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Making Trade Policy Innovation Friendly:

What Role of Trade Agreements?

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ECONOMIC RESEARCH FORUM
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Abstract

The rapid increase in regional trade agreements (RTAs) in previous decades extends their effect beyond trade creation. This paper explores the dynamic effects of RTAs on fostering innovation through knowledge spillovers. By merging the World Bank's Deep Trade Agreements dataset with the World Development Indicators, we make two key contributions. First, we differentiate the influence of various types of trade provisions, namely WTO-plus (enhancing commitments under WTO rules) and WTO-extra (extending beyond WTO rules), on domestic innovation. Second, we analyze how the breadth and depth of these provisions affect innovation outcomes differently. Our findings show that WTO-plus provisions play a more significant role in promoting innovation than WTO-extra provisions, with the depth of these commitments being particularly relevant. Moreover, the impact of RTAs is most pronounced in lower-middle and low-income countries, showing the importance of trade agreements in bridging the technological gap across countries. A strong heterogeneity is observed across different types of provisions. Yet, our results remain robust when we use alternative measures of innovation.

Keywords: Deep trade agreements; domestic innovation; knowledge spillovers.

JEL Classification: F130; O32; F10

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1. Introduction

The last decades witnessed an increase in different types of provisions in regional trade agreements (RTAs) extending the gains to non-economic outcomes beyond enhanced trade volumes. Amongst non-economic outcomes is promoting innovation and technology transfer (Bastiaens et al., 2024). Particularly for developing countries, innovation growth is challenged with middling inputs like R&D stock, low absorptive capacities, unapt infrastructure, and mismatching skill levels. Hence, channeling foreign knowledge through preferential trade agreements is of key importance to developing countries with minimal innovation output. Against this background, we explore the extent of relevance of different trade agreements' provisions to domestic innovation.

The policy areas covered by the RTAs are grouped into WTO-plus (WTO+) and WTO-extra (WTO-X) provisions. The first group pertains to the provisions that are within the mandate of the WTO. In these provisions, parties agree to undertake commitments that go beyond those accepted at the multilateral level, like reducing nontariff measures. On the other hand, WTO-X refers to the provisions that deal with issues beyond the commitments of the WTO (Horn et al., 2010), like labor or environmental standards. While both components extend beyond the traditional shallow trade agreements centered on tariff measures, the former consists of trade-related topics within the commitments of the WTO. Focusing on technological-related provisions, WTO+ relates to TRIPS commitments, and WTO-X includes extra innovation policies and intellectual property rights that go beyond TRIPS. In addition, non-technological provisions in WTO+ (like NTMs, institutions, and services) and WTO-X (like competition policy, industrial policy, and labor standards) can foster innovation and flourish the innovation ecosystem.

Through the intertwined relationship between international trade and knowledge spillovers, provisions in trade agreements upscale absorptive capacities and facilitate knowledge transmission (Khan, 2022; Aghhion et al., 2019). Recent empirical literature exploring the nexus between trade agreements and domestic innovation shows a positive association (Martínez-Zarzoso and Chelala, 2021). Considering the increasing breadth and depth of trade agreements (Larch and Yotov, 2023), studying the effect of different measures on domestic innovation is important to scrutinize the complexities of the multiple provisions targeting goals beyond enhancing trade.

Broad empirical literature employs patent data to measure domestic innovation output and technological spillovers (Hall et al., 2005; Branstettar, 2006; Jinji et al., 2019; Eissa and Zaki, 2023). The literature has evolved to extend the determinants of domestic innovation beyond the level of development, R&D stock, and size of the economy to interlinkages through global value chains, trade policy, quality of institutions, competition, and innovation policy (Eissa and Zaki, 2023). This paper extends the work of Eissa and Zaki (2023) by examining the role of the different types of provisions in trade agreements on domestic innovation across income groups.

Previous literature examining the role of RTAs in fostering technology spillovers analyzes specific trade agreements. Using a gravity model for 18 countries in Western Europe and North America, (Peri, 2005) estimates a negative effect of regional, national, and linguistic borders on technology spillovers. Yet, the impact of the "trade bloc" -the European Union and North America Free Trade Agreement- is statistically insignificant. In contrast, Jinji et al. (2013) capture a positive effect of RTAs on technology spillovers for a sample of nine RTAs for 103 countries spanning the years

1990 to 1999. By extending the number of RTAs, Jinji (2019) captures a positive association between the depth of RTAs and technology spillovers.

RTAs increase knowledge spillovers through two main channels. First, reduced trade barriers enhance the volume of intermediate goods imports, leading to knowledge spillovers from origin counterparts. Indeed, a large body of literature shows how liberalization of intermediate inputs can lead to productivity increases and technology transfer (Martinez- Zarzoso et al., 2021 and Bas, 2013). Second, trade agreements facilitate the movement of service flows (ranging from non-tangible assets to human capital), leading to knowledge transmission between signatories. From another angle, increased provisions can mitigate knowledge transmission due to increased compliance costs that divert expenditures away from R&D (Melitz and Redding, 2021). Likewise, stringent and excessive intellectual property (IP) rules can limit the transmission of technology to countries with low absorptive capacities. Furthermore, the fragmentation of trade agreements creates a "spaghetti bowl effect" in which overlapping trade agreements increase complexity due to inconsistent rules of origin and regulatory standards (Govindaraj, 2023). Consequently, increased fragmentation leads to a mixed impact on integration and innovation. In our econometric analysis, we use the WTO-plus (WTO+) and WTO-extra (WTO-X) groups to classify the policy areas of trade agreements' provisions, construct depth measures of trade agreements (Ezzat and Zaki, 2022 and Guillin et al., 2023), and analyze the effect of each on resident patents per capita across income groups.

In this paper, we contribute to the existing literature in three ways. First, we differentiate between WTO+ and WTO-X in capturing the effect of provisions on domestic innovation. Second, we differentiate between the breadth and depth measures of each group of provisions in fostering innovation. Third, we scrutinize the RTAs-driven innovation across different income groups. This analysis is particularly important in bridging the wide gap in innovation across income levels and providing channels to achieving the ninth sustainable development goal of fostering innovation and infrastructure.

The remainder of the paper is organized as follows: section 2 presents the data and some stylized facts. Section 3 explains the methodology. Section 4 analyzes the results and section 5 concludes and provides some policy recommendations.

2. Data and Stylized Facts

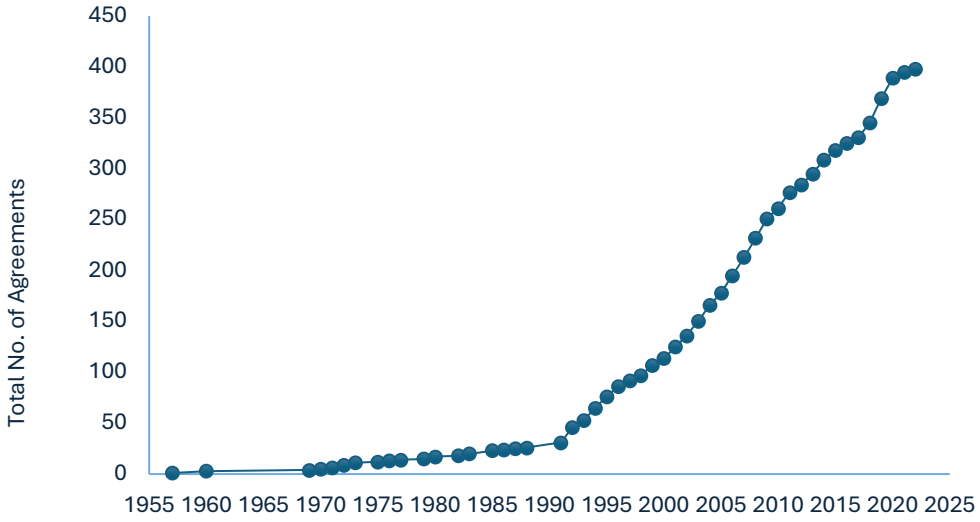
In studying the nexus between trade agreements' provisions and domestic innovation, we need to illustrate the trends of key determinants over time. In this section, we present and analyze trends of RTAs and innovation. Our dataset consists of 2,490 observations for 83 countries at different income levels, spanning the years 1990 and 2019. The dependent and control variables rely on the World Development Indicators and EORA26 dataset. All provisions indicators rely on the World Bank Deep Trade Agreements dataset[3].

In parallel to the increase in the number of RTAs over time, with a particularly higher slope in the 1990s (see Figure 1), Figure 2 shows a steady increase in the number of resident patents from 1990 to 2010, followed by a steeper increase from 2010 to 2018. Besides the possible association

[3] Appendix 2 presents the descriptive statistics of the data.

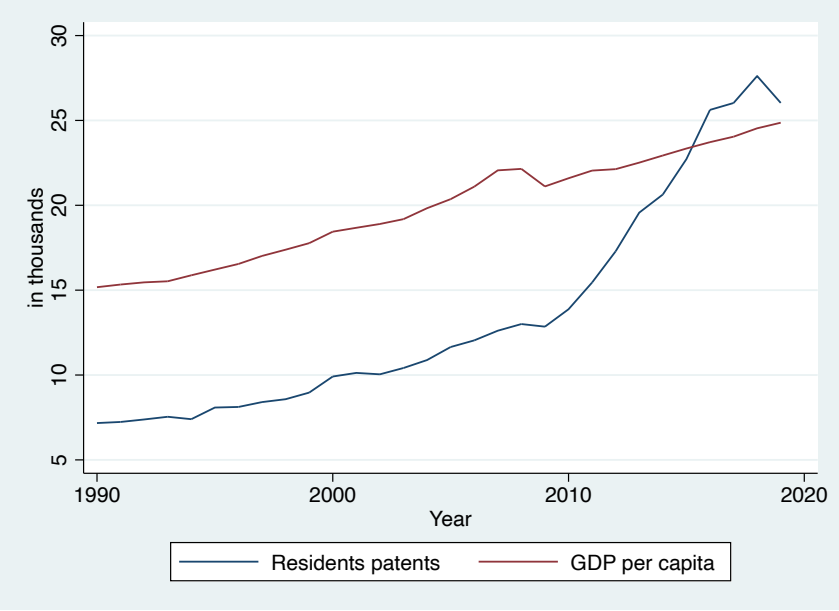
between RTAs and innovation, the sharp growth in resident patents is due to significant technological expansion following the fourth industrial revolution. As for the GDP per capita, it depicts a rather gradual and steady increase throughout the three decades. Although the trends of resident patents and GDP per capita show similarity from 1990 to 2010, the divergence of the slope of resident patents displays - unrelated to wealth- a sharp increase in innovation post-2010. One reason behind the sharper increase in innovation compared to GDP per capita is the extensive trade provisions enforced in regional trade agreements during this period. Analyzing the trends of trade agreements' provisions helps disentangle the role trade agreements play in fostering domestic innovation.

Figure 1 Number of Regional Trade Agreements over time



Source: Own construction based on World Trade Organization online database.

Figure 2 Resident patents and real GDP per capita over time

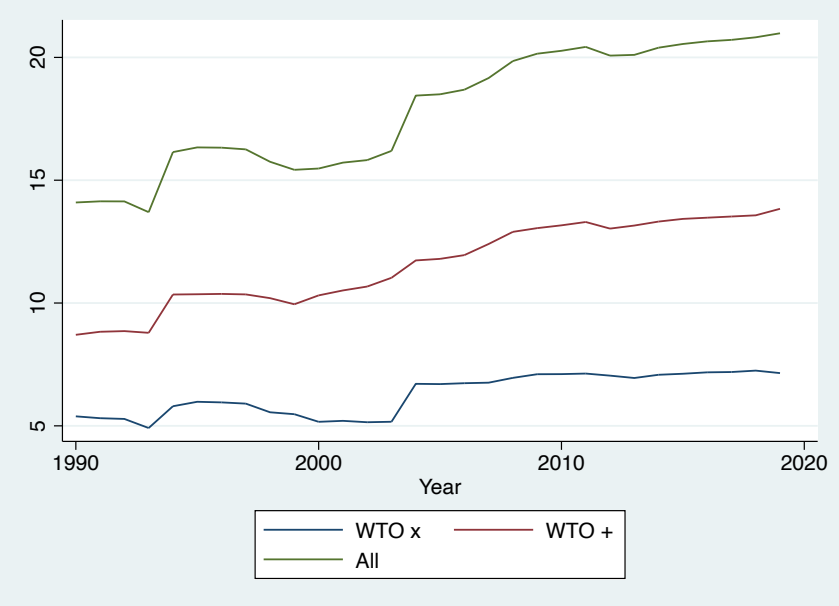


Source: Own construction based on World Development indicators.

Figure 3 presents the trend of provisions categorized as follows: provisions that go beyond the WTO core commitments (WTO-X), provisions that deepen WTO commitments (WTO+), and an aggregated measure including both types of provisions (all)[4]. Over the period 1990 – 2020, WTO-X depicts the slowest rate of increase and the lowest number. In contrast, WTO+ has a sharper and steadier increase over time showing that countries are more willing to commit to deeper trade liberalization measures that align with WTO commitments than the extra obligations. The aggregated measure, including all provisions, shows an upward trend over time, with a significant increase post-2000, suggesting active trade negotiations and implementation of agreements with deeper provisions during this period. While these measures show an increasing breadth of provisions, analyzing the trend of depth is important to understanding the extent of going beyond the traditional trade liberalization measures, like tariffs. Figure 4 presents the depth measure of WTO-X, WTO+, and aggregated related measures. As shown, WTO+ provisions have the highest depth that steadily increases over time. The low depth of WTO-X provisions leads to dampening the total aggregated depth measure. In this respect, the effect of depth in WTO+ provisions can be diluted by the shallow WTO-X provisions.

This heterogeneity in the extent of depth across types of provisions in trade agreements is relevant to understanding the importance of disentangling the role of each type in incentivizing and the possible "spaghetti bowl" leading to a neutral overall effect (Bhagwati, 1995 and Govindaraj, 2023).

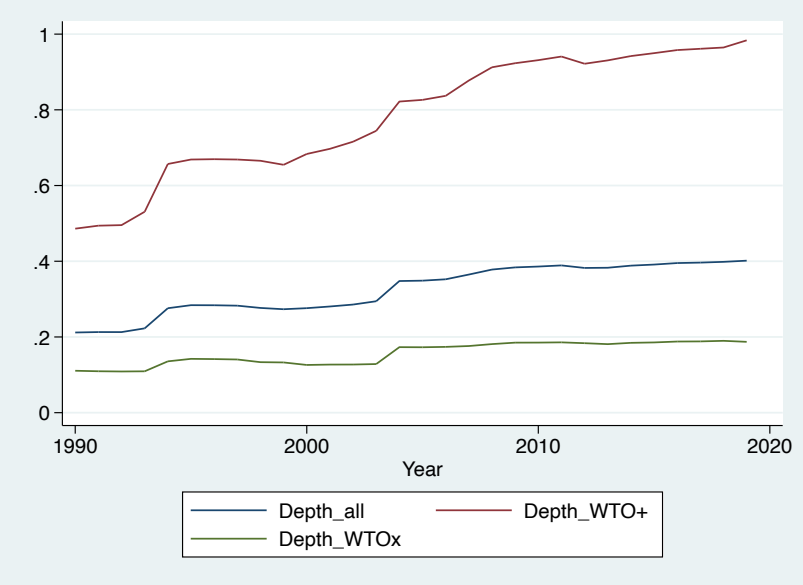
Figure 3 Types of agreements' provisions over time



Source: Own construction based on the World Bank Trade Agreements Data.

[4] Appendix 1 presents the shares of policy areas with each group.

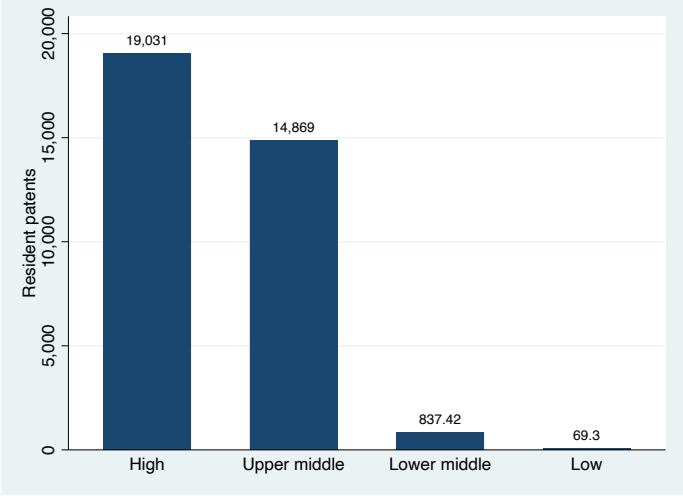
Figure 4 Depth of provisions over time



Source: Own construction based on the World Bank Trade Agreements Data.

In studying the effect of provisions in incentivizing innovation, it is important to show the heterogeneity in innovation output across income groups. As Figure 5 presents, high-income and upper-middle-income countries are the producers of innovation. When it comes to other income groups, innovation output is minimal. This innovation gap is rooted in the lack of knowledge inputs like R&D stock and expenditure at lower income groups. The concentration of innovation in higher-income countries necessitates targeted policies and different mechanisms leading to knowledge spillovers to lower-income counterparts. In attempting trade-related and non-trade-related policy areas, regional trade agreements can have a significant role in an affluent innovation ecosystem, facilitating learning through international interlinkages. To guarantee this innovation channel and to differentiate between the effects of different provisions, econometric modeling is necessary.

Figure 5 Resident patents against income groups



Source: Own construction based on the World Developing Indicators averaging the years 1990-2019.

3. Methodology

Relying on the World Development Indicators (WDI) and the World Bank Deep Trade Agreements datasets, we estimate the effect of different types of trade agreements' provisions on domestic innovation proxied by resident patents per capita. We apply fixed effects regression analysis in a fivefold step to do that. First, we estimate the baseline effect of the breadth of provisions on resident patents per capita as presented in Equation 1:

$$PAT_{it} = a_0 + a_1\, Provisions_{it} + a_2\, X_{it} + u_i + u_t + \varepsilon_{it}$$

Where PAT_{it} is resident patents per capita in log, Provisions' measure alternates the WTO+, WTOx, and the aggregated provisions in regional trade agreements. The latter is a dummy variable that takes the value of 1 if the agreement includes the provision in question and zero otherwise. $X_{it}$is a vector of control variables including GDP per capita in log, R&D stock in log, knowledge spillovers through GVCs, population in log, tariffs, and share of oil exports in merchandise. GDP per capita controls the level of development and is expected to have a positive effect on innovation output, R&D stock is the domestic main innovation input, and knowledge spillovers through GVCs (GVCRD) is the foreign innovation input (Eissa and Zaki, 2023). Oil export controls for oil dependence trap the economy in extracting activities, limiting innovation. Population controls for the size of the country, and tariffs are the direct and traditional trade costs limiting knowledge innovation. $u_i and\ u_t$ are country- and year-fixed effects to control for unobservables. ε_{it} is the error term.

The analysis is extended in several ways. First, we study the role of the horizontal depth of agreements in incentivizing innovation. In this analysis, we integrate the depth measures for WTO-X, WTO+, and their combination. These measures are calculated by taking the share of provisions included in a certain agreement in the total number of provisions one can have (52 policy topics). From the stylized facts presented in Section 2, we expect that WTO+ deep measure plays the main role in incentivizing innovation due to its value and slope of increase over time. Second, given that WTO+ provisions are rather heterogeneous, we estimate the effect of specific groups of provisions related to WTO commitments (NTMs, services, and institutions) on innovation to understand the role of each in fostering innovation. In addition, we study the effect of the detailed provision within each area. Third, we explore the impact across different income groups to grasp the relevance of provisions to lower-income groups with minimal innovation output.

Finally, we tackle robustness by alternating the dependent variable with a weighted knowledge spillover measure[5]. In a future version of this paper, we will address the endogeneity of provisions stemming from reverse causality. In particular, countries with higher innovation output can be more incentivized to engage in deep agreements to protect the property rights of innovators. In this respect, a positive association can be a result of endogeneity bias and a causal effect of provisions on domestic innovation is unguaranteed with a significant and positive coefficient. To bypass this endogeneity, we will employ an instrumental variable fixed effects regression.

[5] We use R&D weighted measure as an alternative knowledge spillover measure (Eissa and Zaki, 2023).

4. Empirical Results

Our results on the effect of trade agreements' provisions on domestic innovation are presented in Tables 1 to 7. The baseline results analyze the impact of the different types of provisions (WTO+ versus WTO-X) in Table 1. We then extend the analysis to explore the depth, the details of provisions that matter, and the role of the level of development in Tables 2, 3, 4, 5, and 6. In Table 7, we present a robustness check by alternating the dependent variable.

4.1. Baseline

Table 1 provides insight into the impact of different types of provisions (WTO-X, WTO+, and a combination of both) on domestic innovation proxied with resident patents per capita. As presented, WTO+ provisions are positively associated with domestic patenting. In particular, a one-unit increase in WTO+ provisions corresponds to a 0.72% increase in resident patents per capita. Our results align with the empirical literature showing that trade agreements' provisions facilitate the transfer of technology across trade partners, highlighting the importance of enforcing provisions that directly foster technology transmission mechanisms (Martínez-Zarzoso and Chelala, 2021). In contrast, WTO-X provisions and the combination of both types are insignificant in incentivizing domestic innovation.

While WTO+ provisions extend the commitments of trade agreements as intellectual properties, trade in services, and technical trade barriers, WTO-X refers to obligations beyond those regulated and covered by the WTO. As our results show, extra commitments to trade agreements focusing on non-traditional trade areas like labor standards and environmental protection do not directly encourage domestic patenting. Furthermore, the aggregated effect of all provisions is insignificant, indicating that the positive effect of WTO+ provisions dilutes when combined with WTO-X provisions. This unpronounced effect is unexpected because WTO-X provisions include technology-specific provisions like IPRs beyond TRIPs commitment, R&D, and innovation policy. However, extra provisions impose a compliance cost that can be burdensome (Autor et al., 2013; Puri, 2005). Yet, these results require further analysis, as it will be shown later.

As for the control variables, results show consistency with expected effects (Eissa and Zaki, 2023). Across all regressions, domestic R&D stock, GDP per capita, GVCRD, and population are positively associated with resident patents per capita due to higher absorptive capacities, domestic (R&D stock), and foreign (GVCRD) innovation inputs. As for direct trade costs, tariffs are negatively associated with domestic innovation due to the higher barriers to knowledge transmission through trade. Indeed, higher tariffs reduce imports, which negatively affects productivity and technology transfer (Bas and Berthou, 2017 and Martinez-Zarzozo et al., 2021). Although GVCRD controls the effect of tangible and intangible trade, tariffs control tangible merchandise only. Likewise, oil exports are negatively associated with domestic innovation due to concentrating on low-value-added extracting activities (Mhuru et al., 2022).

Table 1: Baseline Results

	WTO X	WTO +	ALL
Log(R&D Stock)	0.238***	0.236***	0.239***
	(0.0619)	(0.0617)	(0.0619)
Log(GDP per capita)	0.553***	0.500***	0.544***
	(0.0866)	(0.0873)	(0.0869)
Log(Population)	0.538***	0.448**	0.540***
	(0.172)	(0.175)	(0.172)
Tariffs	-0.0112***	-0.0106***	-0.0112***
	(0.00118)	(0.00119)	(0.00119)
Fuel Exports	-0.00307***	-0.00292***	-0.00306***
	(0.000881)	(0.000880)	(0.000881)
GVCRD	0.252**	0.264***	0.258**
	(0.100)	(0.0998)	(0.100)
Provisions	-0.000464	0.00725***	0.000191
	(0.000751)	(0.00233)	(0.000615)
Observations	2,490	2,490	2,490
R-squared	0.921	0.921	0.921

Notes: (i) Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
(ii) All regressions include a constant, country and year dummies.
(iii) The provision type is mentioned in the first row.
(iv) The dependent variable is log patents per capita.

4.2. Extensions

4.2.1. Does the Agreement Depth Matter?

Besides analyzing the effect of the breadth of different types of provisions on domestic innovation, it is important to study the role of the provisions' depth. As the literature suggests, the depth of provisions in trade agreements enhances global integration and matters for fostering innovation (Mattoo et al., 2020). Using the horizontal depth measure of the different types of provisions, Table 2 shows the effect of RTA depth on resident patents per capita. Our results show that deepening existing WTO commitments (WTO+) fosters domestic innovation. While WTO+ matters in terms of breadth and depth, the latter has a higher magnitude. In particular, as the depth of WTO+ provisions increases by one unit, resident patents per capita increase by 10.2%. This aligns with the literature emphasizing that the depth measure of trade provisions matters more for technology spillover, particularly for North-South and South-South trade (Jinji et al., 2019).

On the other hand, in contrast with Jinji et al. (2019), showing a positive association between deep WTO-X provisions and patent applications, our results show that WTO-X does not matter either in breadth or depth[6]. Again, aggregating the two types dilutes the positive effect of deep WTO + provisions on domestic patenting, as shown by the insignificance of the combined measure.

Meanwhile, besides the corresponding compliance costs effect, the silence of the WTO-X and the aggregated measure in incentivizing innovation is analyzed for a twofold reason. First, through the "spaghetti-bowl" effect, provisions targeting innovation promotion -like R&D and IPRs in WTO-

[6] The effect turns insignificant when including a dummy for RTAs in the model (Jinji et al., 2019).

X- can lose effectiveness when applied differently across multiple trade agreements (Coelli et al., 2022; Akcigit et al., 2018). Second, policies promoting innovation through trade agreements are negated with unapt domestic industrial and institutional policies that hinder competition and free market access (Melitz and Reding, 2021). Accordingly, fragmentation of trade agreements and domestic regulatory framework can overshadow the effect of innovation-related provisions that go beyond the WTO obligations.

Table 2: Results with the Agreement Depth

	WTO X	WTO +	ALL
Log(R&D Stock)	0.239***	0.236***	0.238***
	(0.0619)	(0.0617)	(0.0619)
Log(GDP per capita)	0.544***	0.500***	0.553***
	(0.0869)	(0.0873)	(0.0866)
Log(Population)	0.540***	0.448**	0.538***
	(0.172)	(0.175)	(0.172)
Tariffs	-0.0112***	-0.0106***	-0.0112***
	(0.00119)	(0.00119)	(0.00118)
Fuel Exports	-0.00306***	-0.00292***	-0.00307***
	(0.000881)	(0.000880)	(0.000881)
GVCRD	0.258**	0.264***	0.252**
	(0.100)	(0.0998)	(0.100)
Depth	0.00992	0.102***	-0.0176
	(0.0320)	(0.0327)	(0.0285)
Observations	2,490	2,490	2,490
R-squared	0.921	0.921	0.921

Notes: (i) Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
(ii) All regressions include a constant, country, and year dummies.
(iii) The depth type is presented in the first row.
(iv) The dependent variable is log patents per capita.

To disentangle the effect of the groups of WTO+ provisions, we move to estimate each group (NTMs, services, and institutions) in separate regressions[7]. As the literature endorses, NTMs negatively affect domestic innovation (Eissa and Zaki, 2023). Hence, provisions targeting standardization and enhanced protections are expected to significantly foster innovation. As for service provisions, we expect a positive impact on innovation due to facilitating digital trade and knowledge spillovers. Likewise, institutional provisions enhance trade interlinkages (Ezzat and Zaki, 2021) and foster an innovation-friendly environment through IPR protection.

4.2.2. Which provisions matter?

After showing that depth measure has a spillover effect on knowledge due to broader economic improvements and institutional alignment, we move to scrutinize the effect of specific provisions in incentivizing innovation. We start by analyzing the effect of each trade-related policy area within the WTO+ provisions in Table 3. We then move to scrutinize each topic within each trade-related policy area in Table 4. To analyze the innovation-related topics in WTO-X provisions, we present the separate effect of auxiliary non-trade-related provisions in Table 5.

[7] Appendix 4 provides the topics of each group.

4.2.2.1. Trade-related provisions

As presented in Table 3, NTMs and institutional provisions have the highest magnitude and significance in incentivizing domestic innovation. Starting with NTMs (provisions related to SPS, TBT, countervailing measures, etc.), the significant effect shows that enforcing provisions targeting reducing non-tariff barriers improves access to imported technology by reducing trade costs. Even when we control direct trade costs (tariffs), decreased indirect costs of trade show a positive effect on domestic innovation. As for institutional provisions, our results show that a one-unit increase corresponds to a 2.47% increase in resident patents per capita. Aligning with the literature, better rule of law (Eissa and Zaki, 2023) and legal frameworks foster an innovation-friendly environment where firms are more encouraged to register patents. Improved institutions encourage the formalization of intellectual properties for trading firms as a substitute for engaging in trade secrets. Hence, innovation measurements improve. This is also in line with Donges et al. (2022) who argue that inclusive institutions are a first-order condition of innovation.

As for service provisions, the coefficient is positive but weakly significant. This suggests that while provisions targeting services markets encourage innovation, the effect is less direct than NTMs or institutional provisions. Services provisions may benefit sectors indirectly linked to patenting, such as logistics or professional services, rather than directly stimulating patent filings. Despite the positive association between service provisions and resident patents per capita, the coefficient is weakly significant.

Table 4 presents the detailed effects of trade-related provisions within the areas of NTMs, services, and institutions. Within the institutions, customs and state aid show positive and highly significant associations with knowledge spillovers. Although state and trade enterprises (STE) provisions focus on fair competition and limiting distortions, some literature shows that in many countries state-owned enterprises are less dynamic in R&D investment and innovation due to bureaucracy and lack of incentives (Shleifer and Vishny, 1994). Nevertheless, STE provisions show an unpronounced effect on innovation. In contrast, the effect of customs and state aid provisions aligns with our intuition. Indeed, customs provisions facilitate trade integration by reducing tariff and non-tariff costs to trade and hence facilitate foreign spillovers of innovation (Eissa and Zaki, 2023). Furthermore, state aid provisions allow subsidies aimed at promoting R&D directly fostering patenting (Akcigit et al., 2022).

Although the services show weak significance, detailed provisions of government procurement and TRIMs show higher significance than the overall measure. Likewise, within NTMs, the relevant provisions to innovation are sanitary and phytosanitary measures (SPS), technical trade barriers (TBT), anti-dumping, and counter-veiling provisions. SPS depicts the largest magnitude and stimulates innovation by encouraging firms to meet higher standards related to health and safety. In this respect, firms adopt new technologies to meet stringent regulations. This result matches the literature showing that SPS leads to the technological upgrading of exports (Jaffe and Hanson, 2005; Maskus et al, 2005).

Table 3: Results with WTO+ Groups of Provisions

	NTM	Services	Institutions
Log(R&D Stock)	0.232***	0.237***	0.240***
	(0.0617)	(0.0618)	(0.0618)
Log(GDP per capita)	0.500***	0.516***	0.507***
	(0.0868)	(0.0876)	(0.0873)
Log(Population)	0.402**	0.505***	0.466***
	(0.176)	(0.173)	(0.174)
Tariffs	-0.0104***	-0.0110***	-0.0107***
	(0.00120)	(0.00119)	(0.00119)
Fuel Exports	-0.00301***	-0.00305***	-0.00268***
	(0.000878)	(0.000880)	(0.000891)
GVCRD	0.266***	0.260***	0.265***
	(0.0997)	(0.0999)	(0.0999)
Provisions	0.0207***	0.0118*	0.0247***
	(0.00540)	(0.00610)	(0.00901)
Observations	2,490	2,490	2,490
R-squared	0.921	0.921	0.921

Notes: (i) Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
(ii) All regressions include a constant, country, and year dummies.
(iii) The provisions type is presented in the first row.
(iv) The dependent variable is log patents per capita.

Table 4: Results with WTO+ Detailed Provisions

FTA industrial	-	Public Procurement	0.0494**
	-		(0.0205)
FTA agriculture	-	TRIMS	0.0556***
	-		(0.0188)
Export taxes	-0.0486**	GATS	0.0222
	(0.0243)		(0.0209)
SPS	0.136***	TRIPS	-0.00315
	(0.0218)		(0.0198)
TBT	0.0900***	Customs	0.0895***
	(0.0210)		(0.0242)
Anti-dumping	0.0830***	State and trade enterprises	-0.00267
	(0.0245)		(0.0189)
Counter-veiling	0.0894***	State aid	0.0976***
	(0.0231)		(0.0248)

Notes: (i) Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
(ii) All regressions include the baseline control variable, a constant, country, and year dummies.
(iii) The dependent variable is log patents per capita.
(iv) FTA agriculture and FTA industrial are dropped due to lack of variability.

4.2.2.2.Non-trade-related provisions

Because WTO-X provisions include innovation-related policy areas, we are interested in disentangling the effect of different provisions to understand the shadowing of the overall insignificance of the WTO-X measure. Table 5 presents the results of selected areas within the economic institutions dimension. As presented, competition policy and research and technology provisions have the largest positive magnitude within the non-trade-related provisions. In addition, at a lower significance, innovation policy and SMEs are positively associated with domestic innovation. Our results indicate that both research and technology policies, as well as innovation policy provisions, serve as direct drivers of innovation, as evidenced by their positive and significant association.

When it comes to the role of competition policy in incentivizing innovation, the literature shows multiple effects. First, competition policy encourages market entry by addressing anticompetitive practices. Hence, it enhances the knowledge diffusion of new entrants investing in innovation to sustain their market position (Melitz and Redding, 2021). Second, increased competition reduces market power, forcing reluctant firms to improve efficiency, differentiate products, and engage in new processes (Vives, 2008). Yet, this competition-induced innovation is evident at the medium level of innovation. In fact, at excessive levels of innovation, higher competition reduces innovation due to decreased expected returns. This inverted U-shaped relationship guarantees the positive effect of competition up to a certain threshold of competition (Aghion et al., 2005) after which higher competition can reduce innovation. Hence, competition policy needs to be applied with caution.

Two results seem to be counterintuitive, namely investment and financial assistance related provisions. A potential explanation pertains to the fact that, in most developing countries, investment related provisions can increase investment in capital intensive industries such as oil. primary sectors or in real estate, which are not technology intensive. This is why there is limited room for innovation. As per financial assistance, the literature has shown that aid does not exert a positive effect unless institutions are efficient (White, 1992 and Aboushady et al., 2024). This is why if trade agreements include such provisions, financial assistance can increase without exerting a positive effect on development and its related outcomes such as innovation.

Table 5: Results with WTO-X Detailed Provisions

Competition policy	0.125***	Energy	-0.00713
	(0.0232)		(0.0195)
Investment	-0.0515**	Financial assistance	-0.197***
	(0.0203)		(0.0261)
IPR	0.00792	Industrial coop.	0.0181
	(0.0189)		(0.0216)
Movement of Capital	0.0518***	Mining	0.0377**
	(0.0197)		(0.0176)
Agriculture	0.0324*	Regional cooperation	-0.0397**
	(0.0186)		(0.0189)
Innovation policy	0.0480**	Research and Technology	0.124***
	(0.0206)		(0.0186)
Economic pol. Dialogue	0.0143	SMEs	0.0432**
	(0.0212)		(0.0180)

Notes: (i) Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
(ii) All regressions include the baseline control variable, a constant, country, and year dummies.
(iii) The dependent variable is log patents per capita.

4.2.3. Heterogeneity across income groups

Despite the positive association between WTO+ provisions and resident patents per capita, this effect can be heterogeneous with different income levels. As the literature suggests, knowledge spillovers through global value chain participation are more relevant to lower-middle-income countries (Eissa and Zaki, 2023) because the fewer domestic inputs to innovate, the higher the effect of foreign knowledge transmission. In this respect, we scrutinize the impact of provisions across income groups in Table 6. As presented, the WTO+ provisions preserve the positive and highly significant effect. Yet, when interacting provisions with income levels, we observe varying associations. In reference to high-income countries, all types of provisions negatively interact with upper-middle-income countries and only WTO+ provisions positively interact with lower-middle-income countries. As for the low-income countries, both WTO+ and the aggregated measure show a positive and highly significant effect. Accordingly, we show that provisions are more relevant to lower-income countries with middling absorptive capacity and minimal innovation output. As a substitute for domestic capacity, enhancing provisions in regional trade agreements can boost innovation performance in low-income countries. Yet, to capitalize on this positive association, strengthening the domestic business environment and quality of institutions will foster innovation performance and help lagging countries catch up to the technological frontier.

Table 6: Heterogeneity across income groups

	WTO X	WTO +	ALL
Log(R&D Stock)	.217***	.307***	.32***
	(.069)	(.064)	(.068)
Log(GDP per capita)	.539***	.418***	.48***
	(.105)	(.102)	(.103)
Log(Population)	.316	.384*	.586***
	(.214)	(.205)	(.208)
Tariffs	-.01***	-.009***	-.009***
	(.001)	(.001)	(.001)
Fuel Exports	-.003***	-.002***	-.003***
	(.001)	(.001)	(.001)
GVCRD	.239**	.338***	.421***
	(.115)	(.099)	(.108)
Provisions	-.001	.008**	.001
	(.003)	(.004)	(.002)
Provisions*Upper-middle	-.015***	-.014***	-.007**
	(.005)	(.005)	(.003)
Provisions*Lower-middle	-.01	.033***	.007
	(.006)	(.007)	(.004)
Provisions*Low	-.009	.057***	.026***
	(.011)	(.013)	(.009)
Observations	2189	2189	2189
R-squared	.931	.933	.931

Notes: (i) Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
(ii) All regressions include a constant, country, and year dummies.
(iii) The provisions type is presented in the first row.
(iv) The dependent variable is log patents per capita.

4.3. Robustness checks

To ensure a robust association between provisions and innovation, we alternate the dependent variable with another innovation measure. As presented in Table 7, we use a Coe-Helpmann knowledge spillover measure (Eissa and Zaki, 2023) as the dependent variable. Our results show the consistency of the effects of different types and areas of provisions with the baseline results. Again, only WTO+ provisions show a positive effect on knowledge spillover with a diluted effect when aggregated with WTO-X provisions. In addition, provisions related to NTMs, services, and institutions show a positive and significant impact, and institutions have the largest magnitude.

Table 7: Changing the Dependent Variable – Coe-Helpmann

	WTO X	WTO +	ALL	NTM	Services	Institutions
Log(R&D Stock)	0.375***	0.372***	0.376***	0.370***	0.372***	0.377***
	(0.0763)	(0.0761)	(0.0762)	(0.0761)	(0.0761)	(0.0761)
Log(GDP per capita)	0.163	0.0990	0.151	0.116	0.0953	0.107
	(0.107)	(0.108)	(0.107)	(0.107)	(0.108)	(0.107)
Log(Population)	-0.0890	-0.205	-0.0900	-0.213	-0.162	-0.184
	(0.212)	(0.215)	(0.212)	(0.217)	(0.213)	(0.214)
Tariffs	-0.00454***	-0.00379***	-0.00445***	-0.00379**	-0.00404***	-0.00388***
	(0.00146)	(0.00147)	(0.00146)	(0.00148)	(0.00146)	(0.00147)
Fuel Exports	-0.00742***	-0.00724***	-0.00741***	-0.00737***	-0.00739***	-0.00692***
	(0.00108)	(0.00108)	(0.00108)	(0.00108)	(0.00108)	(0.00110)
GVCRD	0.0508	0.0640	0.0575	0.0628	0.0608	0.0646
	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)
Provisions	-0.000347	0.00918***	0.000402	0.0187***	0.0242***	0.0318***
	(0.000925)	(0.00287)	(0.000757)	(0.00667)	(0.00750)	(0.0111)
Observations	2,460	2,460	2,460	2,460	2,460	2,460
R-squared	0.910	0.910	0.910	0.910	0.910	0.910

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
All regressions include a constant, country, and year dummies. The dependent variable is R&D-weighted imports.

In summary, provisions in trade agreements -particularly those targeting NTMs and institutional reforms- play a significant role in enhancing patenting and innovation. However, not all provisions are equally impactful. To guarantee effectiveness, alignment with broader policies that support R&D and innovation ecosystems is necessary. Our findings emphasize the need for tailored strategies making trade agreements a consistent catalyst for domestic innovation.

In the coming version of this work, we will address the endogeneity of provisions. In particular, countries with high levels of innovation can be already integrated into deep trade agreements, leading to a reverse causality bias (Jinji et al., 2019). To do that, we will instrument the provisions variable with the quality of institutions of the main trading partner. In addition, we will explore different moderating mechanisms of foreign knowledge spillovers (trade, GVCs, and FDI).

5. Conclusion and Policy Implications

By empirically studying the effect of trade agreements' provisions on domestic innovation, we contribute to the existing literature in two ways. First, we estimate the impact of the breadth and depth of different types of provisions in fostering innovation. We provide evidence that trade-related provisions are more relevant than non-trade-related provisions in fostering innovation. In addition, the depth of provisions matters more than the breadth. Second, we show that as a driver of innovation, provisions are more relevant to lower-income countries. Our work aims to unveil the unexplored foreign knowledge transmission channel of deep trade agreements. Our work relates to the ninth sustainable development goal of fostering innovation by 2030.

Our results conclude that specific attention should be given to institutions' provisions, particularly the ones related to customs and technical standard harmonization. In addition, relevant chapters of the WTO-X -like competition policy- have an unpronounced effect on innovation when aggregated

with other non-trade-related provisions. Despite the relevance of innovation-related provisions, trade agreements are insufficient to guarantee technological growth.

From a policy standpoint, this work draws a threefold recommendation. First, prioritizing provisions focusing on NTMs and institutions when negotiating trade agreements maximizes the impact on domestic innovation. Second, additional policies beyond the WTO commitments, like intellectual property rights, require better implementation. Third, promoting an innovation-friendly ecosystem for patenting through enforcing competition policy, innovation policy, and investing in R&D.

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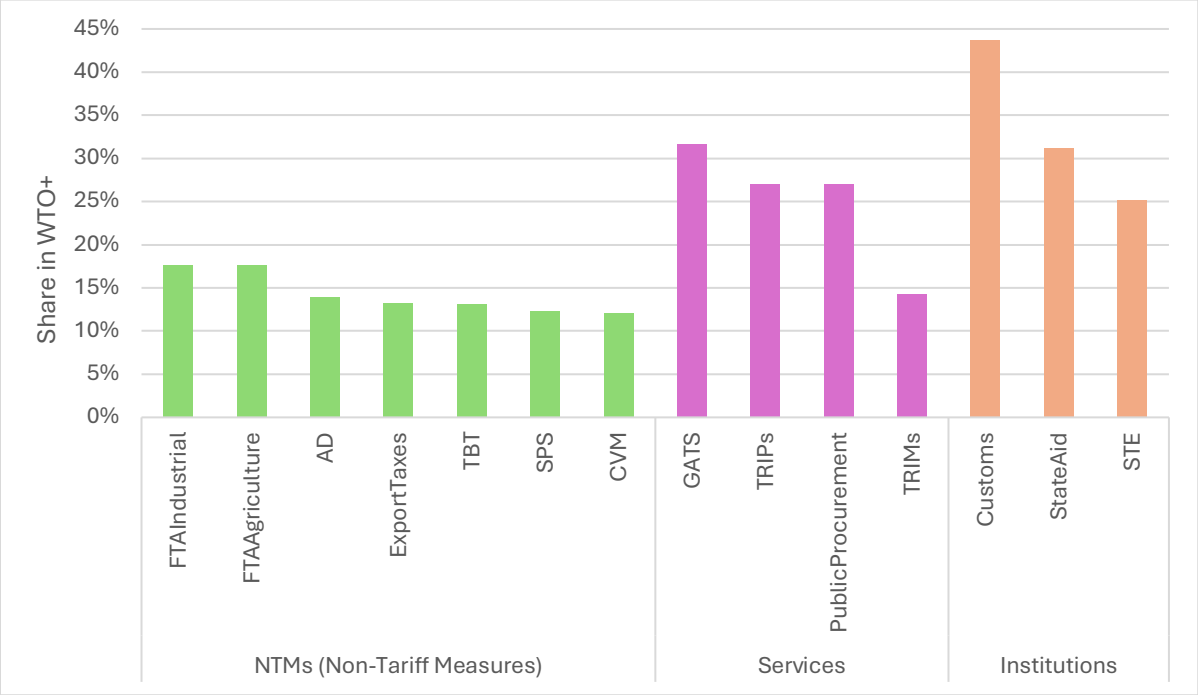
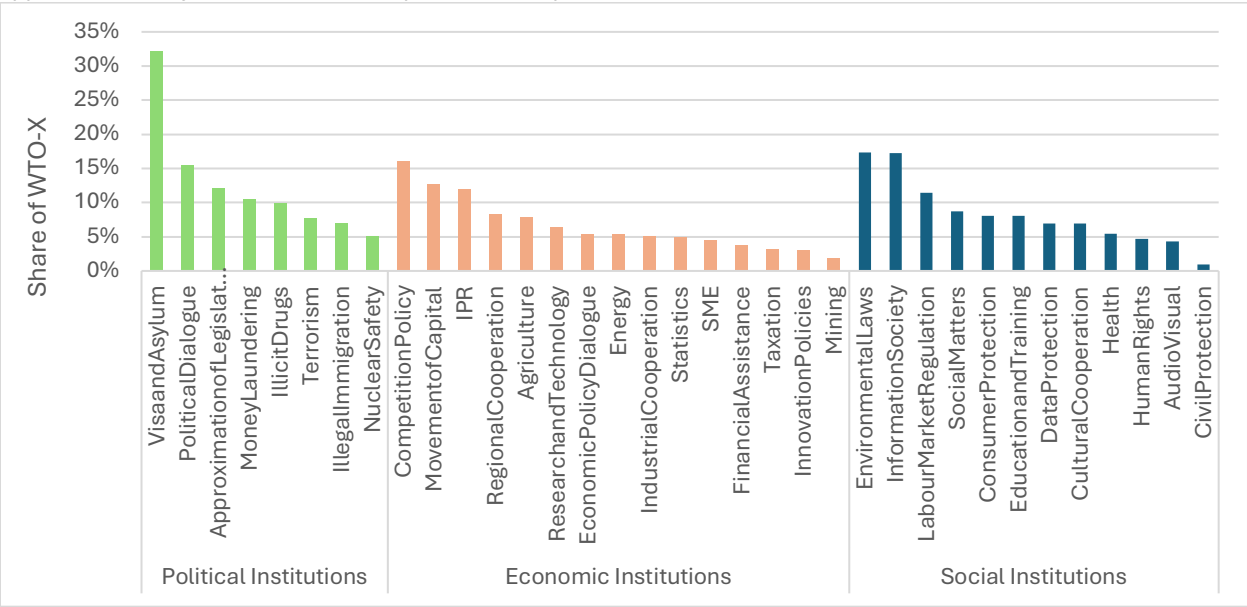
Appendix

Appendix 1a Policy areas within WTO+ provisions chapters



Source: Own elaboration based on the World Bank Deep Trade Agreements Dataset

Appendix 1b Policy areas within WTO-X provisions chapters



Source: Own elaboration based on the World Bank Deep Trade Agreements Dataset

Appendix 2 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Log Patents per capita	2490	-4.6	.927	-7.313	-2.479
GVCRD	2490	.591	.295	.018	1
Log RD Stock	2490	2.92	.679	.871	4.917
Log GDP per capita	2490	3.945	.607	2.565	5.321
Log Population	2490	7.224	.732	4.469	9.145
Tariffs	2490	6.646	8.188	0	90.39
Fuel Exports	2490	13.87	21.94	0	98.764
Coe-Helpmann	2460	1.446	1.072	.017	8.17
WTO-X (breadth)	2189	8.18	8.275	0	30.8
WTO+ (breadth)	2189	13.057	6.828	2.462	28
WTO all (breadth)	2189	21.237	14.158	2.462	53.3
Provisions depth	2490	.359	.288	0	1.025
WTO+ depth	2490	.82	.549	0	2
WTO-X depth	2490	.189	.216	0	.811

Source: Authors' own elaboration

Appendix 3 Topics within the different types of trade agreement provisions

WTO+	WTO-X		
Non Tairiff Measures	**Political institutions**	**Economic institutions**	**Social institutions**
FTA industrial goods	Approximation of legislation	Regional cooperation	Information society
FTA agricultural goods	Illegal immigration	Economic policy dialogue	Social matters
Countervailing measures	Illicit drugs	Research and technology	Human rights
Anti-dumping	Money laundering	Energy	Health
Export taxes	Nuclear safety	Financial assistance	Education and training
SPS	Political dialogue	Industrial cooperation	Cultural cooperation
TBT	Terrorism	Movement of capital	Audio visual
Institutions	Visa and aslym	Mining	Data protection
Customs administration		Statistics	Environmental laws
State and trading enterprises		IPRs beyond TRIPs	Labor market regulations
State aid		SME	Consumer protection
Services		Innovation policies	Civil protection
Public procurement		Competition policies	
TRIMs		Agriculture	
GATS		Taxation	
TRIPs			

Source: Authors' own elaboration