The dynamic effects of the CPTPP and new member accessions*

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The multilateralization of regionalism implies the convergence of a series of previous agreements into a single plurilateral agreement with greater liberalization ambitions at both the intensive and extensive margins. The Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) is an example of this phenomenon. After estimating the structural dynamic gravity model of trade proposed by Anderson, Larch and Yotov (2020), different counterfactual scenarios were simulated according to the countries that are members of the agreement: CPTPP as currently constituted and with the accession of new members (countries that have already submitted their application for membership): China, Ecuador, Costa Rica, Ukraine and Uruguay. A short-run static equilibrium (in which only prices change) and a long-run dynamic equilibrium (with real effects on output and capital stock) were evaluated. The long-run effects are almost twice as large as the short-run effects. In the scenario with China inside the agreement, CPTPP members experience larger welfare gains. The economies that benefit the most are those of Southeast Asia belonging to ASEAN (Malaysia, Vietnam and Singapore), for which the extensive margin is related to the agreements with the countries of the Americas and are closer to the large markets of Asia and Oceania (Japan, China and Australia). Uruguay stands out for the large effect of trade liberalization, ranking fourth in terms of welfare gains and second in terms of total international trade. The agreement improves the country's access to South Asian markets (extensive margin), while deepening trade relations with American countries with which Uruguay already has preferential relations (intensive margin).

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1. Introduction

The past decade has seen several changes in the world that have affected international economic relations, with overlapping forces pulling in different directions. A milestone in this process was the change of government in the United States in 2017, which led to both the withdrawal from the Trans-Pacific Partnership (TPP) and the beginning of an aggressive unilateral trade policy. This policy focused on trade relations with China, in retaliation for that country's anti-trade behavior[1]. At the root of the conflict lies a dispute over global leadership in technology.

More recently, two additional issues contributed to the changing context. First, a heterogeneous set of climate change mitigation policies that spill over into trade rules, using international trade as a mechanism to discipline the adoption of these policies. This process is driven primarily by the European Union, but also by other OECD countries[2]. Second, there is an intensification of geopolitical local conflicts, with global repercussions. The most prominent of these is Russia's invasion of Ukraine and the economic sanctions that followed. This event was followed by other conflicts around the world. All of these have led to an erosion of the multilateral trading system represented by the WTO rules. As a result, it is possible to observe a path towards a discretionary and unilateralist approach to the application of trade policies. This creates an environment of uncertainty in trade policy and thus in market access conditions (Limão, 2023).

Finally, there are the long-term trends in the international economy in terms of the construction of trade rules. The countries of East and Southeast Asia and Oceania are at the center of this process. These countries are the central players in the multilateralization of regionalism, which involves the nesting of a network of existing agreements into a single plurilateral agreement with greater ambitions for trade liberalization (Baldwin and Low, 2009). Two examples illustrate this process. The Trans-Pacific Partnership agreement without the United States (CPTPP) and with the United Kingdom as a new member. Ratifications have taken place since 2018, leading to 12 countries being already members, while another 6 countries have applied for membership. In addition, the Regional Comprehensive Economic Partnership[3] (RCEP) which came into force in 2022. These changes are expected to have the opposite effects to those mentioned in the previous paragraph, improving market access, deepening trade liberalization and creating a set of rules that increase certainty about access conditions. For small countries, the alternative of a world of unilateral policies, in particular with regard to international trade, is a threatening one. These types of countries are more open and therefore depend on the conditions of access to the international market with a certain degree of certainty. At a time when the WTO is weakened, it is essential to participate in some of these initiatives of multilateralization of regionalism.

This paper applies a state-of-the-art methodology to study the impact of preferential trade agreements (PTAs), namely the structural dynamic gravity model of trade proposed by Anderson, Larch and Yotov (2020). It simulates the impact on the trade costs of CPTPP members and their effects on income and capital accumulation. Based on this model, an empirical study is carried out to obtain parameter values that are introduced as inputs for the simulations. Contributions related to the heterogeneity of the effects of PTAs are also important, as well as the use of a newly available data derived from a recent study by the World Bank (Fontagné et al., 2023; Rocha et al., 2023).

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[1] A detailed description of the key events in the U.S.-China trade war is available at the website coordinated by Chad Bown of the Peterson Institute of International Economics (https://www.piie.com/research/trade-investment/us-china-trade-war).

[2] Examples of these policies are: Emissions Trading System (ETS), carbon taxes, production subsidies for clean technologies, Border Carbon Adjustment Mechanism (BCM), export subsidies.

[3] Also known as ASEAN+5 because it includes the ASEAN countries plus Korea, Japan, China, Australia and New Zealand. The agreement has not yet been notified to the WTO, although it is in force among members.

The results show that accounting for dynamic effects almost doubles the results of the static model. China's accession to the agreement also plays an important role in the size of the gains for the remaining members, with an additional gain of 23% in the case of Costa Rica and up to almost 200% for Japan. It takes 20 years for nearly three-fourths of the discounted long-term of the gains to materialize.

The paper is divided into this introduction and four other sections. Section two provides a brief characterization of the CPTPP (Appendix A provides details on the construction of the databases). The third section presents the theoretical framework (Appendix B contains a detailed presentation of the model), and the econometric exercises, both for the determinants of bilateral trade (structural gravity model) and for the income and capital equations corresponding to the dynamic part of the model. In the fourth section, based on the parameters estimated in the previous section, three counterfactual scenarios are considered, with two definitions of equilibrium (static and dynamic). Finally, there is a section of synthesis and conclusions.

2. CPTPP: a new standard for international economics

The proliferation of PTAs since the early 1990s has complemented the process of trade liberalization at the multilateral level. Both by deepening the degree of liberalization of trade barriers and by integrating other disciplines necessary to promote trade and investment. However, this process, while leading to more than three hundred PTAs actually in force, had prompted to a dispersion of rules that becomes an obstacle to the deepening of trade. A simple example is the case of rules of origin. Suppose a country is member of several PTAs, each one with different rules of origin. Not only does this make it difficult for the private sector to adapt its production to a dispersed pattern of rules, but it also inhibits the possibility of other movements of goods and services taking advantage of the network of agreements. One way to overcome this limitation is to build larger agreements that nest several existing PTAs into a single one. This leads to what is known as diagonal accumulation of origin. This process is known as the multilateralization of regionalism[4].

A clear example of this phenomenon today is the case of the CPTPP. The agreement was ratified by all its original members in 2022, with the United Kingdom joining in 2023. It is a plurilateral agreement between 12 economies with heterogeneous levels of development, bringing together economies from East and Southeast Asia (Brunei Darussalam, Japan, Malaysia, Singapore and Vietnam) with others from the Americas (Canada, Chile, Mexico and Peru) and, more recently, one from Europe (the United Kingdom). It has created great expectations and there is now a list of six countries which have formally indicated their intention to begin negotiations to accede to the agreement: China (September 2021), Taiwan (September 2021), Ecuador (December 2021), Costa Rica (August 2022), Uruguay (December 2022) and Ukraine (May 2023). It is a deep integration agreement that, in addition to the traditional topics of liberalization of trade in goods and services, adds many other disciplines that cover issues grouped under the heading of "beyond the border" with other non-trade objectives linked to sustainable development (environment, labor issues, civil rights).

There are many previous PTAs between current CPTPP members[5]. The first dates back to 1983 with the New Zealand-Australia trade agreement. The most recent agreement, in 2017, is the one between the EU and Canada, when the United Kingdom was still a member of the EU. In total, there are 24 previous agreements, including both bilateral and plurilateral PTAs, both intra- and extra-regional. The 24 agreements between CPTPP members have liberalized a large number of bilateral relations, as many of them cover several countries. In fact, as described in Annex C, out of 110 possible bilateral relations, 69 have already been

[4] The term regionalism is used as it is understood in the multilateral jargon at the WTO level, as a synonym for PTAs. This is due to the fact that in their origins they had a distinct regional pattern that was later lost.

[5] Due to data availability, the exercises in this paper do not include Brunei Darussalam, which is one of the original signatories to the CPTPP. Also, the case of Taiwan as new members it is not considered for the same reason.

liberalized[6]. This illustrates the degree of simplification proposed by the CPTPP agreement. Many of these previous agreements have a lower level of liberalization and rules than those associated with the CPTPP. In this sense, the CPTPP implies a change in the intensive margin due to the deepening and multilateralization of previous agreements. At the same time, the CTTPP implies new liberalized bilateral relations, a change in the extensive margin. The latter is particularly evident between the countries of the Americas and Europe and those of the Asia-Pacific region. These relations account for more than a third of the total bilateral relations concerned.

Alternative scenarios are simulated under the assumption that potential new members will join the CPTPP, so it is also important to know about previous agreements between the original CPTPP members and the new members. Prior to joining the CPTPP, the United Kingdom had four agreements with the founding members of the CPTPP. Among the potential new members considered in this paper, Uruguay and Ecuador are in a similar situation, with agreements only with other Latin American countries already in the CPTPP. Costa Rica has three bilateral liberalized relations (with Canada, the United Kingdom and Singapore). China, on the other hand, has agreements with almost all Asian countries and with Peru and Chile in the Americas, without a prior preferential relationship with Canada, Mexico and the United Kingdom.[7]. Ukraine has only one prior agreement with the United Kingdom.

To illustrate the initial situation, it is useful to characterize the nature of the existing agreements, both in terms of the preferences granted and the disciplines covered, as well as the depth of the commitments made in each of them. For this purpose, we use the World Bank database which typifies 937 different provisions in 17 areas (see Table 2.1)[8]. These areas can be divided into border issues (areas 1-7), cross-border issues (services, complementary materials and factor movement, areas 8-13 and 16-17) and so-called non-trade objectives (labor and environment, areas 14-15). Plurilateral agreements bring together several bilateral relationships, and not all of them are exactly the same in terms of the provisions they include, there is typically a degree of bilateral heterogeneity. This is also the case with the CPTPP. In Table 2.1, the CPTPP drives an increase in the number of provisions compared to previous agreements, particularly in the areas of investment, competition, government procurement and intellectual property.

The depth of agreements is related to the number of disciplines and the accumulation of provisions within them. However, the mere accumulation of provisions is a rough indicator of the depth of an agreement in terms of the degree of commitment to reciprocal liberalization. In some cases, for example, fewer provisions are associated with greater liberalization. Consider the case of the European Union, which has no rules of origin or anti-dumping mechanisms in intra-regional trade. Another limitation of looking only at the number of rules is that there is no indication of their effective enforcement. In the empirical application we carry out in section three, we will resort to the classification of Fontagné et al. (2023) to identify those bilateral relations reached by a deep trade agreement.

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[6] See Annex C, Table C.1, which lists the bilateral relations already liberalized by previous agreements among CPTPP members, as well as those involving countries that have applied for membership.

[7] As of 2018, China did not have a PTA with Japan, but since 2022 the ASEAN+5 (ASEAN plus Korea, Japan, China, Australia and New Zealand) called RCEP (Regional Comprehensive Economic Partnership) has been in force. This agreement has not yet been notified at the WTO.

[8] For further details and description of the data used in this section and in the rest of the work, see Appendix A.

Table 2.1. Comparison of areas of CPTPP provisions with selected previous agreements of its members ordered in descending order by the number of provisions (2018)

Provision areas / PTA	CPTPP[a)]	ASEAN - Australia - Nueva Zealand[b)]	ASEAN - Australia - Nueva Zealand[c)]	Canada - Peru	NAFTA	Japan - Australia	ASEAN - Australia - Nueva Zealand[d)]	Malaysia - Australia	Australia - Chile	Japan - Peru	Peru - Singapore	Pacific Alliance[e)]	Pacific Alliance[f)]	Canada - Chile
Trade and customs facilitation	30	33	26	34	21	20	25	25	21	21	23	15	23	15
Anti-dumping and countervailing duties	8	12	10	7	16	6	7	7	4	6	7	5	7	4
Technical barriers to trade	13	16	13	12	15	9	8	8	13	10	13	17	18	7
Sanitary and phytosanitary	50	29	27	35	33	24	27	27	33	22	21	31	30	30
Rules of origin	22	24	21	16	19	16	21	21	16	20	21	27	25	17
Export taxes	31	18	20	23	19	25	20	20	22	16	21	17	11	23
Subsidies	13	15	13	11	19	11	15	15	10	14	14	13	13	11
Services	34	24	28	18	23	17	17	17	13	10	21	33	32	3
Investment	43	25	34	0	0	15	35	35	0	25	0	12	0	0
Competition Policies	27	24	18	19	16	21	17	17	19	19	16	15	23	10
Public procurement	75	42	25	61	52	51	0	0	54	51	51	0	0	59
Intellectual property	93	51	48	36	23	44	54	54	31	42	32	38	30	23
State-owned companies	44	37	42	40	42	37	36	36	41	29	32	40	41	38
Environment regulation	34	6	3	18	23	3	5	5	6	8	4	11	6	13
Labor regulations	16	9	0	17	2	0	3	3	3	1	1	3	13	12
Capital movement	50	51	50	37	40	44	49	49	51	40	42	35	37	34
Visa and asylums	17	16	16	10	18	17	16	16	12	12	11	9	5	8
Total	600	432	394	394	381	360	355	355	349	346	330	321	314	307

[a)] CPTPP in the bilateral version between Australia and Chile; [b)] New Zealand-Singapore version; [c)] Australia-Singapore version; [d)] New Zealand-Malaysia version; [e)] Mexico-Chile version; [f)] Peru-Chile version. Source: own elaboration based World Bank's Deep Trade Agreement database.

Table 2.2 shows the situation before and after the CPTPP and how the number of provisions would change. The previous agreements are highlighted in three levels according to the number of provisions (low - grey, medium – yellow, and medium-high - pink). The before-and-after comparison allows for a first approximation of the extensive margin effect (new liberalized bilateral relations) and the intensive margin effect (deepening of existing relations).

A complementary perspective is to look at ad-valorem tariff barriers imposed on the trade of goods (see Appendix A for the calculation of the applied tariff) and the preferences already granted among the original and potential new members. In part a) of Table 2.3 we show the average applied tariff while in part b) we report the margin of preference over the MFN tariff, in both cases for the year 2017 before the signature of the CPTPP. The different levels of protection and preferences granted are highlighted by different colors. As the data clearly show, there is considerable heterogeneity in terms of applied tariffs and the level of preferences granted. Ecuador and Uruguay are the countries with the highest applied tariffs on their imports, while Vietnam has high tariffs on imports originating in countries with which it has no prior trade agreement. As expected, the differences in the preferential margins reflect the different degrees of openness of each of the economies considered, both in terms of the level of applied tariffs and the network of pre-existing agreements. With regard to the latter, Ecuador, Uruguay and Ukraine appear as the countries with the lowest density of pre-existing agreements, in contrast to Chile and Singapore. It should be noted that, in addition to PTAs, there are other non-reciprocal preferences granted by high-income countries (Japan, United Kingdom, Canada and Australia). Moreover, applied tariffs and margins of preference are partial measures of the level of effective protection, particularly for agricultural products, with the most protectionist countries, Japan and Canada, resorting to other protection instruments (e.g. quotas, specific tariffs, technical barriers).

Table 2.2. PTA depth measured by number of total provisions for the CPTPP+

a) 2017

exp/imp	AUS	NZL	MYS	VNM	SGP	JPN	CAN	MEX	PER	CHL	GBR	CHN	CRI	ECU	URY	UKR
AUS		141	355	280	394	360				349		223				
NZL	141		355	280	432					280		270				
MYS	355	355		155	155	267				114		200				
VNM	280	280	155		155	279				99		200				
SGP	394	432	155	155		269			330	284		256	314			
JPN	360		267	279	269			271	346	260						
CAN								381	394	307			174			
MEX						271	381		297	321	140		263	49	269	
PER					330	346	394	297		314	418	278	325	148	43	
CHL	349	280	114	99	284	260	307	321	314		322	149	178	49	43	
GBR								140	418	322			411			470
CHN	223	270	200	200	256				278	149			192			
CRI					314		174	263	325	178	411	192				
ECU								49	148	49					43	
URY								269	43	43				43		
UKR											470					

b) After 2018

exp/imp	AUS	NZL	MYS	VNM	SGP	JPN	CAN	MEX	PER	CHL	GBR	CHN	CRI	ECU	URY	UKR
AUS		535	614	592	626	593	508	508	508	600	508	508	508	508	508	508
NZL	535		614	592	640	508	508	508	508	573	508	508	508	508	508	508
MYS	614	614		543	543	594	508	514	514	540	508	508	508	508	508	508
VNM	592	592	543		543	596	508	514	514	534	508	508	508	508	508	508
SGP	626	640	543	543		591	508	514	597	576	508	508	508	508	508	508
JPN	593	508	594	596	591		508	577	594	578	508	508	508	508	508	508
CAN	508	508	508	508	508	508		618	604	578	508	508	508	508	508	508
MEX	508	508	514	514	514	577	618		605	604	508	508	508	508	508	508
PER	508	508	514	514	597	594	604	605		599	508	508	508	508	508	508
CHL	600	573	540	534	576	578	578	604	599		508	508	508	508	508	508
GBR	508	508	508	508	508	508	508	508	508	508		508	508	508	508	508
CHN	508	508	508	508	508	508	508	508	508	508	508		508	508	508	508
CRI	508	508	508	508	508	508	508	508	508	508	508	508		508	508	508
ECU	508	508	508	508	508	508	508	508	508	508	508	508	508		508	508
URY	508	508	508	508	508	508	508	508	508	508	508	508	508	508		508
UKR	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	

Note: for the United Kingdom (due to lack of data in the World Bank database), and for the potential new members, the figures are imputed using data from Canada. Source: own elaboration based on World Bank Deep Trade Agreements database.

Table 2.3 Applied tariff and preferences as of 2017 for CPTPP+

a) Applied tariff

exp/imp	AUS	NZL	MYS	VNM	SGP	JPN	CAN	MEX	PER	CHL	GBR	CHN	CRI	ECU	URY	UKR
AUS		0.1	1.5	3.2	0.0	2.6	3.0	7.7	3.0	0.5	5.6	5.0	5.7	13.3	10.5	4.7
NZL	0.0		1.8	3.2	0.0	5.6	3.0	7.7	3.0	0.2	5.6	1.4	5.7	13.4	10.5	4.7
MYS	0.2	0.2		0.7	0.0	1.2	3.5	7.1	3.1	0.6	5.4	1.5	5.5	13.4	11.1	4.6
VNM	0.3	2.8	0.9	1.6	5.6	13.4	3.1	1.6	7.3	0.2	0.5	3.1	0.0	4.6	11.0	
SGP	0.0	0.1	0.2	0.7		1.3	3.5	7.1	1.1	0.2	3.2	1.5	0.9	13.4	11.2	4.5
JPN	0.6	2.5	1.2	5.0	0.0		3.5	1.2	1.1	0.4	5.4	11.9	5.5	13.4	11.2	4.5
CAN	2.4	0.4	6.2	10.2	0.1	5.1		0.3	0.8	0.5	0.7	11.8	0.7	13.4	10.9	2.3
MEX	2.5	2.2	6.3	10.1	0.1	1.2	0.9		0.7	0.4	1.1	11.9	0.4	12.9	1.0	4.6
PER	2.2	1.9	5.9	10.3	0.0	1.8	1.1	1.4		0.0	0.4	2.7	1.8	0.2	2.0	4.7
CHL	0.2	0.1	2.0	8.0	0.0	1.5	0.9	0.1	0.0		1.3	1.0	0.9	0.8	0.3	4.7
GBR	2.8	2.4	6.4	10.1	0.1	4.7	1.3	1.0	1.4	0.3		11.9	3.8	7.9	11.1	1.6
CHN	0.3	0.2	1.3	2.4	0.0	2.6	3.5	7.1	1.9	0.3	5.4		2.4	13.4	11.1	4.6
CRI	1.9	1.7	5.6	10.4	0.0	3.2	1.0	0.5	1.1	0.6	0.7	1.9		13.3	10.1	4.8
ECU	1.7	1.5	5.2	10.5	0.1	3.4	2.9	5.4	0.3	0.4	0.7	11.7	6.1		1.4	4.9
URY	2.2	3.3	0.3	11.8	5.7	2.3	5.5	2.9	1.1	6.0	2.0	1.2	0.1	4.7		10.3
UKR	2.3	2.0	5.7	10.4	0.1	4.5	1.1	7.9	3.0	6.1	1.0	11.8	5.8	13.3	10.2	

b) Tariff preference (1-applied tariff/ MFN rate)*100

exp/imp	AUS	NZL	MYS	VNM	SGP	JPN	CAN	MEX	PER	CHL	GBR	CHN	CRI	ECU	URY	UKR
AUS		96	72	69	100	57	8	0	0	91	1	58	0	1	0	0
NZL	100		68	69	100	0	8	0	0	96	1	88	0	1	0	0
MYS	93	91		93	100	76	0	0	0	91	1	87	0	1	0	0
VNM	88	81	96		100	69	19	0	0	86	43	87	0	1	0	0
SGP	99	95	97	93		72	0	0	65	96	42	87	84	1	0	0
JPN	81	0	81	51	100		0	82	65	93	1	0	0	1	0	0
CAN	12	85	0	1	14	0		96	75	91	87	0	87	1	0	51
MEX	11	7	0	1	11	75	74		78	94	80	0	92	5	91	0
PER	14	9	1	1	100	70	67	83		100	93	77	69	98	82	0
CHL	94	96	65	23	100	74	72	99	100		76	92	85	94	97	0
GBR	0	0	0	0	9	0	63	86	57	95		0	30	42	0	64
CHN	91	90	79	77	100	44	0	0	40	95	1		56	1	0	0
CRI	16	10	1	1	100	47	66	95	64	91	89	84		2	0	0
ECU	18	12	1	2	43	49	1	36	89	94	89	0	1		86	0
URY	13	9	0	1	21	45	0	86	60	96	1	0	0	83		0
UKR	0	0	1	1	29	27	66	0	0	0	82	0	0	2	0	

Note: figures refer to goods that correspond to agricultural and manufacturing sectors (sectors A, B and D of the ISIC Revision 3 classification) considered jointly. Source: own elaboration based data provided by Teti (see Teti, 2020).

3. Theoretical framework and estimation of the structural dynamic gravity model of trade

3.1. The model[9]

The gravity model of trade has its first antecedents in the early 1960s (Tinbergen, 1962; Pöyhönen, 1963). In the following decades, theoretical developments increased to provide a basis for the empirical determinants

[9] See Appendix B for a full presentation of the theoretical framework.

to explain bilateral trade flows (Anderson, 1979; Bergstrand, 1985 and 1989; Deardoff, 1998). But it was not until the beginning of this century, with two seminal contributions, that the gravity model found a strong microeconomic foundation (Eaton and Kortum, 2002; Anderson and van Wincoop, 2003). Anderson and van Wincoop (2003) show that bilateral flows depend on the bilateral trade costs between two countries with respect to what the authors defined as multilateral resistances (MRs). These MRs are aggregate measures of all bilateral trade costs and summarize their trade geography. Either as an exporter (outward MR) or as an importer (inward MR).

The structural gravity model of trade (SGMT) is a general equilibrium model in which a country's supply (measured by the value of its output) equals the sum of all countries' demand for that country's output, which includes internal demand for its own production (domestic trade). Two networks are involved in the SGMT. In the trade network, each node is a country linked to all others by outflows (sales) and inflows (purchases). In the trade cost network, each node is a country linked to each other by the costs to export and to import. Each country has one size as a supplier (production) and another as a buyer (expenditure), which are given. The SGMT explains bilateral trade flows (X_{ijt}) in terms of trade costs (t_{ijt}), trade geography summarized by the aggregate prices of selling (Π_{it}) and buying (P_{jt})[10], and the sizes of the economies that sells (Y_{it}) and that buys (E_{jt}). The SGMT is summarized by the following system of equations:

$$X_{ijt} = \frac{(Y_{it}E_{jt})}{Y_t}\left(\frac{t_{ijt}}{\Pi_{it}P_{jt}}\right)^{1-\sigma} \tag{3.1}$$

$$\Pi_{it} = \left[\sum_j \frac{E_{jt}}{Y_t}\left(\frac{t_{ijt}}{P_{jt}}\right)^{1-\sigma}\right]^{1/1-\sigma} \tag{3.2}$$

$$P_{jt} = \left[\sum_i \frac{Y_{it}}{Y_t}\left(\frac{t_{ijt}}{\Pi_{it}}\right)^{1-\sigma}\right]^{1/1-\sigma} \tag{3.3}$$

$$p_{jt} = \frac{\left(\frac{Y_{jt}}{Y_t}\right)^{1/1-\sigma}}{\Pi_{jt}\gamma_{jt}} \tag{3.4}$$

where $Y_t = \sum_i Y_{it}$ is word output, γ_{jt} is a positive distribution parameter. Additionally, when allowing for unbalanced trade, output and expenditure are related by $E_{jt} = \phi_j Y_{jt}$ with $\phi_j > 0$. As pointed out by Anderson, Larch, and Yotov (2020), equation (3.4) is a restatement of the market-clearing condition ($Y_{it} = \sum_j X_{ijt}$), and it unveils an inverse relationship between the outward multilateral resistance, which captures the incidence of trade costs on the producers in j, and the factory-gate price (p_{jt}) in j. The intuition for this result is that when a country opens to trade, producers in that country enjoy lower outward MR, which, according to equation (3.4), translates into a higher factory-gate price. Working in the opposite direction, an increase in the country's share of world production leads to a decrease in the factory-gate price. Finally, in the static version of the model, output in physical units (Q_j) is constant, with income given by $Y_{jt} = p_{jt}Q_j$.

Anderson, Larch and Yotov (2020) extend the SGMT to allow for capital accumulation, and derive a structural dynamic gravity model of trade (SDGMT), in which the level of expenditure and income are endogenous, using a mechanism that links aggregated prices (equations 3.2 and 3.3) to the dynamics of capital accumulation. They propose a structure of the economy with an equation governing capital accumulation from which optimal behavior can be derived. This mechanism endogenizes the size of the economy on both the production and consumption sides. When trade costs change, the producer price (competitive channel) and the purchase price (substitution between consumption and investment goods) change, affecting income

[10] This is the dual representation of the outward and inward MRs as aggregate prices of selling and buying respectively.

and capital accumulation. The model is a highly interconnected analytical structure that must be solved by numerical calculations. The proposed specification follows a long tradition in growth models linked to the degree of openness of the economy. In this sense, the authors provide a microfoundation of the empirical relationship between growth and the degree of openness of an economy, which has long been supported by the literature (Frankel and Romer, 1999).

As derived by Anderson, Larch and Yotov (2020), and presented with more detail in Appendix B, the SDGMT includes two additional equations:

$$Y_{jt} = p_{jt}Q_{jt} = p_{jt}A_{jt}{L_{jt}}^{1-\alpha}{K_{jt}}^{\alpha} \tag{3.5}$$

$$K_{jt+1} = \left[\frac{\alpha\beta\delta E_{jt}}{(1-\beta+\beta\delta)P_{jt}}\right]^{\delta}{K_{jt}}^{1-\delta} \tag{3.6}$$

Equation (3.5) is the income function for each country j, where physical output (which is now allowed to change) is produced using capital (K_{jt}) and labor (L_{jt}) under a Cobb-Douglas function, and where A_{jt} is a productivity parameter. Finally, equation (3.6) describes the optimal behavior of capital, which determines the dynamic adjustment to a new steady state.

Under the SDGMT model, the structure of the economy has two parts or levels. First, there is the already well-known structural gravity model, in which trade costs negatively affect bilateral trade, while the size of the economies positively affects it. The aggregate measures of trade costs, as seller (Π_{it}) and buyer (P_{jt}), have a positive impact on trade between two countries, given their bilateral costs. Second, the central link to the macroeconomic growth model is production (and expenditure), along with aggregate prices. The competitiveness of the economy is summarized by its output price (factory-gate price), which is the seller's product price before trade costs. Lower selling prices (associated with lower trade costs) imply an increase in product prices. The increase in output prices translates into an increase in income, which impacts on capital accumulation. The latter is also affected by the aggregate import price (which includes trade costs), lower buying prices means more capital accumulation. This set of interactions occurs simultaneously, except for the effect on capital, which occurs with a one-period lag. This mechanism explains the dynamic transition to a new steady state when trade costs are modified. The dynamics of the capital stock depends on that of income, which is the conjunction of the product price relative to consumption prices and an effect on the level of physical production, which can also be expressed as a function of this relative price (see equations B.9 to B.11 in Appendix B). The insight of the model is simple: when trade costs are reduced, the country increases its level of openness associated with the change in the relative price (p_{jt}/P_{jt}), which in the dynamic setting of the model generates greater incentives for capital accumulation and production expansion.

The model of economic growth used in Anderson, Larch and Yotov (2020) is standard in the literature[11]. Given an employment path, the dynamics of income depends on factor productivity and the saving rate. The former is exogenous to the model and is assumed to depend on technical progress, which has its own dynamics. The savings rate is derived from the consumer's optimal intertemporal consumption decisions. The optimal rate of saving implies more or less capital accumulation according with the relative price of own production compared to the price of a consumption basket of domestic and imported goods. This capital accumulation determines the level of per capita consumption to which the trajectories of the variables converge in the steady state. In summary, the structural gravity model of trade is combined with a classical Solow growth model. Given constant saving rates, the change in the terms of trade (p_{jt}/P_{jt}) allow a higher capital accumulation, and through this mechanism affect the income of the economy. In this dynamic

[11] See Solow (1956). For a recent application of Eaton y Kortum (2002) model see Alvarez (2017).

context, changes in welfare are amplified by the effects on capital accumulation and income. More open economies save more and thus achieve higher per capita income.

3.2. Empirical specification

Consistent with the theoretical framework, the empirical specification of the SDGMT means the estimation of two sets of equations.

First we need to estimate the equation that explains bilateral trade flows (X_{ijt}) as a function of the trade costs (t_{ijt}), the economies' sizes (Y_{it}, E_{jt}) , and the pair of MRs (Π_{it}, P_{jt}) as derived from the SGMT. A challenge in the estimation is that multilateral resistances are endogenous to trade costs, so the empirical literature suggests the use of origin-time and destination-time fixed effects (which also control for the economies' sizes). Trade costs are decomposed into two components, one time-invariant controlled by origin-destination fixed effects, and a second time-varying component controlled by countries' trade policies. Following the literature on the SGMT, we adopt the following specification:

$$X_{ijt} = \exp\left(\eta_{it} + \xi_{jt} + \psi_{ij} + \beta_1 DTA_{ijt} + \beta_2 NRBL_{ijt} + \beta_3 \ln\left(1 + AT_{ijt}\right) + \beta_4 CC_{ijt} + \omega_t IT_t\right) + \mu_{ijt} \tag{3.7}$$

where:

η_{it}, ξ_{jt}, and ψ_{ij} are, respectively, origin-time, destination-time, and origin-destination fixed effects;

DTA_{ijt} is a dummy variable equal to 1 when at time t countries i and j are related by a deep trade agreement[12];

$NRBL_{ijt}$ is the product of the number of preferential bilateral relationships that countries i and j have at time t. A preferential bilateral relationship is one that is equivalent to a free trade area type or with a broader coverage of disciplines and instruments (e.g., customs union, common market, economic union, etc.);

AT_{ijt} is the tariff applied by importer j to imports originating from exporter i, at time t;

CC_{ijt} is a variable that measures the degree of trade complementarity between country i's export structure and country j's import structure;

IT_t is a dummy variable equal to 1 when X_{ijt} corresponds to an international flow at time t, i.e. when $i \neq j$. The set of variables IT_t, for t = 1995, ..., 2017, controls for globalization effects that have a worldwide impact on trade flows, e.g. the decline experienced during the 2009 global crisis.

Also, following what has become standard in the empirical literature, we use a pseudo maximum likelihood Poisson estimator (Santos Silva and Tenreyro, 2006; Correira, Guimarães and Zylkin, 2020), in addition to applying the correction of Weidner and Zylkin (2021).

The specification of trade costs has some innovations. First, the discrete variable measuring the effect of PTAs builds upon the proposal of the World Bank work to identify the effects of deep PTAs (Fontagné et al.,

[12] Deep trade agreements are considered to be those catalogued by Fontagné et al. (2023) when using the classification obtained by means of the k-means++ clustering algorithm, with a subsequent re-categorization of some agreements that the authors define as "borderline PTAs".

2023). The remaining variables used to control for time-varying trade costs follow Moncarz et al. (2023) in that trade costs are asymmetric ($t_{ijt} \neq t_{jit}$).

The second set of equations means the estimation of equations (3.5) and (3.6). In the first case, using (3.4) to replace p_{jt} into (3.5), the equation to estimate is:

$$\ln Y_{jt} = \kappa_1 \ln L_{jt} + \kappa_2 \ln K_{jt} + \kappa_3 \ln \Pi_{jt}^{\sigma-1} + \nu_t + \vartheta_j + \varepsilon_{jt} \quad (3.8)$$

As discussed by Anderson, Larch and Yotov (2020), equation (3.8) provides a theoretical basis for the reduced-form equation of Frankel and Romer (1999), enabling to test whether there is a causal relationship between trade openness and income. Moreover, given the structural nature of the SDGMT, the estimates of the coefficients in equation (3.8) leads to estimations of the elasticity of substitution, as well as the labor and capital shares in production, given to the following structural relationships: $\hat{\sigma} = -1/\hat{\kappa}_3$, $\hat{\alpha} = \hat{\kappa}_2/(1+\hat{\kappa}_3)$, y $\hat{\kappa}_1 + \hat{\kappa}_2 = 1 + \hat{\kappa}_3$.

From equation (3.6) Anderson, Larch and Yotov (2020) proposes the estimation of:

$$\ln K_{jt} = \psi_1 \ln E_{jt-1} + \psi_2 \ln K_{jt-1} + \psi_3 \ln P_{jt-1}^{\sigma-1} + \nu_t + \vartheta_j + \varepsilon_{jt} \quad (3.9)$$

As pointed out by Anderson, Larch and Yotov (2020), equation (3.9) captures the effect of trade (liberalization) on capital accumulation. Its estimation provides three results: (i) testing whether there is a causal relationship between trade openness and temporary growth; (ii) providing an estimate of the elasticity of substitution; and (iii) providing an estimate of the rate of capital depreciation. Equation (3.9) imposes the following structural relationships: $\psi_1 = \delta$; $\psi_2 = 1 - \delta$; and $\psi_3 = -\delta/(\sigma - 1)$. Thus, to the extent that multilateral resistances as an importer are a measure of general equilibrium trade costs, a significant estimate of ψ_3 supports a causal relationship between trade and capital accumulation.

Finally, Anderson, Larch and Yotov (2020) propose the estimation of a reduced form of the income equation, which takes the following form:

$$\ln Y_{jt} = \kappa_1 \ln L_{jt} + \kappa_2 \ln E_{jt-1} + \kappa_3 \ln K_{jt-1} + \kappa_4 \ln \mathrm{P}_{jt-1}^{\sigma-1} + \kappa_5 \ln \Pi_{jt}^{\sigma-1} + \nu_t + \vartheta_j + \varepsilon_{jt} \quad (3.10)$$

with $k_1 = (1-\alpha)(\sigma-1)/\sigma$, $k_2 = \alpha\delta(\sigma-1)/\sigma$, $k_3 = \alpha(1-\delta)(\sigma-1)/\sigma$, $k_4 = -\alpha\delta/\sigma$, y $k_5 = -1/\sigma$. Equation (3.10) enables to identify the direct effect of trade on income, through trade openness (term $\ln \Pi_{jt-1}^{\sigma-1}$), as well as the indirect effect of trade on income via the accumulation of capital (term $\ln P_{jt-1}^{\sigma-1}$). It also reveals the elasticity of substitution $\hat{\sigma} = 1/\hat{\kappa}_5$, the capital share in output value $\hat{\alpha} = 1 - \hat{\kappa}_1/(1+\hat{\kappa}_5)$, and the transition rate of the capital stock $\hat{\delta} = \hat{\kappa}_2/(\hat{\kappa}_2 + \hat{\kappa}_3)$, subject to the following restrictions: $\hat{\kappa}_2 = (1/\hat{\kappa}_5 + 1)\hat{\kappa}_4$ y $\hat{\kappa}_1 = 1 + \hat{\kappa}_5 - \hat{\kappa}_2 - \hat{\kappa}_3$.

The estimation of equations (3.8), (3.9) and (3.10) involve quite a few challenges derived from the potential endogeneity of the explanatory variables. For their estimation we follow Anderson, Larch and Yotov (2020), and use different specifications of estimators with instrumental variables. See Table 3.2 for the list of instruments used in each of the three equations.

3.3. Estimation results

Table 3.1 reports the results of various specifications of the structural gravity equation. In all cases the estimates are statistically significant at the usual levels and have the expected signs.

The applied tariff term (AT_{ijt}) aims to identify the effect of the heterogeneous treatment that each country i receives from a given importing country j on bilateral trade flows. The coefficients show, as expected, that imports increase in the face of lower tariffs. An important implication of including applied tariffs is that the (absolute) value of the estimated coefficient is a measure of the elasticity of substitution between varieties produced by different origins, the parameter σ in equation (3.7). The estimated value, which varies between 3.503 and 3.802, falls within the range of values reported in the literature according to Head and Mayer (2014).

Higher levels of openness, often manifested in the signing of preferential trade agreements, may also be associated with other liberalizing trade policies, such as trade facilitation, special regimes or FDI facilitation policies, among others. Based on this assumption, and following Moncarz et al. (2023), we propose to use the number of liberalized bilateral relations of each country as a consequence of the signature of PTAs to assess the preference for openness. This choice is based on the stylized fact that countries with more liberalized bilateral relations have higher levels of trade openness. In particular, the variable we propose $(NRBL_{ijt})$ corresponds to the product of the number of preferential bilateral relations that a given country pair ij possesses at a time t. As expected, and as reported in columns (3) and (4) of Table 3.1, positive and statistically significant coefficients are obtained. The same is true for the variable that measures the complementarity (CC_{ijt}) between the sectoral structure of country i's imports and that of country j's exports.

Table 3.1. Structural gravity equation results.1995-2017

	(1)	(2)	(3)	(4)
DTA_{ijt}	0.232***	0.252***	0.197***	0.210***
$NRBL_{ijt}$			0.0000688***	0.0000739***
$\ln(1+AT_{ijt})$	-3.503***	-3.625***	-3.630***	-3.802***
CC_{ijt}	1.427***	1.372***	1.345***	1.277***
Bias correction	No	Yes	No	Yes
# Observations	287,638	287,638	287,638	287,638

Robust standard errors.*** p<0.01, ** p<0.05, * p<0.1. In all cases we controlled for globalization effects, and included origin-time, destination-time, and origin-destination fixed effects.

As mentioned above, the variable AT_{ijt} controls for the heterogeneity that exists in the tariff treatment that importer j offers to imports from different origins i. This heterogeneity is explained to a greater extent by the existence of preferential trade agreements, but also by the so-called Generalized Systems of Preferences, which include tariff preferences granted unilaterally by developed economies. Within the group of preferential trade agreements, however, there may be important differences. On the one hand, there are agreements with a limited scope, both in terms of the products covered and in the depth of the trade agreement. With regard to the latter, a distinction that is becoming increasingly important in applied analysis relates to the different disciplines included in trade agreements, which have given rise to the concept of deep trade agreements, i.e. those agreements that go beyond tariff preferences and advance on different dimensions of economic relations between countries, such as the homogenization of labor policies, the adoption of common technical criteria, etc. As can be seen in Table 3.1, the fact that a pair ij is linked by a deep trade agreement $(DTA_{ijt}=1)$ increases trade, between 21.7% and 28.7% over what would be expected from the lower applied tariffs associated with the signing of a preferential trade agreement.

Table 3.2 presents the results of equations (3.8), (3.9) and (3.10), which, as mentioned above, correspond to the extension of the structural gravity model to allow for capital accumulation. Columns (1), (3) and (5) report the results of the instrumental variables estimations, while columns (2), (4) and (6) additionally impose the restrictions arising from the structural model as discussed above. Before commenting on the results, let us note that, in the case of the static version of the income equation (3.8) and the capital equation (3.9), the instruments used meet the required conditions, as derived from the results of the

Kleibergen-Paap rk LM and the Hansen J tests. However, this is not the case for the dynamic income equation (3.10), where the Hansen J test rejects the null hypothesis that the excluded instruments are correctly excluded.

For the static income equation (3.8), the results show a positive and significant relationship between factor endowments (labor and capital) and income. The negative coefficient for $\ln \widehat{\Pi_{Jt}^{\sigma-1}}$ is explained by the fact that greater trade freedom, which is reflected in lower multilateral resistance as an exporter for liberalizing countries, translates into higher factory-gate price, leading to an increase in the value of output/income. The results of the capital equation (3.9) again show statistically significant estimates, and with the expected signs. In this case, the effect of greater trade openness on capital accumulation is again channeled through an increase in the factory-gate price as well as through the decrease in multilateral resistance as an importer. Higher factory-gate prices incentivize higher investment in countries that are open to international trade, similar to the effect of lower multilateral resistance as an importer, the reduction in $\ln \widehat{P_{Jt}^{\sigma-1}}$ following liberalization. Finally, the coefficients of multilateral resistance as exporter $\left(\ln \widehat{\Pi_{Jt}^{\sigma-1}}\right)$ and as importer $\left(\ln \widehat{P_{Jt}^{\sigma-1}}\right)$ that evidence the effect of trade liberalization in the dynamic reduced form of income (3.10), have the expected negative sign, but are statistically significant only when the restrictions by the structural model are imposed.

As for the values of the structural parameters derived from the equations, they are significant in all cases except for equation (3.10), when no structural constraints are imposed. The values obtained for the elasticity of substitution (σ) are within the range reported in the literature, as discussed in Head and Mayer (2014). For the share of capital in output (α), the values are also within the range reported in the empirical evidence. Finally, the estimates of the depreciation rate (δ) in column (3) seems to be very low, while the values reported in columns (5) and (6) seem somewhat high at first sight. However, the latter can be justified following Anderson, Larch, and Yotov (2020), who point out that in their model the parameter δ combines the depreciation of old capital with the adjustment costs when incorporating the investment in new capital. Given the variability of the values obtained for the different parameters, in the next section an average of the values resulting from the different estimates are used: $\sigma = 3.277$[13]; $\alpha = 0.503$; $\delta = 0.143$. These are similar to the ones used by Anderson, Larch and Yotov (2020) in their simulations on the impact of NAFTA.

[13] This value is just below those obtained from equation (3.7) and reported in Table 3.1.

Table 3.2. Trade, income and capital accumulation, 1995-2017

Equation	Income static (equation 3.8)		Capital (equation 3.9)		Income dynamic (equation 3.10)	
Estimator	IV (1)	IV Rest. (2)	IV (3)	IV Rest. (4)	IV (5)	IV Rest. (6)
$\ln L_{jt}$	0.444***	0.358***			0.4420***	0.1610***
$\ln K_{jt}$	0.291***	0.320***				
$\ln \widehat{\Pi_{jt}^{\sigma-1}}$	-0.181***	-0.322***			-0.2610	-0.2650***
$\ln E_{jt-1}$			0.0136***	0.0077***	0.0557	0.1210***
$\ln K_{jt-1}$			0.9790***	0.9920***	0.2110***	0.4520***
$\ln \widehat{P_{jt-1}^{\sigma-1}}$			-0.0155***	-0.0140***	-0.2000	-0.0428***
# Observations	1,566	1,566	2,090	2,090	1,566	1,566
R^2	0.998	0.998	1.000	1.000	0.999	0.999
Underid. Test – Kleibergen-Paap rk LM statistic	47.93***		73.61***		12.23***	
Hansen J statistic	4.952		1.114		16.55***	
$\hat{\sigma}$	5.525**	3.106***	1.877***	1.549***	3.831	3.774***
$\hat{\alpha}$	0.355***	0.472***			0.402	0.781***
$\hat{\delta}$				0.008***	0.209	0.211***
Instruments	$\ln \widetilde{\Pi}_{jt}^{\sigma-1}$; $\ln \widetilde{\Pi}_{jt-1}^{\sigma-1}$; $\ln \widetilde{\Pi}_{jt-2}^{\sigma-1}$; $\ln \widetilde{\Pi}_{jt-3}^{\sigma-1}$; $\ln K_{jt-4}$; $\ln POP_{jt}$; $\tilde{t}_{ijt}^{\sigma-1}$; ND_{jt}; TFP_{jt-5}		$P_{jt-1}^{\sigma-1}$; $P_{jt-2}^{\sigma-1}$; $\ln E_{jt-2}$; $\ln K_{jt-4}$; ND_{jt-1}		$\ln \widetilde{\Pi}_{jt}^{\sigma-1}$; $P_{jt-5}^{\sigma-1}$; $\ln K_{jt-5}$; $\ln E_{jt-4}$; $\tilde{t}_{ijt}^{\sigma-1}$; ND_{jt-1}; TFP_{jt-4}	

Robust standard errors. *** p<0.01, ** p<0.05, * p<0.1. In all cases, country and time fixed effects were included. $\boldsymbol{\widetilde{\Pi}_{jt}^{\sigma-1}}$: inverse of multilateral resistance as exporter, using population data from 1995 as weights and excluding the internal trade component. $\boldsymbol{P_{jt}^{\sigma-1}}$: inverse of multilateral resistance as importer, using population data from 1995 as weights and excluding the internal trade component. $\boldsymbol{POP_{jt}}$: population. $\boldsymbol{\tilde{t}_{ijt}^{\sigma-1}}$: instrument based on the inverse of trade costs estimated with a traditional gravity model without using exporter and importer fixed effects because they would contaminate the IV estimate, since they implicitly take into account income and expenditure. $\boldsymbol{ND_{jt}}$: instrument based on the occurrence of natural disasters. $\boldsymbol{TFP_{jt-5}}$: measure of total factor productivity, obtained from the Penn World Tables.

4. Contrafactual analysis

The starting point is to solve the SDGMT for the set of endogenous variables: income, capital, export prices, import prices, and factory-gate prices (see Appendix B) in a baseline scenario, corresponding to the trade costs estimated in section 3 (see Table 3.1) for the year 2017. The counterfactual exercise consists of simulating the trade costs reduction according to three scenarios, depending on the countries that are members of the CPTPP:

i. CPTPP according its current composition (CPTPP),
ii. CPTPP including the accession of Costa Rica, Ecuador, Ukraine, Uruguay (CPTPP+4),
iii. CPTPP including the accession of China, Costa Rica, Ecuador, Ukraine, Uruguay (CPTPP+5).

For each of the scenarios, the change between the baseline and counterfactual equilibria are analyzed. In the short-run or static equilibrium it is assumed that there is no capital accumulation. In this equilibrium, real output is constant. The effect of the reduction in trade costs (t_{ijt}) among countries that become members of the agreement affects the average prices of buying (P_{jt}) and selling (Π_{it}). The selling price together with the relative size of the economies $\left(\frac{Y_{jt}}{Y_t}\right)$ affect the factory-gate prices (p_{jt}) and through this mechanism, the output value.

The second counterfactual equilibrium is the long-run or dynamic equilibrium in a new steady state, for which capital accumulation and production growth are allowed. The steady state equilibrium for capital (K_{jt}) is presented in Appendix B (see equation B.6'). In summary, 2 equilibria for each of the 3 counterfactuals are analyzed.

In order to perform the counterfactual exercises, the estimates in section 3 are used (see Table 3.2). The value of the elasticity of substitution is $\sigma = 3.277$, the share of capital in the value of production $\alpha = 0.503$, and the depreciation rate of capital $\delta = 0.143$[14].

To obtain a measure of the statistical significance of the results, for each scenario, two hundred realizations of trade costs are simulated based on the estimation of the structural gravity model (equation 3.7). The procedure involves generating two hundred pseudo-random realizations of the estimated parameters, using the estimated variance-covariance matrix. Only the coefficients for the variables DTA_{ijt}, $NRBL_{ijt}$, AT_{ijt}, CC_{ijt}, and IT_t are considered, assuming that the values of the origin-time (η_{it}), destination-time (ξ_{jt}), and origin-destination (ψ_{ij}) fixed effects remain constant[15]. Finally, two hundred counterfactuals are run, using the results to obtain the interquartile range for each of the outcome variables (welfare, capital, trade, etc.).

The change in welfare is measured as the percent change in real consumption. In the steady state, this change is also equal to the change in the stock of capital and the change in real income in terms of consumer prices (see equation B.8 in Appendix B). Note that consumer prices include also purchases on the domestic market. In the static equilibrium, this change is purely a relative price effect between the change in the output and the purchase prices. That is, trade liberalization generates a terms of trade effect that translates into a change in openness that is directly related to the change in welfare (see equation B.9 in Appendix B). In dynamic equilibrium, there is capital accumulation and real output changes in addition to the price change. This second effect is a consequence of the relative price change mentioned above, so the welfare effect is amplified (see equations B.10 and B.11 in Appendix B).

Graph 4.1 shows that the welfare effect for CPTPP members is positive in all counterfactuals, with the largest effects associated with China joining the agreement (CPTPP+5), with a maximum effect of 2.6% relative to the

[14] For the transitional equilibrium, we use a consumer discount factor $\beta = 0.98$, which is standard in the literature.
[15] The only reason for this is choice is to ensure that the problem remains within the limits of computational feasibility.

baseline scenario. In general, the welfare effect in the new steady state - the long-run effect - is larger than in the static equilibrium, almost twice as large for the countries that are members of the agreement.

The group of nonmember countries have overall positive but small effect on welfare, however there are some countries with negative effects in welfare. Countries' individual results are presented in Appendix C (Table C.2 to C.4). The size of the effect within this group can be associated to the proximity of each economy to the treated ones in terms of permanent trade costs. The sign depends of the balance between the positive liberalization effects through the trade facilitation mechanism and the negative effect associated with the reduction in the multilateral resistances of treated countries.

The effect of the agreement on the world as a whole is positive of reduced magnitude. All of the interquartile ranges of welfare estimates exclude the zero value, except for the non-treated countries.

Following ALY (2020) we estimate de discounted welfare gains between baseline and the new steady state equilibrium, summing yearly the level of consumption in the baseline scenario that consumers need to be paid to achieve the same level of utility as in the counterfactual scenario (eq. B.12 in Appendix B). Using a standard value for the utility discount factor (0.98), the transitional equilibrium reports welfare gains that are about 87% of those obtained for the dynamic equilibrium (see table C.2 in Appendix C). Nearly three-fourths of the discounted long-term effect is achieved within a 20-year time horizon (see Graph C.1. in Appendix C).

The dynamic equilibrium allows a decomposition of the welfare gains (W) into two components: the increase in real output (GDPr) and the improvement in the terms of trade (T.I.). Equation 4.1 (see Appendix B) summarizes this decomposition, where a country's gains are related to the magnitude of trade costs reduction.

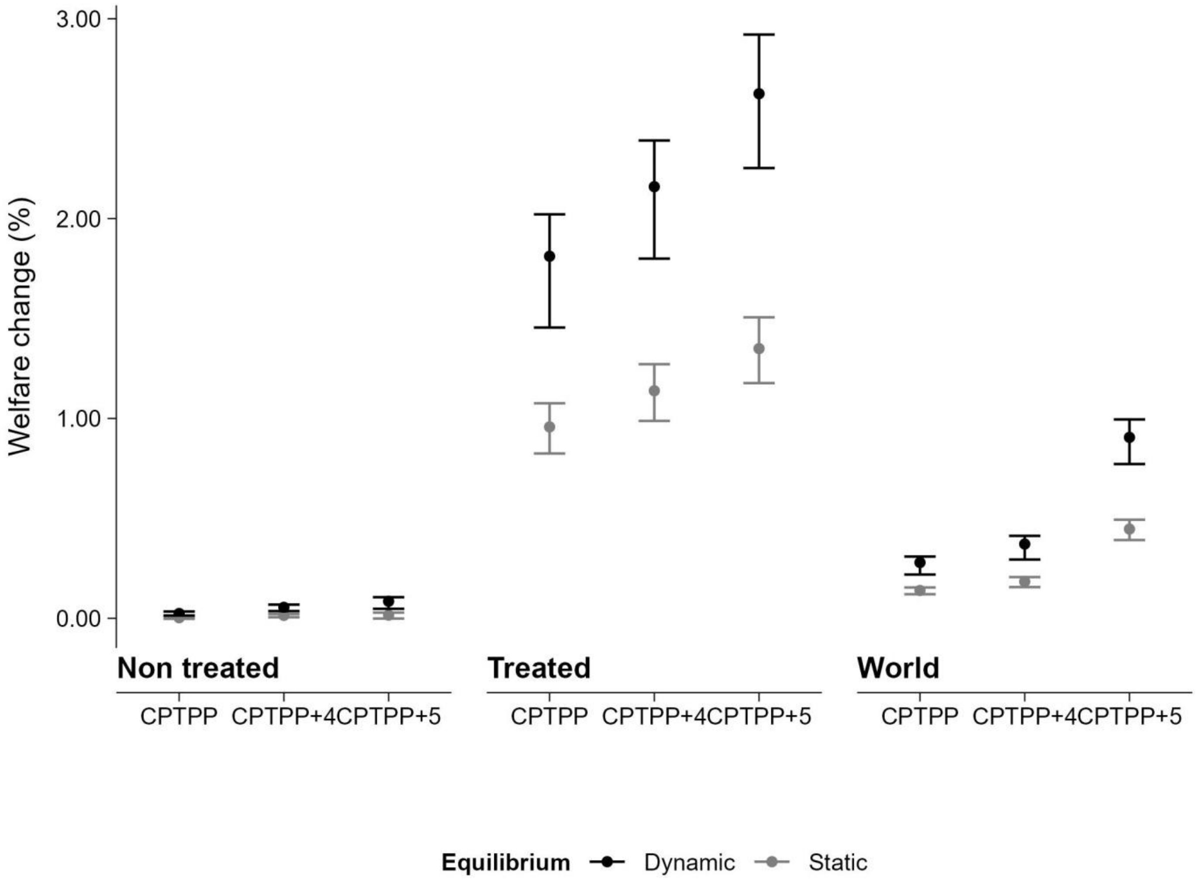
$$w_j = k_j = (\lambda_j)^{1/(1-\sigma)(1-\alpha)} = \underbrace{(\lambda_j)^{1/(1-\sigma)}}_{T.I.}\underbrace{(\lambda_j)^{\alpha/(1-\sigma)(1-\alpha)}}_{GDPr} \quad (4.1)$$

This relationship is established according to the domestic supply method ($\lambda_{jt} = \frac{X_{jjt}}{Y_{jt}}$), either through greater openness or through domestic production, which is captured by the ratio $\lambda_j = \frac{\lambda_{jC}}{\lambda_{jB}}$ and the two of the structural parameters of the model (elasticity of substitution (σ) and the share of capital in the value of production (α)). Results show that terms of trade and real GDP growth contribute in similar percentages to the increase in welfare.

Table 4.1 disaggregates the results for each member country. Member countries are arranged geographically (Oceania, East and Southeast Asia, the Americas, and Europe), the potential new members are listed last.

The countries that benefit most from the agreement in terms of welfare are some Asian countries (Malaysia, Vietnam, and Singapore), followed by New Zealand in Oceania. However, if China becomes member, Uruguay and Costa Rica rank fourth and fifth, respectively. China and Japan, as well as the American countries (Mexico, Chile, Ecuador and Peru), are the least favored. This heterogeneity can be attributed to the ways the extensive and intensive margins work for each country. The scenarios involving China produce the largest welfare gain. Considering the dynamic equilibrium, the CPTPP alone results in a maximum gain of 3.8% for Singapore and Malaysia. When China is included, the largest gain is just above 6.7% for Vietnam.

Graph 4.1. Welfare variation by groups of countries. Estimate and Interquartile range



Source: own

Table 4.1. Change in welfare for treated countries according to scenario. Dynamic equilibrium (%)

Scenario	AUS	NZL	MYS	VNM	SGP	JPN	CAN	MEX	PER	CHL	GBR	UKR	ECU	CRI	URY	CHN	Treated
CPTPP	2.1	3.0	3.8	3.3	3.8	1.2	1.9	0.9	1.4	1.4	2.3						**1.8**
CPTPP+4	2.4	3.5	4.4	4.0	4.3	1.4	2.3	1.1	1.7	1.8	2.8	1.8	2.8	3.9	2.6		**2.2**
CPTPP+5	4.0	4.7	6.3	6.7	6.2	3.5	3.8	2.3	2.5	3.8	4.2	2.8	3.8	4.8	5.6	1.6	**2.6**

Source: own

The largest impact on the signatory countries occurs in the trade variable (exports and imports), with rates of change that far exceed the variations in income and welfare. The aggregate exports of all member countries are expected to increase by almost 10% (Table 4.2), leveraged by an increase of 40.9% within member countries, while exports to non-participating countries would diminish by 1%.

At the country level, the decline in trade costs would, as expected, lead to a reduction in the importance of domestic sales due to increased competition from foreign goods. As equation (4.1) shows, the countries with the largest relative declines in domestic sales (as a percentage of GDP), measured by the parameter λ_j, are the countries with the largest welfare gains. However, at the same time, the increase in total exports means an increase in total sales. Ukraine, Ecuador, Uruguay, the United Kingdom and Japan are the countries with the largest increases in exports to other members, while Singapore, New Zealand and Chile are at the opposite extreme. In terms of total exports, Japan, Uruguay, Australia and China are the most favored, while the United Kingdom, Costa Rica, Canada and Mexico experience the smallest gains.

Table 4.2. Variation in internal trade and exports of members of the agreement (CPTPP+5)

Country	λ_j	Exports destination (%)		
		No partners	Partners	Total
AUS	0.957	-4.3	31.7	13.7
NZL	0.949	-4.3	22.2	10.8
MYS	0.934	-2.9	28.5	10.4
VNM	0.930	-0.6	33.9	11.6
SGP	0.935	-4.5	23.9	7.9
JPN	0.962	-4.3	54.6	17.0
CAN	0.959	-2.2	45.8	4.6
MEX	0.975	-0.9	30.7	2.0
PER	0.972	-2.8	29.9	8.2
CHL	0.958	-4.5	20.5	6.5
GBR	0.955	-0.1	55.7	6.5
UKR	0.969	0.7	66.7	4.9
ECU	0.959	1.3	51.0	12.0
CRI	0.948	-1.6	33.0	5.4
URY	0.940	-2.4	56.4	14.2
CHN	0.983	1.3	43.2	12.9
Total	0.971	-1.1	40.9	9.4

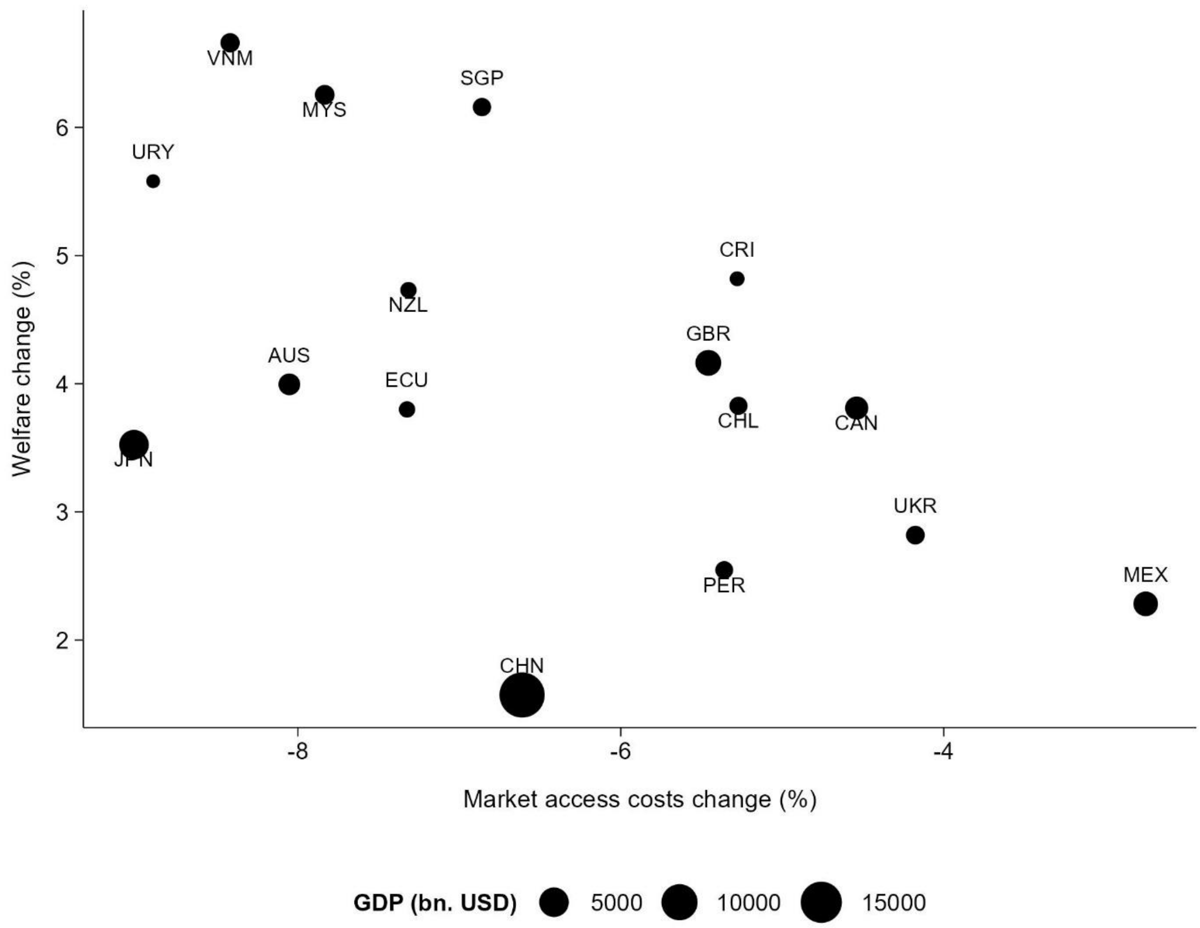
Source: own

Graph 4.2 illustrates the relationship between the variation in each member's welfare attributable to entering the CPTPP (counterfactual vs. baseline) and the reduction of total trade costs due to the same reason (market access costs). The latter is measured as the variation in costs for an exporting country towards its target markets relative to trading with itself. This relative trade costs are a power transformation of the well-known index developed by Agnosteva et al. (2014), called Constructed Intrarregional Bias (CIB), which is derived from the structural gravity model.[16] In Graph 4.2, the size of each country is measured by its GDP and is represented by the size of the bubbles. The results reveal that greater reductions in market access costs lead to higher welfare gains.

All participating countries experience a reduction in trade costs of more than -3.3% (Mexico), with Japan achieving the largest reductions (-10.5%), followed by Vietnam and Uruguay (-9.2%). Additionally, besides the positive correlation between the reduction in trade costs and the increase in welfare, smaller countries which are close to major consumption centers, such as Malaysia, Vietnam, and Singapore, benefit the most. Similarly, countries that are geographically distant and had little prior integration into this agreement, like Uruguay, also gain significantly from the reduction in trade costs.

[16] For country i as an exporter, market access costs are measured as $\xi_{it} = \left(\frac{GDP_{it}}{\sum_{j \neq i} GDP_{jt}} \frac{X_{it}}{X_{iit}}\right)^{\frac{1}{1-\sigma}}$.

Graph 4.2. Welfare gains vs. total market access cost reduction



Source: own

From the perspective of a country as an exporter, it can be shown that the change in welfare is given by the following expression:

$$w_i = \frac{W_{iC}}{W_{iB}} = \left(\frac{\xi_{iB}}{\xi_{iC}}\right)^{\frac{1}{(1-\alpha)}} \left(\frac{X_{iC}/\sum_{j\neq i} GDP_{jC}}{X_{iB}/\sum_{j\neq i} GDP_{jB}}\right)^{\frac{1}{(1-\sigma)(1-\alpha)}} \tag{4.2}$$

As equation (4.2) shows, from the first term it is clear that a larger reduction in market access costs favors the increase in welfare, however, from the second term we have that countries for which their exports gain more participation in other countries' expenditures, *ceteris paribus*, benefit less. This latter effect would explain the results for Japan and China, which rank first and fourth, respectively, in terms of the increase in the share of their exports in other countries' markets.

Finally, as a robustness check, two exercises were carried out using alternative values of some of the model parameters. The values of the parameters used in the baseline and in the alternative settings and their results are summarized in Table 4.3[17]. The first exercise *($R\alpha$)* consisted in increasing the parameter of capital share in the economy, which lead to a more than proportional growth in welfare. Under a higher share of capital (α), the relation between capital sock in counterfactual versus baseline scenario is magnified leading to higher real income and higher consumption, i.e. more aggregate welfare in the economy (see eq. B.8 in Appendix B). Based on this thought, although the exercise did not consider any variations in α to reflect possible country

[17] Table C.4 and Graph C.1 in Appendix C report the results for the robustness exercises.

heterogeneities, it would be expected that more developed countries face greater benefits from signing the agreement, relative to least developed countries, everything else equal.

Table 4.3. Parameters for counterfactual exercises

	Base (B)	**Change α (Rα)**	**Change σ (Rσ)**
Elasticity of substitution (σ)	3.277	3.277	6
Capital share (α)	0.503	0.7	0.503
Results under CPTPP+5 scenario			
Change of Welfare for members	2.6	4.2	1.2
[Inter Quartile range]	*[2.25 - 2.92]*	*[3.5 - 4.7]*	*[0.9 - 1.3]*

Source: own.

The second robustness exercise ($R\sigma$) assumes a higher elasticity of substitution between varieties. In a model where consumers have a preference for variety, the gains from international trade come from access to a larger number of varieties. However, the higher the elasticity of substitution between varieties, the more similar they are, so the smaller the gains from having access to a larger pool of varieties through imports. This effect outweighs the greater reduction in the share of domestic varieties in expenditure, since a higher σ, *ceteris paribus*, leads to a greater substitution of consumption of domestic varieties by imported varieties, given the reduction in the relative price of the latter. Although smaller, the effects on welfare for the treated countries are still statistically different from zero.

5. Summary and conclusions

The analytical framework used in this paper allows focusing on changes in trade costs and their impact on aggregate variables. It is particularly suitable for analyzing the effects of the CPTPP (twelve members including the United Kingdom) and the inclusion of new members. As described in the section two, the CPTPP is a plurilateral agreement that nests a set of previous PTAs that are deepened (intensive margin) and new ones are added (extensive margin). This phenomenon has been called the multilateralization of regionalism, which deepens trade liberalization and increases certainty about the trade rules of participating countries. This is a long-term evolution of the structure of international trade, counteracting ongoing tendencies in the opposite direction[18].

The applied analysis follows the methodology of Anderson, Larch and Yotov (2020). The estimation of the structural gravity model uses the latest available techniques to obtain the determinants of trade costs in order to simulate different scenarios depending on the countries that are member of the CPTPP.

The gravity equation incorporates some following innovations: a discrete variable identifying the effect of deep PTAs (Fontagné et al. (2023)), bilaterally applied tariff that allows trade costs to be asymmetric $(t_{ijt} \neq t_{jit})$ and to control for the heterogeneous treatment that countries give to imports from different origins as a result of preferential agreements. A non-discriminatory effect that is diffused to countries not participating in the agreement due to the greater trade facilitation brought about by the growth in the number of liberalized bilateral relations; and it also controls for countries' trade complementarity by capturing the influence of different productive specializations (Moncarz et al., 2023). In addition, given the dynamic nature of the model, three equations are estimated that provide the effects of liberalization, which translate into reductions in the selling and purchasing prices (multilateral resistances) of the liberalizing

[18] Aggressive unilateralism of trade policy, climate change mitigation policies that use trade as a mechanism to discipline their adoption, increase in geopolitical conflicts.

countries, as well as an increase in the factory-gate price, favoring the rate of investment, which in the long run translates into gains in terms of income and capital. The results of the estimations show statistically significant coefficients with the expected signs. As for the values of the structural parameters (elasticity of substitution, capital share in production and depreciation rate), they are within the ranges reported in the literature, in particular by Anderson, Larch and Yotov (2020).

The counterfactual exercises allow estimating the short- and long-term effects of the CPTPP in an international general equilibrium framework. Three scenarios were constructed: CPTPP in its current composition; CPTPP plus Costa Rica, Ecuador, Uruguay and Ukraine, and CPTPP plus Costa Rica, Ecuador, Uruguay, Ukraine and China[19]. Trade liberalization implies a first effect, which is the reduction of trade costs for countries participating in the agreement, and a trade facilitation effect, which also generates reductions with non-partners. The results are measured in two different equilibria: a static equilibrium, where all changes occurring only through changes in prices; and a dynamic equilibrium, where changes in prices affect real variables (capital stock and output), leading in the long run to a new steady state.

The overall results are clear and parsimonious. Considering the scenario in which China and the rest of new members join the CPTPP, the static equilibrium reports welfare gains for the participating countries in the order of half to the dynamic equilibrium in the steady state, 1.35% compared to 2.62% respectively. Prices improve with liberalization, there is more trade openness, and welfare gains are amplified when prices are allowed to affect real investment decisions (the stock of capital) and hence the real level of output. This process takes time and there is a dynamic transition in which the world economy converges to a new steady state. The speed of convergence depends on the rate of capital depreciation and the discount rate. This correction reduces the welfare gains to 2.28% for the group of countries in the CPTPP+ 5.

The results show heterogeneity among countries, which can be explained by the combination of two factors: the intensity of liberalization for each country according to its starting point (balance between intensive and extensive margin), and the level of structural proximity of the countries to the other members of the agreement (permanent trade costs expressed by bilateral fixed effects ψ_{ij}). Greater liberalization implies greater impact and also greater proximity.

The economies that benefit the most are those of Southeast Asia that belong to ASEAN (Vietnam 6.7%, Malaysia 6.3% and Singapore 6.2% in the steady state), for which the extensive margin is related to the agreements with the countries of the Americas and because they are also closer to the large markets of Asia and Oceania (Japan, China and Australia). Uruguay stands out for appearing in fourth place (5.6%). This last case has a particular interest with the result explained by the large effect of trade liberalization that the agreement implies. This happens despite the fact that Uruguay is an economy that is far from the large Asian markets (high permanent trade costs), but the agreement improves access to these markets (extensive margin) and at the same time deepens trade relations with the American countries with which Uruguay already has preferential relations (intensive margin). Simple robustness exercises were performed in the parameter space. A higher share of capital in the value of production (higher α) amplifies the effect via real output, while a reduction in the degree of differentiation of products according to their origin (increase in σ) reduces both effects, the terms of trade and real output.

[19] As already mentioned, Brunei Darussalam and Taiwan are not considered due to the lack of data.

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Appendix A. Data

Estimation of the structural gravity trade model

The database of bilateral trade flows (including domestic transactions) has a geographical coverage of 113 countries, representing about 94% of world trade during the period 1995-2017, corresponding to the Agriculture, Livestock, Hunting and Fishing (Sector AB) and Manufacturing (Sector D) sectors according to the International Standard Industrial Classification (ISIC, Revision 3). The design of this database is based on Moncarz et al. (2021).

To compile the database it was necessary to develop four separate databases: output in current dollars, total exports in current dollars, domestic transactions in current dollars, and bilateral trade flows in current dollars. These databases were then merged after making the necessary adjustments. The final step was to integrate the bilateral trade flows data with the domestic transactions data.

Aggregate trade data are from CEPII's BACI. An advantage of the BACI database is that it reports trade flows after the harmonization between what is declared by the importing country and what is declared by the exporting country. The data are expressed in FOB values and the original source of information is COMTRADE.

Other data sources used are the UNSTAS National Accounts - Analysis of Principal Aggregates (AMA) database for production and value added; the World Bank's World Development Indicators (WDI) database for value added; and the OECD Input-Output Tables (IOTs), which provide data on production, value added, gross exports and net exports.

The variables on bilateral trade agreements are based on the World Bank's Deep Trade Agreements Database, organized in 18 areas. The typology of agreements includes superficial, medium and deep (Fernandez, Rocha and Ruta, 2023), adjusted by data from the Latin American Integration Association (ALADI) and the World Trade Organization (WTO). The DTA variable used in the econometric model is based on information from Fontagné et al. (2023), which provides a classification of agreements according to their depth and degree of commitment.

To construct the variable product of liberalized bilateral relations, we used information on trade agreements from the Dynamic Gravity Dataset (DGD) prepared for the United States International Trade Commission (USITC), with corrections based on information from ALADI, OAS, WTO and Fontagné et al. (2023).

The commercial complementarity variable was calculated as in Moncarz et al. (2023).

The applied tariff variable comes from Teti (2020) database. First, for each sector AB and D, we have the simple average of the tariffs applied by country j on imports originating in country i. To obtain the tariff applied by country j on imports originating in country i for sectors AB and D together, we calculate the weighted average, using as weights the total exports of exporting country i of goods corresponding to each of the two sectors.

Estimation of income and capital equations and counterfactual exercises

Data on GDP, employment, capital stock, and total factor productivity are from the Penn World Tables (version 10.1).

Following Anderson, Yotov, and Larch (2020), we use Real GDP using national-accounts growth rates (variable rgdpna) for the income and capital equations. Instead, Output-side real GDP at current PPPs (variable cgdpo) was used as the starting level in the counterfactual exercises, which compare the relative productive capacity between countries at a single point in time. Employment is measured in effective units, as the product of the number of persons employed in the labor force (variable emp) and the human capital index (variable hc), based on average years of schooling. The capital stock corresponds to the series at constant national prices (variable rnna).

Total factor productivity corresponds to the series TFP at current values corrected by PPPs (variable ctfp).

The occurrence of natural disasters comes from the International Disaster Database.

Finally, the standard gravity model variables come from the CEPII Distance Database.

Due to missing data, 3 of the 113 countries were excluded from the counterfactual exercises: Cuba, Samoa, and Tonga.

Appendix B. The model

Anderson and van Wincoop (2003) derive the SGMT in the framework of a monopolistic competition model with products differentiated by origin, for given costs and outputs. The SGMT equations are presented in the system B.1 (NxNxT equations), B.2 (NxT equations), B.3 (NxT equations) and B.4 (NxT equations).

$$X_{ijt} = \frac{Y_{it}E_{jt}}{Y_t}\left(\frac{t_{ijt}}{\Pi_{it}P_{jt}}\right)^{1-\sigma} \tag{B.1}$$

$$\Pi_{it} = \left[\sum_j \frac{E_{jt}}{Y_t}\left(\frac{t_{ijt}}{P_{jt}}\right)^{1-\sigma}\right]^{1/1-\sigma} \tag{B.2}$$

$$P_{jt} = \left[\sum_i \frac{Y_{it}}{Y_t}\left(\frac{t_{ijt}}{\Pi_{it}}\right)^{1-\sigma}\right]^{1/1-\sigma} \tag{B.3}$$

$$p_{jt} = \frac{\left(\frac{Y_{jt}}{Y_t}\right)^{1/1-\sigma}}{\Pi_{jt}\gamma_{jt}} \text{[20]} \tag{B.4}$$

where: X_{ijt} is the bilateral trade from origin country i to destination country j at time t, Y_{it} is the output of country i at time t, E_{jt} is the expenditure of country j at time t, Y_t is world output (equal to world expenditure) at time t; t_{ijt} are the trade costs between origin i and destination j at time t[21], Π_{it} is the outward MR (the aggregate selling price) of country at time t, P_{jt} is the inward MR (the aggregate purchase price) of country j at time t, and σ is the elasticity of substitution between the different varieties produced in the different origins. Equation B.4 determines output prices that depend negatively on supply $\left(\frac{Y_{jt}}{Y_t}\right)$ and the aggregate selling prices (Π_{jt}).

Anderson, Larch and Yotov (2020) propose a dynamic version of the gravity model (SDGMT) in which the level of expenditure and income are endogenous, using a mechanism that links the prices obtained at the first level (equations B.1 to B.4) to the dynamics of capital accumulation[22]. The structure of the economy is given by consumers seeking to maximize an intertemporal utility function with an appropriate discount rate[23]. The solution to the problem generates two new set of equations. Equation B.5 is the income function for each country j, while equation (B.6) describes the optimal behavior of capital given the second-level maximization problem, which determines the dynamic adjustment to a new steady state.

$$Y_{jt} = \mathrm{p}_{jt}A_{jt}{L_{jt}}^{1-\alpha}{K_{jt}}^{\alpha} \tag{B.5}$$

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[20] Note that the factory-gate price for each country arises from the following derivation. First the demand function that arises from the first level of optimization for a given income: $X_{jit} = \frac{Y_{it}}{{P_{it}}^{1-\sigma}}\left(\gamma_{jt}p_{jt}t_{jit}\right)^{1-\sigma}$. Then adding up for all destinations: $Y_{jt} = \sum_i X_{jit} = \sum_i Y_{it}\left(\frac{\gamma_{jt}p_{jt}t_{jit}}{P_{it}}\right)^{1-\sigma} = \left(\gamma_{jt}p_{jt}\right)^{1-\sigma}\sum_i Y_{it}\left(\frac{t_{jit}}{P_{it}}\right)^{1-\sigma}$. Finally: $\frac{Y_{jt}}{Y_t} = \left(\gamma_{jt}p_{jt}\right)^{1-\sigma}\sum_i \frac{Y_{it}}{Y_t}\left(\frac{t_{jit}}{P_{it}}\right)^{1-\sigma} = \left(\gamma_{jt}p_{jt}\right)^{1-\sigma}{\Pi_{jt}}^{1-\sigma}$, and the factory-gate price is: $p_{jt} = \frac{\left(\frac{Y_{jt}}{Y_t}\right)^{1/1-\sigma}}{\Pi_{jt}\gamma_{jt}}$.

[21] Trade costs are specified as $t_{ijt} = \tau_{ij}\tau_{ijt}$, where τ_{ij} are the permanent trade costs associated with factors such as physical and cultural distance, etc., and τ_{ijt} are the trade costs that change over time and refer to tariff and non-tariff barriers, basically influenced by trade policy.

[22] As a simplifying assumption, which we keep here, trade is balanced and therefore output is equal to expenditure ($Y_{it} = E_{it}$).

[23] The consumer's problem is to solve the following maximization problem: $\max_{C_{jt},\Omega_{jt}} \sum_{t=0}^{\infty}\beta^t \ln C_{jt}$, subject to the following restrictions: $K_{jt+1} = {\Omega_{jt}}^{\delta}{K_{jt}}^{1-\delta}$, $Y_{jt} = \mathrm{p}_{jt}A_{jt}{L_{jt}}^{1-\alpha}{K_{jt}}^{\alpha}$, $Y_{jt} = P_{jt}C_{jt} + P_{jt}\Omega_{jt}$. Where: C_{jt} is consumption in country j, at time t, Ω_{jt} is investment in country j, at time t, K_{jt} is the stock of capital in country j, at time t, p_{jt} is the Factory-gate Price of country j's production, at time t, A_{jt} is a measure of productivity in country j, at time t, and L_{jt} is the labor endowment of country j, at time t,. In addition to the elasticity of substitution (σ), another key parameters are the consumer discount rate (β), δ the capital depreciation rate (δ), and the share of capital in total output (α).

$$K_{jt+1} = \left[\frac{\alpha\beta\delta Y_{jt}}{(1-\beta+\beta\delta)P_{jt}}\right]^{\delta} {K_{jt}}^{1-\delta} \tag{B.6}$$

Given a certain trade costs t_{ijt}, an initial stock of capital K_{j0}, and a set of parameter values β, σ, δ and α, the system B.2-B.6 allows to obtain for each country j the values for the following set of variables: Π_{j1}, P_{j1}, p_{j1}, E_{j1} y K_{j1}, after iterating until the system converges to a new steady state. The steady state equilibrium to which the system converges can be easily obtained from equation B.6. With the other 4 equations we can solve for the rest of the endogenous variables in the steady-state equilibrium. The proposed procedure converges to:

$$K_{jS} = \frac{\alpha\beta\delta Y_{jS}}{(1-\beta+\beta\delta)P_{jS}} \tag{B.6'}$$

where the subscript S refers to the steady-state equilibrium.

We simulate changes in trade costs and obtain the effects on the endogenous variables mentioned above in two different equilibrium contexts. One is a short-run equilibrium in which capital accumulation is absent (static model), and the other is a short-run equilibrium in which capital decisions also become endogenous (dynamic model). In the static equilibrium, only equations B.2 to B.4 are required. All changes that occur for a given country j are reflected only through prices $(p_{jt}, \Pi_{it}, P_{jt})$ and in the value of income (Y_{jt})[24]. The dynamic equilibrium is as presented in the beginning with equations B.2 to B.6.

The effects of trade costs changes are evaluated under different scenarios. The baseline scenario is the one observed before the changes (B). Then, different exercises of changes in trade costs are carried out. This is generally referred to as the counterfactual scenario (C).

$$K_{jB} = \frac{\alpha\beta\delta Y_{jB}}{(1-\beta+\beta\delta)P_{jB}} \qquad K_{jC} = \frac{\alpha\beta\delta Y_{jC}}{(1-\beta+\beta\delta)P_{jC}}$$

Taking the ratio K_{jC}/K_{jB} we obtain:

$$k_j = \frac{K_{jC}}{K_{jB}} = \frac{P_{jB}Y_{jC}}{Y_{jB}P_{jC}} = \frac{y_j}{P_j} = \frac{p_j}{P_j}{k_j}^{\alpha} \tag{B.7}$$

where: $y_j = \frac{Y_{jC}}{Y_{jB}}$; $P_j = \frac{P_{jC}}{P_{jB}}$; $p_j = p_{jC}$ given that $p_{jB} = 1$ is chosen as normalization.

The change in capital is equal to the change in real income $\left(\frac{Y_j}{P_j}\right)$, which is a way of computing the change in welfare since its change is equal to the change in real consumption[25].

$$w_j = k_j = \frac{Y_j}{P_j} = c_j = \frac{p_j}{P_j}{k_j}^{\alpha} \tag{B.8}$$

where: $w_j = \frac{W_{jC}}{W_{jB}}$; $c_j = \frac{C_{jC}}{C_{jB}}$.

It is possible to derive the same measure of welfare change using the level of openness of the economy measured as the domestic supply of expenditure ($\lambda_{jt} = \frac{X_{jjt}}{Y_{jt}}$). For this purpose and using the gravity equation it can be shown that[26]:

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[24] In this equilibrium, physical production (Q_j) is constant, with income given by $Y_j = p_j Q_j$.

[25] Given: $K_{je} = \frac{\alpha\beta\delta Y_{je}}{(1-\beta+\beta\delta)P_{je}} = \frac{\alpha\beta\delta P_{je}(C_{je}+\Omega_{je})}{(1-\beta+\beta\delta)P_{je}} = \frac{\alpha\beta\delta(C_{je}+K_{je})}{(1-\beta+\beta\delta)}$ with e=B,C. In the steady state it is satisfied that: $\Omega_{je} = K_{je}$. Then, consumption is: $C_{je} = K_{je}\left(\frac{(1-\beta+\beta\delta)}{\alpha\beta\delta} - 1\right) = K_{je}\left(\frac{(1-\beta(1-\delta(1-\alpha)))}{\alpha\beta\delta}\right) = \frac{\alpha\beta\delta Y_{jC}}{(1-\beta+\beta\delta)P_{jC}}\left(\frac{(1-\beta(1-\delta(1-\alpha)))}{\alpha\beta\delta}\right) = \frac{Y_{jC}}{P_{jC}}\left(\frac{(1-\beta(1-\delta(1-\alpha)))}{(1-\beta+\beta\delta)}\right)$. The change in consumption is equal to the change in real income and therefore also to the change in capital.

$$\left(\lambda_{jt}\right)^{1/1-\sigma} = \frac{p_{jt}}{P_{jt}} \tag{B.9}$$

If the degree of openness, given by $\left(1-\lambda_{jt}\right)$ increases (falls) is because the relative product to consumption prices $\left(\frac{p_{jt}}{P_{jt}}\right)$ increase (fall)[27]. Substituting (B.9) in (B.8):

$$w_j = \left(\lambda_j\right)^{1/1-\sigma} k_j{}^{\alpha} \tag{B.10}$$

where: $\lambda_j = \frac{\lambda_{jC}}{\lambda_{jB}}$.

Returning to the change in capital, one can further reduce the expression and see that it depends exclusively on the change in openness, which in turns depend on the change in relative price between the factory-gate price $\left(p_j\right)$ and the aggregate price as buyer (P_j).

$$w_j = k_j \; = \left(\lambda_j\right)^{1/(1-\sigma)(1-\alpha)} = \left(\lambda_j\right)^{1/(1-\sigma)}\left(\lambda_j\right)^{\alpha/(1-\sigma)(1-\alpha)} \tag{B.11}$$

Changes in prices have a direct impact on welfare $\left(\left(\lambda_j\right)^{1/(1-\sigma)}\right)$ and another that is generated via increased accumulation and the higher real income it generates $\left(\left(\lambda_j\right)^{\alpha/(1-\sigma)(1-\alpha)}\right)$. In the static equilibrium only the first mechanism is present, while in the dynamic equilibrium the second one is also present. The expression for the change in welfare in (B.11) is similar to the one derived in Arkolakis, Costinot, and Rodriguez-Clare (2012).

Finally, it remains to define a welfare measure for the dynamic transition between the steady states corresponding to the baseline and counterfactual scenarios. The calculation in B.11 assumes an immediate transition to the new steady state. Following what is proposed by Anderson, Larch and Yotov (2020), we use the Lucas (1987) formula that calculates the constant fraction of consumption (ζ) in each year with respect to the level of consumption in the baseline scenario that consumers need to be paid to achieve the same level of utility as in the counterfactual scenario.

$$\sum_{t=0}^{\infty}\beta^t \ln C_{jt}^{C}\, C_{jt}^{c} = \sum_{t=0}^{\infty}\beta^t ln(1+\zeta)C_{jt}^{b} \tag{B.12}$$

from where we obtain[28]:

$$\zeta = \exp\left((1-\beta)\left(\sum_{t=0}^{\infty}\beta^t lnC_{jt}^{c} - \sum_{t=0}^{\infty}\beta^t lnC_{jt}^{b}\right) - 1\right) \tag{B.13}$$

---

[26] Given $X_{jjt} = \frac{(Y_{jt}Y_{jt})}{Y_t}\left(\frac{t_{jjt}}{\Pi_{jt}P_{jt}}\right)^{1-\sigma}$, we have: $\left(\lambda_{jt}\right)^{1/1-\sigma} = \left(\frac{X_{jjt}}{Y_{jt}}\right)^{1/1-\sigma} = \left(\frac{(Y_{jt})}{Y_t}\right)^{1/1-\sigma}\left(\frac{1}{\Pi_{jt}P_{jt}}\right) = \frac{\left(\frac{(Y_{jt})}{Y_t}\right)^{1/1-\sigma}}{\Pi_{jt}}\left(\frac{1}{P_{jt}}\right) = \frac{p_{jt}}{P_{jt}}$.

[27] This is the similar to an improvement in the terms of trade. See that $\frac{p_{jt}}{P_{jt}} = \frac{p_{jt}}{\left[\sum_i \frac{Y_{it}}{Y_t}\left(\frac{t_{ijt}}{\Pi_{it}}\right)^{1-\sigma}\right]^{1/1-\sigma}} = \frac{1}{\left[\frac{1}{p_{jt}{}^{1-\sigma}}\sum_i \frac{Y_{it}}{Y_t}\left(\frac{t_{ijt}}{\Pi_{it}}\right)^{1-\sigma}\right]^{1/1-\sigma}} = \frac{1}{\left[\frac{1}{p_{jt}{}^{1-\sigma}}\sum_i p_{it}{}^{1-\sigma}t_{ijt}{}^{1-\sigma}\right]^{1/1-\sigma}} = \frac{1}{\left[\frac{1}{p_{jt}{}^{1-\sigma}}\left(p_{jt}{}^{1-\sigma}+\sum_{i\neq j}p_{it}{}^{1-\sigma}t_{ijt}{}^{1-\sigma}\right)\right]^{1/1-\sigma}} = \frac{1}{\left[1+\frac{\sum_{i\neq j}p_{it}{}^{1-\sigma}t_{ijt}{}^{1-\sigma}}{p_{jt}{}^{1-\sigma}}\right]^{1/1-\sigma}}$

[28] Given $\sum_{t=0}^{\infty}\beta^t lnC_{jt}^{c} = \sum_{t=0}^{\infty}\left(\beta^t ln\left(C_{jt}^{b}\right) + \beta^t ln(1+\zeta)\right) = \sum_{t=0}^{\infty}\left(\beta^t ln\left(C_{jt}^{b}\right)\right) + ln(1+\zeta)\sum_{t=0}^{\infty}(\beta^t)$, then $\sum_{t=0}^{\infty}\beta^t lnC_{jt}^{c} - \sum_{t=0}^{\infty}\left(\beta^t ln\left(C_{jt}^{b}\right)\right) = \frac{1}{1-\beta}ln(1+\zeta)$. Taking exponential on both sides and solving for ζ gives the equation B.13.

Appendix C. Statistics

Table C.1. Bilateral relations liberalized prior to 2018 between CPTPP members and new countries which were apply to membership.

exp/imp	AUS	NZL	MYS	VNM	SGP	JPN	CAN	MEX	PER	CHL	GBR	CHN	CRI	ECU	URY	UKR
AUS		ANZCERTA 1982	AUS-MYS 2012	ASEAN-AUS-NZL 2009	ASEAN-AUS-NZL 2009	JPN-AUS 2014				AUS - CHL 2008		AUS-CHN 2015				
NZL	ANZCERTA 1982		ASEAN-AUS-NZL 2009	ASEAN-AUS-NZL 2009	ASEAN-AUS-NZL 2009					TPSEP 2005		NZL-CHN 2008				
MYS	AUS-MYS 2012	ASEAN-AUS-NZL 2009		ASEAN 1992	ASEAN 1992	JPN - MYS 2005				CHL-MYS 2010		ASEAN-CHN 2005				
VNM	ASEAN-AUS-NZL 2009	ASEAN-AUS-NZL 2009	ASEAN 1992		ASEAN 1992	JPN-VNM 2008				CHL-VNM 2011		ASEAN-CHN 2005				
SGP	ASEAN-AUS-NZL 2009	ASEAN-AUS-NZL 2009	ASEAN 1992	ASEAN 1992		JPN-SGP 2002			PER-SGP 2008	TPSEP 2005		SGP-CHN 2009	SGP-CRI 2010			
JPN	JPN-AUS 2014		JPN - MYS 2005	JPN-VNM 2008	JPN-SGP 2002			JPN - MEX 2004	JPN-PER 2011	CHL-JPN 2007						
CAN								NAFTA 1992	CAN-PER 2008	CAN - CHL 1996	EU-CAN 2017		CAN-CRI 2001			
MEX						JPN - MEX 2004	NAFTA 1992		PA 2014	PA 2014	EU-MEX 1997		MEX-CRI 2011	ECU-MEX 1995	MEX-URY 2003	
PER					PER-SGP 2008	JPN-PER 2011	CAN - PER	PA 2014		PA 2014	EU-COL&PER 2012	PER-CHN 2010	CRI-PER 2011	ECU-PER 1990	MERCOSUR-PER 2005	
CHL	AUS - CHL 2008	TPSEP 2005	CHL-MYS 2010	CHL-VNM 2011	TPSEP 2005	CHL-JPN 2007	CAN - CHL 1996	PA 2014	PA 2014		EU-CHL 2002	CHL-CHN 2006	CHL-CRI 1999	ECU-CHL 2010	MERCOSUR-CHL 1996	
GBR							EU-CAN 2017	EU-MEX 1997	EU-COL&PER 2012	EU-CHL 2002			EU-CA 2012			EU-UKR 2014
CHN	AUS-CHN 2015	NZL-CHN 2008	ASEAN-CHN 2005	ASEAN-CHN 2005	SGP-CHN 2009				PER-CHN 2010	CHL-CHN 2006			CHN-CRI 2010			
CRI							CAN-CRI 2001	MEX-CRI 2011	CRI-PER 2011	CHL-CRI 1999	EU-CA 2012	CHN-CRI 2010				
ECU								ECU-MEX 1995	ECU-PER 1990	ECU-CHL 2010					ECU-URY 2005	
URY								MEX-URY 2003	MERCOSUR-PER 2005	MERCOSUR-CHL 1996				ECU-URY 2005		
UKR											EU-UKR 2014					

Note: ISO3 country nomenclature code is used. Green- No agreement in 2017; Gray- agreement in 2017 among members of CPTPP; White- agreement in 2017 between members and countries that apply to be members.
Source: own elaboration using World Bank's Deep Trade Agreements database (see https://datatopics.worldbank.org/dta/table.html).

Table C.2. Variation in welfare over group of countries by scenario, model and parameters (%)

Group of countries	Static			Steady State			Transitional		
	Base	**R1**	**R2**	**Base**	**R1**	**R2**	**Base**	**R1**	**R2**
CPTPP									
World	0.139	0.139	0.063	0.279	0.221	0.127	0.242	0.326	0.110
Untreated	0.003	0.003	0.000	0.024	-0.068	0.005	0.019	0.026	0.003
Treated	0.958	0.958	0.442	1.812	1.958	0.861	1.586	2.128	0.749
CPTPP+4									
World	0.184	0.184	0.083	0.372	0.620	0.168	0.320	0.461	0.145
Untreated	0.015	0.015	0.005	0.055	0.137	0.017	0.042	0.083	0.013
Treated	1.138	1.138	0.525	2.160	3.345	1.024	1.888	2.599	0.890
CPTPP+5									
World	0.446	0.446	0.202	0.905	1.513	0.409	0.779	1.125	0.352
Untreated	0.016	0.016	0.004	0.085	0.237	0.021	0.063	0.137	0.016
Treated	1.350	1.350	0.619	2.625	4.188	1.221	2.281	3.198	1.058

Source: own.

Table C.3. Variation in welfare treated countries by scenario, model and parameters (%)

Treated countries	Static			Steady State			Transitional		
	Base	R1	R2	Base	R1	R2	Base	R1	R2
CPTPP									
AUS	1.1	1.1	0.5	2.1	2.4	1.0	1.8	2.5	0.9
CAN	1.1	1.1	0.5	1.9	2.0	1.0	1.7	2.2	0.8
CHL	0.7	0.7	0.3	1.4	1.2	0.7	1.2	1.6	0.6
GBR	1.3	1.3	0.6	2.3	2.5	1.1	2.1	2.7	1.0
JPN	0.6	0.6	0.3	1.2	1.3	0.5	1.0	1.4	0.5
MEX	0.5	0.5	0.2	0.9	0.9	0.4	0.8	1.1	0.4
MYS	2.0	2.0	0.9	3.8	4.1	1.8	3.3	4.5	1.6
NZL	1.6	1.6	0.7	3.0	3.1	1.4	2.6	3.5	1.2
PER	0.7	0.7	0.3	1.4	1.5	0.6	1.2	1.6	0.6
SGP	2.1	2.1	1.0	3.8	4.1	1.9	3.3	4.4	1.6
VNM	1.8	1.8	0.8	3.3	3.6	1.6	2.9	3.9	1.4
CPTPP+4									
CRI	2.2	2.2	1.0	3.9	5.8	1.9	3.5	4.6	1.7
ECU	1.4	1.4	0.6	2.8	4.4	1.3	2.4	3.4	1.1
UKR	1.0	1.0	0.4	1.8	2.8	0.9	1.6	2.2	0.8
URY	1.3	1.3	0.6	2.6	4.0	1.2	2.2	3.1	1.1
AUS	1.2	1.2	0.6	2.4	3.9	1.1	2.1	3.0	1.0
CAN	1.3	1.3	0.6	2.3	3.5	1.1	2.0	2.7	1.0
CHL	0.9	0.9	0.4	1.8	2.7	0.9	1.6	2.1	0.7
GBR	1.5	1.5	0.7	2.8	4.2	1.3	2.4	3.3	1.2
JPN	0.7	0.7	0.3	1.4	2.2	0.6	1.2	1.7	0.6
MEX	0.6	0.6	0.3	1.1	1.8	0.5	1.0	1.4	0.5
MYS	2.3	2.3	1.1	4.4	6.7	2.1	3.8	5.2	1.8
NZL	1.8	1.8	0.8	3.5	5.4	1.7	3.0	4.2	1.4
PER	0.9	0.9	0.4	1.7	2.7	0.8	1.5	2.1	0.7
SGP	2.3	2.3	1.1	4.3	6.4	2.1	3.8	5.1	1.8
VNM	2.1	2.1	1.0	4.0	6.1	1.9	3.5	4.8	1.6
CPTPP+5									
CHN	0.8	0.8	0.3	1.6	2.6	0.7	1.4	2.0	0.6
CRI	2.6	2.6	1.2	4.8	7.2	2.3	4.2	5.7	2.0
ECU	1.9	1.9	0.9	3.8	6.1	1.7	3.3	4.6	1.5
UKR	1.5	1.5	0.7	2.8	4.3	1.3	2.5	3.4	1.2
URY	2.9	2.9	1.4	5.6	8.7	2.7	4.9	6.7	2.3
AUS	2.0	2.0	1.0	4.0	6.4	1.9	3.5	4.9	1.6
CAN	2.1	2.1	1.0	3.8	5.7	1.9	3.4	4.5	1.6
CHL	2.0	2.0	1.0	3.8	5.9	1.9	3.3	4.6	1.6
GBR	2.2	2.2	1.0	4.2	6.4	2.0	3.6	5.0	1.7
JPN	1.8	1.8	0.8	3.5	5.7	1.7	3.1	4.3	1.4
MEX	1.2	1.2	0.5	2.3	3.5	1.1	2.0	2.7	0.9
MYS	3.3	3.3	1.5	6.3	9.7	3.0	5.5	7.5	2.6
NZL	2.4	2.4	1.1	4.7	7.5	2.3	4.1	5.8	2.0
PER	1.3	1.3	0.6	2.5	4.1	1.2	2.2	3.1	1.0
SGP	3.3	3.3	1.6	6.2	9.3	3.0	5.4	7.3	2.6
VNM	3.5	3.5	1.6	6.7	10.3	3.1	5.8	8.0	2.7

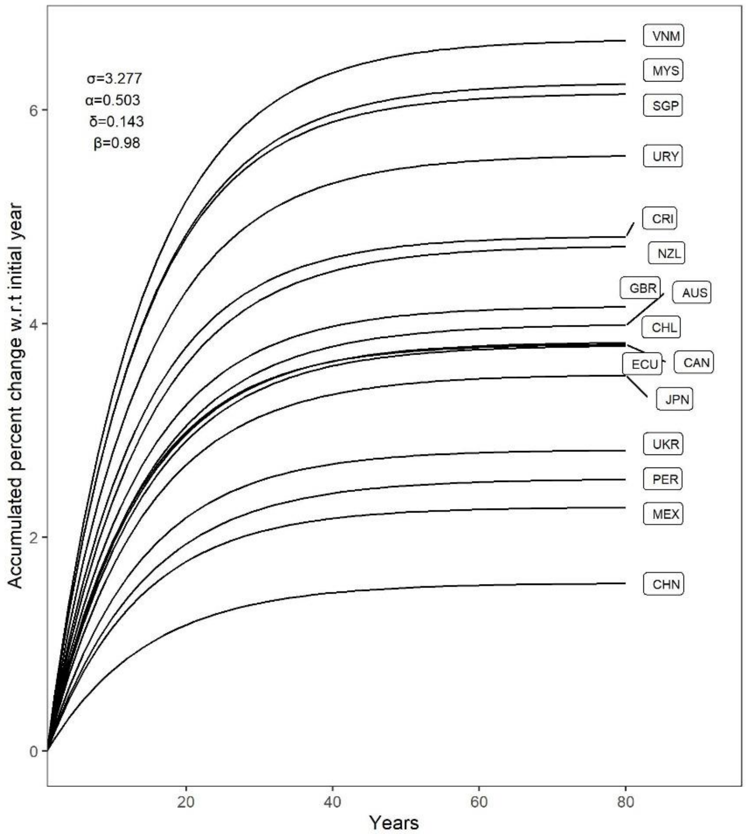
Source: own

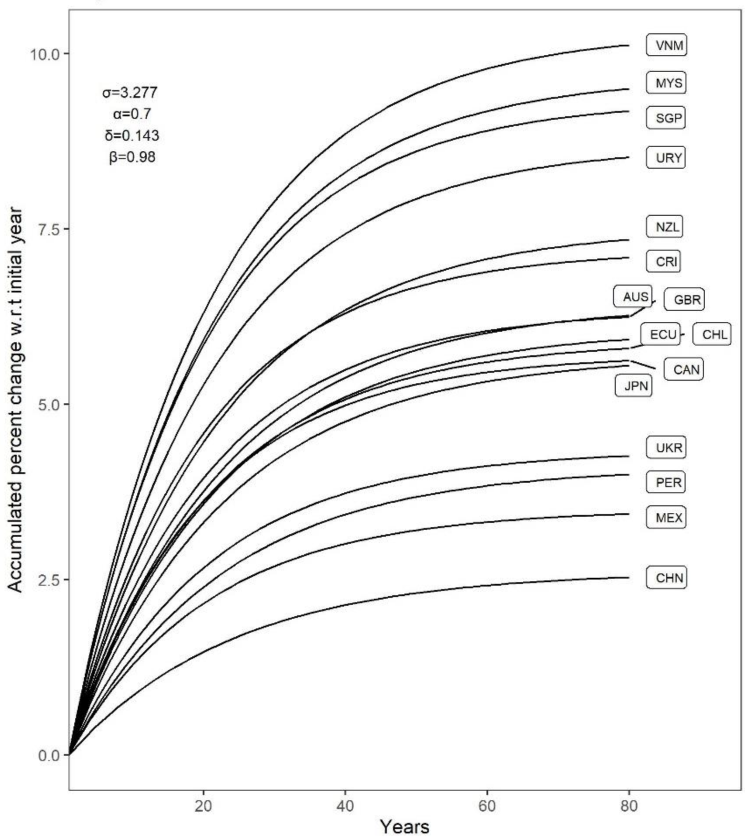
Table C.4. Variation in welfare for selected untreated countries by scenario, model and parameters (%)

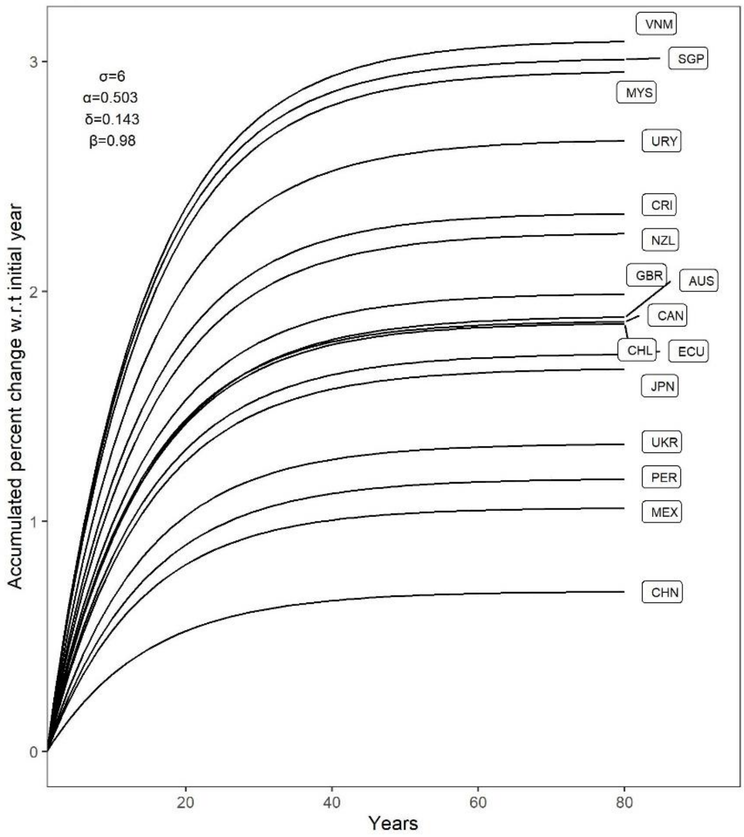
Untreated countries	Static			Steady State			Transitional		
	Base	**R1**	**R2**	**Base**	**R1**	**R2**	**Base**	**R1**	**R2**
CPTPP									
Firsts 5 winners									
IRL	0.24	0.24	0.10	0.57	0.61	0.23	0.48	0.70	0.19
BEL	0.07	0.07	0.03	0.18	0.11	0.07	0.15	0.22	0.06
CYP	0.07	0.07	0.03	0.17	0.09	0.07	0.14	0.20	0.06
SWE	0.06	0.06	0.03	0.15	0.05	0.06	0.13	0.19	0.05
ISL	0.06	0.06	0.02	0.16	-0.12	0.06	0.13	0.18	0.05
Firsts 5 losers									
FJI	-0.06	-0.06	-0.04	0.00	-0.23	-0.04	-0.02	0.05	-0.04
HKG	-0.04	-0.04	-0.02	-0.04	-0.11	-0.03	-0.04	-0.04	-0.03
LAO	-0.03	-0.03	-0.01	-0.03	-0.27	-0.02	-0.03	-0.04	-0.02
KWT	-0.02	-0.02	-0.01	-0.02	-0.14	-0.02	-0.02	-0.02	-0.02
THA	-0.02	-0.02	-0.01	0.02	-0.07	-0.01	0.01	0.04	-0.01
CPTPP+4									
Firsts 5 winners									
IRL	0.35	0.35	0.15	0.78	1.38	0.32	0.66	1.00	0.27
CYP	0.15	0.15	0.07	0.33	0.59	0.14	0.28	0.42	0.12
BEL	0.12	0.12	0.05	0.28	0.53	0.12	0.24	0.37	0.10
ISL	0.10	0.10	0.04	0.26	0.51	0.10	0.22	0.35	0.09
SWE	0.10	0.10	0.04	0.23	0.44	0.09	0.19	0.31	0.08
Firsts 5 losers									
HKG	-0.05	-0.05	-0.03	-0.04	0.02	-0.04	-0.05	-0.02	-0.03
LAO	-0.03	-0.03	-0.02	-0.02	0.03	-0.02	-0.03	-0.01	-0.02
KWT	-0.02	-0.02	-0.01	-0.01	0.05	-0.02	-0.02	0.01	-0.02
GMB	-0.02	-0.02	-0.01	-0.02	0.01	-0.02	-0.02	-0.01	-0.01
SAU	-0.02	-0.02	-0.01	-0.01	0.04	-0.01	-0.01	0.01	-0.01
CPTPP+5									
Firsts 5 winners									
IRL	0.33	0.33	0.13	0.83	1.60	0.31	0.68	1.11	0.26
CYP	0.16	0.16	0.07	0.38	0.73	0.16	0.32	0.51	0.13
BEL	0.12	0.12	0.05	0.32	0.66	0.12	0.26	0.44	0.10
HUN	0.12	0.12	0.05	0.28	0.55	0.11	0.23	0.37	0.09
NLD	0.11	0.11	0.05	0.30	0.62	0.11	0.25	0.41	0.09
Firsts 5 losers									
HKG	-0.15	-0.15	-0.08	-0.16	0.00	-0.12	-0.16	-0.11	-0.11
LAO	-0.08	-0.08	-0.04	-0.08	0.00	-0.06	-0.09	-0.06	-0.06
FJI	-0.07	-0.07	-0.05	0.09	0.54	-0.04	0.03	0.24	-0.04
GMB	-0.07	-0.07	-0.03	-0.08	-0.04	-0.06	-0.08	-0.07	-0.05
THA	-0.04	-0.04	-0.03	0.05	0.32	-0.02	0.02	0.14	-0.03

Source: own

Graph C.1. Dynamic transition of the capital stock (percentage change) under different parameters. Scenario CPTPP+5






σ=6
α=0.503
δ=0.143
β=0.98
VNM
SGP
MYS
URY
CRI
NZL
GBR
AUS
CAN
CHL
ECU
JPN
UKR
PER
MEX
CHN
Accumulated percent change w.r.t initial year
Years
0
1
2
3
20
40
60
80