signed and hence captures one potential form of interdependencies across FTAs. In particular, if $s(\cdot)$ is increasing in this term, an agreement raises the cost of successfully negotiating other FTAs, while the opposite situation would correspond to the case of learning-by-doing in drafting and negotiating FTAs. Signing an FTA has hence several direct and indirect effects: On the one hand it directly affects current welfare through a lower tariff between country n and its trade partner. In addition, it also affects the marginal benefit of signing other FTAs as well as the benefits of future agreements.

Figure 1 summarizes each country's decision making in the presence of interdependence across FTAs intuitively in an example in which country n can sign an FTA with 3 other countries. Given Equation (22), a country will sign an FTA if the net benefit of doing so is positive, conditional on other present agreements. However, if n signs an agreement with

country 1, this decision will also affect both the predicted welfare gains or losses from an agreement with countries 2 and 3. In addition, it will affect the negotiation cost s_{int} due to the its dependence on other FTAs in place. These relationships between agreements significantly complicate the analysis and require one to determine all decisions simultaneously, which, in our empirical application with 44 countries, results in about 9 quadrillion (2^{43}) possible outcomes.[2]

An equilibrium is defined by a situation in which (1) conditions (16) to (21) hold, (2) the demand for FTAs is given by Equation (22), and (3) $D_{int} = 1$ if $D_{int} = 1$ and $D_{nit} = 1$. The complexity of the model and particularly the interdependence of FTAs generally prevent the ability of finding closed-form solutions for the outcomes of interest. For that reason, we develop a quantitative version of the model below and study its implications within the context of counterfactuals.

3 Data and Estimation

3.1 Data

Our analysis requires five main pieces of information: (1) trade flows, (2) tariffs, (3) domestic output, (4) value added, and (5) country-specific input-output tables. Since these data sources are generally not collected or reported on a sectoral level in many countries, data availability is the primary determinant of which countries we include in the analysis. We use a sample of 43 countries which range from richer to poorer countries as well as a constructed rest of the world.[3] Given that most of the data is available for about three decades, we use the years 1988 - 2020 for our analysis.

To construct trade shares, we use publicly available information on imports from UN Comtrade for the years 1988 - 2020. Specifically, we collect data on the 6-digit HS level and concord it to 2-digit ISIC Rev.3 industries via concordances provided by the World Bank (WITS). For some countries, trade data is not available for the earliest years in the dataset.

[2] An alternative approach would be to employ, potentially arbitrary, assumptions on the order in which a country decides on negotiating FTAs with other countries. Given that such an order will likely affect the set of FTAs that are signed, we pursue a less restrictive approach by building on the literature on solving large-scale discrete-choice problems.

[3] Specifically, the countries included in the analysis are: Argentina, Australia, Austria, Brazil, Canada, Chile, China, Denmark, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, (South) Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, South Africa, Spain, Sweden, Turkey, UK, U.S., ROW, Brunei Darussalam, Colombia, Costa Rica, Iceland, Israel, Malaysia, Peru, Philippines, Russian Federation, Singapore, Switzerland, Thailand, Viet Nam.

In those cases, we impute the missing information by computing the median growth rate in imports across all countries in each year and assume that imports grow at the same rate in those countries that are missing from the data.

We rely on tariff data provided by UN TRAINS for years 1988 - 2020. Following Caliendo and Parro (2015), we use the average applied tariff across all tariff lines within a sector in our analysis, which capture both MFN tariffs as well as those negotiated in regional free trade agreements. In years in which tariff data is not available for a country, we use data from the closest year for the analysis.

Data on gross output, value added, and IO tables are sourced from the 2015 and 2021 editions of the OECD Inter-Country Input-Output (ICIO) Tables, which provide data for 66 countries for the years 1995 to 2018. Since this data is not readily available for earlier years, we assume that sectoral input-output linkages before 1995 are the same as in year 1995. We use the same sectoral classification as in Caliendo and Parro (2015), that is, we include 20 tradable and 20 non-tradable sectors in the analysis.[4] For consistency and comparability, we also employ the same trade elasticities as estimated by Caliendo and Parro (2015).

Lastly, we collect information on the date, type and signatories of free-trade agreements from the WTO's *Regional Trade Agreements Database*.

3.2 Estimation

In line with the model presented in Section 2, we assume that there are $i = 1, ..., N$ countries who in each period $t = 1, ..., T$ decide to negotiate potential free trade agreements between each other. In order to sign an agreement, countries face a negotiation cost s_{int} which might vary depending on the country pair (i, n) as well as over time. Specifically, in the empirical application, we assume that the negotiation cost can be written as

$$\begin{aligned} s_{int} = \gamma_t^{(0)} + \gamma^{(d)} \cdot \text{Dist}_{in} + \gamma^{(b)} \cdot \text{Bord}_{in} + \gamma^{(l)} \cdot \text{Lang}_{in} + \gamma^{(g1)} \cdot \text{GDP}_{it} + \gamma^{(g2)} \cdot \text{GDP}_{nt} \\ + \gamma^{(f)} \sum_{i' \neq i} FTA_{i'nt} + \epsilon_{int} \end{aligned} \tag{24}$$

where Dist_{in} denotes the bilateral distance between countries, Bord_{in} denotes whether or not both countries share a border, Lang_{in} denotes whether or not i and n speak the same language, and GDP_{it} denotes country i's gross domestic product at time t. We assume that

[4] See Appendix Table A2 for a detailed list.

this cost has to be paid in each period for every country with which an FTA was agreed on.

The term $\sum_{i' \neq i} FTA_{i'nt}$ describes the number of other FTAs that country n has signed and hence captures one potential form of interdependencies across FTAs. Specifically, if $\gamma^{(f)} > 0$, an agreement raises the cost of successfully negotiating other FTAs, while $\gamma^{(f)} < 0$ would correspond to the case of learning-by-doing in drafting and negotiating FTAs.

In this setting, signing an FTA has several direct and indirect effects: On the one hand it directly affects current welfare through a lower tariff between country n and its trade partner. In addition, it also affects the marginal benefit of signing other FTAs as well as the benefits of future agreements. This latter property significantly complicates the analysis and creates interdependencies across trade partners, which also implies the potential presence of multiple equilibria as for example in Jia (2008) or Ciliberto and Tamer (2009). In order to estimate the parameters of Equation (24), we hence follow an approach based on Jia (2008) which allows us to infer the parameters $\gamma_t^{(0)}, \gamma^{(d)}, \gamma^{(b)}, \gamma^{(l)}, \gamma^{(g1)}$, $\gamma^{(g2)}$, and $\gamma^{(f)}$.

As discussed in Section 2, country n will be willing to sign an FTA with country i, if the predicted welfare gain exceeds the negotiation cost. In practice, one additional aspect to consider is that especially in recent years, many trade agreements not only lower or eliminate tariffs but may also include other provisions. To make these two distinct sources of welfare gains associated with FTAs explicit, one can write the condition under which country n will be willing to sign an FTA with country i as

$$\underbrace{\hat{W}_{nt}|(\Delta D_{int}=1,\mathbf{D})}_{\text{Welfare Gain from tariff removals with country i}} + \underbrace{\hat{W}_{nt}^{\text{Non-Tariff}}|(\Delta D_{int}=1,\mathbf{D})}_{\text{Other Welfare Gains from FTA with country i}} > s_{int}(\mathbf{D})$$

$$\Leftrightarrow \underbrace{\hat{W}_{nt}|(\Delta D_{int}=1,\mathbf{D})}_{\text{Welfare Gain from tariff removals with country i}} > \tilde{s}_{int}(\mathbf{D}). \tag{25}$$

Hence, country n will want to sign an FTA if the predicted welfare gain from tariff reductions exceeds the negotiation cost net of non-tariff related gains, $\tilde{s}_{int}(\mathbf{D}) := s_{int}(\mathbf{D}) - \hat{W}_{nt}^{\text{Non-Tariff}}$. In the estimation procedure, we infer both components of $\tilde{s}_{int}(\mathbf{D})$ jointly but then propose a way of identifying each individually using information on the nature of specific agreements. In what follows, we will refer to $\tilde{s}_{int}(\mathbf{D})$ as (net) negotiation cost.

It is well known that solving structural discrete choice models can be challenging due to the dimensionality of the problem. In the current setting for example, a country can sign a free-trade agreement with 43 other countries, resulting in about 9 quadrillion (2^{43}) country-

pair combinations in each time-period. Further, the choice set is equally large for every country which significantly complicates the analysis. For that reason, we adapt the approach used in Jia (2008) to the present setting in order to solve the model and counterfactually evaluate the impact of changes in policy parameters or productivity.

Specifically, we assume that country n would sign an FTA with country i at time t if the welfare gain $\hat{W}_{nt}$ exceeds the negotiation cost $\tilde{s}_{int}$, conditional on the set of other signed FTAs. Defining D_{int} as a dummy variable that equals 1 if there is an FTA between countries n and i in place at time t, we can write the decision of a country as a fixed-point problem, with

$$D_{int} = 1\{ \underbrace{\hat{W}_{nt}|(\Delta D_{int} = 1, \mathbf{D})}_{\text{Welfare Gain from FTA with country i}} - \tilde{s}_{int}(\mathbf{D}) > 0\}. \tag{26}$$

As shown in Tarski (1955), The set of fixed points is nonempty and there exists a greatest and least fixed point if the right-hand side is increasing in $\mathbf{D}$, i.e. if

$$d\tilde{s}_{int}(\mathbf{D})/d\mathbf{D} < d\hat{W}_{nt}|(\Delta D_{int} = 1, \mathbf{D})/d\mathbf{D}. \tag{27}$$

Put differently, this condition requires that FTAs are complements, that is, signing an FTA raises the marginal benefit of other FTAs. Alternatively, if all FTAs are substitutes, and if this relationship is known ex ante, such a problem can also be solved via recent methods developed in Arkolakis, Eckert and Shi (2021).

In the present case however, whether or not FTAs are complements or substitutes is not clear ex ante and may also depend on the specific country pair. There are two reasons for this ambiguity: On the one hand, as discussed in detail below, two countries signing an FTA with each other has an ex ante ambiguous effect on welfare of a third country which is to a large extent due to the fact that tariff reductions that countries commit to are generally not the same, especially when countries differ in the initial level of tariffs. Countries which commit to larger tariff reductions therefore, on average, tend to experience smaller welfare gains than others, which translates into variation in the gains from future FTAs as well. On the other hand however, signing an FTA may lower (or increase) the negotiation cost of other agreements through parameter $\gamma^{(f)}$, which represents an additonal source of interdependence as described in Figure 1.

In practice, we therefore modify the approach by Jia (2008) by calibrating the model

first for the parameter region in which FTAs are complements, that is, when experience in signing an FTA lowers the negotiation cost by more than the marginal welfare gain of other FTAs declines. We then update the parameters depending on the difference in predicted and actual moments until the model matches each of the targeted moments. We found that in practice, for several iterations in the estimation, not all FTAs are complements anymore. However, since such cases are the exception in practice, it is feasible to manually resolve decisions for such cases.[5]

As is the case in Jia (2008), using a starting point at which other countries sign only FTAs which increase the marginal benefit of a country's FTAs allows us to determine the largest set of FTAs that a country may optimally want to sign. On the other hand, a starting point at which other countries sign FTAs which lower the marginal benefit delivers the smallest set. As is the case in many applications, these two sets effectively bound the possible set of FTAs that will be optimally signed and reduce the choice set to a manageable size. We find that in practice, in order to match the data, past experience in signing an FTA must noticeably lower the cost of negotiating other FTAs, especially compared to the impact of one FTA on the marginal welfare benefit of other FTAs.

We obtain estimates of $\hat{W}_{nt}|(\Delta D_{int} = 1, \mathbf{D})$ in a similar way as Caliendo and Parro (2015) do, that is, we combine estimates of sectoral trade elasticities with information on trade shares, value added, input-output relationships, and so on. This information in combination with Equations (16) to (21) then allows us to obtain predictions for the welfare changes associated with FTAs between any country pair n and i. The main unknowns of the estimation are therefore the parameters of the negotiation cost Equation (24). We estimate these parameters with the simulated method of moments. Specifically, we target six moments: (1) The fraction of FTAs that are signed overall, (2) The fraction of FTAs that are signed with neighboring countries, (3) The fraction of FTAs that are signed with countries that share a common language, (4) The fraction of FTAs that are signed with large countries that exceed the median GDP in the data, (5) the fraction of countries that sign more than 10 FTAs, and (6) The fraction of FTAs that are signed overall in the 1990s. Table A4

[5]Specifically, in the case in which an FTA with one of the countries lowers the marginal benefit of other agreements, we solve the model separately for the case in which country n signs an agreement with this country versus the case in which it does, that is, we apply the main algorithm but treat this particular choice as given. We then compare welfare for the two cases and choose the outcome which delivers a higher welfare level. This approach is conceptually similar to Arkolakis, Eckert and Shi (2021) who resolve cases in which the remaining choice set is large in a similar fashion.

summarizes in more detail which values we target. We solve the model at each point in time and in a given year, each country can sign an FTA with other countries.

Intuitively, the parameters of the model are identified as follows: The intercept in Equation (24) is largely pinned down by the frequency at which FTAs are signed in each period. The other parameters are identified from the frequency with which FTAs are signed with geographically or culturally close countries, as well as with larger and smaller economies. If for example, conditional on welfare gains, FTAs are disproportionately more often signed with neighbors, the procedure would infer $\gamma^{(b)}$ to be negative.

In summary, we hence estimate the parameters of the model in the following steps

1. Start with a guess of γ.
2. For country 1, compute how each agreement affects the marginal benefit of other agreements and evaluate Condition (27). If an agreement is not complementary to all other agreements, set D_{i1t} to 1.
3. For starting point $D = \{1, 1, ..., 1\}$, solve the fixed point problem defined by Equation (26). This will result in an upper bound D^U for the set of potential FTAs.
4. For starting point $D = \{0, 0, ..., 0\}$, solve the fixed point problem defined by Equation (26). This will result in a lower bound D^L for the set of potential FTAs.
5. Using these bounds, find country 1's optimal choice D^*.
6. Repeat steps 3 - 5, but for other possible outcomes of D_{i1t} for non-complementary agreements. Specifically, if there are NC such agreements, this step will require 2^{NC} repetitions of steps 3-5. Choose the combination of D_{i1t} for those agreements which maximizes $d\hat{W}_{nt}$ and update D^* accordingly.
7. Repeat steps 2-6 for countries 2 - 44.
8. Check if $D_{int} = D_{nit} = 1$. Set all other elements of D to 0.
9. Check if the predicted moments match the empirical ones. If not, adjust γ until a match is achieved.

In practice, this algorithm works best when $\gamma^{(f)}$ is updated in comparably small steps. If $\gamma^{(f)}$ is larger, there will be many FTAs that are not complements and Step 6 can become very time-intensive. We hence employ a simple algorithm, that, for a given $\gamma^{(f)}$ finds the other parameters that match all targeted moments except of (5). We do so by for example increasing the constant in Equation (24) whenever the fraction of signed FTAs exceeds that in the data and we reduce it otherwise. Once this procedure converges, we update $\gamma^{(f)}$ downward, if the fraction of countries that sign more than 10 FTAs is too low and we increase it otherwise. We stop once all the targeted moments summarized in Table A4 are matched.

In principle, one can use this approach for each year and country in the data, which would require solving this problem $44 \cdot 26 = 1,144$ times. In practice, since solving the model for only a small number of countries can already take several days, due to the requirement to repeatedly predict counterfactual welfare changes within the model, we restrict the sample to 7 time periods of 1993, 1995, 2000, 2005, 2010, 2015, and 2018.

3.3 Counterfactuals

The main benefit of being able to solve the model is that it allows us to counterfactually evaluate the impact of changes in the parameters and we use the model to answer three main questions: First, how important are both the level and any heterogeneity in negotiation costs compared to the welfare benefit of FTAs? We determine the importance of changes in negotiation costs by for example lowering the average $\tilde{s}_{int}$ to the average estimate for the year 2020. This allows us to understand to what degree the trend documented in Figure A1 is due to changes in negotiation costs. By shutting down the impact of for example distance or a common language in Equation (24), we are also able to identify to which extent various factors that facilitate negotiations determine the likelihood of being able to successfully negotiate an FTA.

Second, we evaluate the quantitative importance of complementarities across FTAs. To do so, we ask how signing an FTA today would affect the equilibrium number of other FTAs that a country signs. In practice, we answer this question by setting the negotiation cost for one country, for example, the U.S. to a low value such that countries always sign an FTA with this country. We then compare the number of FTAs that are signed in the baseline case with that in this alternative scenario.

Third, we ask to what extent IO linkages, intermediate goods, and sectoral heterogeneity matters. These features can be readily shut down in the model and since these channels result in more interdependencies between countries, they are plausibly particularly relevant in the present context.

One practical consideration is which year to use for the counterfactuals. We choose the earliest year in the sample in our baseline specification, 1993, to start from a situation in which only few FTAs had already been in place. We then use the model to predict which FTAs will be signed compared to 1993, both factually and counterfactually, using the algorithm described above for the estimated parameter vector γ. Since we do not always have reliable tariff data for countries before 1993, we take FTAs that have been signed before 1993 as given.[6]

3.4 Discussion

The presence of a negotiation cost warrants a more detailed discussion. Essentially, this cost creates a friction in the ability of two countries to sign an agreement, even if the net welfare benefit is positive to both countries. There are at least two reasons for why this would be the case. First, negotiating, signing, and maintaining an FTA is known to require a substantial amount of time and effort, for example the drafting of legal provisions, the establishment of institutions that evaluate and enforce rules, the harmonization of product, quality, and environmental standards, or agreeing on regulation regarding rules of origin.[7] Especially (1) the creation of institutions that monitor and enforce rules, (2) learning-by-doing in the legal process, (3) and tighter standards induced by an FTA, are likely factors that facilitate successful FTA negotiations with other countries as well.[8]

Second, there may be benefits from a membership in a free trade zone that exceed those based purely on economic considerations and that vary by size. For example, a free-trade

[6] One notable group of countries for which this decision matters is the EU. In principle, we could use pre-EU tariffs to quantify the welfare benefit of EU membership. However, since we are mainly interested in the determinants of the rise of FTAs since the 1990s, this approach would not affect our conclusions about why this trend took place.

[7] See for example Gourdon, Gourdon and de Melo (2023) for a detailed description of the complexity of several of these details.

[8] As evident from many legal documents that specify the provisions of FTA, there is a substantial amount of similarity among the FTAs signed by the same country. For example, comparing the text of the Canada-Jordan and the Canada-Panama agreements reveals many passages that are identical word-for-word (e.g. regarding Rules of Origin). See https://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/panama/fta-ale/index.aspx?lang=eng and https://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/panama/fta-ale/index.aspx?lang=eng.

agreements may also improve the relationship between countries more generally and may for example deter other forms of conflicts with third parties. Such motives may hence make reaching agreements with a larger number of countries more attractive compared to being involved in solely a small number.

Lastly, it is important to point out that the cost $\tilde{s}_{int}$ will likely also capture political motives to some degree and may reflect that policy makers in some countries are more hesitant to sign agreements than others or that two countries have historically poor relationships with each other. Hence, one may be tempted to augment Equation (24) by including measures of the relationship between two countries, such as the presence of violent conflict in the past. We do however choose not to do so given the potential endogeneity of such variables and the fact that the relationship between two countries may be affected by the presence of a free trade zone.

4 Results

4.1 Reduced-Form Evidence

To provide an initial sense of the determinants of the decision to enter into an FTA, we first use a simplified specification in which we regress a dummy which equals one if a country pair signed an FTA in a particular year and zero otherwise on the predicted welfare gain as well as other covariates. Specifically, we estimate

$$\begin{aligned} 1\{\text{FTA signed}\}_{int} = \beta_t^{(0)} + \beta_i^{(0)} + \beta_n^{(0)} + \beta^{(w)} \cdot \Delta W_{inft} + \beta^{(d)} \cdot \text{Dist}_{in} + \beta^{(b)} \cdot \text{Bord}_{in} \\ + \beta^{(l)} \cdot \text{Lang}_{in} + \beta^{(g1)} \cdot \text{GDP}_{it} + \beta^{(g2)} \cdot \text{GDP}_{nt} + \epsilon_{int} \end{aligned} \tag{28}$$

where i and n denote the respective countries that are potentially involved, and t the time period. The inclusion of country dummies $\beta_i^{(0)}$ and $\beta_n^{(0)}$ as well as that of time dummies $\beta_t^{(0)}$ controls for any variation due to the specific countries and year and this regression hence identifies why country n signed a specific agreement with country i and not for example with country i'.

To provide an initial sense of how the determinants of signing FTAs change over time, we also estimate the coefficients of the above specification separately for the early as well as the late 2000s. Table 2 summarizes the results and summarizes in a first stage to what extent the ability for a country pair to successfully negotiate an FTA depends on the expected welfare

Table 1: Parameter Estimates: Negotiation Cost and Welfare

	(1) All years	(2) 2001-2010	(3) 2011-2020
Δ%Welfare	4.006***	1.122	3.189***
	(0.365)	(1.057)	(0.586)
Distance	-0.181***	-0.303***	0.128***
	(0.011)	(0.020)	(0.017)
Common Border	0.0708	0.0452	-0.506**
	(0.085)	(0.129)	(0.185)
Common Language	-0.0596	0.184**	0.218**
	(0.042)	(0.069)	(0.069)
GDP - Partner (in logs)	-0.0733***	-0.108***	-0.131***
	(0.007)	(0.012)	(0.013)

Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

gain and other country and country-pair characteristics. Column (1) in this table estimates the coefficients in Equation (28) for all years in the sample and shows that countries are generally more likely to sign an FTA if the expected welfare gain is higher. We find that these gains are particularly relevant in the 2010s compared to other periods, although the relationship is positive throughout all periods.

We also find that, over the full sample, the probability of signing an FTA tends to be increasing in the geographical distance between two countries, which suggests that closer countries find it easier to engage in successful trade negotiations. The results do however also indicate that this pattern might be changing over time, as evident from a positive coefficient in the 2010s. As countries typically have many FTAs in place with neighboring countries, FTAs between more distant economies are more common in recent years of the sample, as for example evident from new agreements such as CPTPP (Comprehensive and Progressive Agreement for Trans-Pacific Partnership), which is the main reason for this particular estimate.

Conditional on distance, we find that, on average across all time periods, a common border or language affects the probability of two countries signing an FTA only little. One exception however is that countries which share a common language have become more likely to sign an FTA today than in the past, as evident from columns (2) and (3).

Table 2: Structural Negotiation Cost Estimates

	(1)
Avg. Negotiation Cost	0.2403
Common Language	-0.0527
Distance (in logs)	0.0565
GDP (in logs)	0.0279
$\sum_{i' \neq i} FTA_{i'nt}$	-0.0057
Additional Cost (1990s)	0.0340

Notes: All estimates reported in this table are multiplied by 1,000.

We find that conditional on welfare gains and other gravity variables, the economic size of the partner country makes it less likely to successfully negotiate an FTA. This finding holds even when controlling for predicted changes in welfare, which suggests that it may generally be harder to reach agreements with larger economies than it is with smaller ones. Interestingly, this result tends to become stronger over time and the probability of signing FTAs with large countries is especially low in the 2010s.

4.2 Parameter Estimates

Table 2 summarizes the average negotiation cost as well as the parameter estimates we obtain for Equation (24), which are largely intuitive and in line with reduced-form results. We find that a common language lowers the negotiation cost, which suggests that communication frictions tend to make successful negotiations less likely. Further, as expected, we find that geographical distance has a positive impact on $\tilde{s}_{int}$ and hence lowers the probability of two countries signing an FTA with each other. As a consequence, the model predicts that, conditional on comparable predicted welfare gains, two closer countries or neighbors are more likely to successfully sign an FTA with each other than more distant economies. This result is consistent with the observation that the majority of free trade agreements are regional agreements.

Interestingly, we find that the negotiation cost is higher for large countries, such as the U.S. or China, than for smaller ones, as evident from a negative coefficient on log country GDP. This finding suggests that, even conditional on comparable predicted welfare gains, negotiations with larger countries are more challenging than those with smaller ones or that larger countries have fewer incentives to engage in FTAs.

Table 3: Highest and lowest negotiation cost

Country 1	Country 2	$\tilde{s}_{int}$
Malaysia	Brunei Darussalam	.0071822
Singapore	Malaysia	.0111777
Malaysia	Singapore	.0125358
Sweden	Finland	.0147775
Austria	Hungary	.0166852
Colombia	Costa Rica	.0340745
Finland	Sweden	.0357326
Hungary	Austria	.0465737
France	Switzerland	.0479158
Philippines	Brunei Darussalam	.0506508
⋮	⋮	⋮
Korea, Republic of	USA	.3751994
Japan	USA	.3767368
Colombia	China	.3778941
Viet Nam	USA	.3876046
Thailand	USA	.3893984
Peru	China	.3899287
Indonesia	USA	.3905938
Chile	China	.3941878
Brunei Darussalam	USA	.3944976
Malaysia	USA	.3954859

Notes: All estimates reported in this table are multiplied by 1,000.

Table 3 and Table 4 summarize to what extent these parameter estimates translate into differences in negotiation costs across country pairs in two more illustrative ways. First, Table 3 shows the 10 country pairs with the lowest as well as the 10 country pairs with the highest negotiation cost in our sample. We find that particularly neighbors have comparably low costs of negotiation, for example Malaysia and Signapore, Sweden and Finland, or Austria and Hungary. On the other end, the negotiation cost is generally highest for distant country pairs that involve large countries, such as the U.S. or China. Consequentially, we estimate the highest values of $\tilde{s}_{int}$ for Malaysia and the U.S., Brunei Darussalam and the U.S., and between Chile and China.

Table 4 shows the highest and lowest negotiation cost that a country may face as well as the corresponding partner country. Also these figures are directly related to the parameter estimates presented in Table 2 and show that for most countries, a neighbor will typically

be the partner country for which it is easiest to successfully negotiate an FTA, conditional on the predicted change in welfare. For example, Australia would find it easiest to negotiate with New Zealand due to a common language and close proximity and the same holds true for the U.S. and Canada. Our results imply that also many Scandinavian countries would find it easiest to negotiate with other Scandinavian partners.

On the other hand, countries face the largest $\tilde{s}_{int}$ when negotiating with large countries and the vast majority of partner countries with the highest negotiation cost are large. Interestingly, the model predicts that China's negotiation cost are highest versus the U.S. and those for the U.S. highest when negotiating with China. These results appear consistent with the observation that these countries are in fact involved in a tariff war and arguably far from moving towards a free trade agreement.

Interdependence. Lastly, our estimates point to two reasons for why countries would sign more FTAs over time. First, we find that signing an agreement with one country reduces the negotiation cost of signing agreements with other countries, as evident from the negative coefficient on $\sum_{i' \neq i} FTA_{i'nt}$. Hence, all else equal, this channel introduces a degree of complimentarity between FTAs, with one signed FTA increasing the probability of a country signing an FTA with others.

Overall however, whether or not FTAs are complements will also depend on how the predicted welfare impact of an agreement between country n and another country i, that is, $\hat{W}_{nt}|(\Delta D_{int} = 1, \mathbf{D})$, depends on other agreements signed by country n. Since this object is a complex equilibrium outcome, its sign and magnitude is not clear ex ante and we do in fact find that other agreements may frequently raise or lower the marginal benefit of other agreements. However, as described in more detail in Section 5, we find that most agreements are compliments to each other and hence that the reduction in the negotiation cost is quantitatively more relevant than other sources of interdependence.

Why would this be the case in practice? While the reduced-form nature of the negotiation cost does not allow for a conclusive explanation, we believe there are at least three reasons for our findings. First, drafting and setting up FTAs may be subject to learning by doing or increasing returns to scale. As evident from many legal documents that specify the provisions of FTA, there is a substantial amount of similarity among the FTAs signed by the same country. For example, comparing the text of the Canada-Jordan and the Canada-Panama agreements reveals many passages that are very similar or even word-for-word identical (e.g.

Table 4: Partner Countries with Highest and lowest negotiation cost

Country	Partner with lowest $\tilde{s}_{int}$	Partner with highest $\tilde{s}_{int}$
Australia	New Zealand	China
Austria	Hungary	USA
Brunei Darussalam	Malaysia	USA
Canada	Iceland	China
Chile	Argentina	China
China	Brunei Darussalam	USA
Colombia	Costa Rica	China
Costa Rica	Colombia	China
Denmark	Norway	USA
Finland	Sweden	USA
France	Switzerland	China
Germany	Netherlands	China
Greece	Hungary	USA
Hungary	Austria	USA
Iceland	Ireland	China
India	Brunei Darussalam	Brazil
Indonesia	Brunei Darussalam	USA
Ireland	Iceland	China
Israel	Greece	Japan
Italy	Switzerland	USA
Japan	Brunei Darussalam	USA
Korea, Republic of	Brunei Darussalam	USA
Malaysia	Brunei Darussalam	USA
Mexico	Costa Rica	China
Netherlands	Iceland	China
New Zealand	Brunei Darussalam	China
Norway	Iceland	USA
Peru	Costa Rica	China
Philippines	Brunei Darussalam	Brazil
Portugal	Iceland	China
Russian Federation	Finland	USA
Singapore	Malaysia	USA
South Africa	Israel	Japan
Spain	Portugal	China
Sweden	Finland	USA
Switzerland	Austria	China
Thailand	Brunei Darussalam	USA
Turkey	Greece	USA
USA	Canada	China
Viet Nam	Brunei Darussalam	USA

regarding Rules of Origin).[9] A detailed textual analysis of trade agreements by Alschner, Seiermann and Skougarevskiy (2017) finds for example a textual similarity of 79% between the United States-Morocco and the United States-Australia FTA and document that especially recent preferential trade agreements have become more and more standardized. Such

[9]See https://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/panama/fta-ale/index.aspx?lang=eng and https://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/panama/fta-ale/index.aspx?lang=eng.

observations suggests that policy makers do make extensive use of previous legislation when designing new one, which plausibly facilitates drafting new agreements.

Perhaps more importantly, setting up and monitoring compliance with trade agreements may also involve a component that is common to multiple agreements. For example, to ensure that trade partners comply with product or environmental standards, countries frequently set up institutions that evaluate these standards, which requires training of workers, experience, and financial resources. Setting up such institutions for one FTA may therefore allow a country to make use for other FTAs as well, without having to start anew. Especially if developing this infrastructure involves a certain degree of sunk costs, one would expect to observe a negative relationship between $\tilde{s}_{int}$ and the number of other FTAs signed.

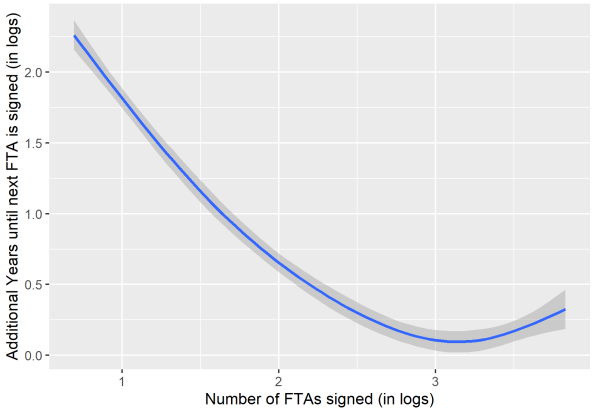
Second, as evident from Figure 2, we observe in the data, that a country is more likely to sign an additional FTA if it has already signed more FTAs with others in the past (see also Egger and Larch (2008), Baldwin and Jaimovich (2012), and Baier, Bergstrand and Mariutto (2014), who make similar observations). Specifically, we find a negative correlation between the number of additional years a country takes until it signs an additional FTA and the number of FTAs it has signed in the past. This relationship is robust to the inclusion of country and year fixed effects.

Table A3 highlights this relationship in more detail for the example of Canada. As evident from this table, Canada initially started to become gradually more active in negotiating free-trade agreements after Nafta in 1994. It announced two agreements in 1997 followed by three more in the 2000s. After that however, Canada became substantially more active and negotiated agreements in close succession, for example with two agreements, respectively, in 2013, 2015, 2017, and 2020.

Interestingly, we also find that the relationship shown in Figure 2 is particularly strong at the beginning, that is, when countries have not signed many FTAs in the past. For those countries, doubling the number of FTAs signed in the past lowers the expected number of years until another one is signed by about 1.5 years. For countries which are already involved in a sizable number of FTAs on the other hand, doubling the number of FTAs has a much smaller effect.[10] This pattern is consistent with learning-by-doing or increasing returns to scale in negotiations, in which the benefit from the first FTAs that are drafted and negotiated

[10]Note that the relationship at some point becomes even positive, which makes sense intuitively, given that there is a limited number of countries that an FTA can be signed with.

Figure 2: Frequency of FTA signings based on history



Notes: Figure plots the number of additional years a country takes until it signs an FTA (in logs) against the number of FTAs it has signed in the past (in logs). The shaded area represents 95% confidence bands based on a simple non-parametric model (GAM).

are larger than those of later ones.

Lastly, we find that the impact that an FTA has on the marginal welfare benefit of other FTAs is small and its sign ambiguous in many cases. To highlight this finding, Figures A4 and A5 graphically summarize the impact of two major trade agreements on the potential benefits of other agreements. Specifically, we choose the recent CPTPP as well as ASEAN-China and plot how each one affects the benefits of other potential agreements. We find that the results are highly country-specific. First, as expected, the impact of an FTA is strongest for those actually involved in the FTA, that is, for the respective signatories. For other countries, the impact is typically close to 0.

Among signatories, the impact of a signed FTA on the benefits of future FTAs with other countries can, however, be positive or negative. As evident from Figure A4, CPTPP lowered the benefit of further agreements for Vietnam and Malaysia, but noticeably increased them for Australia, New Zealand, and Singapore. The picture is similar for ASEAN-China as summarized in Figure A5: Thailand, the Philippines, and Brunei see sizable declines in the benefit of future agreements, but the opposite is true for China, Indonesia, Malaysia, and Singapore. Intuitively, this heterogeneity is due to two factors. First, imports are both substitutes and complements and lower tariffs hence result in increased import competition as well as improved availability of inputs. Which channel is of greater importance therefore determines both the welfare gain from a current FTA as well as that from future ones. Second, the tariff reductions that countries commit to are generally not the same, especially

Table 5: Counterfactuals - The Importance of Sectoral Linkages

No Sectoral Linkages	
	Counterfactual Change
Number of signed FTAs	-12.93%

when countries differ in the initial level of tariffs. Countries which commit to larger tariff reductions therefore, on average, tend to experience smaller welfare gains than others, which translates into variation in the gains from future FTAs as well.

As described above, the presence of a certain degree of complimentarity is not the only reason why countries would sign more FTAs over time. As shown in Table 2, we also estimate a higher negotiation cost in the 1990s than in later years. We discuss the quantitative importance of each channel in detail in Section 5 along with potential explanations for this observation as well.

5 Counterfactuals

We use the quantitative model along with the estimated parameters of the negotiation cost function given by Equation (24). We do so for two main reasons: On the one hand, the parameter estimates presented in Table 2 are challenging to interpret and do not immediately allow conclusions about the quantitative importance of each component. On the other hand, counterfactual analysis allows us to understand how policy changes may alter the fraction and distribition of FTAs that are optimally signed by countries.

Specifically, we discuss four main counterfactuals: (1) To what extent can sectoral linkages explain the recent rise in the number of FTAs, (2) to what extent does interdependence across FTAs matter, (3) how important are similarities and differences across countries for FTA negotiations, and (4) to what extent do the findings in Figure A1 depend on falling negotiation costs or other benefits of FTAs over time?

5.1 The Importance of Sectoral Linkages

We first use the model to determine the importance of sectoral linkages. As found by Caliendo and Parro (2015), such relationships across sectors tend to magnify the welfare effects of FTAs and may hence make free-trade agreements overall more attractive, which may plausibly contribute to the trend shown in Figure A1. To understand to what extent this is of importance, we solve the model with and without input-output linkages and compare

Table 6: Counterfactuals - The Importance of Interdependence

Reducing complementarities by 50%:	
Number of signed FTAs	-25.40%
Signing FTA with the U.S.:	
Number of signed FTAs with other countries	+11.61%

the fraction of FTAs that countries optimally sign.

Table 5 summarizes the results. We find that the number of FTAs that countries sign would be about 12.9% lower in the absence of input-output linkages. The larger predicted welfare effects are therefore sizable enough to affect the decision of countries to agree on a trade liberalization. For that reason, overall, the rising importance of intermediate-good trade hence appears to be a moderate contributor to the rise in FTAs since the 1990s.

5.2 The Importance of Interdependence

In order to assess to what extent interdependence across agreements is important, we consider an alternative scenario in which $\gamma^{(f)}$ is reduced to half the estimated value and compare the number of predicted FTAs with those in the baseline case. As shown in Table 6, we find that about 25% fewer FTAs would be signed. Hence interdependencies can explain a sizable portion of the increase in FTAs as well, especially in combination with falling negotiation costs.

To highlight the importance of interdependencies further, we perform a second experiment in which we impose that each country signs an agreement with the U.S., which can be done in practice by setting the negotiation cost versus the U.S. to a negative value. We then predict how many FTAs each country would sign with others, not including the United States. We find that signing an FTA with the U.S. makes each country more likely to sign other FTAs as well with an increase in the average number by 11.6%. Hence, such an agreement lowers the potential welfare gains from other agreements not significantly enough to overcome the marginal reduction in the negotiation cost through parameter $\gamma^{(f)} = 0$.

More generally, these results also suggest a rather moderate risk for countries to be "left out" when other countries sign FTAs. In fact, the model predicts that a general rise in FTAs will translate into a higher probability of signing FTAs for all outside countries as well. Hence, the observed trend that the number of FTAs between developed economies have increased disproportionately should not come at the cost of poorer countries in the long

Table 7: Counterfactuals - Barriers to Negotiating

Same cost for large and small countries: $\gamma^{(g)} = 0$	
Avg. change in signed FTAs over all years	+10.56%
(Large versus small countries)	
No common language differences:	
Avg. change in signed FTAs over all years	+5.01%

run. Instead, our estimates imply that heterogeneity in the potential gains and negotiation costs from FTAs are the main reason for why FTAs are mainly negotiated between richer economies.

5.3 The Importance of Barriers to Negotiating

As summarized in Section 4, we find that the negotiation cost varies with several so-called gravity variables, such as country size and distance. In order to understand the quantitative importance of these variables however, we rely on counterfactuals to understand how setting some of the coefficients to zero would affect the distribution of signed FTAs in equilibrium.

The results are presented in Table 7. We find that a common language and differences in country size are both important determinants of FTA negotiations. If country size would not matter, the ratio of FTAs signed by large countries relative to small ones would increase by 10.6%. Without language barriers, countries would sign on average 5.0% more FTAs compared to the baseline scenario. Hence, such frictions contribute both to the share of FTAs that are signed each year as well as to differences in terms of which partners countries are more likely to successfully negotiate such agreements.

5.4 Changes in Negotiation Cost over time

To understand to what extent changes in the level of the (net) negotiation cost $\tilde{s}_{int}$ shape trends in the number of signed FTAs, we counterfactually set the average negotiation cost in 2020 equal to a higher value that is consistent with the average cost in the 1990s and resolve the model. The difference between the factual and counterfactual number of signed FTAs can then be interpreted as being due to a change in negotiation cost.

Table 8 summarizes the results. We find that the number of signed FTAs in 2020 would have been about 49.8% lower if negotiation costs had not fallen during that time period. These findings would suggest a sizable role of declining negotiation costs in the recent rise of newly signed FTAs.

Table 8: Counterfactuals - Changes in Negotiation Cost over time

Changes in Negotiation Cost (revert back to 1990s levels):	
	Counterfactual Change
Number of signed FTAs	-49.76%

What is the main reason for the decline in $\tilde{s}_{int}$? As discussed in Section 3, $\tilde{s}_{int}$ captures the cost of negotiating an FTA net of non-tariff related gains from an agreements. Given the recent rise in so-called *Deep Agreements* it is therefore plausible that the non-tariff gains from FTAs has increased disproportionately over the last decades.

To assess this hypothesis and to decompose changes in $\tilde{s}_{int}$ into its two components, we utilitize the fact that FTAs differ in terms the extent to which they include reductions in non-tariff barriers. We do so in two ways. First, we rely on past literature that measures how deep agreements are based on textual analysis as well as AI techniques and reestimate the level of $\tilde{s}_{int}$ for agreements with the greatest focus on tariffs and least focus on reductions in non-tariff barriers. To do so, we reestimate the model for the subset of agreements with the shortest length, as provided by Alschner, Seiermann and Skougarevskiy (2017). We define free trade agreements below the 25% percentile in terms of length as agreements that are focused primarily on tariff reductions. Alternatively, given that deep agreements have become much more prevalent in recent years, we estimate $\tilde{s}_{int}$ based on the earliest FTAs in our dataset, which arguably focused mainly on tariff reductions.

We find that, for both approaches, the net negotiation cost is noticeably higher for agreements that focused on tariff reductions. Specifically, if we set $\tilde{s}_{int}$ in the 2010s equal to the level obtained for these agreements, we obtain a decline in FTAs being signed that is very similar to the decline reported in Table 8. Hence, it appears that the trend pointed out in Figure A1 is primarily consistent with greater benefits associated with the reduction in non-tariff barriers.

6 Conclusion

This paper develops a model to quantify the costs and benefits of free-trade agreements in the presence of intermediate goods, input-output linkages, and sectoral heterogeneity. We evaluate the welfare consequences of nearly 60,000 factual and counterfactual free trade agreements and use these predictions to quantify the costs of negotiating an FTA across country pairs. In light of challenges regarding the dimensionality of the problem, we adapt the

approach developed by Jia (2008) to the present setting and quantify the relative importance of falling negotiating costs, welfare gains, cross-country heterogeneity, and complementarities in the recent rise in the number of new FTAs. We estimate a large degree of variation across country pairs in the ease with which two countries can successfully negotiate trade agreements and document that the negotiation cost is particularly high for distant and large countries.

We perform a range of counterfactuals and find that the increasing importance of sectoral linkages across sectors and countries, interdependence across FTAs, as well as declines in negotiating costs and the rising importance of reductions in non-tariff barriers can explain most of the recent increase in the number of signed FTAs. More generally, our results also suggest a rather moderate risk for countries to be "left out" when other countries sign FTAs. In fact, the model predicts that a general rise in FTAs will translate into a higher probability of signing FTAs for all outside countries as well. Hence, the observed trend that the number of FTAs between developed economies have increased disproportionately should not come at the cost of poorer countries in the long run. Instead, our estimates imply that heterogeneity in the potential gains and negotiation costs from FTAs are the main reason for why FTAs are mainly negotiated between richer economies.

As described above, the underlying model we use to predict welfare changes for factual and counterfactual FTAs builds heavily on Caliendo and Parro (2015). Note however that the methods we utilize in this paper could be readily applied to other frameworks as well, for example based on Melitz (2003)-type models, which would for example shed light on how the presence of market power and markups shapes FTA negotiations. There are also several other aspects that this paper abstracts from but that could be relevant in future research. First, we focus primarily on the impact of tariffs. It would however be interesting to extend the analysis to a setting with both tariff and non-tariff barriers. Second, the model has little to say about how firms respond to anticipated and implemented FTAs in terms of investment. Lastly, the model does not explicitly model political motives in tariffs, as e.g. present in Grossman and Helpman (1994) or Ossa (2014). Extending the model along those lines will likely be helpful to understand and predict the evolution of FTAs more accurately.

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A Additional Figures and Tables

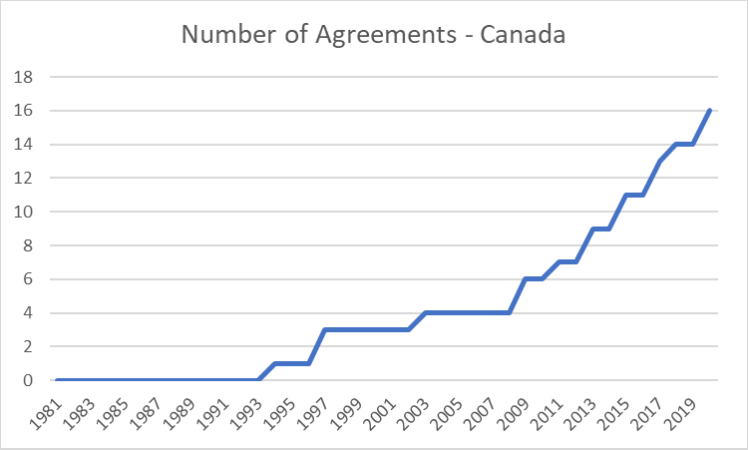
Table A1: Final List of Countries

	Country		Country		Country
1	Argentina	16	Ireland	31	ROW
2	Australia	17	Italy	32	Brunei Darussalam
3	Austria	18	Japan	33	Colombia
4	Brazil	19	(South) Korea	34	Costa Rica
5	Canada	20	Mexico	35	Iceland
6	Chile	21	Netherlands	36	Israel
7	China	22	New Zealand	37	Malaysia
8	Denmark	23	Norway	38	Peru
9	Finland	24	Portugal	39	Philippines
10	France	25	South Africa	40	Russian Federation
11	Germany	26	Spain	41	Singapore
12	Greece	27	Sweden	42	Switzerland
13	Hungary	28	Turkey	43	Thailand
14	India	29	UK	44	Viet Nam
15	Indonesia	30	U.S.		

Table A2: List of Sectors

CP 2015 ISIC Rev.3	Industry	Description	OECD Ed 2015 ISIC Rev.3	OECD Ed 2018 ISIC Rev 4
1-5	Agriculture	Agriculture, hunting, forestry and fishing	1-5	1-3
10-14	Mining	Mining and quarrying	10-14	5-9
15-16	Food	Food products, beverages and tobacco	15-16	10-12
17-19	Textile	Textiles, textile products, leather and footwear	17-19	13-15
20	Wood	Wood and products of wood and cork	20	16
21-22	Paper	Pulp, paper, paper products, printing and publishing	21-22	17-18
23	Petroleum	Coke, refined petroleum products and nuclear fuel	23	19
24	Chemicals	Chemicals and chemical products	24	20-21
25	Plastic	Rubber and plastics products	25	22
26	Minerals	Other non-metallic mineral products	26	23
27	Basic metals	Basic metals	27	24
28	Metal products	Fabricated metal products	28	25
29	Machinery n.e.c	Machinery and equipment, nec	29	28
30	Office	Office, accounting and computing machinery	30, 32, 33	26
32	Communication	Radio, television and communication equipment		
33	Medical	Medical,precision and optical equipments, watches and clocks		
31	Electrical	Electrical machinery and apparatus, nec	31	27
34	Auto	Motor vehicles, trailers and semi-trailers	34	29
351-359	Other Transport	Other transport equipment	351-359	30
36-37	Other	Manufacturing nec; recycling	36-37	31, 32, 33
40-41	Electricity	Electricity, gas and water supply	40-41	35, 36, 37, 38, 39
45	Construction	Construction	45	41, 42, 43
50-52	Retail	Wholesale and retail trade; repairs	50-52	45, 46, 47
55	Hotels	Hotels and restaurants	55	55, 56
60	Land Transport	Land transport via pipelines	60,61,62,63	49
61	Water Transport	Water transport		50
62	Air Transport	Air transport		51
63	Aux Transport	Support. & aux. transport act. Travek agencies activ.		52
64	Post	Post and telecommunications	64	53, 58, 59, 60, 61
65-67	Finance	Financial intermediation	65-67	64, 65, 66
70	Real State	Real estate activities	70	68
71	Renting Mach	Renting of machinery and equipment	71	
72	Computer	Computer and related activities	72	62, 63
73	R&D	R&D and other business activities	73	69 to 75
74	Other Business	Other business activities	74	77 to 82
75	Public	Public admin. and defence; compulsory social security	75	84
80	Education	Education	80	85
85	Health	Health and social work	85	86, 87, 88
90-93	Other services	Other community, social and personal services	90-93	90-96
95	Private	Private households with employed persons	95	97, 98

Table A3: Number of Trade agreements over time - Canada



Agreement	Date of Notification	Involved countries
United Kingdom - Canada	31-Dec-2020	Canada; United Kingdom
U.S.-Mexico-Canada Agreement	16-Sep-20	Canada; Mexico; United States of America
CPTPP	20-Dec-18	Canada, Australia, ..., Viet Nam
EU - Canada	19-Sep-17	Canada; Austria, ..., Sweden
Canada - Ukraine	13-Sep-17	Canada; Ukraine
Canada - Honduras	5-Feb-15	Canada; Honduras
Canada - Korea, Republic of	20-Jan-15	Canada; Korea, Republic of
Canada - Panama	10-Apr-13	Canada; Panama
Canada - Jordan	10-Apr-13	Canada; Jordan
Canada - Colombia	7-Oct-11	Canada; Colombia
EFTA - Canada	4-Aug-09	Canada; Iceland;Liechtenstein;Norway;Switzerland
Canada - Peru	31-Jul-09	Canada; Peru
Canada - Costa Rica	13-Jan-03	Canada; Costa Rica
Canada - Chile	30-Jul-97	Canada; Chile
Canada - Israel	15-Jan-97	Canada; Israel
Nafta	29-Jan-93	Canada; Mexico; United States of America

Table A4: Targeted Moments

Share of country pairs with FTA in place	32.8%
- conditional on common language	57.7%
- conditional on distance > Median	36.1%
- conditional on GDP > Median	35.3%
Share of countries that have an FTAs with more than 10 countries	19.3%

B Reduced-Form Evidence

This section describes the welfare estimates obtained for each year and factual and counterfactual free trade agreements and documents several findings and trends.

Figure A1 shows that the number of free trade agreements that are signed every year has been generally high since the 1990s with on average 15-20 FTAs being signed in a given year. This trend has been slower in the 2010s but has recently again caught up with for example more than 20 FTAs signed in the year 2020. The increase in FTA is primarily due to agreements signed by high- and middle-income countries. Only about 13% of signatories are low or lower-middle income countries, according to the World Bank's classification of countries by income group.

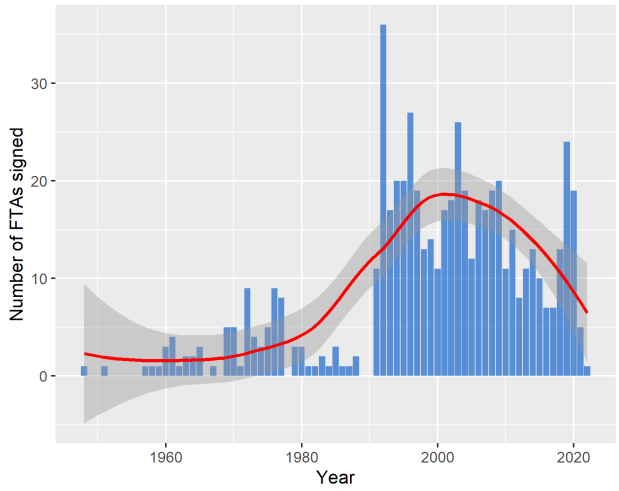
Surprisingly, however, as evident from Figure A2, the welfare benefits of newly signed FTAs are generally declining over time. This figure plots the median welfare gain for all involved signatories of FTAs that were signed in a given year. We find that this median welfare gain equaled close to 2.5% in 1989 and has declined since to values of about 0.6% in the mid-1990s and quite small effects since the mid-2000s. We find that the median welfare gain from an agreement in 2018, the last year in our sample, equals only 0.02%.

Figure A3 paints a similar picture: For this plot, we compute the welfare gains from each potential bilateral FTA between the 44 countries in our dataset in each year. This plot hence provides a sense of how the welfare gains of an FTA between any two countries change over time. As evident from the figure, the potential gains from bilateral agreements decline nearly linearly with each year with about 0.01% in 1990 to about 0.001% in the last year of our sample, 2018. Also the maximum welfare gains, which range from about 10% to 170%, are declining over time as evident from Panel c) and fell particularly strongly in the 1990s.

How important are past free trade agreements for the impact of current ones? If past agreements strongly lower the benefits of potential other FTAs, outsiders are more at risk of being unable to enter successful negotiations with the same countries later on. On the other hand, if past agreements affect the impact of other agreements positively, we would expect to see the opposite.

To shed a preliminary light on this question, we quantify the impact of major agreements in history on the potential benefits of agreements between countries in our data set. To do so, we evaluate all potential bilateral agreements among the 44 countries in our data set

Figure A1: Number of FTAs signed over time



Notes: The figure plots the total number of newly signed FTAs in each year. The shaded area refers to the smoothed values from a local polynomial regression.

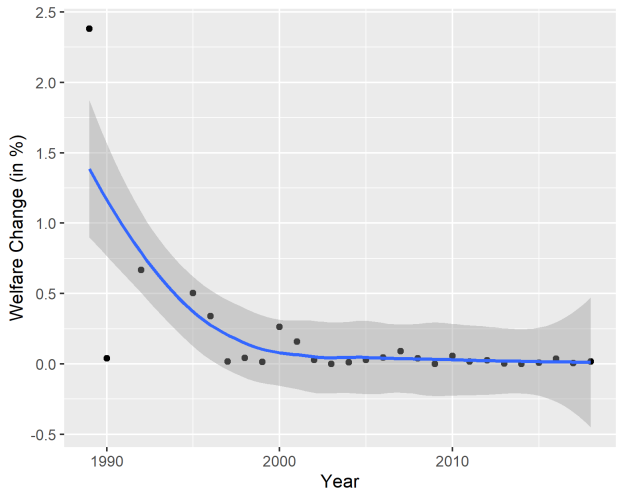
with and without the respective major FTA being in place and compare the outcomes. For example, we compute the average welfare gains of agreements between all country pairs, conditional on CPTPP[11] being in place versus a counterfactual scenario in which it is not. The comparison hence provides an estimate of the impact of past FTAs on the benefits of current ones.

Figures A4 and A5 graphically summarize the impact of two major trade agreements on the potential benefits of other agreements. Specifically, we choose the recent CPTPP as well as ASEAN-China and plot how each one affects the benefits of other potential agreements. We find that the results are highly country-specific. First, as expected, the impact of an FTA is strongest for those actually involved in the FTA, that is, for the respective signatories. For other countries, the impact is typically close to 0.

Among signatories, the impact of a signed FTA on the benefits of future FTAs with other countries can, however, be positive or negative. As evident from Figure A4, CPTPP lowered the benefit of further agreements for Vietnam and Malaysia, but noticeably increased them for Australia, New Zealand, and Singapore. The picture is similar for ASEAN-China as summarized in Figure A5: Thailand, the Philippines, and Brunei see sizable declines in the benefit of future agreements, but the opposite is true for China, Indonesia, Malaysia, and

[11] Comprehensive and Progressive Agreement for Trans-Pacific Partnership.

Figure A2: Welfare Gains for FTAs over time



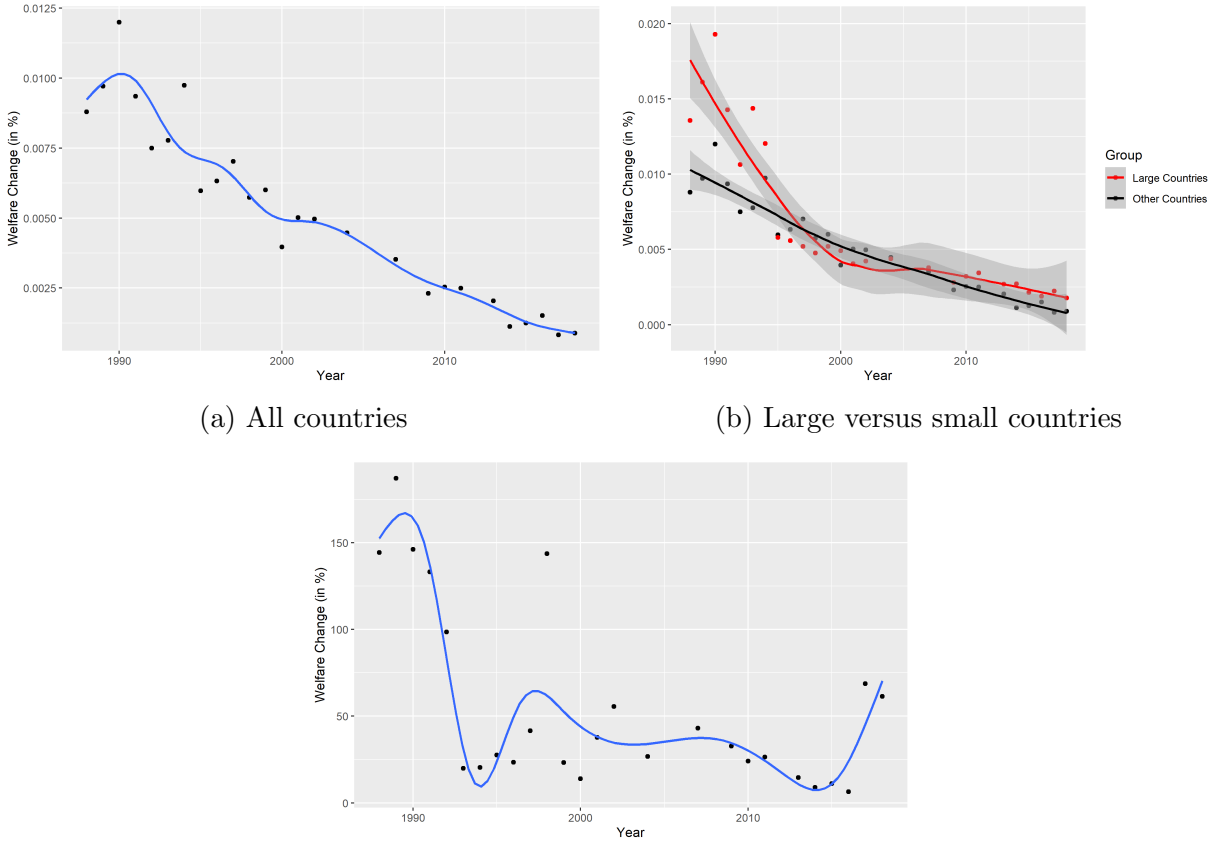
Notes: The figure plots the median welfare gain of signed free trade agreements for each year across involved signatories. The shaded area refers to the smoothed values from a local polynomial regression.

Singapore. Intuitively, this heterogeneity is due to two factors. First, imports are both substitutes and complements and lower tariffs hence result in increased import competition as well as improved availability of inputs. Which channel is of greater importance therefore determines both the welfare gain from a current FTA as well as that from future ones. Second, the tariff reductions that countries commit to are generally not the same, especially when countries differ in the initial level of tariffs. Countries which commit to larger tariff reductions therefore, on average, tend to experience smaller welfare gains than others, which translates into variation in the gains from future FTAs as well.

Lastly, as evident from Figure A6, a country is more likely to sign an additional FTA if it has already signed more FTAs with others in the past. Specifically, we find a negative correlation between the number of additional years a country takes until it signs an additional FTA and the number of FTAs it has signed in the past. This relationship is robust to the inclusion of country and year fixed effects.

Table A3 highlights this relationship in more detail for the example of Canada. As evident from this table, Canada initially started to become gradually more active in negotiating free-trade agreements after Nafta in 1994. It announced two agreements in 1997 followed by three more in the 2000s. After that however, Canada became substantially more active and negotiated agreements in close succession, for example with two agreements, respectively, in

Figure A3: Welfare Gains for potential bilateral FTAs over time



(a) All countries

(b) Large versus small countries

(c) Maximum Gains

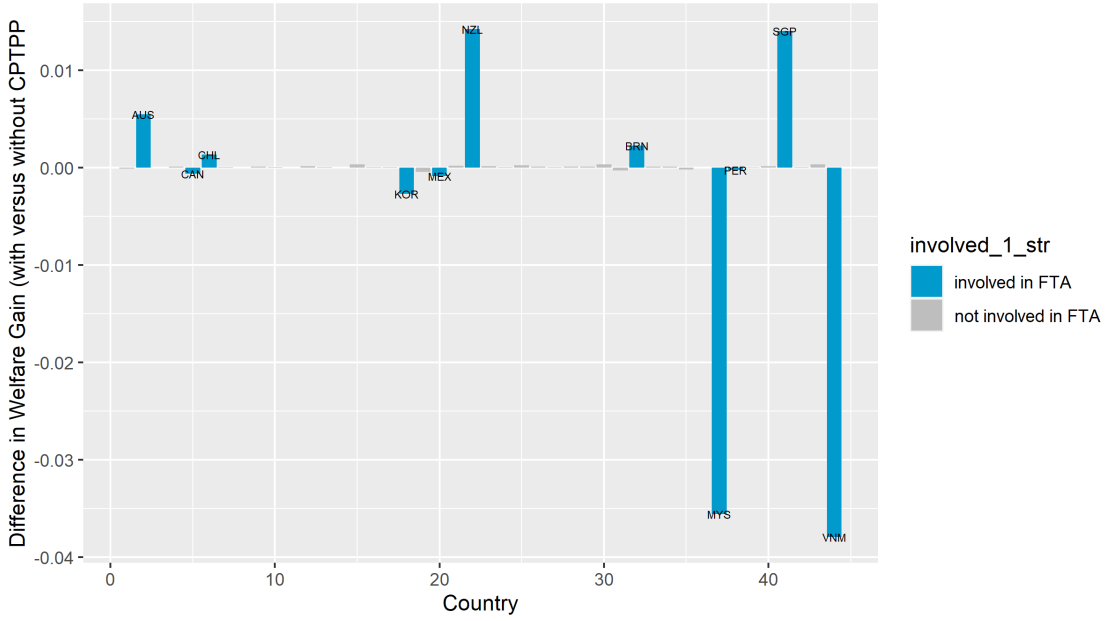
Notes: The left panel plots the median welfare gain of potential bilateral free trade agreements across involved signatories for each country pair in the data for each year. The right panel shows these numbers separately for the five large, non-EU economies U.S., China, Japan, South Korea, and Canada, as well as when those countries are excluded. The bottom panel plots the maximum welfare gain of potential bilateral free trade agreements across involved signatories.

2013, 2015, 2017, and 2020.

Interestingly, we also find that the relationship shown in Figure A6 is particularly strong at the beginning, that is, when countries have not signed many FTAs in the past. For those countries, doubling the number of FTAs signed in the past lowers the expected number of years until another one is signed by about 1.5 years. For countries which are already involved in a sizable number of FTAs on the other hand, doubling the number of FTAs has a much smaller effect.[12] This pattern is consistent with learning-by-doing in negotiations, in which

[12]Note that the relationship at some point becomes even positive, which makes sense intuitively, given that there is a limited number of countries that an FTA can be signed with.

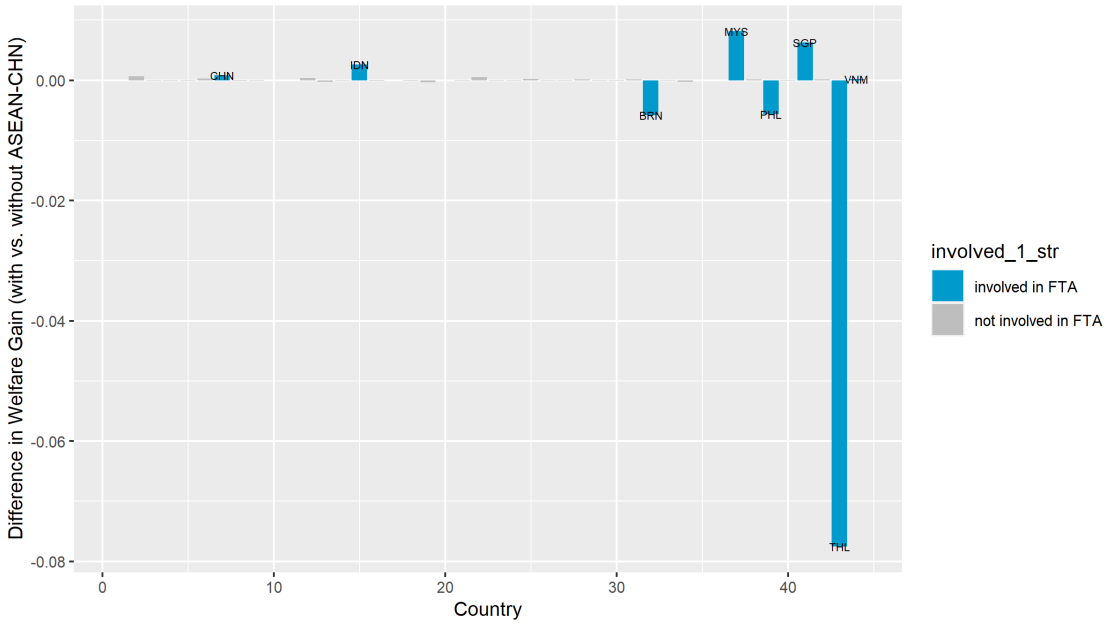
Figure A4: Welfare Gains for potential bilateral FTAs: With and without CPTPP



Notes: The figure plots the median welfare gain of potential bilateral free trade agreements for each country pair in the data for each year across involved signatories, comparing a scenario in which CPTPP is in place versus when it is not. A positive value implies that the country benefits more from other future agreements when CPTPP is in place compared to a scenario in which it is not.

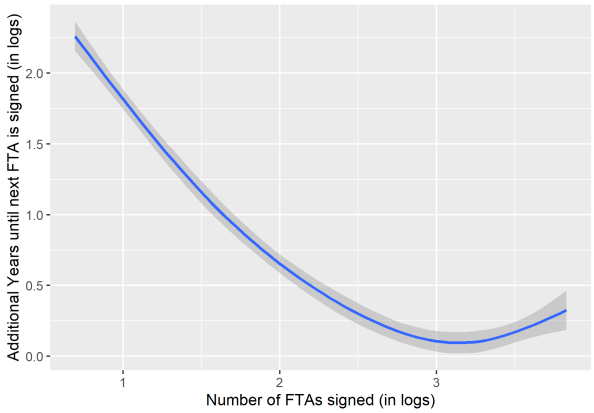
the benefit from the first FTAs that are drafted and negotiated are larger than those of later ones.

Figure A5: Welfare Gains for potential bilateral FTAs: With and without ASEAN-China



Notes: The figure plots the median welfare gain of potential bilateral free trade agreements for each country pair in the data for each year across involved signatories, comparing a scenario in which ASEAN-China is in place versus when it is not. A positive value implies that the country benefits more from other future agreements when ASEAN-China is in place compared to a scenario in which it is not.

Figure A6: Frequency of FTA signings based on history



Notes: Figure plots the number of additional years a country takes until it signs an FTA (in logs) against the number of FTAs it has signed in the past (in logs). The shaded area represents 95% confidence bands based on a simple non-parametric model (GAM).