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Effect of the Duration of Membership in the World Trade Organization on Trademark Applications

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Abstract: This article has examined the effect of the duration of membership in the World Trade Organization (WTO) on the submission of trademarks by countries' residents. The analysis used an unbalanced sample of 124 countries (including developed and developing countries) and, primarily, the binominal regression approach supplemented by the generalized method of moments estimator, which was utilized for the robustness check. Results have shown that the effect of the duration of WTO membership on trademarks works through the channel of trade costs. This effect is positive for less developed economies and negative for relatively advanced economies. These findings reflect the fact that as countries spend more time as WTO members, they experience a higher submission of patents in relation to trademarks, especially if they enjoy an improvement in their real per capita income (and export complex products). Furthermore, countries that receive higher Aid for Trade flows (which help to reduce trade costs) experience yet a higher number of trademark applications, but to a lesser extent than patent filings.

Keywords: duration of WTO membership; residents' trademark applications; trade costs; aid for trade

JEL Classification: O34; F14; F35

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1. Introduction

Does the World Trade Organization (WTO) contribute to promoting trademark applications by residents in its member states? The current article addresses this question by examining how the WTO membership duration affects the submission of trademarks by residents.

Many empirical works have demonstrated that membership in the WTO influences trade flows positively and significantly (e.g., Dutt 2020; Herz and Wagner 2011; Kohl and Trojanowska 2015; Larch et al. 2019). In particular, Dutt (2020) has revealed that the strong positive effect of the WTO membership increases almost monotonically with years of membership. Few other recent studies have focused not on the implications of mere membership in the WTO but rather on the duration of such membership. For example, Gnangnon (2021) has investigated the effect of membership duration on the utilization of non-reciprocal trade preferences, and Gnangnon (2023) has considered how such duration affects investment-oriented remittance inflows.

The rationale for focusing on the implications of the duration of the WTO membership (and not on the mere WTO membership) is twofold. First, the duration of WTO membership captures both the membership in the WTO and the time spent by a member in the organization. Second, thanks to the monitoring function of the WTO, the WTO membership allows countries to improve their trade policy regime, including through progressive trade liberalization, enhancement of governance, and implementation of better economic policies (e.g., Aaronson and Abouharb 2014; Drabek and Bacchetta 2004) and the establishment or the improvement of trade-related institutions (e.g., Basu et al. 2008). Therefore, over time, member states would further improve their trade policy and consequently enjoy a greater

stability and predictability of their trade policy as the duration of their membership increases. This signifies that, all things being equal, longstanding members are likely to enjoy a greater stability and predictability of their trade policy than relatively new members.

On another note, the relationship between intellectual property rights, economic growth, and development has been largely explored in the literature (e.g., Ahn et al. 2014; Chang 2001; Eicher and García-Peñalosa 2008; Hudson and Minea 2013; Kim et al. 2012; Maskus 2000; Taubman and Watal 2022). A trademark is a specific form of intellectual property rights[1] (IPR) that can be filed by individuals, firms, or other actors, and is granted by official specialized authorities (e.g., Castaldi and Mendonça 2022). It represents "any sign that individualizes the goods of a given enterprise and distinguishes them from the goods of its competitors" (WIPO 2004, chp. 2, p. 54). The registration for a trademark builds on three criteria, including distinctiveness, no misleading or immoral character, and (intent to) use in the market (WIPO 2004). Trademark registration fees[2] are far lower than those for most other statutory intellectual property forms. In particular, the lower costs of trademark applications compared to those of patents are essentially attributed to the fact that the filing of trademarks does not require proving novelty[3] (e.g., Castaldi and Mendonça 2022). For this reason, trademarks are often used by financially constrained firms and smaller enterprises (Mendonça et al. 2004). They represent attractive intellectual property assets in which they could invest in the long term (e.g., Castaldi and Mendonça 2022). Castaldi et al. (2020) have provided an integrated framework that helps understand 'why and when firms file trademarks'. Firms apply for trademarks so as to secure market positions (industrial organization perspective), to appropriate rents (innovation perspective), and to attract resources (this is the case for start-ups that suffer from liabilities of newness and smallness) (entrepreneurship perspective). Trademarks contribute significantly to promoting international trade (e.g., Fu and Ghauri 2020; Yang et al. 2018) and can promote economic development through its effect on resource allocation in the economy, innovation via competition enhancement, and reduction of asymmetries in the market (e.g., Erixon and Salfi 2015; Spitals 1981).

At the WTO's Bali Ministerial Conference held in December 2013, members adopted the Trade Facilitation Agreement (TFA), which aims to simplify, modernize, and harmonize export and import processes. By modifying existing trade procedures, the TFA helps to address soft infrastructure problems (for example, transparency, customs efficiency, and institutional reforms) and not hard infrastructure ones (for example, the development of highways, railroads, and ports) (see Beverelli et al. 2015). Some studies (e.g., Moïsé et al. 2012) have demonstrated that the implementation of this agreement could contribute to significantly reducing the overall trade costs[4], particularly in developing countries, and hence promote countries' participation in international trade (e.g., Beverelli et al. 2015; de Melo and Wagner 2016; Hillbery and Zhang 2018; Hoekman and Shepherd 2015). For developing countries, Aid for Trade (AfT) flows have been instrumental in bringing down trade costs. The portion of AfT flows associated with the TFA (i.e., Aid for Trade facilitation) will help developing countries benefit from the TFA through the lowering of the soft infrastructural-related trade costs (e.g., Busse et al. 2012; Calì and te Velde 2011). The other components of total AfT flows, especially aid flows allocated to develop economic infrastructure, will help reduce the hard infrastructural-related trade costs (e.g., Calì and te Velde 2011; Tadesse et al. 2021; Vijil and Wagner 2012).

The present paper investigates the effect of WTO membership and, in particular, the duration of such membership (which captures both the membership in the WTO and the time spent in the organization as a WTO member) on trademark applications, especially through the channel of trade costs. Thus, it does not consider whether the effect works through the global protection provided by the TRIPS Agreement to holders of trademarks, as such an issue could appropriately be addressed in future research. Existing studies on the determinants of trademark applications (e.g., Fink et al. 2005, 2021; Ghazal and Zulkhibri 2015; Gnangnon 2019, 2020; Zolas et al. 2017) have paid less attention to the trademark effect of WTO membership. In contrast with some of these studies that used firm-level

data or a country-pair/year framework in their analyses, the present paper addresses the above-mentioned question using the country/year analytical framework.

The empirical analysis, conducted using a sample of 124 countries (both developed and developing countries), has primarily used the binomial regression approach and, for robustness, the two-step system generalized method of moments (GMM) estimator. Several findings emerged from the empirical exercise. First, the duration of WTO membership on trademarks does work through the channel of trade costs. Less developed economies experience a positive effect of the duration of WTO membership on trademark applications, including to a greater extent than on patent applications. On the other hand, the duration of WTO membership leads to a fall in trademark applications, including in relation to patent applications in relatively advanced economies. These findings reflect the fact that as countries spend more time as WTO members, they tend to experience a higher submission of patents in relation to trademarks, especially if they enjoy an improvement in their real per capita income (and export complex products). The analysis has additionally revealed that recipient countries of Aid for Trade (AfT) flows tend to submit a higher number of trademarks, but to a lesser extent than patent filings, as they receive higher AfT flows (which help to reduce trade costs).

The rest of the paper is structured as follows. Section 2 provides a theoretical discussion (building on a literature review) on the effect of the duration of WTO membership on trademark applications through the trade costs channel. Section 3 presents the empirical strategy (model specification and econometric approach), and Section 4 interprets empirical outcomes. Section 5 deepens the analysis, and Section 6 concludes.

2. Literature Review and Theoretical Discussion

This section first discusses the rationale for submitting trademarks (including in relation to patents as an alternative intellectual tool to protect innovations). It, then, builds on this discussion to explore theoretically how the duration of WTO membership can affect the filing of trademarks.

2.1. Trademarks and Patents as IP Forms to Protect New Innovations

Trademarks capture innovations (including incremental innovations and soft innovations) being commercialized, as well as non-technological types of innovations (those that could not be protected by patents, for example, services innovations[5] and marketing and organizational innovations) (e.g., Davis 2006; Greenhalgh and Rogers 2012; Millot 2009). In contrast, patents are often confined to hard or functional forms of innovation (Lhuillery et al. 2017; Stoneman 2010) and tend to refer more to inventions (that are technically new to the world) than innovations. According to Block et al. (2022), trademarks allow for capturing innovation in sectors where patents are not applicable, and, in the downstream phases of the innovation process, that often involves softer activities such as marketing, design, and business development. According to the WIPO (2013), trademarks are much more popular than patents and represent the most widely used form of intellectual property, including by firms in all sectors, and especially in countries at lower levels of economic development.

Although intellectual property tools tend to complement each other (e.g., Graham and Somaya 2006; Sandner and Block 2011; Seip et al. 2019), there is specifically a vast literature on the complementarity or substitutability between trademarks and patents (e.g., Castaldi 2020; Castaldi and Mendonça 2022). Many studies in this literature have reported a tendency for trademark assets to complement[6] technological assets, including patents (e.g., Götsch and Hipp 2012; Greenhalgh and Rogers 2012; Mendonça et al. 2004; Schmoch 2003).

According to Flikkema et al. (2015, pp. 9–10), at the firm level, the trademark-to-patent ratio represents the size of a firm's trademark portfolio to the size of its patent portfolio. An increase in this ratio (which reflects a relatively large number of trademarks) suggests that the firm may have succeeded in moving a patent to the market, i.e., new trademarks may have been filed for new innovations. Meanwhile, the rise in this ratio

may also reflect the capacity of a firm to capitalize on at least one of its patents. This is especially the case when firms have many trademarks but just one or a few valuable patents granted a long time ago. In such a case, the application for a new trademark would aim to continue the capitalization process, including through brand modernization in domestic markets (Block et al. 2014), brand creation for foreign markets, or protection of a slogan, for patent substitution purposes after patent expiry. The pursuit of a branded house strategy by firms (Aaker 2004), whereby firms use a single brand to market all products and services (Flikkema et al. 2015), could lead to lower applications for trademarks. Hence, for example, an increase in trademark applications in relation to patent applications by residents can have several explanations. These are, for example, the existence of a fierce competition in the market (e.g., Allegrezza and Guarda-Rauchs 1999; De Vries et al. 2017); a strong direct interaction between firms and final consumers (e.g., De Vries et al. 2017); the dominance of small size firms in the domestic market (as larger firms can make more use of patents compared to smaller firms) (e.g., Castaldi and Mendonça 2022; Jensen and Webster 2006; Mendonça et al. 2004); the lack of financial resources by firms to apply for patents (Flikkema et al. 2014; Flikkema et al. 2019; Mendonça et al. 2004); the impossibility to patent some radical innovations (e.g., Hall et al. 2013), including in the service industries (e.g., Leiponen 2012); and the protection of incremental or new-to-the-firm innovation, as well as non-technological innovation (e.g., commercialized innovation, soft innovation, marketing, business model innovation, and organizational innovation) (e.g., Castaldi and Mendonça 2022; Mendonça et al. 2004).

Trademarks are also used by services firms in markets featured by strong information asymmetries (e.g., financial, information, and digital services) in order to secure the protection of important reputational assets (e.g., Castaldi and Giarratana 2018; Castaldi 2020), to pursue firms' capitalization process, for example, through brand modernization in domestic markets (Block et al. 2014) or brand creation for foreign markets, or to substitute for patents and prolong market dominance after patent expiry[7]. On another note, Arundel and Patel (2003) have put forth that the application for patents rests on two reasons, namely, offensive and defensive reasons. Offensive patenting means that trademarks are used by firms to announce the introduction of new products and services simply because patented inventions do not speak for themselves (Schwiebacher and Müller 2009). In this context, the number of trademark applications can be higher than the number of patent applications. Conversely, defensive patenting entails a firm applying for a patent with a view to preventing other firms from applying for it, even though they do not purport to commercialize the new innovation, at least not in the short run (Blind et al. 2009). In such a scenario, trademarks are likely to decrease in relation to patents.

2.2. Effect of the Duration of WTO Membership on Trademarks through Trade Costs

One of the objectives of the WTO is to ensure the stability and predictability of its member countries' trade policies. This is achieved through the commitments by WTO members to reducing and binding tariff rates, and to limiting the utilization of nontariff trade barriers (e.g., Chowdhury et al. 2021; Koopman et al. 2020; Mansfield and Reinhardt 2008). The benefits for a country entering into international trade agreements, especially the WTO, have been well documented in the literature. For example, according to Maggi and Rodriguez-Clare (1998), the binding nature of trade policy commitments in an international agreement enhances the credibility of countries, especially those with weak institutions. Limão and Maggi (2015) have shown that trade agreements constrain risk-averse governments' behavior during periods of uncertainty. Furthermore, the transparency provisions included in the majority of WTO agreements and decisions allow for greater clarity on countries' trade policies and contribute to enhancing the predictability and stability of trade policies. WTO members are required to disclose their trade regulations and notify changes to these regulations[8] (e.g., Chowdhury et al. 2021). The fulfillment of these obligations by member states is monitored not only by different WTO bodies, including the different WTO Councils and Committees but more importantly in the Trade Policy Review Mechanism

(TPRM) (e.g., Chaisse and Matsushita 2013; Collins-Williams and Wolfe 2010; Ghosh 2010; Laird 1999). Additionally, the WTO dispute settlement legal rulings serve to, inter alia, provide "security and predictability to the multilateral trading system, and to preserve the rights and obligations of Members under the covered agreements" (Article 3.2 of the DSU[9]). It also serves to ensure a positive and prompt settlement of disputes and foster the adoption of mutually acceptable solutions consistent with the covered agreements (Article 3.7 of the DSU). Hence, from a theoretical standpoint, the DSB's legal rulings against respondents' trade-restrictive measures generate trade gains. Shin and Ahn (2019) have shown that the WTO dispute settlement system has achieved its objective as a regulatory instrument for promoting multilateralism and market competition. This is because legally winning a WTO dispute contributes to promoting multilateral trade liberalization, not only by addressing trade problems for prevailing complainants but also by improving market access for all WTO members.

We argue that the effect of the duration of WTO membership on trademark applications could work through its effect on trade costs, which include traditional border measures (including tariffs) and nontariff trade policy measures (e.g., Milner 1996; Anderson and van Wincoop 2004; Arvis et al. 2016). Nontariff trade policy measures (which account significantly for trade costs, given the significant tariff liberalization by countries since the inception of the WTO) relate here to "the costs (time delays, charges, etc.) involved in moving goods through customs and ports, of transporting goods to and between home and foreign ports and by the additional costs (communication, information, etc.) of conducting business across national frontiers" (Ali and Milner 2016, p. 1918). Anderson and van Wincoop (2004, p. 691) have defined trade costs more broadly as "all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself: transportation costs (both freight costs and time costs), policy barriers (tariffs and nontariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail)".

Higher trade costs raise uncertainty about firms' profits (e.g., Deardorff 2014; Dixit and Pindyck 1994), limit countries' participation in international trade[10], and may discourage the filing of trademarks, especially by firms involved in international trade activities. The WTO can contribute to reducing trade costs by facilitating[11] trade, that is, by simplifying, modernizing, and harmonizing export and import processes. This can take place through the implementation by its member states of the Trade Facilitation Agreement (TFA) adopted at the WTO Bali Ministerial Conference in December 2013. The TFA contains provisions for expediting the movement, release, and clearance of goods, including goods in transit, as well as measures for effective cooperation between customs and other appropriate authorities on trade facilitation and customs compliance issues. In addition, through its provisions for technical assistance and capacity building in the trade facilitation area, the TFA could help developing countries address the problems faced by traders at the border[12]. de Melo and Wagner (2016, p. 938) have argued that a "successful implementation of the TFA would reduce uncertainty related to trade, streamline market access procedures and provide greater transparency at customs, all factors leading to lower transaction costs".

However, the TFA does not contain provisions for infrastructure and related transport and logistics services, but the Aid for Trade (AfT) financial resources that the WTO mobilizes in order to help developing countries and the least developed countries (LDCs) among them address their structural bottlenecks could be instrumental in building up the economic infrastructure (soft and hard infrastructure), strengthening the productive capacities, and improving the design of trade policy and the establishment (or improvement) of trade-related institutions in a manner consistent with WTO rules. The literature has reported a strong trade-promoting effect of aid for trade facilitation (which is part of AfT flows) (e.g., Busse et al. 2012; Calì and te Velde 2011; de Melo and Wagner 2016; Helble et al. 2012; Hillbery and Zhang 2018; Hoekman and Nicita 2011; OECD/WTO 2015), and many other studies have shown that AfT interventions for the development of economic infrastructure

also help to reduce trade costs (e.g., Calì and te Velde 2011; Tadesse et al. 2021; Vijil and Wagner 2012). In addition, numerous empirical studies[13] (e.g., Moïsé and Sorescu 2013; Novy 2013; Papalia and Bertarelli 2015) have also reported a strong trade cost reduction effect of trade facilitation (considered in a large sense). As far as the TFA effects are concerned, Moïsé et al. (2012) have found that the implementation of the various provisions of the TFA would reduce trade costs in developing countries by around 14%. Many other studies[14] have found that trade facilitation promotes export flows and export diversification. According to Beverelli et al. (2015), the TFA is likely to reduce both fixed and variable trade costs, with the fixed costs capturing the number and complexity of the documents needed for clearance[15]. The authors have then provided empirical evidence that trade facilitation has promoted the extensive margins of trade, with substantial gains from trade facilitation reform accruing to countries in Sub-Saharan Africa, Latin America, and the Caribbean. Precisely, the implementation of the TFA could increase the number of products exported (export product diversification at extensive margins) by up to 16.7% and increase the number of export destinations by-products by up to 14.1% in Sub-Saharan African countries.

In light of this literature review, we can expect that as countries spend more time as WTO members, they will improve the stability and predictability of their trade policy and reduce the level of their overall trade costs, including tariff costs and nontariff costs (the reduction of the latter could take place through the implementation of the TFA). As a result, longstanding WTO member states would likely experience a higher submission of trademark applications by their residents than relatively new members, as the former might have significantly reduced trade costs compared to the latter. In addition, countries that are not all WTO members might be less incentivized to adopt policies and measures to unilaterally reduce trade costs. Consequently, they could experience lower trademark submissions than WTO members.

Against this background, we formulate the following hypothesis:

Hypothesis 1. *The duration of WTO membership could encourage the filing of trademarks as countries enjoy lower overall trade costs.*

However, there can be many other instances where the duration of WTO membership will lead to the submission by residents of fewer trademarks in relation to other intellectual property forms, especially patents, to protect new product innovations. In this scenario, the ratio of trademark applications to patent applications by residents will decline over time (this is reflected in an increase in the ratio of residents' patent counts to residents' trademark applications). Gallié and Legros (2012) have shown that firms' propensity to use trademark protection is larger for larger companies that operate in more competitive markets. Specifically, firms operating in the manufacturing sector tend to apply for fewer trademarks unless they produce consumer goods. Along the same lines, patents tend to be intensively used by large corporations operating in high-tech manufacturing sectors, high technological inventions, and functional innovations sectors (e.g., Castaldi and Mendonça 2022). Likewise, the fall in the ratio of trademark applications to patent applications by residents may also be attributed to the short lifecycle of trademarks. In fact, the literature on the trademark lifecycle has shown that the failure of the owner of a trademark to confirm that the trademark is still in commercial use through the renewal of the trademark registration shortens the lifecycle of trademarks. For example, Millot (2009) has found that the absolute majority of the United States' trademarks die six to seven years after the registration date. According to Gao and Hitt (2012), significant improvements in information technologies have led to more frequent updates in product lines, and this situation may explain why firms with higher information technology capital may actually experience a shorter trademark lifecycle. In the same vein, for trademarks in the United States software security industry, Melnyk et al. (2014) have found that larger and more innovative companies often have a short duration of their trademarks, while older com-

panies tend to opt for the prolongation of a trademark. Additionally, Castaldi (2018) has argued that firms might not trademark their innovations at all because of both myopic and rational motives. Myopic motives refer to the lack of awareness of the possibility and/or the benefits of trademark registration due to the fact that firms do not have the requisite knowledge or resources. This is in particular the case for small and medium enterprises, as well as start-ups (e.g., Block et al. 2015). In the same spirit, Athreye and Fassio (2020) have put forth two main reasons (alleviation of both information asymmetries and constraints imposed by collaborative innovation) to explain why innovators might not trademark all their valuable inventions at all. When information asymmetries are not at stake, that is, when firms protect their position through other means such as the use of an already existing trademark[16] for their innovations or the use of alternative distribution channels, trademarks no longer serve their purpose, and firms do not resort to new trademarks for their new innovations. Moreover, the incentive to apply for trademarks decreases when firms collaborate with external partners[17] on an innovation project (open innovation). This is mainly because of the bespoke nature of the innovation or for contractual reasons (firms do not claim property of rights as they do not want to endanger the goodwill in the collaboration) or because open firms/clients have better distribution channels that the innovators may also use to market their products.

In light of the foregoing, we formulate the following hypothesis:

Hypothesis 2. *As member states spend more time in the WTO and reduce their overall trade costs, they could experience a higher submission of patents in relation to trademarks.*

This is exemplified by the fact that by reducing the opportunity cost of inputs, greater import competition releases some trapped factors inside firms and encourages firms' innovation (e.g., Bloom et al. 2013). Likewise, tariff cost reductions could promote the submission of a higher number of patent applications as exporting firms that expand sales are likely to innovate more than non-exporting firms (e.g., Bustos 2011). More recently, Coelli et al. (2022) have used data on tariff cuts during the 1990s and detailed data on innovation among firms from 65 countries to provide strong evidence of a large positive effect of tariff cuts on innovation (measured by patent data).

3. Empirical Strategy

This section lays out the model specification (Section 3.1) and presents the appropriate econometric approach to estimate this model (Section 3.2).

3.1. Model Specification

To analyze the effect of the duration of WTO membership on trademark applications, we build on previous works concerning the determinants of trademark applications, conducted using the country-pair/year framework or firm-level data (e.g., Fink et al. 2005, 2021; Zolas et al. 2017), as well as the country-year framework (e.g., Ghazal and Zulkhibri 2015; Gnangnon 2019, 2020). In addition to our key variable of interest (i.e., the duration of WTO membership), we consider a number of controls that are likely to influence the effect of the duration of WTO membership on trademark applications. These variables are the real per capita income ("GDPC"), the level of financial development ("FINDEV"), the regulatory quality policy ("REGQUAL"), foreign direct investment (FDI) inflows ("FDI"), human capital ("HUM"), and the population size ("POP").

3.1.1. Real per Capita Income and the Population Size

The real per capita income aims to capture differences in trademark applications across countries. According to Baroncelli et al. (2005), trademark ownership tends to be distributed unevenly among countries and is highly skewed towards companies from advanced market-based economies, which together represent the bulk of trademark registrations. Mangàni (2007) has observed a positive correlation between trademark applications and the size and

wealth of an economy. We, therefore, expect that an increase in the real per capita income would be associated with a higher number of trademark applications. Fink et al. (2005) have found a positive effect of the real per capita income on trademark applications. On another note, the population size has been introduced in the analysis so as to account for the effect of countries' size on innovation and hence on the submission for trademarks (e.g., Naghavi and Strozzi 2015; Ghazal and Zulkhibri 2015).

3.1.2. Financial Development

Better access to credit would allow financially constrained firms to export more (e.g., Amiti and Weinstein 2011; Kohn et al. 2016; Manova 2013; Minetti and Zhu 2011) and, potentially, apply for a higher number of trademarks (and/or alternatively for other intellectual property forms such as patents).

3.1.3. FDI Inflows

FDI inflows are associated with higher trademark applications (Gnangnon 2019, 2020; Zolas et al. 2017). For example, Zolas et al. (2017) have uncovered that FDI inflows foster the submission of trademarks. In particular, in low-income countries, trademark applications are mostly driven by FDI inflows.

3.1.4. Regulatory Quality and Human Capital

Good institutional quality (e.g., Diebolt and Hippe 2019; Liu et al. 2021) and the accumulation of human capital (e.g., Andreeva et al. 2021; You et al. 2021) could promote innovation and lead to a greater number of trademark applications. Ghazal and Zulkhibri (2015) and Gnangnon (2019, 2020) have obtained a positive effect of human capital on trademark applications.

We postulate the following baseline model specification:

$$\begin{aligned} TRMARK_{it} = \exp \quad & (\alpha_1 DURWTO_{it-1} + \alpha_2 Log(GDPC)_{it-1} + \alpha_3 FINDEV_{it-1} \\ & + \alpha_4 REGQUAL_{it-1} + \alpha_5 FDI_{it-1} + \alpha_6 HUM_{it-1} + \alpha_7 Log(POP)_{it} \\ & + \mu_i + \delta_t + \epsilon_{it}) \end{aligned} \quad (1)$$

where the dependent variable "TRMARK" represents the number of trademark applications by residents of a given country in a given year. The subscripts i and t are associated, respectively, with a country and a time-period. The panel dataset used in the analysis contains 124 countries (both developed and developing countries) over the annual period of 1996–2019, based on data availability.

The variable "DURWTO" is the transformed indicator of the duration of WTO membership. The original indicator of the duration of WTO membership computed is denoted "DURWTO1" and takes the value of "1" in 1995 (as the WTO was created in 1995), "2" in 1996, and so on, and "25" in 2019. As this variable contains many zeros and displays a skewed distribution, it has been transformed using the following formula: $DURWTO = \log(1 + DURWTO1)$.

Table A1 contains the description and source of all variables used in the analysis, and Table A2 reports the standard descriptive statistics on these variables. Appendix C lists the set of 124 countries contained in the full sample, along with the duration of WTO membership of each country in 2019.

It is worth noting that all regressors, except for the population size variable, have been considered with a one-year lag in order to ensure that contemporaneous changes do not suffer from reverse causality. For example, a country (non-member of the WTO) that wishes to enhance its participation in international trade (and encourage the submission of trademarks) would endeavor to join the WTO and reform its trade regime. The same rationale applies to the other control variables.

α_1 to α_7 are coefficients that will be estimated, μ_i are country-fixed effects (time-invariant of unobserved cross-country heterogeneity), and δ_t are year dummies that capture global shocks that influence the submission of trademark applications in all countries

together. These dummies help avoid the contemporaneous correlation by eliminating time-related shocks from the error term. ϵ_{it} is a well-behaving error term.

3.2. Econometric Approach

The variable capturing the number of trademark applications by residents in a country i at time t is a standard count variable, which has discrete and non-negative values and a skewed discrete distribution. As such, it violates the normality assumption of residuals, which is required for obtaining unbiased estimates when using standard econometric techniques such as the ordinary least squares (e.g., Atkins and Gallop 2007; Tabachnick and Fidell 2007). As a consequence, the estimation of model (1) by means of the ordinary least squares or within fixed effects estimators can generate inefficient, inconsistent, and biased estimates (Green 2002; King 1988). If the variable capturing the number of trademark applications fits equi-dispersion (including equality of the conditional mean and variance functions) and if there is independence between occurrences, then model (1) can be estimated using the Poisson regression model (e.g., Green 2002; Gujarati 2004). Otherwise, the use of the Poisson regression approach to estimate this model would yield inefficient estimates, with downward biased standard errors (Cameron and Trivedi 1986; Kennedy 2003). In particular, when the variance of the count variable is higher than its mean (i.e., in the presence of the overdispersion structure—see Cox 1983), a credible estimator is the negative binomial model, which is a generalization of the Poisson distribution with an additional parameter that allows the variance to be higher than the mean (e.g., Cameron and Trivedi 1998, 2013; Green 2002, 2003; Johnson et al. 1993). In the present analysis, the variance of the variable capturing the number of trademark applications amounts to 94,749.04, while its mean is 24,530.95 (see Table A2). Against this background, our primary estimator in the analysis is the negative binomial regression with fixed effects (e.g., Cameron and Trivedi 1998, 2013; Green 2003). We have additionally corrected for the heteroskedasticity by uncovering robust standard errors.

4. Empirical Results

This section presents the outcomes of the estimation of the baseline model (1) and many variants of this model. The estimates represent the average marginal effects of regressors (obtained from the negative binomial models) on the number of trademark applications.

At this stage of the analysis, it is also worth providing a few words concerning the interpretation of outcomes obtained based on the negative binomial regressions.

First, to interpret the binomial regressions-based outcomes, we need to calculate the incidence rate ratio (IRR) by taking the exponential of each coefficient. The IRR indicates the factor by which the dependent variable can be expected to change for a one-unit increase in the explanatory variable. Hence, a value of the IRR above one reflects a positive effect, while a value below one corresponds to a negative effect. For example, an IRR equal to 1.05 obtained for a given variable "X" is to be interpreted as follows: a one-unit increase in the variable "X" generates an increase in the dependent variable by 5% (=100(1.05 − 1)), holding other variables constant.

Second, the way the variable "DURWTO" has been transformed matters for the interpretation of estimations' outcomes. To recall, the variable "DURWTO1", which indicates the genuine number of years spent by a country in the WTO has been transformed as follows: DURWTO $= \log(1 + DURWTO1)$. Hence, a one-year increase in the value of "DURWTO1" means an increase in the values of "DURWTO" by 0.693 years (=Log(2)), which is equivalent to 8.3 months ("Log" being the natural logarithm). Concurrently, an increase in the values of the transformed indicator "DURWTO" by 1 year means an increase in the values of "DURWTO1" by 1.72 years [=exponential (1) − 1].

Additionally, for all regressions whose results are interpreted below, we have tested the existence of an overdispersion of the Poisson distribution. The outcomes reported at the bottom of all Tables 1–5 presented below reveal that the hypothesis that $\alpha = 0$ is

always rejected, thereby indicating that the negative binominal model is better than the Poisson model.

Table 1. Effect of the duration of WTO membership on the number of trademark applications submitted by residents—average marginal effects over the full sample. ***Estimator***: Conditional FE negative binomial regression.

Variables	TRMARK	TRMARK	TRMARK	TRMARK	RATIO
	(1)	(2)	(3)	(4)	(5)
$DURWTO_{t-1}$	0.160 ***			0.128 ***	0.501 ***
	(0.0372)			(0.0383)	(0.0600)
WTO_{t-1}		0.377 ***			
		(0.0500)			
$DURGATT_{t-1}$			0.156 ***		
			(0.0204)		
$Log(TRCOST)_{t-1}$				0.156 **	0.332 **
				(0.0792)	(0.139)
$Log(GDPC)_{t-1}$	0.330 ***	0.324 ***	0.312 ***	0.360 ***	0.218 ***
	(0.0319)	(0.0314)	(0.0318)	(0.0330)	(0.0524)
$FINDEV_{t-1}$	0.000195	0.000123	0.000143	0.000527	−0.00177 **
	(0.000356)	(0.000353)	(0.000348)	(0.000353)	(0.000871)
$REGQUAL_{t-1}$	0.0367	0.0381	0.0243	0.00486	0.117 *
	(0.0321)	(0.0318)	(0.0316)	(0.0322)	(0.0661)
FDI_{t-1}	0.00102 ***	0.00104 ***	0.00100 ***	0.00115 **	0.00140
	(0.000378)	(0.000378)	(0.000369)	(0.000458)	(0.000883)
Log(POP)	0.257 ***	0.260 ***	0.253 ***	0.262 ***	0.364 ***
	(0.0192)	(0.0190)	(0.0194)	(0.0218)	(0.0345)
HUM_{t-1}	0.287 ***	0.308 ***	0.296 ***	0.251 ***	0.698 ***
	(0.0513)	(0.0518)	(0.0513)	(0.0520)	(0.0854)
Constant	−5.920 ***	−6.127 ***	−5.937 ***	−6.854 ***	−10.20 ***
	(0.439)	(0.434)	(0.438)	(0.725)	(1.216)
Observations–Countries	1881–124	1881–124	1881–124	1756–120	1497–114
Log likelihood	−14,623.738	−14,603.186	−14,602.23	−13,642.518	−5009.3658
Wald Chi2 (*p*-value)	2221.29	2257.58	2218.80	1879.24	379.96
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Overdispersion test (LR test of alpha = 0): Chi2 statistic (*p*-value)	1.5×10^7	1.4×10^7	1.5×10^7	1.4×10^7	1.9×10^5
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: * *p*-value < 0.1; ** *p*-value < 0.05; *** *p*-value < 0.01. Robust standard errors are in parentheses. Time dummies have been included in the regressions.

Let us now take up the results in Table 1. In column (1) of this Table, we present the outcomes of the estimation of the baseline model (1). The results in column (2) of the same Table were obtained by estimating a specification of the model (1), where the variable "DUMWTO" was replaced with the dummy "WTO", which took the value of 1 in years during which a country was a member of the WTO and 0 otherwise. The purpose of estimating this variant of model (1) is to examine how the mere membership (and not the duration of such a membership) affects trademark applications.

Table 2. Average marginal effects of the duration of WTO membership on the number of trademark applications submitted by residents across countries in the full sample and sub-samples. ***Estimator***: Conditional FE negative binomial regression.

Variables	TRMARK	RATIO	TRMARK	TRMARK	TRMARK	RATIO
	(1)	(2)	(3)	(4)	(5)	(6)
$DURWTO_{t-1}$	1.353 ***	0.586 ***	0.149 ***	0.0929 **	0.108 ***	0.198 ***
	(0.0805)	(0.158)	(0.0342)	(0.0367)	(0.0382)	(0.0577)
$[DURWTO_{t-1}] \times [Log(GDPC)_{t-1}]$	−0.151 ***	−0.0286				
	(0.00917)	(0.0199)				
$[DURWTO_{t-1}] \times HIC$			−0.447 ***			
			(0.0275)			
$[DURWTO_{t-1}] \times LDC$				0.424 ***		
				(0.0494)		
$[DURWTO_{t-1}] \times LLDC$					0.201 ***	0.496 ***
					(0.0459)	(0.0811)
HIC			1.180 ***			
			(0.155)			
LDC				−0.0703		
				(0.159)		
LLDC					−0.224	−1.517 ***
					(0.145)	(0.236)
$Log(GDPC)_{t-1}$	0.529 ***	0.210 ***	0.209 ***	0.375 ***	0.338 ***	−0.0250
	(0.0338)	(0.0582)	(0.0415)	(0.0348)	(0.0353)	(0.0601)
$FINDEV_{t-1}$	0.000736 **	−0.00185 **	0.000255	0.000175	0.000274	−0.00187 **
	(0.000348)	(0.000831)	(0.000347)	(0.000349)	(0.000355)	(0.000825)
$REGQUAL_{t-1}$	0.145 ***	0.186 ***	0.157 ***	0.0453	0.0396	0.225 ***
	(0.0325)	(0.0681)	(0.0318)	(0.0324)	(0.0323)	(0.0673)
FDI_{t-1}	0.000966 **	0.000240	0.000989 ***	0.000982 ***	0.00102 ***	9.68×10^{-5}
	(0.000387)	(0.000839)	(0.000379)	(0.000381)	(0.000379)	(0.000843)
Log(POP)	0.273 ***	0.363 ***	0.284 ***	0.253 ***	0.256 ***	0.339 ***
	(0.0192)	(0.0330)	(0.0193)	(0.0198)	(0.0201)	(0.0330)
HUM_{t-1}	0.245 ***	0.713 ***	0.244 ***	0.343 ***	0.285 ***	0.970 ***
	(0.0502)	(0.0805)	(0.0512)	(0.0524)	(0.0518)	(0.0915)
Constant	−7.732 ***	−8.202 ***	−5.559 ***	−6.359 ***	−5.926 ***	−6.178 ***
	(0.451)	(0.731)	(0.440)	(0.490)	(0.491)	(0.809)
Observations–Countries	1881–124	1598–118	1881–124	1881–124	1881–124	1598–118
Log likelihood	−14,495.818	−5457.0621	−14,490.621	−14,583.972	−14,613.998	−5433.7496
Wald Chi2 (*p*-value)	2193.45	385.99	2386.35	2289.76	2173.95	427.01
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Overdispersion test (LR test of alpha = 0): Chi2 statistic (*p*-value)	1.5×10^7	2.1×10^5	1.4×10^7	1.4×10^7	1.5×10^7	2.1×10^5
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: * *p*-value < 0.1; ** *p*-value < 0.05; *** *p*-value < 0.01. Robust standard errors are in parentheses. Time dummies have been included in the regressions.

We note from column (1) of Table 1 that the marginal effect of the duration of WTO membership on trademark applications is positive and significant at the 1% level. The coefficient of the variable "DURWTO" is 0.16, and the associated computed IRR amounts to 1.1735. This suggests that an additional year as a WTO member (i.e., an increase in the value of "DURWTO" by 0.693 years) generates a rise in the trademark count submitted

by countries' residents by 12% (=0.693 × 17.35). Similarly, results in column (2) of the same Table reveal that WTO membership induces a greater submission of trademarks, as the coefficient of the dummy "WTO" is positive and significant at the 1% level and amounts to 0.377 (the calculated associated IRR is 1.458). This suggests that trademark counts increase, on average, by 45.8% for WTO members compared to non-WTO members. Results in column (3) of Table 1 are obtained by replacing the variable "DURWTO" with "DURGATT", where the latter is the transformed indicator of the duration of membership in the GATT/WTO and is calculated such that DURGATT $= \log(1 + DURGATT1)$, with "DURGATT1" measuring the duration of membership in both the GATT and WTO. Note that the variable "DURGATT1" has been computed taking into account the month in which a country has joined the GATT and/or the WTO. Estimates reported in column (3) of Table 1 confirm those in column (1) of the Table as the coefficient (0.156) of the variable "DURGATT" is almost identical to the one in column (1) of the Table.

Table 3. Average marginal effects of the duration of WTO membership on the number of trademark applications submitted by residents for varying levels of innovation (economic complexity). ***Estimator***: Conditional FE negative binomial regression.

Variables	**TRMARK**	**RATIO**
	(1)	**(2)**
$DURWTO_{t-1}$	0.147 ***	0.333 ***
	(0.0339)	(0.0626)
$[DURWTO_{t-1}] \times [ECI_{t-1}]$	−0.185 ***	−0.0447
	(0.0161)	(0.0328)
ECI_{t-1}	0.439 ***	0.190 *
	(0.0521)	(0.100)
$Log(GDPC)_{t-1}$	0.286 ***	0.187 ***
	(0.0352)	(0.0556)
$FINDEV_{t-1}$	0.000232	−0.00300 ***
	(0.000377)	(0.000925)
$REGQUAL_{t-1}$	0.0653 *	0.192 ***
	(0.0337)	(0.0721)
FDI_{t-1}	0.00146 ***	0.00232 *
	(0.000510)	(0.00137)
Log(POP)	0.157 ***	0.372 ***
	(0.0255)	(0.0389)
HUM_{t-1}	0.213 ***	0.652 ***
	(0.0562)	(0.0932)
Constant	−3.634 ***	−8.020 ***
	(0.541)	(0.910)
Observations–Countries	1701–116	1485–112
Log likelihood	−13,348.57	−4979.113
Wald Chi2 (*p*-value)	1719.31 (0.0000)	378.45 (0.0000)
Overdispersion test (LR test of alpha = 0): Chi2 statistic (*p*-value)	1.4×10^7 (0.0000)	1.7×10^5 (0.0000)

Note: * *p*-value < 0.1; ** *p*-value < 0.05; *** *p*-value < 0.01. Robust standard errors are in parentheses. Time dummies have been included in the regressions.

Table 4. Average marginal effects of the duration of WTO membership on the number of trademark applications submitted by residents before and after the adoption of the TFA/and for varying levels of the overall trade costs. ***Estimator***: Conditional FE negative binomial regression.

Variables	TRMARK	TRMARK	TRMARK	RATIO	TRMARK	RATIO
	(1)	(2)	(3)	(4)	(5)	(6)
TFA	0.522 *** (0.0556)	0.651 *** (0.109)				
$DURWTO_{t-1}$		0.135 *** (0.0349)	−1.848 *** (0.373)	−2.297 *** (0.810)	−0.481 (0.335)	−2.026 *** (0.766)
$[DURWTO_{t-1}] \times TFA$		−0.133 *** (0.0212)				
$[DURWTO_{t-1}] \times [Log(TRCOST)_{t-1}]$			0.341 *** (0.0643)	0.477 *** (0.138)		
$[Log(TRCOST)_{t-1}]$			−0.797 *** (0.196)	−1.008 ** (0.408)		
$[DURWTO_{t-1}] \times [Log(TARIFF)_{t-1}]$					4.341 *** (0.450)	−0.999 (0.973)
$[DURWTO_{t-1}] \times [Log(NTARIFF)_{t-1}]$					0.0358 (0.0594)	0.443 *** (0.132)
$[Log(TARIFF)_{t-1}]$					−10.58 *** (1.121)	4.989 ** (2.381)
$[Log(NTARIFF)_{t-1}]$					0.0805 (0.178)	−0.959 ** (0.387)
$Log(GDPC)_{t-1}$	0.353 *** (0.0316)	0.341 *** (0.0317)	0.328 *** (0.0339)	0.204 *** (0.0526)	0.351 *** (0.0342)	0.0870 (0.0578)
$FINDEV_{t-1}$	0.000283 (0.000355)	0.000197 (0.000355)	0.000577 (0.000358)	−0.00157 * (0.000867)	0.000695 ** (0.000344)	−0.00125 (0.000864)
$REGQUAL_{t-1}$	0.0461 (0.0325)	0.0278 (0.0321)	0.00539 (0.0322)	0.130 * (0.0662)	0.0498 (0.0328)	0.118 * (0.0685)
FDI_{t-1}	0.000993 *** (0.000377)	0.00104 *** (0.000378)	0.00102 ** (0.000459)	0.00131 (0.000880)	0.00113 ** (0.000460)	0.00117 (0.000922)
Log(POP)	0.242 ***	0.262 ***	0.236 ***	0.349 ***	0.286 ***	0.342 ***

Table 4. *Cont.*

Variables	TRMARK	TRMARK	TRMARK	RATIO	TRMARK	RATIO
	(1)	(2)	(3)	(4)	(5)	(6)
	(0.0189)	(0.0190)	(0.0222)	(0.0347)	(0.0232)	(0.0358)
HUM_{t-1}	0.270 ***	0.266 ***	0.196 ***	0.640 ***	0.144 ***	0.919 ***
	(0.0509)	(0.0519)	(0.0534)	(0.0876)	(0.0540)	(0.100)
Constant	−5.724 ***	−6.013 ***	−0.716	−2.125	−5.371 ***	−2.632
	(0.437)	(0.434)	(1.373)	(2.609)	(1.257)	(2.442)
Observations–Countries	1881–124	1881–124	1756–120	1497–114	1714–120	1468–114
Log likelihood	−14,634.191	−14,607.145	−13,628.332	−5003.4234	−13,306.542	−4888.141
Wald Chi2 (*p*-value)	2190.84 (0.0000)	2251.57 (0.0000)	1793.59 (0.0000)	385.48 (0.0000)	1749.40 (0.0000)	360.58 (0.0000)
Overdispersion test (LR test of alpha = 0): Chi2 statistic (*p*-value)	1.5×10^7 (0.0000)	1.5×10^7 (0.0000)	1.3×10^7 (0.0000)	1.9×10^5 (0.0000)	1.3×10^7 (0.0000)	1.8×10^5 (0.0000)

Note: * *p*-value < 0.1; ** *p*-value < 0.05; *** *p*-value < 0.01. Robust standard errors are in parentheses. Time dummies have been included in the regressions. The dummy "TFA" is a dummy variable that represents the period after the adoption of the WTO Trade Facilitation Agreement (it was adopted in December 2014). It takes the value of 1 for the sub-period from 2014 to 2019 and 0 from 1996 to 2013.

Table 5. Average marginal effects of the duration of WTO membership on the number of trademark applications submitted by residents for varying amounts of AfT flows. ***Estimator***: Conditional FE negative binomial regression.

Variables	TRMARK	TRMARK	TRMARK	TRMARK	TRMARK	RATIO	RATIO	RATIO	RATIO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$DURWTO_{t-1}$	0.131 ***	−1.005 ***	−0.432 ***	−0.600 ***	−0.0668	2.227 ***	1.806 ***	1.649 ***	0.777 ***
	(0.0428)	(0.185)	(0.115)	(0.170)	(0.107)	(0.439)	(0.302)	(0.465)	(0.242)
$[DURWTO_{t-1}] \times [Log(AfTTOT)_{t-1}]$		0.0618 ***				−0.102 ***			
		(0.0101)				(0.0236)			
$[DURWTO_{t-1}] \times [Log(AfTINFRA)_{t-1}]$			0.0324 ***				−0.0833 ***		
			(0.00645)				(0.0168)		
$[DURWTO_{t-1}] \times [Log(AfTPROD)_{t-1}]$				0.0421 ***				−0.0735 ***	
				(0.00960)				(0.0260)	
$[DURWTO_{t-1}] \times [Log(AfTPOL)_{t-1}]$					0.0148 **				−0.0328 **
					(0.00698)				(0.0164)

Table 5. *Cont.*

Variables	TRMARK	TRMARK	TRMARK	TRMARK	TRMARK	RATIO	RATIO	RATIO	RATIO
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Log(AfTTOT)_{t-1}$		−0.161 ***				0.210 ***			
		(0.0288)				(0.0690)			
$Log(AfTINFRA)_{t-1}$			−0.0892 ***				0.192 ***		
			(0.0171)				(0.0466)		
$Log(AfTPROD)_{t-1}$				−0.0807 ***				0.120	
				(0.0278)				(0.0761)	
$Log(AfTPOL)_{t-1}$					−0.0165				0.0564
					(0.0193)				(0.0449)
$Log(GDPC)_{t-1}$	0.134 ***	0.111 **	0.119 **	0.138 ***	0.189 ***	0.161 **	0.154 **	0.173 **	0.119
	(0.0488)	(0.0515)	(0.0508)	(0.0513)	(0.0508)	(0.0730)	(0.0731)	(0.0719)	(0.0731)
$FINDEV_{t-1}$	0.000980	0.000541	0.000640	0.000727	0.001000	−0.000845	−0.00105	−0.000849	−0.00189
	(0.000864)	(0.000873)	(0.000871)	(0.000878)	(0.000876)	(0.00149)	(0.00149)	(0.00148)	(0.00153)
$REGQUAL_{t-1}$	0.119 **	0.178 ***	0.174 ***	0.150 ***	0.0863	0.118	0.106	0.129	0.244 ***
	(0.0490)	(0.0503)	(0.0504)	(0.0504)	(0.0531)	(0.0822)	(0.0828)	(0.0851)	(0.0930)
FDI_{t-1}	0.00660 **	0.00578 *	0.00540	0.00582 *	0.00683 **	−0.0134 **	−0.0137 **	−0.0138 **	−0.0145 **
	(0.00336)	(0.00331)	(0.00332)	(0.00333)	(0.00338)	(0.00678)	(0.00676)	(0.00669)	(0.00659)
Log(POP)	0.282 ***	0.299 ***	0.297 ***	0.281 ***	0.261 ***	0.540 ***	0.511 ***	0.534 ***	0.518 ***
	(0.0282)	(0.0288)	(0.0285)	(0.0287)	(0.0301)	(0.0511)	(0.0497)	(0.0511)	(0.0509)
HUM_{t-1}	0.240 ***	0.327 ***	0.308 ***	0.260 ***	0.203 **	0.968 ***	1.012 ***	0.894 ***	0.980 ***
	(0.0785)	(0.0789)	(0.0790)	(0.0786)	(0.0809)	(0.115)	(0.117)	(0.114)	(0.118)
Constant	−4.418 ***	−1.717 **	−3.112 ***	−3.041 ***	−4.152 ***	−15.25 ***	−14.24 ***	−13.36 ***	−11.37 ***
	(0.657)	(0.830)	(0.709)	(0.826)	(0.715)	(1.770)	(1.417)	(1.845)	(1.297)
Observations–Countries	976–76	971–76	971–76	970–76	928–76	787–69	787–69	787–69	766–69
Log likelihood	−7304.4523	−7238.5565	−7243.643	−7239.8026	−6959.5673	−3197.6419	−3197.4345	−3200.619	−3112.0708
Wald Chi2 (*p*-value)	1073.96	1216.24	1167.26	1171.54	1073.44	266.43	265.84	252.49	238.33
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Overdispersion test (LR test of alpha = 0):	3.7×10^6	3.7×10^6	3.7×10^6	3.6×10^6	3.5×10^6	1.4×10^5	1.3×10^5	1.4×10^5	1.3×10^5
Chi2 statistic (*p*-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: * *p*-value < 0.1; ** *p*-value < 0.05; *** *p*-value < 0.01. Robust standard errors are in parentheses. Time dummies have been included in the regressions. The regressions cover the period of 2002–2019 because AfT disbursements data are only available from 2002.

Control variables exhibit similar coefficients (in terms of magnitude, sign, and statistical significance) across the three columns (1) to (3). An increase in the real per capita income, higher FDI inflows, an improvement in human capital, and a rise in the population size are all positively and significantly associated with the number of trademarks submitted by residents. These outcomes are consistent with the theoretical expectations. However, financial development and regulatory quality do not significantly affect trademark applications at the conventional significance levels.

We hypothesized above that the duration of WTO membership could affect trademark applications through the trade costs channel. One way to test the validity of this hypothesis is to include in the model (1) the variable measuring the overall trade costs in each country and year. The resulting model is then estimated, and the related outcomes are provided in column (4) of Table 1. In principle, if 'trade costs' is a channel through which the duration of WTO membership could affect trademark applications, then the coefficient of the variable "DURWTO" in column (1) (i.e., the estimate of this variable in the baseline model—in the absence of the channel-variable) should decrease in magnitude or become statistically nil at the conventional significance levels, in particular at the 5% level. The indicator of the overall trade costs used encompasses tariffs, international transport costs, direct and indirect costs associated with differences in languages, and currencies as well as cumbersome import or export procedures. It has been computed using the UNESCAP-World Bank Trade Cost Database, developed by Arvis et al. (2012, 2016) following the approach proposed by Novy (2013). This dataset contains bilateral overall trade costs computed by building on the definition of trade costs by Anderson and van Wincoop (2004). Bilateral comprehensive trade costs are all costs involved in trading goods (agricultural and manufactured goods) internationally with another partner (i.e., bilaterally) relative to those involved in trading goods domestically (i.e., intranationally). Our indicator of the overall trade costs (denoted "TRCOST") is obtained by calculating, per country and for every year, the average of the bilateral overall trade costs on goods (both agriculture and manufacturing) across all trading partners of this country (see Table A1 for details on the computation of this indicator).

Results in column (4) of Table 1 suggest that the introduction of the variable measuring the overall trade costs in the baseline model (1) leads to a fall in the magnitude of the average marginal effect of the variable "DURWTO" from 0.16 in column (1) to 0.128 in column (4). We can, therefore, deduce that trade costs constitute a channel through which the duration of the WTO membership affects trademark applications.

Meanwhile, we note that the average marginal effect of trade costs on trademark applications is positive (amounting to 0.156) and significant at the 5% level. This suggests that on average over the full sample, a rise in the overall trade costs is associated with an increase in the number of trademark applications. This outcome may reflect the fact that trademarks tend to be far cheaper than most other statutory forms of intellectual property; therefore, firms that face higher trade costs tend to file trademarks at the detriment of other forms of intellectual property, including patents. One could also interpret this outcome by the fact that higher trade costs may discourage technological innovation (by confining firms to soft innovations), and hence induce a higher number of trademark applications, including in relation to patent applications, particularly in developing countries. Outcomes in column (5) of Table 1 confirm the latter interpretation. They are obtained by running a regression similar to the one whose results are reported in column (4), but here the dependent variable "TRMARK" is replaced with the ratio of the total trademark applications by residents of a country in a year to the total patent applications by the residents of the same country in the same year (this ratio is denoted "RATIO"). As noted in Section 2, this indicator has the advantage of helping to assess how the duration of WTO membership affects the number of trademark applications in relation to the number of patent applications. We note from this column of the Table that the coefficient of the trade cost indicator is positive and significant at the 5% level, thereby suggesting that as trade costs rise, countries tend to make more use of trademarks than patents as a form of intellectual property tool to protect their new innovations. Incidentally, in this column of Table 1, the duration of

WTO membership exerts a positive and significant effect (at the 1% level) on the ratio of trademark counts to patent counts. Put together, these outcomes indicate that not only does the duration of WTO membership increase trademark counts (see column (4) of Table 1) but it also leads to a higher number of trademark applications in relation to patent applications (see column (5) of Table 1). Regarding control variables, we observe that the increase in the ratio of trademark counts in relation to patent counts is positively and significantly driven by an improvement in the real per capita income, the accumulation of human capital, and an increase in the population size. Financial development tends to be positively associated with a rise in patent counts in relation to trademark counts. While there is no significant effect (at the conventional significance levels) of FDI inflows on the ratio of trademark applications to patent applications, regulatory quality exerts a positive and significant effect on this ratio, but only at the 10% level.

We now consider the outcomes reported in Table 2. Column (1) of this Table contains the outcomes arising from the estimation of different variants of model (1) that allow examining the effect of the duration of WTO membership on trademark applications across countries in the full sample. These outcomes are obtained by estimating a specification of model (1) that includes the interaction between the variable capturing the duration of WTO membership and the real per capita income. It appears that while the coefficient of the indicator of membership duration is positive and significant at the 1% level, the interaction term of the interaction variable is negative and significant at the 1% level. These outcomes tend to suggest that the duration of WTO membership induces fewer trademark applications as the real per capita income increases, in particular for high per capita income countries. However, as noted, for example, by Brambor et al. (2006), it can be misleading to infer the magnitude and significance of the effect of an interaction variable simply by considering the coefficient and standard error of the interaction term. The true interaction effect could, for example, be obtained by a graphical analysis that takes into account together the estimate of the main and interaction variables (i.e., here, the coefficient of both "$DURWTO_{t-1}$" and "$[DURWTO_{t-1}] \times [Log(GDPC)_{t-1}]$" variables).

Therefore, we present in Figure 1, at the 95 percent confidence intervals, the marginal impact of the duration of WTO membership on trademark applications for varying levels of the real per capita income. While not always statistically significant, this marginal impact takes positive and negative values and decreases as the real per capita income rises. It is positive and significant for countries whose real per capita income is strictly lower than USD 5320.5 [=exponential (8.579323)]. It is negative and significant for high-income countries, i.e., for countries whose real per capita income is higher than USD 11,190 [=exponential (9.322758)]. It is not statistically significant when the real per capita income is comprised between USD 5320.5 and USD 11,190. These findings suggest that the duration of WTO membership induces the submission of fewer trademarks in high-income countries, that is, these countries tend to submit fewer trademarks, possibly for the benefit of other forms of intellectual property such as patents. Conversely, the duration of WTO membership increases the number of trademarks submitted by residents in relatively lower-income countries (in particular poor countries), i.e., those with a real per capita income tending to be lower than USD 5320.5. In this group of countries, the lower the real per capita income, the greater the number of trademarks submitted by residents. To check the findings in column (1) of Table 2, we present in column (2) of the same Table the results of the estimation of a variant of model (1) that includes the interaction between the variable representing the duration of WTO membership and the real per capita income, but where the dependent variable "TRMARK" is replaced with variable "RATIO". While the coefficient of the variable "$DURWTO_{t-1}$" is positive and significant, the interaction term is not significant at the conventional significance levels. Figure 2 shows, at the 95 percent confidence intervals, the marginal impact of the duration of WTO membership on the ratio of trademark counts to patent counts for varying levels of the real per capita income. It confirms that as countries experience an improvement in their real per capita income, they tend to submit a relatively higher number of patent applications than trademark

applications. In fact, this marginal impact is always positive and significant but declines as the real per capita income increases.

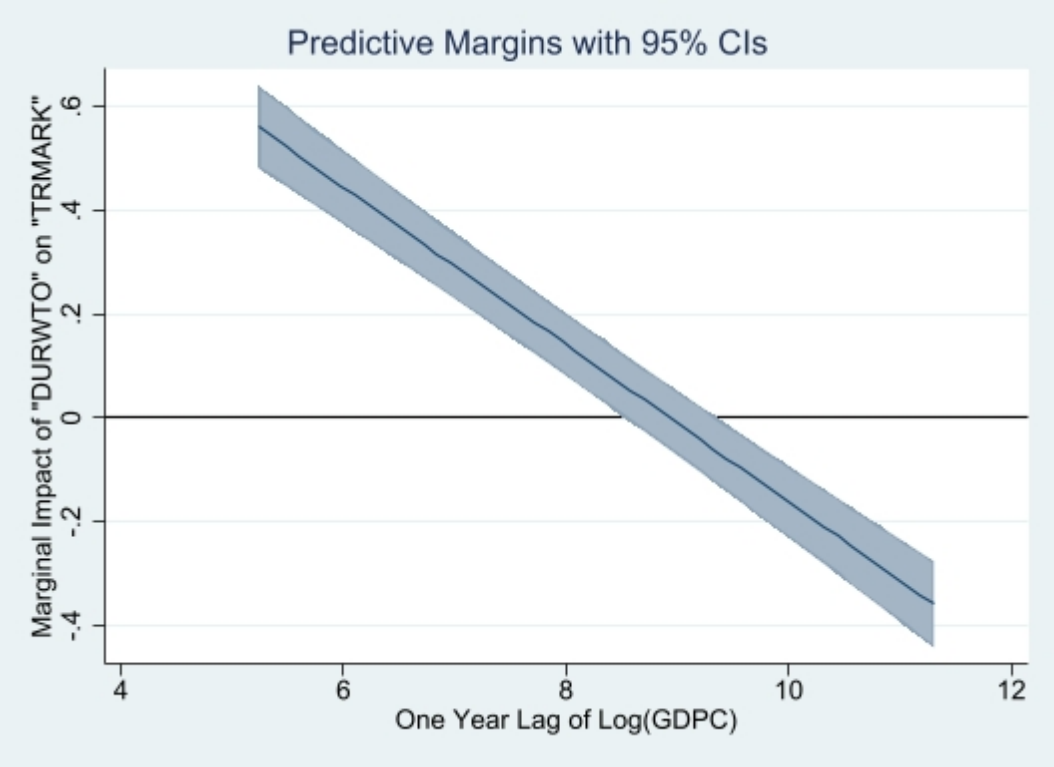

Figure 1. Marginal impact of "DURWTO" on "TRMARK" for varying levels of the real per capita income. Source: Author.

Columns (3) and (4) of Table 2 report outcomes that allow exploring the effect of the duration of the WTO membership on trademark applications, respectively, in high-income countries (HICs) and least-developed countries (LDCs). The purpose of these outcomes is to check whether the findings in column (1) are confirmed when we consider the effect of the duration of WTO membership on trademark applications in these two sub-samples. The sub-sample of HICs is obtained from the World Bank classification of countries as of July 2019 (2019 being the last year of the panel dataset). Countries included in the category of LDCs are obtained from the list of LDCs developed by the United Nations and considered as such in 2019. According to the United Nations, LDCs[18] are the poorest countries in the world that are concurrently the most vulnerable to external economic and environmental shocks. The panel dataset used in the analysis contains 50 HICs (and hence 74 NonHICs that we consider as 'developing countries') and 18 LDCs among developing countries. The results in columns (3) and (4) were obtained by estimating two different variants of model (1) that contain, respectively, the dummy "HIC" and its interaction with the variable "$DURWTO_{t-1}$" (for results in column (3)) and the dummy "LDC" along with its interaction with the variable "$DURWTO_{t-1}$" (for results in column (4)). The dummy "HIC" takes the value of 1 for countries classified by the World Bank as HICs and 0 otherwise. The dummy "LDC" takes the value of 1 for countries classified by the United Nations as LDCs and 0 otherwise. Outcomes in column (3) of Table 2 indicate that at the 1% level, the duration of WTO membership exerts a higher negative effect on the filing of trademarks in HICs than in developing countries. The net average marginal effect of the membership duration on trademark applications in HICs and developing countries amounts, respectively, to -0.298 ($=0.149 - 0.447$) and 0.149. The associated IRRs are 0.7423 and 1.1607, respectively, for HICs and developing countries. We, therefore, conclude that an additional year as a

WTO member (i.e., an increase in the value of "DURWTO" by 0.693 year) is associated with a fall in trademark counts by 17.86% (=0.693 × 100 × (0.7423 − 1)] in HICs, and an increase in trademark applications by 11.14% (=0.693 × 100 × (1.1607 − 1)] in developing countries. Estimates in column (4) of Table 2 reveal that the duration of WTO membership induces a higher number of trademark applications in LDCs than in other countries in the full sample. Specifically, the net average marginal effect of the WTO membership duration on trademark applications in LDCs is positive and amounts to 0.517 (=0.0929 + 0.424), and the associated IRR is 1.677. This suggests that an additional year spent as a WTO member by LDC members generates, on average, a rise in trademark applications by 46.92% [(=0.693 × 100 × (1.677 − 1)] in LDCs. In a nutshell, these outcomes suggest that while trademark applications increase in developing countries (particularly in LDCs) as these countries experience a greater duration of WTO membership, HICs tend to submit fewer trademark applications (probably for the benefit of patent applications) as they expand their WTO membership duration. These findings definitely confirm those in column (1) of Table 2.

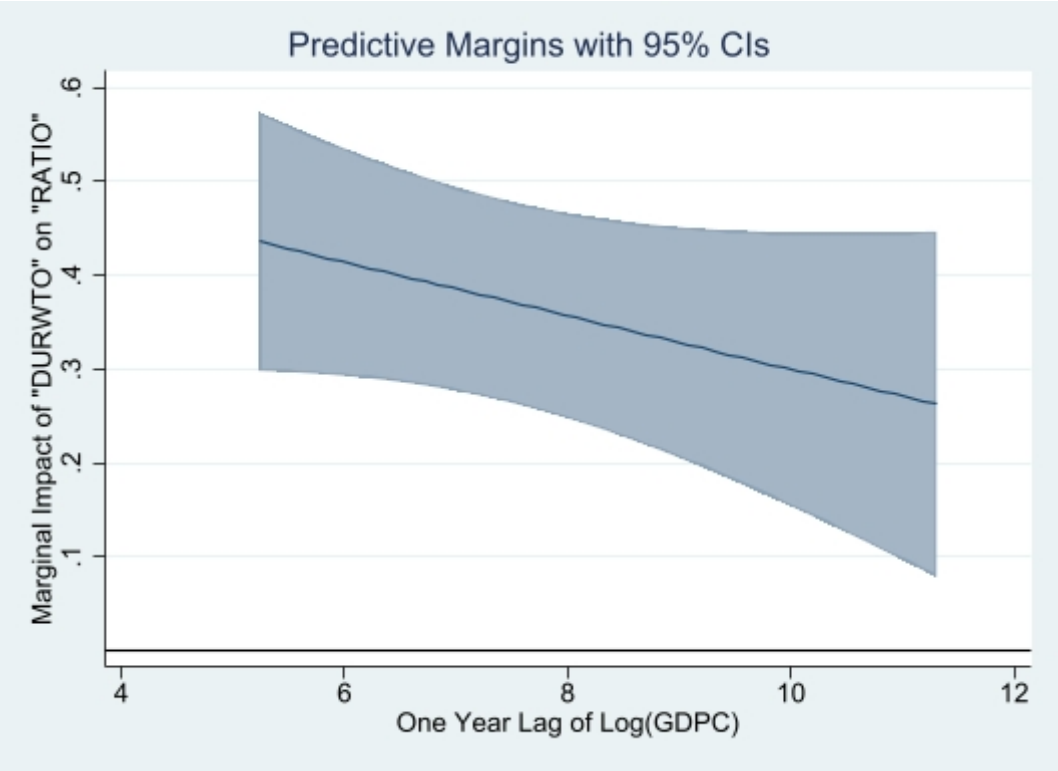

Figure 2. Marginal impact of "DURWTO" on "RATIO" for varying levels of the real per capita income. Source: Author.

Landlocked developing countries face higher trade costs than other countries due to specific trade bottlenecks, including heavy dependence on transport corridors and trade logistics of neighboring coastal countries (e.g., Beverelli et al. 2015; de Melo and Wagner 2016; WTO 2021). Therefore, it could be useful to investigate how the duration of WTO membership affects trademark applications by countries in this specific group[19]. The list of landlocked developing countries (LLDCs) is designated by the United Nations[20]. We undertake this empirical exercise by estimating a variant of model (1) that includes the dummy variable "LLDC" (which represents landlocked developing countries) and the interaction between this dummy variable and the variable measuring the duration of WTO membership. The dummy "LLDC" takes the value of 1 if a country is considered an LLDC and 0 otherwise. The outcomes of this estimation are presented in column (5) of

Table 2. We also perform the same regression, but now with the variable "RATIO" as a dependent variable. This is simply to assess whether the outcomes obtained in column (5) concerning the effect of the duration of WTO membership on trademark applications in LLDCs are confirmed when we consider this effect on the ratio of trademark applications to patent applications for the same set of countries. Results of this estimation are provided in column (6) of Table 2. In column (5) of this Table, we see that LLDCs experience a higher positive effect of the duration of WTO membership on trademark applications than other countries in the full sample. Likewise, estimates in column (6) of the same Table indicate that as their membership duration rises, LLDCs submit a higher number of trademarks in relation to patents than other countries in the full sample. The net average marginal effect of the membership duration on trademark applications in LLDCs amounts to 0.309 (=0.108 + 0.201), and the related IRR is 1.362. This signifies that an additional year of WTO membership is associated with an increase in trademark applications by 25.08% [(=0.693 $\times$ 100 $\times$ (1.362 $-$ 1)] in LLDCs. In addition, the net average marginal effect of the membership duration on the ratio of trademark counts to patent counts in LLDCs amounts to 0.694 (=0.198 + 0.496), and the related IRR is 2.0017. Thus, an additional year of WTO membership in LLDCs is associated with an increase in the ratio of trademark counts to patent counts by 69.42% (=0.693 $\times$ 100 $\times$ (2.0017 $-$ 1)]. While these outcomes suggest that firms in LLDCs submit greater trademark applications as these countries experience a higher duration of WTO membership, they also indicate that as this duration expands, the ratio of trademark counts to the patent counts decreases. The latter finding likely indicates that higher trade costs may inhibit LLDC firms' ability to develop technological innovation (including sophisticated innovations) as their membership duration in WTO increases (i.e., as these countries likely improve their trade regimes and trade-related institutions).

We now turn to the results in Table 3. Findings in Table 2, especially those in columns (1) and (2), suggest that countries with greater economic sophistication (which reflects a high degree of technological innovation) may submit a higher number of patents in relation to trademarks, for multiple reasons put forth in Section 2 (see for example, Castaldi and Mendonça 2022; Gallié and Legros 2012). Mangàni (2007) has obtained that differences in quantity within markets contribute significantly to explaining country variations in trademark applications, whereas the differences in quality within markets have a negligible effect on trademark applications across countries. This is in line with the findings that firms operating in the manufacturing sector as well as those in high-tech manufacturing sectors, high technological inventions, and functional innovations sectors tend to apply less for trademarks than for patents (e.g., Castaldi and Mendonça 2022; Gallié and Legros 2012). At the same time, economic complexity[21] is positively associated with technological complexity (e.g., Ivanova et al. 2017). Given that membership in the WTO contributes to trade upgrading and promotes exports at the extensive product margin[22] (e.g., Dutt et al. 2013; Dutt 2020; Felbermayr and Kohler 2010), we expect that the duration of WTO membership could lead to fewer trademark applications (eventually at the benefit of patent[23] applications) in countries that experience greater economic complexity. If these theoretical expectations are confirmed empirically, then they will lend support to the findings in Table 2, in particular to the outcomes in columns (1) and (2) of the Table. To examine empirically whether the effect of the membership duration on trademark applications depends on countries' level of economic sophistication, we estimate a variant of the baseline model (1) that includes both the indicator of economic sophistication and its interaction with the indicator capturing the duration of WTO membership. The indicator of economic sophistication used here is the index of economic complexity developed by Hausmann and Hidalgo (2009), which reflects the diversity and sophistication of a country's export structure. Column (1) of Table 3 contains the outcomes arising from the estimation of this specification of model (1). We also investigate whether the outcomes obtained from the estimation of the previous model specification hold when we re-run the same regression but with the ratio of trademark counts to patent counts as the dependent variable. In

column (2) of Table 3 we present the outcomes arising from the estimation of this new variant of model (1).

Outcomes in column (1) of Table 3 indicate that the coefficient of the variable "$DURWTO_{t-1}$" is positive and significant at the 1% level, while the interaction term of the variable ("$[DURWTO_{t-1}] \times [ECI_{t-1}]$") is negative and significant at the 1% level. Taken together, these outcomes suggest that as countries enjoy greater economic sophistication, they tend to submit fewer trademarks. We display in Figure 3, at the 95 percent confidence intervals, the marginal impact of the duration of WTO membership on trademark counts for varying degrees of economic sophistication. This marginal effect takes both positive and negative values and decreases as the level of economic sophistication rises but is not always statistically significant. For levels of the economic complexity index lower than 0.45 (values of this indicator range between −2.2 and 2.5—see Table A2), the membership duration exerts a positive and significant effect on trademark applications, but the magnitude of this positive effect decreases as the degree of economic sophistication rises. In other words, longstanding less sophisticated countries submit a greater number of trademarks, and the lower the degree of sophistication (which is likely to be the case for less developed countries), the higher the magnitude of the positive effect of the duration of WTO membership on trademark applications for this set of countries. On the other hand, countries whose level of economic sophistication is higher (or equal) to 1.22 (i.e., relatively advanced economies) experience a negative effect of the WTO membership duration on trademark applications, with the magnitude of this negative effect increasing in absolute value as their economies become highly sophisticated. These findings tend to confirm our previous outcomes that developing countries (i.e., less sophisticated countries) tend to submit greater trademark applications (and eventually relatively lower patent applications) as the duration of their WTO membership increases. In contrast, relatively advanced economies apply for fewer trademarks (and eventually relatively higher patents) as the duration of their WTO membership expands. Finally, countries whose degree of economic sophistication lies between 0.45 and 1.22 experience no significant effect of the duration of WTO membership on trademark applications.

At the same time, outcomes in column (2) of Table 3 show that while the coefficient of "$DURWTO_{t-1}$" is positive and significant at the 1% level, the interaction term of the variable ("$[DURWTO_{t-1}] \times [ECI_{t-1}]$") is not significant at the conventional significance levels. As a consequence, we could be tempted to infer that the average marginal effect of the duration of the WTO membership on the ratio of trademark counts to patent counts does not significantly depend on countries' level of economic sophistication. However, as this effect reflects "an average marginal effect over the full heterogenous sample", we present in Figure 4, at the 95 percent confidence intervals, the marginal impact of the duration of WTO membership on the ratio of trademark counts to patent counts for varying degrees of economic sophistication. The pattern observed in this Figure is similar to the one in Figure 3. We note that the marginal effect of the duration of WTO membership on this ratio is always positive but not always significant. In addition, it falls as the degree of economic sophistication rises. It is statistically significant for levels of economic complexity comprised between −2.2 and 2.38, and it is statistically nil for degrees of economic complexity higher or equal to 2.38. Thus, the duration of WTO membership induces a higher submission of patents than trademarks as countries improve the sophistication of their economies, but for very high levels of economic sophistication (i.e., very high-income countries), there is no significant effect of the duration of WTO membership on the ratio of trademark applications to patent applications. These outcomes definitely confirm our theoretical expectations that as less sophisticated countries (including less developed countries) experience an increase in the duration of their membership, they submit higher trademark applications in relation to patent applications, while relatively advanced economies (i.e., those that enjoy a relatively high degree of economic sophistication) tend to submit a higher number of patents in relation to trademark counts as the duration of their WTO membership rises. These findings lend support Hypothesis 2.

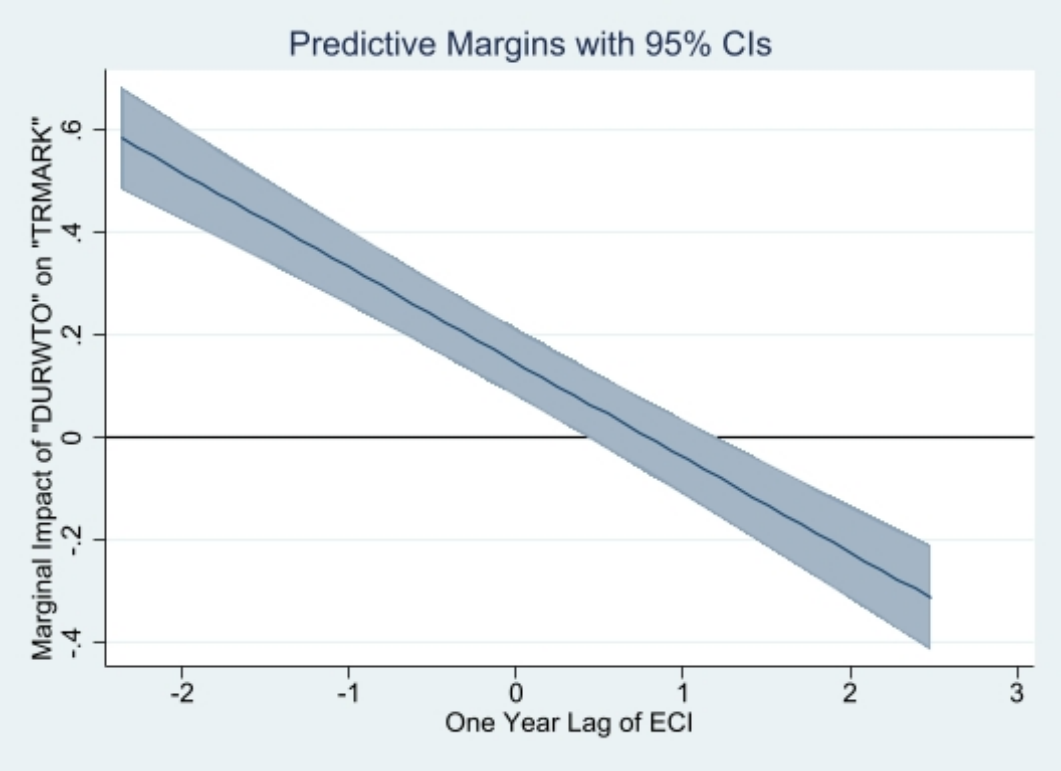

Figure 3. Marginal impact of "DURWTO" on "TRMARK" for varying levels of economic complexity. Source: Author.

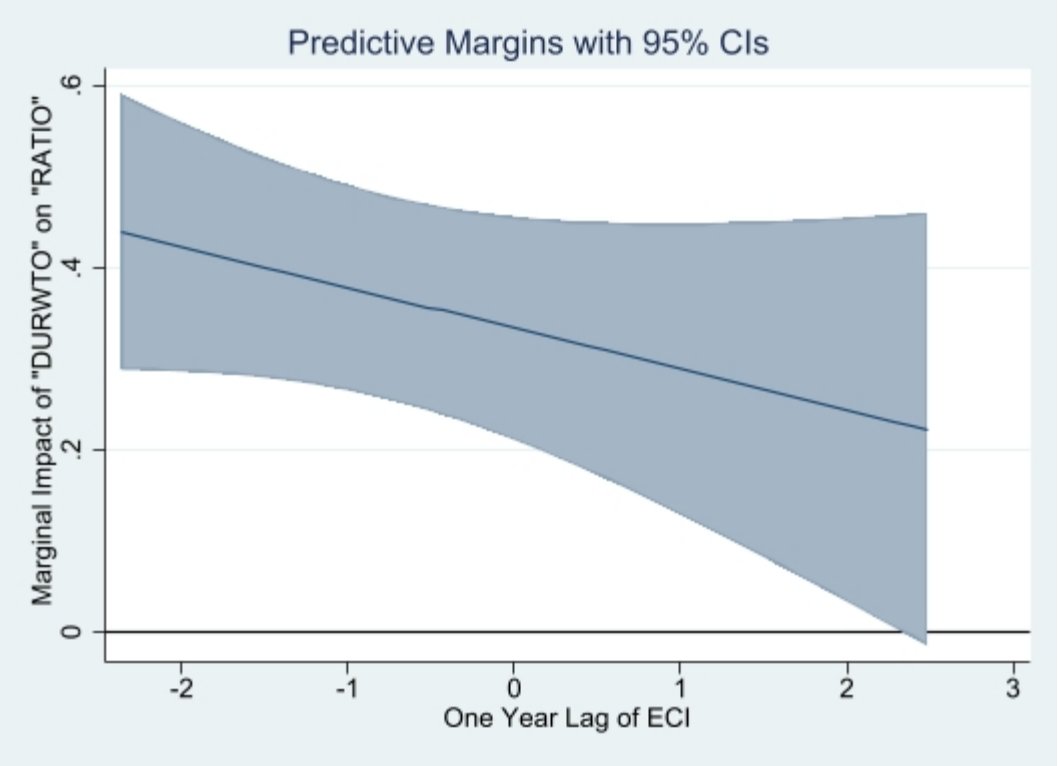

Figure 4. Marginal impact of "DURWTO" on "RATIO" for varying levels of economic complexity. Source: Author.

We now examine outcomes in Table 4, which aim to test Hypothesis 1, that is, the extent to which the effect of the duration of WTO membership on trademark applications depends on trade costs. However, before testing this hypothesis empirically, we found it useful to examine how the duration of WTO membership affects trademark applications through its effect on trade facilitation insofar as our theoretical argument in Section 2 rests on the hypothesis that the WTO could affect trademark applications through trade cost reduction due to the implementation of the TFA. To that end, we start by estimating a specification of model (1), that is, model (1) in which we replace the variable "$DURWTO_{t-1}$" with the dummy variable "TFA". The latter takes the value of 0 from 1996 to 2013 and 1 from 2014 to 2019 (to recall, the TFA was adopted in December 2013 by Trade Ministers). The estimation of this model helps to examine the effect of the TFA on trademark applications. The dummy "TFA" was not lagged (with one year) because this is an international agreement adopted by consensus of all WTO members, and it is, therefore, less subject to the 'reverse causality effect' of an individual country's trademark counts. The outcome of the estimation of this model specification is presented in column (1) of Table 4. We then move on to estimate another variant of model (1), that is, model (1) that includes both the "TFA" dummy and its interaction with the variable "DURWTO"; the objective here was to examine how the duration of WTO membership has affected trademark applications after the adoption of the TFA compared to the period preceding the adoption of this multilateral agreement.

The estimates in column (1) of Table 4 show that the TFA has exerted a positive and significant (at the 1% level) effect on trademark applications. The IRR associated with the estimate of "TFA" amounts to 1.685. It suggests that, on average over the full sample, after the adoption of the TFA, trademark applications increased by 68.5% compared to the period preceding the adoption of the multilateral agreement. Concurrently, outcomes in column (2) of the same Table indicate a positive and significant (at the 1% level) estimate of "$DURWTO_{t-1}$" but a negative and significant (at the 1% level) interaction term related to the variable ("$[DURWTO_{t-1}] \times TFA$"). These two outcomes jointly suggest that longstanding WTO members (or alternatively relatively new WTO members) experienced fewer (higher) trademark applications after the adoption of the TFA compared to the period preceding the adoption of this agreement. The net average marginal effect of the duration of WTO membership on trademark applications before and after the adoption of the TFA is, respectively, 0.002 (=0.135 − 0.133) (the related IRR is 1.002) and 0.135 (the related IRR is 1.145). Hence, an additional year of WTO membership leads to an increase in the trademark counts by 13.86% [=0.693 × 100 × (1.145 − 1)], before the adoption of the TFA, and by 10.05% [=0.693 × 100 × (1.002 − 1)], after the adoption of the TFA. How could one explain this surprising outcome? Do these findings mean that longstanding WTO members had submitted fewer trademarks in relation to patents when they enjoyed lower trade costs (due inter alia to the implementation of the TFA)? Addressing this question is nothing else than testing Hypothesis 1 set out in Section 2 concerning whether the effect of the duration of WTO membership on trademark applications works through the channel of trade costs.

To address this question, we estimate a variant of model (1) that contains the trade costs' indicator along with its interaction with the variable "$DURWTO_{t-1}$". The outcomes of the estimation of this model specification are provided in column (3) of Table 4. We notice that the estimate of ["$DURWTO_{t-1}$"] is negative and significant at the 1% level, and the interaction term of the variable ("$[DURWTO_{t-1}] \times [Log(TRCOST)_{t-1}]$") is positive and significant at the 1% level. On the basis of these outcomes, we will be tempted to deduce that longstanding WTO members that face higher trade costs tend to apply for higher trademarks, probably at the expense of other forms of intellectual property tools such as patents (as higher trade costs inhibit the development of sophisticated products). Figure 5 presents, at the 95 percent confidence intervals, the marginal impact of the duration of WTO membership on trademark counts for varying levels of the overall trade costs. This marginal impact increases as the level of the trade costs rises but is not always statistically significant. For levels of the overall trade costs[24] lower than 164.9 (=exponential (5.105472), the duration of WTO membership exerts a negative and significant effect on trademark applications

(possibly at the profit of patent applications), with the magnitude of this negative effect increasing (in absolute value) as the level of trade costs decreases. Countries that face a level of overall trade costs higher than 283.65 (=exponential (5.647758)) experience a positive effect of the duration of WTO membership on trademark counts, with the magnitude of this effect rising as the level of the overall trade costs increases. Finally, countries whose levels of trade costs range between 164.9 and 283.65 experience no significant effect of their membership duration on the submission of trademarks by their residents. These findings lend support to Hypothesis 1 and, in this regard, provide an affirmative answer to the question raised above. They may suggest that countries tend to submit a higher number of patents in relation to trademarks as their membership duration increases and as they experience lower trade costs. This interpretation of the outcomes is confirmed by the results reported in column (4) of Table 4, which allows for examining the effect of the duration of WTO membership on the ratio of trademark counts to patent counts. These results are obtained by estimating a specification of model (1) similar to the one whose results are reported in column (3) of Table 4 (and interpreted just above) but in which we replace the dependent variable "TRMARK" with "RATIO". Patterns of outcomes in column (4) of Table 4 are close to those in column (3) of the same Table, given that the coefficients of ["$DURWTO_{t-1}$"] and ("[$DURWTO_{t-1}$] × [$Log(TRCOST)_{t-1}$]") are significant at the 1% level, but the former is negative while the latter is positive. We deduce that the duration of WTO membership leads to a higher number of trademarks applied in relation to the number of patents applied in countries that face higher trade costs. Figure 6 shows, at the 95 percent confidence intervals, the marginal impact of the duration of WTO membership on the ratio of trademark counts to patent counts for varying levels of the overall trade costs. It shows that this marginal impact increases as countries face higher trade costs, but is significant only when its values are positive, in particular when the level of the overall trade costs is higher than 183.8 [=exponential (5.213929)].

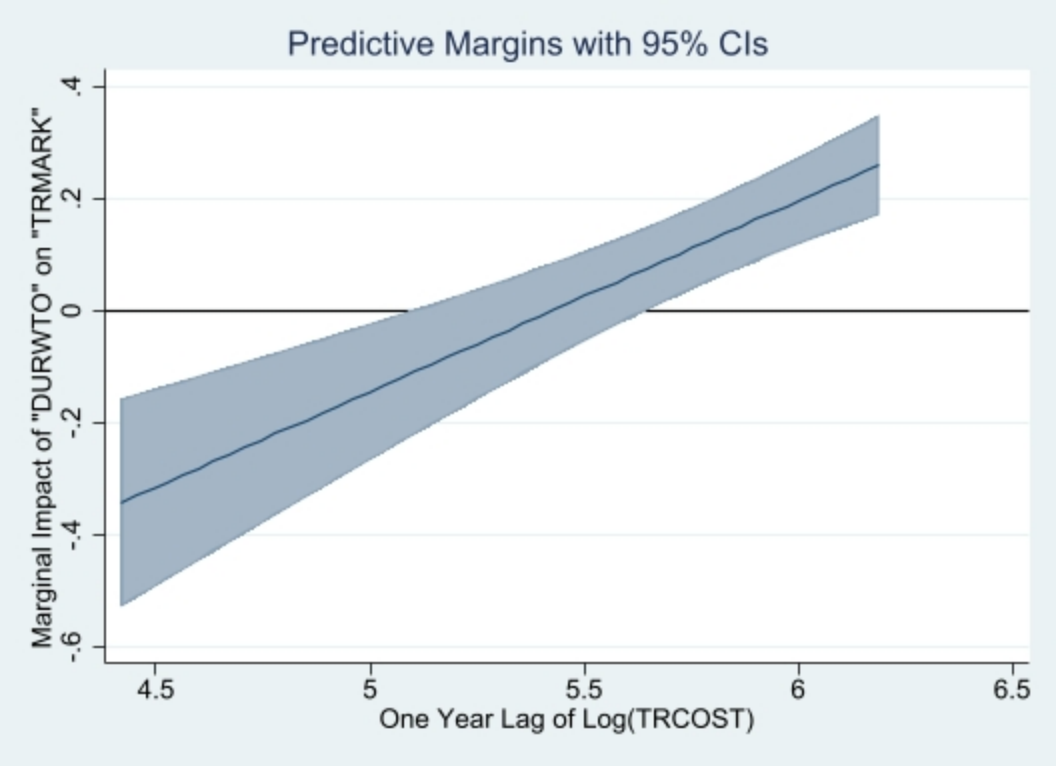

Figure 5. Marginal impact of "DURWTO" on "TRMARK" for varying levels of the overall trade costs. Source: Author.

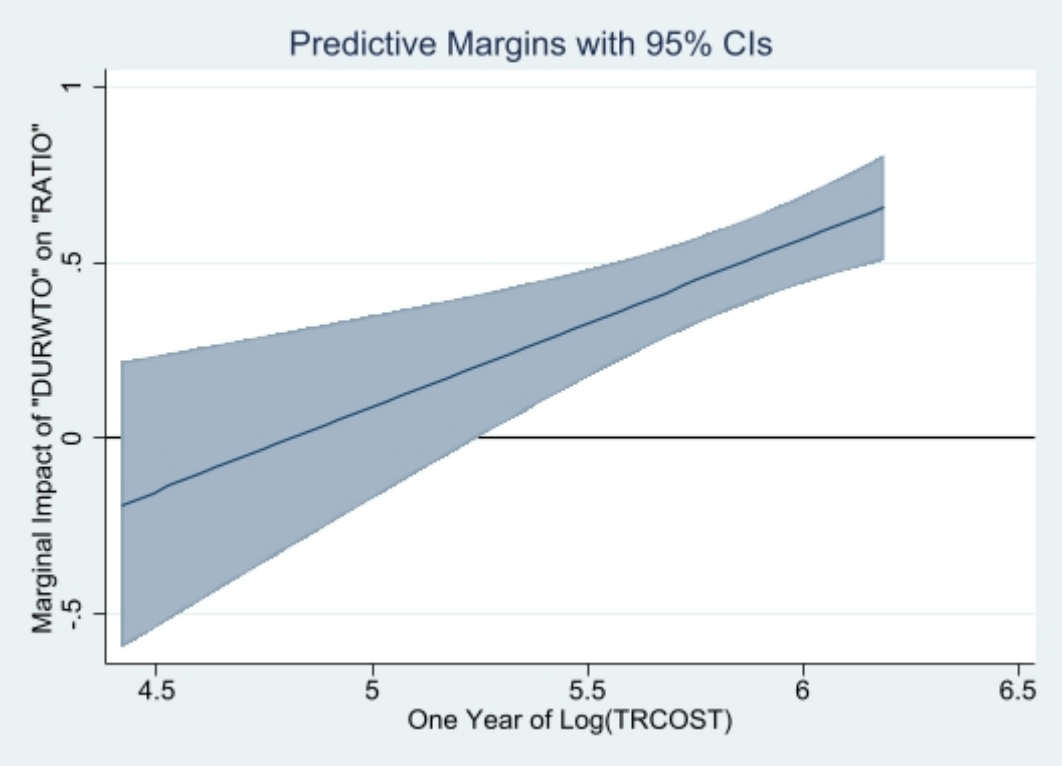

Figure 6. Marginal impact of "DURWTO" on "RATIO" for varying levels of the overall trade costs. Source: Author.

We deepen the analysis by examining the extent to which the effect of the membership duration on trademark applications depends on the components of the overall trade costs. To do so, we replace the variable "TRCOST" with its two main components, namely, tariff costs denoted "TARIFF" and nontariff costs denoted "NTARIFF" (see Table A1 for details on the computation of these two indicators) (see columns (5) and (6) of Table 4). We obtain that the coefficient of "[$DURWTO_{t-1}$] × [$Log(TARIFF)_{t-1}$]" is positive and significant at the 1% level, and the coefficient of the interaction variable "[$DURWTO_{t-1}$] × [$Log(NTARIFF)_{t-1}$]" is positive but not significant at the conventional significance levels. At the same time, the coefficient of the variable "DURWTO" is not significant at the 10% level. We conclude that the outcomes obtained in column (3) are driven essentially by the positive effect of the membership duration on trademark applications for varying levels of tariff costs, including as tariff costs rise. The effect of the membership duration on trademark applications does not depend on nontariff costs. When it comes to the effect of the membership duration on the ratio of trademark applications to patent applications for varying levels of tariff costs (and nontariff costs), we obtain that the coefficient of "[$DURWTO_{t-1}$] × [$Log(TARIFF)_{t-1}$]" is not significant at the 10% level, and the coefficient of the interaction variable "[$DURWTO_{t-1}$] × [$Log(NTARIFF)_{t-1}$]" is positive and significant at the 1% level. Given that the coefficient of "[$DURWTO_{t-1}$]" is negative and significant at the 1% level. We deduce that as nontariff costs increase, the duration of the membership in the WTO exerts a positive effect on the ratio of trademark applications to patent applications. In other words, as the membership duration increases, countries tend to submit a relatively higher number of trademark applications compared to the number of patent applications, when they face higher nontariff costs. The effect of the duration of the membership in the WTO on the ratio of trademark applications to patent applications does not depend on tariff costs.

Overall, one major finding from Table 4 is that the effect of the duration of WTO membership on trademark applications genuinely works through the channel of trade costs, and longstanding WTO members tend to experience a higher submission (by residents) of

trademark applications in relation to patent applications when they face higher trade costs, especially tariff costs. This is possibly because higher trade costs discourage innovation, including investments in the development of sophisticated (technologically) products, and lead to firms to protect their soft innovation (in the context of higher trade costs) by trademarks (the latter being relatively cheaper than most of the statutory intellectual property forms). Additionally, by helping to reduce trade costs, the WTO's TFA has generated higher patent applications in relation to trademark applications. These findings support Hypothesis 2.

5. Further Analysis

This section deepens the previous analysis by firstly examining whether AfT flows matter for the effect of the duration of WTO membership on trademark applications, including in relation to patent applications. Second, it provides a robustness check analysis for findings based on the negative binomial by considering a dynamic specification of model (1) and using the two-step system GMM estimator as the estimator for this dynamic specification (as well as its different variants described below).

5.1. Does the Effect of the Membership Duration on Trademark Applications Depend on the Amounts of AfT That Accrue to Countries?

The empirical analysis preformed in Section 4 focused on a sample of both developed and developing countries. It shows that the duration of WTO membership affects trademark applications (including in relation to patent applications) through the channel of trade costs. In the meantime, as noted in Section 2, AfT flows[25], in particular AfT interventions for the build-up of economic infrastructure and AfT interventions related to trade policy and regulation, contribute significantly to reducing trade costs in recipient countries. Therefore, this section investigates whether the effect of the duration of WTO membership on trademark applications depends on the amounts of AfT flows that accrue to recipient countries. The issue is all the more relevant as Lee et al. (2015) have provided empirical evidence of a positive effect of WTO membership on total AfT flows, with LDC WTO members receiving, on average, relatively more AfT than other developing countries. In addition, LDC WTO members received higher AfT flows for building productive capacity and higher AfT flows for trade policy and regulation, but their positive membership effect declined for AfT flows for economic infrastructure.

To address this issue empirically, we restrict the panel dataset to the sub-sample of AfT-recipient countries with a span over the period 2002–2019 (as AfT-disbursement data are available only from 2002). The list of AfT-recipient countries is provided in Table A3. We first estimate (by means of the binominal regression approach) the baseline model (1) over this sub-sample in order to check whether the positive effect of the duration of WTO membership observed in Table 1 also holds here. The outcomes of this estimation are presented in column (1) of Table 5. Still using the binominal regression approach, we move on to estimate different specifications of model (1) that include an AfT variable and its interaction with the variable "$DURWTO_{t-1}$". AfT variables are total AfT ("AfTTOT") and, alternatively, each of its three components, i.e., AfT allocated for the development of economic infrastructure ("AfTINFRA"), AfT for productive capacities ("AfTPROD"), and AfT related to trade policy and regulation ("AfTPOL"). All AfT variables are real gross disbursements of aid expressed in constant prices (2019, US dollar). Note that in the regressions, all AfT variables have been introduced with a one-year lag in order to mitigate the reverse causality problem. The results of the estimation of these different specifications of model (1) are provided in columns (2) to (5) of Table 5. We estimate again the different specifications of model (1), the results of which are presented in columns (2) to (5) of Table 5, but now with the variable "RATIO" as a dependent variable. The objective of doing so is to examine whether (and if so to what extent) the duration of WTO membership affects the ratio of trademark counts to patent counts. The outcomes arising from the estimation of these different specifications of model (1) are provided in columns (6) to (9) of Table 5.

Estimates in column (1) of Table 5 suggest that over AfT-recipient countries, longstanding WTO members enjoy a higher positive effect of their membership on trademark counts than relatively new WTO members. This is because the coefficient of "$DURWTO_{t-1}$" is positive and significant at the 1% level and amounts to 0.131 (the related IRR amounts to 1.14). Thus, an additional year of WTO membership in AfT-recipient countries is associated with an increase in trademark applications by 9.7% [(= $0.693 \times 100 \times (1.14 - 1)$). In columns (2) to (5), the interaction terms of the variables capturing the interaction between a relevant AfT variable and the variable "$DURWTO_{t-1}$" are all significant at least at the 5% level (they are significant at the 1% level in columns (2) to (4) and at the 5% level in column (5)). These outcomes indicate that by potentially reducing trade costs, AfT interventions generate greater trademark applications as countries spend more time as WTO members. Figures 7–10 display, at the 95 percent confidence intervals, the marginal impact of the duration of WTO membership on trademark counts for varying amounts of AfT flows, including, respectively, total AfT flows, AfT flows for economic infrastructure, AfT flows for productive capacities, and AfT flows for trade policy and regulation. In all these figures, the marginal effects move up as the amount of the relevant AfT variable rises, and it takes both positive and negative values. However, it is not always statistically significant. In Figure 7, the marginal effect of the duration of WTO membership on trademark applications is not significant for total AfT amounts[26] ranging between USD million 2.188 [=exponential (14.59853)] and USD million 43.33 [=exponential (17.58445)]. It is negative and significant for total AfT amounts lower than USD million 2.188 and positive and significant for total AfT higher than USD million 43.334. Thus, countries that receive amounts of total AfT flows higher than USD million 43.334 experience a positive effect of their membership duration on trademark applications, and the greater the AfT flows, the higher the magnitude of this positive effect.

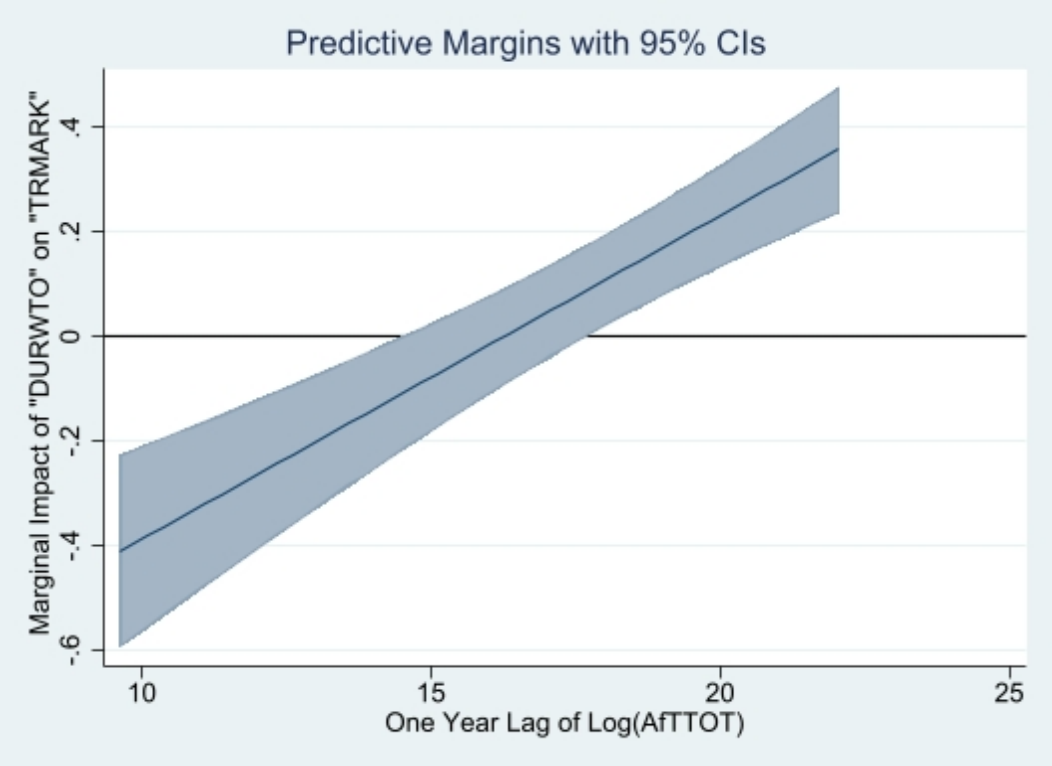

Figure 7. Marginal impact of "DURWTO" on "TRMARK" for varying amounts of total AfT. Source: Author.

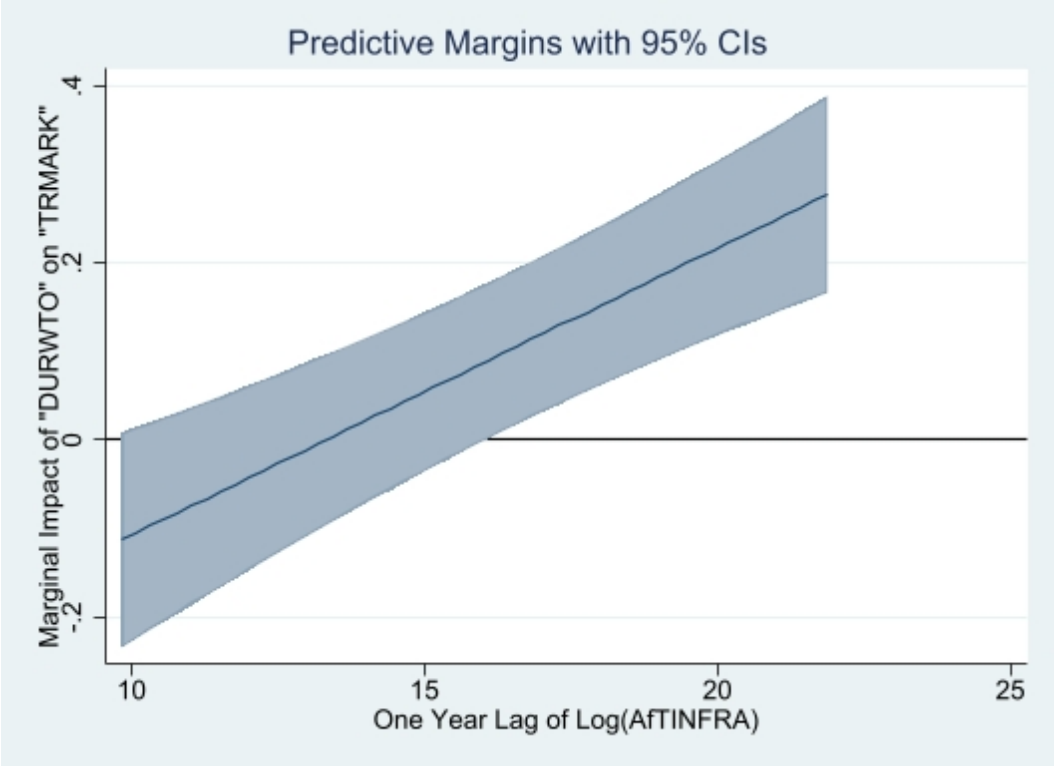

Figure 8. Marginal impact of "DURWTO" on "TRMARK" for varying amounts of AfT for economic infrastructure. Source: Author.

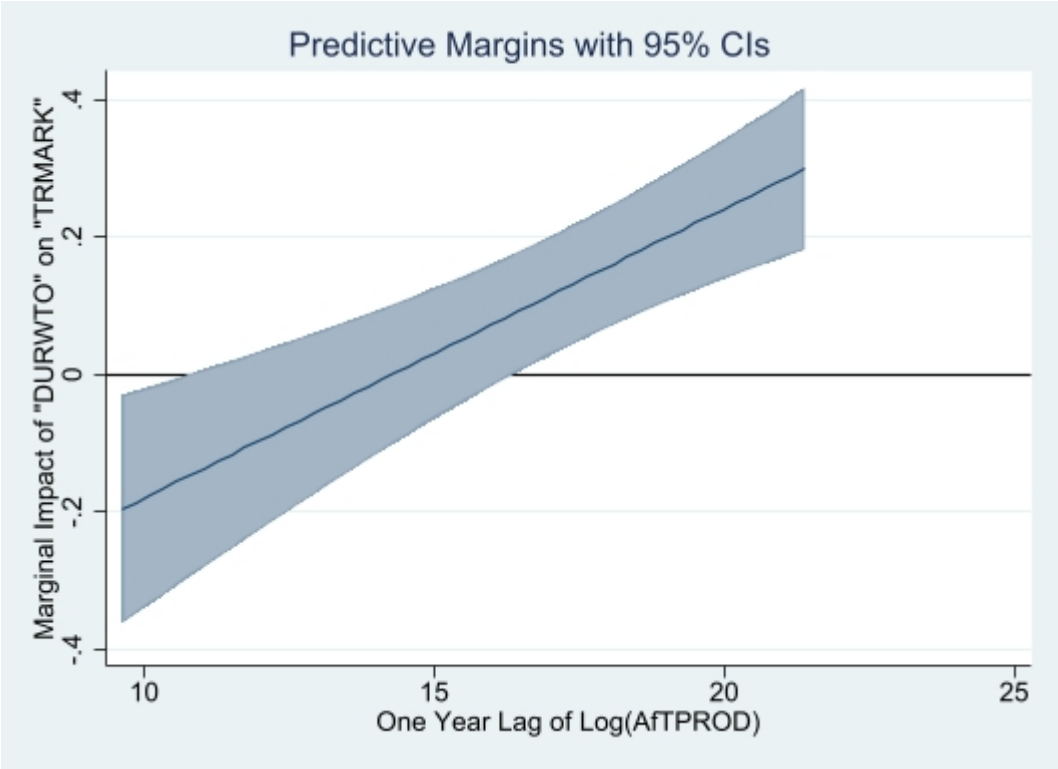

Figure 9. Marginal impact of "DURWTO" on "TRMARK" for varying amounts of AfT for productive capacities. Source: Author.

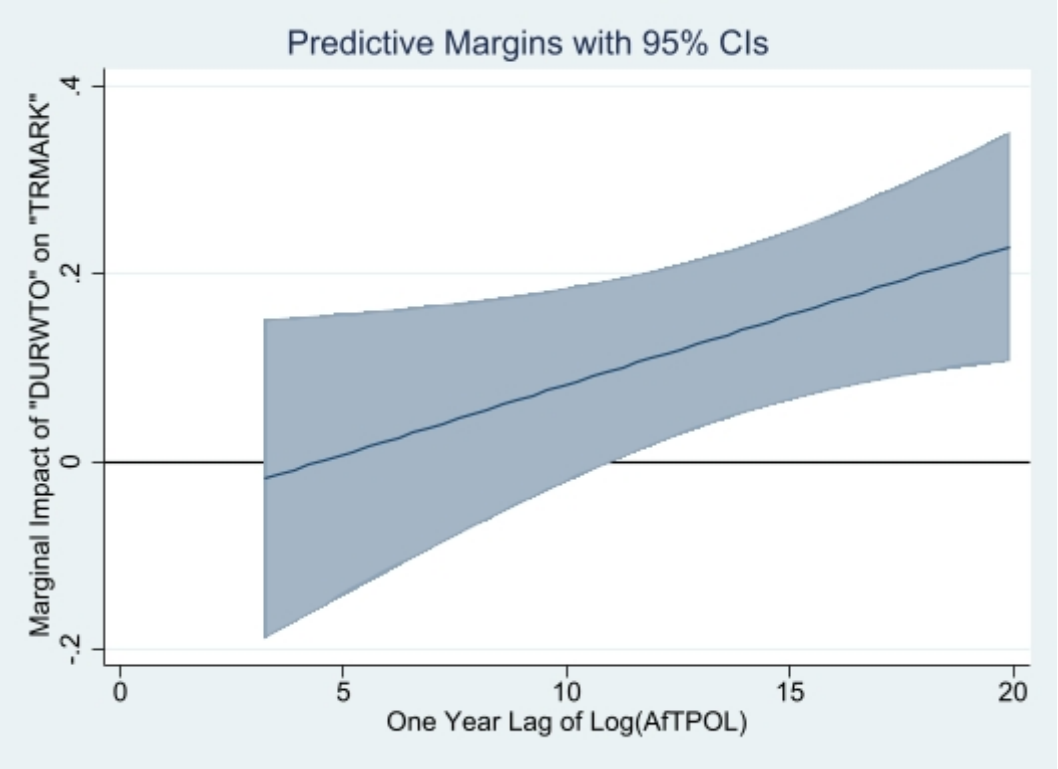

Figure 10. Marginal impact of "DURWTO" on "TRMARK" for varying amounts of AfT for trade policy and regulation. Source: Author.

The marginal effect of the duration of WTO membership on trademark applications is positive and significant for amounts of AfT[27] for economic infrastructure higher than USD million 9.793 [=exponential (16.09715)], otherwise, it is statistically nil. The marginal effect of the duration of WTO membership on trademark applications is negative and significant for amounts of AfT[28] for productive capacities lower than USD 243,394.8 [=exponential (12.40244)], otherwise, it is positive and significant for values of AfT flows for productive capacities higher than USD million 14.82 (=(exponential (16.51145)) and statistically nil for values of AfT flows for productive capacities comprising between USD 243,394.8 and USD million 14.82. Finally, the higher the amounts of AfT[29] flows for trade policy and regulation, the greater the magnitude of the positive effect of the duration of WTO membership on trademark applications, especially when amounts of AfT for trade policy and regulation exceed USD 54,636.64 [=exponential (10.90846)]. Otherwise (for amounts of AfT for trade policy and regulation lower than USD 54,636.64), there is no significant effect of the duration of WTO membership on trademark applications.

Turning to estimates presented in columns (6) to (9) of Table 5, we find that in all these columns, the interaction terms of the interaction variables are negative and significant, in particular at the 1% level for outcomes in columns (6) to (8) and at the 5% level for outcomes in column (9). We, therefore, conclude that the effect of the duration of WTO membership on the ratio of trademark counts to patent counts diminishes as AfT amounts increase. This finding applies to all AfT variables, i.e., total AfT and each of its three components. They indicate that longstanding WTO members tend to submit a relatively higher number of patents than trademarks as they enjoy higher amounts of AfT flows. The graphical analyses[30] of the marginal effect of the duration of WTO membership on the ratio of trademark counts to patent counts for varying amounts of AfT variables would provide better pictures of these impacts. For total AfT flows, we observe that this marginal impact is always positive, but decreases as the amounts of total AfT flows become higher. In particular, for very high amounts of AfT variables (total AfT and each of its

three components), there is no significant effect on the duration of WTO membership on the ratio of trademark counts to patent counts, i.e., countries tend to submit trademarks and patents. equally so as to protect their innovative products. The amounts of the AfT above, which show the marginal effect of the duration of WTO membership on the ratio of trademark counts to patent counts, are USD million 669.2 [=exponential (20.32154)] for total AfT flows, USD million 462,4 [=exponential (19.95203)] for AfT flows related to economic infrastructure, USD million 474,9 [=exponential (19.97864)] for AfT flows for productive capacities, and USD million 61,183 [(=exponential (17.92938))] for AfT flows for trade policy and regulation.

Overall, the outcomes in Table 5 suggest that the duration of WTO membership helps to promote the submission of trademarks but to a lesser extent than patent applications as countries experience higher AfT flows. One could, therefore, conclude that as developing countries spend more time as WTO members and, concurrently, receive higher AfT flows, they tend to submit a higher number of patents (in relation to trademarks) to protect their product innovations.

Finally, it is worth pointing out that estimates of control variables in Table 5 are, with some exceptions, in line with those in column (1) of Table 1.

5.2. Robustness Check Analysis

This section performs a robustness check analysis of some findings in the previous analysis, by considering a dynamic specification of the baseline model (1) (which we henceforth label model (2)), that is, model (1) in which we include the one-period lag of the dependent variable as a right-hand side regressor. Note that in model (2), the dependent variable has been logged using the natural logarithm so as to reduce the skewness of its distribution. The panel dataset used here is the full sample of 124 countries over the period 1996–2019. To dampen the effects of business cycles on variables in model (2), we use eight non-overlapping sub-periods with a 3-year average. These are 1996–1998; 1999–2001; 2002–2004; 2005–2007; 2008–2010; 2011–2013; 2014–2016; and 2017–2019.

This dynamic model specification could suffer from an endogeneity problem, which is associated with the lagged dependent variable (Nickell bias—Nickell 1981), as well as the possible reverse causality problem for all other regressors included in the model (except for the population size). We use the two-step system generalized method of moments (GMM) estimator (see Arellano and Bover 1995; Blundell and Bond 1998) to address these endogeneity concerns and to obtain reliable and efficient estimates of the dynamic specification of model (1). This estimator is particularly suitable for dynamic models where series display a strong persistence over time and when the time dimension is short while the cross-sectional dimension is large (this is the case in the present analysis). The utilization of the two-step system GMM estimator involves estimating a system of equations, which combines an equation with variables in the first difference and an equation with variables in levels. This system uses the lags of the variables taken in first differences as instruments in the equation in levels and the lags of the variables in levels as instruments in the first-difference equation.

The correctness of the different specifications of model (2), whose estimation's results are presented below, is examined using the Arellano–Bond test of the presence of first-order serial correlation in the first-differenced error term (AR (1)) (the related *p*-value is expected to be lower than 0.1 at the 10% level); the Arellano–Bond test of the absence of second-order autocorrelation in the first-differenced error term (denoted as AR (2)) (the related *p*-value is expected to be higher than 0.1 at the 10% level); and the Sargan/Hansen test of over-identifying restrictions (OID), which tests the validity of instruments used in the regressions (the related *p*-value is expected to be higher than 0.1 at the 10% level). In addition, we cap the number of lags of instrumental variables to two so as to avoid the proliferation of instruments. Note that in all the specifications of model (2) described below, all regressors except for the population size (not lagged as in model (1)) have been treated as endogenous.

The results of the estimation of the dynamic model (2) (by means of the two-step system GMM approach) are presented in column (1) of Table 6. These results serve to explore how the duration of WTO membership affects trademark applications in the dynamic setting and check whether the findings here line up with those in column (1) of Table 1.

Column (2) of Table 6 contains outcomes obtained by estimating a variant of model (2) that contains the interaction between the indicator of the duration of WTO membership and the real per capita income. These outcomes serve to investigate how the effect of the duration of WTO membership on trademark applications varies across countries in the full sample.

Outcomes reported in column (3) of Table 6 allow testing Hypothesis 1 in the dynamic model (2), that is, whether (and if so, to what extent) the effect of the duration of WTO membership on trademark applications depends on the overall trade costs. Finally, we examine the extent to which total AfT flows (through its trade costs reduction effects) influence the effect of the duration of WTO membership on trademark applications. To that end, we estimate a variant of model (2) that includes both the variable capturing total AfT flows and its interaction with the indicator representing the duration of WTO membership. The results of the estimation of this model are reported in column (4) of Table 6.

Across all columns of Table 6, the coefficient of the one-period lag of the dependent variable is positive and significant at the 1% level, which highlights the relevance of considering model (1) in a dynamic setting. Additionally, all model specifications described above (and whose results are reported in Table 6) are correctly specified. This is because the requirements of the two-step system GMM (the Arellano–Bond tests and the OID test) are met (see the bottom of all columns of Table 6). We note from column (1) of Table 6 that at the 1% level, longstanding WTO members experience a higher number of trademark applications than relatively new members, with the estimate being 0.104 (which is lower than the one (0.16) obtained in column (1) of Table 6). As the IRR associated with this estimate is 1.1096, we conclude that an additional year of WTO membership is associated with an increase in the number of trademarks filed by 7.60% [$=0.693 \times 100 \times (1.1096 - 1)$]. These findings confirmed the ones in column (1) of Table 1, although with a different magnitude of the effects.

Outcomes in column (2) of Table 6 are in line with those in column (1) of Table 2, as the coefficient of "DURWTO" is positive and significant at the 1% level, and the interaction term of the variable ("DURWTO $\times$ Log(GDPC)"] is negative and significant at the 5% level. We conclude that as countries' duration of WTO membership increases, they file fewer trademark applications (likely at the profit of patent applications) to protect their new innovations when they experience an improvement in their real per capita income. The greater the real per capita income, the higher the magnitude of the negative effect of the membership duration on trademark applications. Estimates in column (3) of Table 6 reveal patterns similar to those in column (3) of Table 4, as far as the outcomes of the extent to which the duration of WTO membership on trademarks depends on trade costs are concerned. We, therefore, conclude that countries' duration of WTO membership does affect the filing of trademarks because longstanding member states facing higher trade costs tend to experience a higher number of trademark applications than longstanding countries facing lower trade costs. The higher the trade costs, the greater the magnitude of the positive effect of the duration of WTO membership on trademark applications. The explanation of similar findings provided above applies here as well. Finally, results in column (4) of Table 6 line up with those in column (2) of Table 5 and indicate that countries that receive greater amounts of total AfT flows tend to submit higher trademark applications. To test whether this outcome hides the fact that the duration of WTO membership induces a higher submission of patents in relation to trademarks as countries receive higher AfT flows (as observed in column (6) of Table 5), we estimate another variant of model (2), where the dependent variable is "RATIO" and in which we introduce the interaction between the variable measuring total AfT flows and the indicator of the duration of WTO membership.

The outcomes of this estimation (by means of the two-step system GMM approach) are reported in column (5) of Table 6. It is important to note here that two lags of the dependent variable "RATIO" are used here in order to meet the requirements of the two-step system GMM approach (i.e., to ensure that the model is correctly specified). The results suggest, as found in column (6) of Table 5, that the effect of the duration of WTO membership on the ratio of trademark counts to patent counts falls as the amounts of total AfT flows rise. This is exemplified by the positive and significant interaction term of the variable ["DURWTO*Log(AfTTOT)"] in column (5) of Table 6. The graphical analysis[31] of the marginal effect of the duration of WTO membership on the ratio of trademark counts to patent counts for varying amounts of AfT variables shows that this marginal effect is almost always positive and declines as the amount of total AfT flows rises. For amounts of total AfT lower than USD million 6057 [=exponential (20.22189)], this marginal effect is positive and significant, with the magnitude of this positive effect declining as the amounts of total AfT flows move up. For values of total AfT flows higher than USD million 6057, the duration of the WTO membership exerts no significant effect on the ratio of trademark counts to patent counts, although it becomes negative and significant for values of total AfT flows higher than USD billion 2.339.

With some few exceptions, estimates of control variables in columns (1) to (4) of Table 6 tend to show similar signs. Taking up those in column (1), we obtain that the submission of trademark applications is positively and significantly driven by an improvement in the real per capita income, the rise in the population size, an accumulation of human capital, and higher FDI inflows. In the meantime, financial development exerts no significant effect on trademark applications, while the improvement in regulatory policy induces the submission of fewer trademarks. The latter outcome is confirmed by the estimates presented in column (5) of Table 6, as the improvement in regulatory quality policy is negatively associated with the ratio of trademark counts to patent counts. This ensues that a better regulatory quality policy encourages the submission of a higher number of patents in relation to trademarks.

We proceed with an additional robustness check analysis by exploring the effect of the membership duration in the WTO on trademark applications across various groups of countries within the full sample depending on the degree of stringency of trade liberalization reform commitments undertaken before joining the WTO. In fact, WTO member states did not undertake the same level of trade liberalization commitments when joining the WTO (or the GATT for many of them). Some member states undertook extensive trade liberalization policy commitments and passed through long negotiation processes, while others did not. In particular, member states that joined the GATT under Article XXVI 5(c) of the GATT (and then later joined the WTO through simple procedures) did not undergo long negotiation procedures or undertake stringent policy reform commitments. We refer to this group of countries as "Article XXVI Members". A second group of countries that were members of the GATT (and that joined the WTO through simple procedures) joined the GATT through long negotiation processes. This set of countries undertook extensive reforms. We refer to this group of member states as "Non-Article XXVI Members". Finally, a third group of countries were not members of GATT and joined the WTO directly after its creation. This group of member states, referred to as "Article XII Members", joined the WTO under Article XII of the Marrakesh Agreement establishing the WTO. This set of member states joined the WTO through more rigorous procedures than the ones undergone by Article XXVI Members and Non-Article XXVI Members (i.e., contracting parties of the GATT). This is because the scope and coverage of WTO agreements are wider than the those of the GATT Agreements (e.g., Drabek and Bacchetta 2004).

Table 6. Effect of the duration of WTO membership on the number of trademark applications submitted by residents. ***Estimator***: Two-step system GMM.

Variables	Log(TRMARK)	Log(TRMARK)	Log(TRMARK)	Log(TRMARK)	Log(RATIO)
	(1)	(2)	(3)	(4)	(5)
One-period lag of the dependent variable	0.754 ***	0.731 ***	0.657 ***	0.642 ***	0.807 ***
	(0.0150)	(0.0131)	(0.0110)	(0.0150)	(0.0234)
Two-period lag of the dependent variable					−0.112 ***
DURWTO	0.104 ***	0.238 ***	−1.827 ***	−0.186	2.300 ***
	(0.0157)	(0.0540)	(0.156)	(0.125)	(0.326)
DURWTO × Log(GDPC)		−0.0142 **			
		(0.00680)			
Log(TRCOST)			−1.235 ***		
			(0.0716)		
DURWTO × Log(TRCOST)			0.345 ***		
			(0.0270)		
DURWTO × Log(AfTTOT)				0.0168 **	−0.110 ***
				(0.00673)	(0.0166)
Log(AfTTOT)				−0.0509 ***	0.218 ***
				(0.0140)	(0.0493)
FINDEV	−0.000140	-1.99×10^{-5}	7.69×10^{-5}	0.00315 ***	0.218 ***
	(0.000227)	(0.000221)	(0.000165)	(0.000400)	(0.0493)
REGQUAL	−0.126 ***	−0.156 ***	−0.171 ***	−0.0606 **	−0.00478 ***
	(0.0358)	(0.0281)	(0.0308)	(0.0282)	(0.000838)
FDI	0.000924 ***	0.00114 ***	0.000647 ***	−0.000172	−0.200 ***
	(0.000163)	(0.000156)	(0.000185)	(0.00236)	(0.0624)
HUM	0.189 ***	0.167 ***	0.194 ***	0.107 ***	−0.00302
	(0.0486)	(0.0405)	(0.0232)	(0.0316)	(0.00421)
Log(GDPC)	0.149 ***	0.227 ***	0.201 ***	0.197 ***	−0.0453
	(0.0272)	(0.0291)	(0.0191)	(0.0275)	(0.0490)
Log(POP)	0.272 ***	0.289 ***	0.339 ***	0.363 ***	0.0630
	(0.0185)	(0.0158)	(0.0127)	(0.0191)	(0.0507)
Constant	−4.289 ***	−5.041 ***	1.723 ***	−4.425 ***	0.00524
	(0.337)	(0.313)	(0.484)	(0.475)	(0.0372)

Table 6. *Cont.*

Variables	Log(TRMARK)	Log(TRMARK)	Log(TRMARK)	Log(TRMARK)	Log(RATIO)
	(1)	(2)	(3)	(4)	(5)
Observations–Countries	690–122	690–122	653–119	291–74	173–55
AR1 (*p*-Value)	0.0003	0.0003	0.0008	0.0059	0.0479
AR2 (*p*-Value)	0.8268	0.8271	0.9989	0.6884	0.1313
OID (*p*-Value)	0.10	0.1243	0.3452	0.3433	0.8968

Note: * *p*-value < 0.1; ** *p*-value < 0.05; *** *p*-value < 0.01. Robust standard errors are in parentheses. The variables "DURWTO", "TRCOST", "AfTTOT", "FINDEV", "FDI", "REGQUAL", "HUM", and the interaction variables have been treated as endogenous. The variable "POP" has been treated as exogenous. Time dummies have been included in the regressions. The latter have used 2 lags of the dependent variable as instruments and 2 lags of endogenous variables as instruments.

We explore the effect of the membership duration in the WTO on trademark applications over four groups of WTO members: Article XII Members, Article XXVI Members, Non-Article XXVI Members (including Article XII Members and states that are neither GATT nor WTO members), and Non-Article XXVI Members including Article XII Members but excluding states that are neither GATT nor WTO members. To that effect, we estimate model (1) over each of these groups of countries using the conditional FE negative binomial regression approach. Results of these regressions are reported in columns (1) to (4) of Table 7. However, these outcomes may hide differentiated effects across countries within each group of countries. Therefore, we additionally examine how the effects reported in columns (1) to (4) of Table 7 vary across countries within each group of countries. We do so by estimating for each group of countries a specification of model (1) that includes the interaction between the variable capturing the membership duration in the WTO and the real per capita income. The outcomes of these regressions are reported in columns (5) to (8) of Table 7.

Results in column (1) of Table 7 suggest that there is no significant effect of the membership duration on trademark applications for Article XII Members, although this finding may hide differentiated effects, including positive and negative effects across Article XII Members. In contrast, results in column (2) of the same Table indicate that the membership duration exerts a positive and significant effect (at the 5% level) on trademark applications in Article XXVI Members. Outcomes in columns (3) and (4) of the same Table show a positive and significant effect (at the 1% level) of the membership duration on trademark applications in Non-Article XXVI Members (including both Article XII Members and states that are neither GATT nor WTO members) (see column (3)) as well as in Non-Article XXVI Members (including Article XII Members but excluding states that are neither GATT nor WTO members) (see column (4)). Interestingly, across columns (1) to (4), the effect of the membership duration on trademark applications appears to be higher for Article XXVI Members than for other groups of countries.

Outcomes in columns (5) to (8) of the Table show that the coefficient of the interaction variable "$[DURWTO_{t-1}] \times [Log(GDPC)_{t-1}]$" is negative and significant at the 1% level, while the coefficient of the variable $[DURWTO_{t-1}]$ is positive and significant at the 1% level. We deduce that, on average, within each group of countries, there is a turning point of the real per capita income above which the effect of the membership duration in the WTO on trademark applications becomes negative. In other words, these outcomes tend to suggest that less advanced countries within each of these four groups of countries experience a positive effect of the membership duration on trademark applications, while relatively advanced countries within each of these four groups of countries experience a negative effect of the membership duration on trademark applications. The values of the turning point of the real per capita income are reported at the bottom of columns (5) to (8) of Table 7. They amount to USD 3687.73 for Article XII Members[32], USD million 14.82 for Article XXVI Members[33], USD 8103.08 for Non-Article XXVI Members[34] (including both Article XII Members and states that are neither GATT nor WTO members), and USD 8879.9 for Non-Article XXVI Members[35] (including Article XII Members but excluding states that are neither GATT nor WTO Members). We note specifically that for Article XXVI Members, the real per capita income never exceeds USD million 14.82. We conclude that for Article XXVI Members, the membership duration always exerts a positive and significant effect on trademark applications, but the magnitude of this positive effect is larger for less advanced countries than for relatively advanced countries among Article XXVI Members.

Table 7. Effect of the duration of membership in the GATT/WTO on trademark applications. ***Estimator***: Conditional FE negative binomial regression.

	Article XII Members	**Article XXVI Members**	**Non-Article XXVI Members (Including Article XII Members)**	**Non-Article XXVI Members (Excluding Article XII Members)**	**Article XII Members**	**Article XXVI Members**	**Non-Article XXVI Members (Including Article XII Members)**	**Non-Article XXVI Members (Excluding Article XII Members)**
Variables	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
$DURWTO_{t-1}$	0.0335	2.651 **	0.158 ***	0.206 ***	1.158 ***	2.906 ***	1.323 ***	1.291 ***
	(0.0530)	(1.036)	(0.0390)	(0.0440)	(0.197)	(1.089)	(0.0897)	(0.0897)
$[DURWTO_{t-1}] \times [Log(GDPC)_{t-1}]$					−0.141 ***	−0.176 ***	−0.147 ***	−0.142 ***
					(0.0240)	(0.0292)	(0.0103)	(0.0105)
$Log(GDPC)_{t-1}$	0.423 ***	0.175 **	0.420 ***	0.459 ***	0.529 ***	0.436 ***	0.578 ***	0.618 ***
	(0.0894)	(0.0772)	(0.0364)	(0.0378)	(0.0878)	(0.0887)	(0.0377)	(0.0387)
$FINDEV_{t-1}$	0.00572 ***	0.00174	3.56×10^{-5}	4.13×10^{-5}	0.00570 ***	0.00332 ***	0.000693 **	0.000642 *
	(0.00139)	(0.00113)	(0.000341)	(0.000334)	(0.00127)	(0.00112)	(0.000345)	(0.000339)
$REGQUAL_{t-1}$	−0.0358	0.155 *	−0.00793	−0.0340	0.122	0.276 ***	0.0938 ***	0.0593 *
	(0.0983)	(0.0904)	(0.0341)	(0.0350)	(0.102)	(0.0894)	(0.0348)	(0.0358)
FDI_{t-1}	0.0159 ***	0.000340	0.00329 ***	0.00332 ***	0.0133 ***	7.59×10^{-5}	0.00339 ***	0.00348 ***
	(0.00430)	(0.000591)	(0.00107)	(0.00105)	(0.00405)	(0.000569)	(0.00114)	(0.00113)
Log(POP)	−0.00642	0.373 ***	0.0976 ***	0.102 ***	−0.0786	0.371 ***	0.120 ***	0.124 ***
	(0.0555)	(0.0493)	(0.0284)	(0.0284)	(0.0552)	(0.0461)	(0.0282)	(0.0281)
HUM_{t-1}	−0.0479	0.170	0.233 ***	0.136 **	−0.279 **	0.409 ***	0.0867	−0.00424
	(0.128)	(0.104)	(0.0604)	(0.0642)	(0.137)	(0.108)	(0.0605)	(0.0642)
Constant	−1.932	−9.039 ***	−3.774 ***	−3.908 ***	−0.865	−10.55 ***	−5.087 ***	−5.209 ***
	(1.268)	(1.574)	(0.561)	(0.566)	(1.279)	(1.591)	(0.579)	(0.582)
Observations–Countries	384–24	442–35	1439–89	1366–83	384–24	442–35	1439–89	1366–83

Table 7. *Cont.*

	Article XII Members	Article XXVI Members	Non-Article XXVI Members (Including Article XII Members)	Non-Article XXVI Members (Excluding Article XII Members)	Article XII Members	Article XXVI Members	Non-Article XXVI Members (Including Article XII Members)	Non-Article XXVI Members (Excluding Article XII Members)
Variables	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**	**TRMARK**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Turning point of "GDPC"					USD 3687.73 [=exponential (1.158/0.141)]	USD Million 14.82 [=exponential (2.906/0.176)]	USD 8103.08 [=exponential (1.323/0.147)]	USD 8879.9 [=exponential (1.291/0.142)]
Log likelihood	−2812.4064	−2716.5809	−11,837.301	−11,274.149	−2795.8898	−2698.4423	−11,742.865	−11,189.045
Wald Chi2 (P-value)	568.33 (0.0000)	766.80 (0.0000)	1556.03 (0.0000)	1459.31 (0.0000)	594.98 (0.0000)	817.76 (0.0000)	1477.69 (0.0000)	1388.27 (0.0000)
Overdispersion test (LR test of alpha = 0): Chi2 statistic (*p*-value)	6.2×10^5 (0.0000)	1.4×10^5 (0.0000)	1.3×10^7 (0.0000)	1.3×10^7 (0.0000)	5.7×10^5 (0.0000)	1.4×10^5 (0.0000)	1.3×10^7 (0.0000)	1.3×10^7 (0.0000)

Note: * *p*-value < 0.1; ** *p*-value < 0.05; *** *p*-value < 0.01. Robust standard errors are in parentheses. Time dummies have been included in the regressions.

6. Conclusions

Using a panel dataset of 124 countries (developed and developing countries), this study has examined how the duration of the membership in the WTO affects trademarks submitted by countries' residents. Such an effect is expected to take place primarily through the channel of trade costs. This analysis has revealed that the effect of the duration of WTO membership on trademarks does affect trademark applications through trade costs. Especially, the duration of WTO membership is positively associated with trademark applications in less developed members but negatively associated with trademark filings in relatively advanced members. These findings reflect the fact that the membership duration induces a higher submission of patents in relation to trademarks in advanced WTO members, while it generates a higher submission of trademarks compared to patents in relatively less developed countries. Finally, the analysis has shown that higher AfT flows lead to a higher submission of trademarks in AfT-recipient countries, but to a lesser extent than the submission of patents.

This analysis complements other studies on the economic effects of the membership in the WTO by showing that such a membership and more importantly its duration contributes significantly to explaining the development of trademark applications, including in relation to patent applications. This study has also revealed that AfT flows play an essential role in promoting the submission of trademark applications in developing countries, particularly in encouraging innovation by spurring patent filings.

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Data Availability Statement: The data used in this analysis is available online in the public databases, could be obtained upon request.

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Conflicts of Interest: I hereby confirm that there is no actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, the work.

Appendix A

Table A1. Definition and source of variables.

Variables	Definition	Source
TRMARK	The number of trademarks applications by residents.	World Development Indicators of the World Bank (WDI)
DURWTO	This is the transformed indicator of a country's duration of WTO membership. We denote "DURWTO1" as the duration of WTO membership for a given country. It represents the time elapsed since the country has joined the WTO. This variable takes the value of "0" for years during which the country was not a WTO member. It takes the value of "1" for the first year the country had become a WTO member (i.e., the year it acceded to the WTO) and is incremented by 1 for every subsequent (additional) year spent as a WTO member. As the WTO was created in 1995, and the period of analysis in the present study covers the period of 1996 to 2019, we first attribute the value of "1" to the variable "DURWTO1" for the year 1995. Then the year 1996 takes the value of "2", and then we increment by "1" for every additional year until the last year of the period under analysis. As a result, the variable "DURWTO1" takes the value of "25" in 2019. For a given country, the higher the value of the indicator "DURWTO1", the greater the duration of the membership in the WTO. As the variable "DURWTO1" contains many zeros and has a skewed distribution, it has been transformed using the following formula: $\text{DURWTO} = \log(1 + DURWTO1)$.	Author's computation based on data on WTO membership extracted from the WTO's website: (https://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm) (Accessed on 17 June 2023).
DURGATT	This is the indicator of the duration of the GATT/WTO membership. It is computed in the same way as the indicator "DURWTO" described above, while taking into account the duration of membership in both the GATT and the WTO, staring from the month in which a given country has joined the GATT or the WTO. In computing this indicator, we start from the year the countries first joined the GATT.	Author's computation based on data collected from the website of the WTO. The list of countries (128) that had signed GATT by 1994 is accessible online at https://www.wto.org/english/thewto_e/gattmem_e.htm (Accessed on 17 June 2023). The list of states that were GATT members, and that joined the WTO, as well as those that joined the WTO under the WTO's Article XII is accessible online at (https://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm) (Accessed on 17 June 2023).

Table A1. *Cont.*

Variables	Definition	Source
TRCOST	This is the indicator of the average comprehensive (overall) trade costs. We have calculated the average overall trade costs for a given country in a given year, as the average of the bilateral overall trade costs on goods across all trading partners of this country. Data on bilateral overall trade costs has been computed by Arvis et al. (2012, 2016), following the approach proposed by Novy (2013). Arvis et al. (2012, 2016) have built on the definition of trade costs by Anderson and van Wincoop (2004) and considered bilateral comprehensive trade costs as all costs involved in trading goods (agricultural and manufactured goods) internationally with another partner (i.e., bilaterally) relative to those involved in trading goods domestically (i.e., intranationally). Hence, the bilateral comprehensive trade costs indicator captures trade costs in its wider sense, including not only international transport costs and tariffs but also other trade cost components discussed in Anderson and van Wincoop (2004), such as direct and indirect costs associated with differences in languages and currencies as well as cumbersome import or export procedures. Higher values of the indicator of average overall trade costs indicate higher overall trade costs. Detailed information on the methodology used to compute the bilateral comprehensive trade costs could be found in Arvis et al. (2012, 2016), as well as in the short explanatory note accessible online at https://www.unescap.org/sites/default/d8files/Trade%20Cost%20Database%20-%20User%20note.pdf (Accessed on 17 June 2023).	Author's computation using the UNESCAP-World Bank Trade Cost Database. It is accessible online at https://www.unescap.org/resources/escap-world-bank-trade-cost-database (Accessed on 17 June 2023).
TARIFF	This is the indicator of the average tariff costs. It is the tariff component of the average overall trade costs. We have computed it, for a given country in a given year, as the average of the bilateral comprehensive tariff costs across all trading partners of this country. Data on the bilateral tariff costs indicator has been computed by Arvis et al. (2012, 2016). As the bilateral tariff costs indicator is (like the comprehensive trade costs) bi-directional in nature (i.e., it includes trade costs to and from a pair of countries), Arvis et al. (2012) have measured it as the geometric average of the tariffs imposed by the two partner countries on each other's imports (of agricultural and manufactured goods). Higher values of the indicator of the average tariff costs show an increase in the average tariff costs.	Author's computation using the ESCAP-World Bank Trade Cost Database. Detailed information on the methodology used to compute the bilateral tariff costs could be found in Arvis et al. (2012, 2016), as well as in the short explanatory note accessible online at https://www.unescap.org/sites/default/d8files/Trade%20Cost%20Database%20-%20User%20note.pdf (Accessed on 17 June 2023).
NTARIFF	This is the indicator of the average nontariff costs. It represents the second component (i.e., nontariff component) of the comprehensive trade costs. It is the indicator of the comprehensive trade costs, excluding the tariff costs. We have computed it, for a given country in a given year, as the average of the bilateral comprehensive nontariff costs (i.e., the comprehensive trade costs, excluding the tariff costs) across all trading partners of this country. Data on the bilateral nontariff costs indicator has been computed by Arvis et al. (2012, 2016), following Anderson and van Wincoop (2004). Comprehensive trade costs excluding tariff encompass all additional costs other than tariff costs involved in trading goods (agricultural and manufactured goods) bilaterally rather than domestically. Higher values of the indicator of average nontariff costs reflect a rise in nontariff costs. Detailed information on the methodology used to compute the bilateral nontariff costs could be found in Arvis et al. (2012, 2016), as well as in the short explanatory note accessible online at https://www.unescap.org/sites/default/d8files/Trade%20Cost%20Database%20-%20User%20note.pdf (Accessed on 17 June 2023).	Author's computation using the ESCAP-World Bank Trade Cost Database. Detailed information on the methodology used to compute the bilateral nontariff costs could be found in Arvis et al. (2012, 2016), as well as in the short explanatory note accessible online at https://www.unescap.org/sites/default/d8files/Trade%20Cost%20Database%20-%20User%20note.pdf (Accessed on 17 June 2023).

Table A1. *Cont.*

Variables	Definition	Source
ECI	This is the economic complexity index. It reflects the diversity and sophistication of a country's export structure, and hence indicates the diversity and ubiquity of that country's export structure. It has been estimated using data connecting countries to the products they export and by applying the methodology in described in Hausmann and Hidalgo (2009). Higher values of this index reflect greater economic complexity.	MIT's Observatory of Economic Complexity (https://oec.world/en/rankings/eci/hs6/hs96) (Accessed on 17 June 2023).
AfTTOT, AfTINFRA, AfTPROD, AfTPOL	"AfTTOT" is the total real gross disbursements of total Aid for Trade. "AfTINFRA" is the real gross disbursements of Aid for Trade allocated to the buildup of economic infrastructure. "AfTPROD" is the real gross disbursements of Aid for Trade for building productive capacities. "AfTPOL" is the real gross disbursements of aid allocated for trade policies and regulation. All four AfT variables are expressed in constant prices 2019, US dollar.	Author's calculation based on data extracted from the OECD statistical database on development, in particular the OECD/DAC-CRS (Organization for Economic Cooperation and Development/Donor Assistance Committee)-Credit Reporting System (CRS). Aid for Trade data cover the following three main categories (the CRS Codes are in brackets): Aid for Trade for Economic Infrastructure ("AfTINFRA"), which includes transport and storage (210), communications (220), and energy generation and supply (230); Aid for Trade for Building Productive Capacity ("AfTPROD"), which includes banking and financial services (240), business and other services (250), agriculture (311), forestry (312), fishing (313), industry (321), mineral resources and mining (322), and tourism (332); and Aid for Trade policy and regulations ("AfTPOL"), which includes trade policy and regulations and trade-related adjustment (331).
GDPC	Real per capita Gross Domestic Product (constant 2015 USD).	WDI
POP	Total population	WDI
TP	This is the indicator of trade policy measured by the score of the freedom to trade internationally. The latter is a component of the economic freedom index. It is a composite measure of the absence of tariff and nontariff barriers that affect imports and exports of goods and services. The trade freedom score is graded on a scale of 0 to 100, with a rise in its value indicating lower trade barriers, i.e., higher trade liberalization, while a decrease in its value reflects rising trade protectionism.	Heritage Foundation (https://www.heritage.org/index/explore?view=by-region-country-year) (Accessed on 17 June 2023).
OPEN	This is the ratio (in percentage) of the sum of a country's exports and imports of goods and services to its GDP.	WDI

Table A1. *Cont.*

Variables	Definition	Source
HUM	This is the proxy for the human capital. It is measured by the index of educational attainment. It measures the number of years of schooling and returns to education in a given country and a given year t.	Data extracted from the Penn World Table (version 10.0) (see Feenstra et al. 2015).
FINDEV	This a proxy for financial development. It is measured by the share of domestic credit to private sector by banks in GDP (expressed in percentage).	WDI
FDI	The variable represents the net inflows of foreign direct investment (in percentage of GDP).	WDI
REQUAL	This is the indicator of regulatory quality. Higher values of this indicator indicate better regulatory quality policy.	Data are extracted from World Bank Governance Indicators developed by Kaufmann et al. (2010) and updated recently. See online at: https://info.worldbank.org/governance/wgi/ (Accessed on 17 June 2023).

Appendix B

Table A2. Descriptive statistics on variables used in the analysis over the annual period 1996–2019.

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
TRMARK	1881	24,530.950	94,749.040	1.000	1,997,058.000
RATIO	1599	91.759	261.848	0.250	4857.000
DURWTO	1881	13.480	7.318	0.000	25.000
DURGATT	1881	34.566	21.893	0.000	72
TRCOST	1733	286.393	66.351	82.978	505.828
TARIFF	1811	1.083	0.032	1.029	1.259
NTARIFF	1706	250.121	61.254	78.804	469.736
ECI	1703	0.283	0.955	−2.196	2.482
AfTTOT	987	293,000,000	479,000,000	21,987	3,820,000,000
AfTINFRA	985	178,000,000	336,000,000	16,819	3,300,000,000
AfTPROD	987	111,000,000	185,000,000	5168	1,950,000,000
AfTPOL	960	4,994,045	17,500,000	25	282,000,000
GDPC	1880	16,327.190	19,394.120	191.572	92,123.710
FINDEV	1869	62.075	49.300	1.616	304.575
REGQUAL	1654	0.326	0.919	−2.244	2.261
FDI	1880	5.644	18.514	−40.330	449.083
HUM	1881	2.681	0.652	1.065	4.352
POP	1881	56,700,000	173,000,000	255,068	1,370,000,000

Appendix C

Table A3. List of the 124 countries used in the analysis along with the duration of their WTO membership as of 2019 (end-year of the period under analysis).

Country	Duration of Membership in 2019	Country	Duration of Membership in 2019	Country	Duration of Membership in 2019	Country	Duration of Membership in 2019
Albania **	20	El Salvador **	25	Lao PDR **	1	Russian Federation	8
Algeria **	0	Estonia	21	Latvia	20	Rwanda **	23
Angola **	25	Ethiopia **	0	Lithuania	19	Saudi Arabia	15
Argentina **	25	Finland	25	Macao SAR, China	25	Serbia **	0
Armenia **	17	France	25	Madagascar **	25	Sierra Leone **	25
Australia	25	Gambia **	23	Malawi **	25	Singapore	25
Austria	25	Germany	25	Malaysia **	25	Slovak Republic	25
Bahrain	25	Ghana **	25	Maldives **	25	Slovenia	25
Bangladesh **	25	Greece	25	Malta	25	South Africa **	25
Barbados	25	Guatemala **	25	Mauritius **	25	Spain	25
Belgium	25	Guyana **	25	Mexico **	25	Sri Lanka **	25
Belize **	25	Haiti **	24	Moldova **	19	Sudan **	0
Bolivia **	25	Honduras **	25	Mongolia **	23	Sweden	25
Botswana **	25	Hong Kong SAR, China	25	Morocco **	25	Switzerland	25
Brazil **	25	Hungary	25	Mozambique **	25	Tajikistan **	7
Brunei Darussalam	25	Iceland	25	Myanmar **	25	Tanzania **	25
Bulgaria	24	India **	25	Namibia **	25	Thailand **	25
Burkina Faso **	25	Indonesia **	25	Nepal **	16	Trinidad and Tobago	25
Cambodia **	16	Iran, Islamic Rep **	0	New Zealand	25	Tunisia **	25
Canada	25	Iraq **	0	Nicaragua **	25	Turkey **	25
Chile **	25	Ireland	25	Nigeria **	25	Uganda **	25
China **	19	Israel	25	Norway	25	Ukraine **	1

Table A3. *Cont.*

Country	Duration of Membership in 2019	Country	Duration of Membership in 2019	Country	Duration of Membership in 2019	Country	Duration of Membership in 2019
Colombia **	25	Italy	25	Pakistan **	25	United Arab Emirates	23
Costa Rica **	25	Jamaica **	25	Panama **	22	United Kingdom	25
Croatia	20	Japan	25	Paraguay **	25	United States	25
Cyprus	25	Jordan **	20	Peru **	25	Uruguay **	25
Czech Republic	25	Kazakhstan **	5	Philippines **	25	Venezuela **	25
Denmark	25	Kenya **	25	Poland	25	Vietnam **	13
Dominican Republic **	25	Korea, Rep.	25	Portugal	25	Yemen, Rep **	6
Ecuador **	24	Kuwait	25	Qatar	23	Zambia **	25
Egypt, Arab Rep **	25	Kyrgyz Republic **	22	Romania	25	Zimbabwe **	25

Note: AfT-recipient countries are marked with "**".

Table A4. List of countries used in the sub-samples of HICs, LLDCs, and LDCs.

HICs		LLDCs	LDCs
Australia	Kuwait	Armenia	Angola
Austria	Latvia	Bolivia	Bangladesh
Bahrain	Lithuania	Botswana	Burkina Faso
Barbados	Macao SAR, China	Burkina Faso	Cambodia
Belgium	Malta	Ethiopia	Ethiopia
Brunei Darussalam	Mauritius	Kazakhstan	Gambia
Canada	New Zealand	Kyrgyz Republic	Haiti
Chile	Norway	Lao PDR	Lao PDR
Croatia	Panama	Malawi	Madagascar
Cyprus	Poland	Moldova	Malawi
Czech Republic	Portugal	Mongolia	Mozambique
Denmark	Qatar	Nepal	Myanmar
Estonia	Romania	Paraguay	Nepal
Finland	Saudi Arabia	Rwanda	Rwanda
France	Singapore	Tajikistan	Sierra Leone
Germany	Slovak Republic	Uganda	Sudan
Greece	Slovenia	Zambia	Tanzania
Hong Kong SAR, China	Spain	Zimbabwe	Uganda
Hungary	Sweden		
Iceland	Switzerland		
Ireland	Trinidad and Tobago		
Israel	United Arab Emirates		
Italy	United Kingdom		
Japan	United States		
Korea, Rep.	Uruguay		

Table A5. List of Article XXVI Members and Article XII Members.

Article XXVI Members	Article XII Members	Non-Article XXVI Members (Excluding Article XII Members)	
Angola	Albania	Argentina	Nicaragua
Bahrain	Armenia	Australia	Norway
Barbados	Bulgaria	Austria	Pakistan
Belize	Cambodia	Bangladesh	Paraguay
Botswana	China	Belgium	Peru
Brunei Darussalam	Croatia	Bolivia	Philippines
Burkina Faso	Ecuador	Brazil	Poland
Cyprus	Estonia	Canada	Portugal
Gambia	Jordan	Chile	Romania
Ghana	Kazakhstan	Colombia	Slovak Republic
Guyana	Kyrgyz Republic	Costa Rica	Slovenia
Hong Kong SAR, China	Lao PDR	Czech Republic	South Africa

Table A5. *Cont.*

Article XXVI Members	Article XII Members	Non-Article XXVI Members (Excluding Article XII Members)	
Indonesia	Latvia	Denmark	Spain
Jamaica	Lithuania	Dominican Republic	Sri Lanka
Kenya	Moldova	Egypt, Arab Rep.	Sweden
Kuwait	Mongolia	El Salvador	Switzerland
Macao SAR, China	Nepal	Finland	Thailand
Madagascar	Panama	France	Tunisia
Malawi	Russian Federation	Germany	Turkey
Malaysia	Saudi Arabia	Greece	United Kingdom
Maldives	Tajikistan	Guatemala	United States
Malta	Ukraine	Haiti	Uruguay
Mauritius	Vietnam	Honduras	Venezuela, RB
Mozambique	Yemen, Rep.	Hungary	Zimbabwe
Namibia		Iceland	
Nigeria		India	
Qatar		Ireland	
Rwanda		Israel	
Sierra Leone		Italy	
Singapore		Japan	
Tanzania		Korea, Rep.	
Trinidad and Tobago		Mexico	
Uganda		Morocco	
United Arab Emirates		Myanmar	
Zambia		New Zealand	

Notes

1 It is important to note that the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement), which is one of the founding Agreements of the WTO, contains several provisions that deal with the protection that members can accord for trademarks (see Articles 15 to 21 of Section 2 in Part II of the Agreement). Information on the TRIPS Agreement can be found online at https://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm (Accessed on 17 June 2023).

2 Herz and Mejer (2016) have explained the substantial increase in national demand for trademark applications over the past decades in developed countries (in particular Europe) by the substantial decrease in trademark filing fees. In contrast, a recent study by de Rassenfosse (2020) has revealed, using a larger sample of countries (42 countries), that the price elasticity of the demand for trademarks is low, which suggests that higher fees hardly reduce demand.

3 It is important to note here that voluminous literature has considered the complementarity/substitutability between trademarks and patents as intellectual property tools in firms' strategies to protect their innovations (see the literature review provided by Castaldi 2020).

4 The overall trade costs are due not only to import tariffs but also to the costs associated with the burden imposed by the insufficiency or lack of both soft and hard infrastructure.

5 For example, according to Castellacci (2008), a small number of innovators is engaged in patent application in service industries as well as in personal goods industries.

6 According to Llerena and Millot (2020), the complementarity or substitutability between trademarks and patents depends on market characteristics, especially on advertising spillovers and depreciation rates. The complementarity between these two types of intellectual property assets is stronger, the higher the advertising spillovers and the lower the advertising depreciation rates, as a consequence of the long life cycles of technologies. Similarly, Thoma (2020) has used data of the United States Patent and

Trademark Office to demonstrate that the intellectual property strategy (of appropriating the economic rents from innovation) that consists of pairing patents and trademarks leads to the doubling of patent value.

[7] This is particularly the case for science- or technology-based markets (Reitzig 2004) and in the event of copyright expiry in creative industries (Calboli 2014).

[8] Basic information on the TPRM's role concerning the WTO's transparency objective can be found online at https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm11_e.htm (Accessed on 17 June 2023).

[9] 'DSU' refers to the Dispute Settlement Understanding of the WTO. The legal text of the DSU is accessible online at https://www.wto.org/english/tratop_e/dispu_e/dsu_e.htm (Accessed on 17 June 2023).

[10] See, for example, Anderson and Marcouiller (2002); Hoekman and Nicita (2011); Noureen and Mahmood (2022); Papalia and Bertarelli (2015); and Yanase and Tsubuku (2022).

[11] It is important to note that the WTO's definition is a narrower definition as it covers only soft infrastructure soft institutional and regulatory infrastructure (e.g., border procedures and the logistics of moving goods across frontiers). Further information on the TFA can be obtained online at https://www.wto.org/english/tratop_e/tradfa_e/tradfa_e.htm (Accessed on 17 June 2023).

[12] This involves the multiple documents that should be completed, the inspections by different agencies, customs formalities, and fees and charges.

[13] A literature review on the trade costs that effect soft trade facilitation, including the WTO trade facilitation, is provided by Beverelli et al. (2015) and Hoekman and Shepherd (2015).

[14] See, for example, Beverelli et al. (2015); Dennis and Shepherd (2011); Feenstra and Ma (2014); Freund and Rocha (2011); Hoekman and Nicita (2011); Hoekman and Shepherd (2015); Hausman et al. (2013); Hendy and Zaki (2021); Iwanow and Kirkpatrick (2009); Noureen and Mahmood (2022); Portugal-Perez and Wilson (2012); and Zaki (2014).

[15] It is important to underline here that Dutt et al. (2013) have obtained that the positive effect of the WTO membership on the extensive product margin of trade works essentially through fixed trade cost reduction and not the variable trade costs.

[16] Some firms pursue a branded house strategy (Aaker 2004) that involves using a single brand to market all products and services (Flikkema et al. 2015).

[17] According to Athreye and Fassio (2020, p. 136), "*a large proportion of modern day innovators are service firms who innovate through collaboration with suppliers and clients.*"

[18] Further information on LDCs can be obtained online at https://www.un.org/ohrlls/content/least-developed-countries (Accessed on 17 June 2023).

[19] The recent WTO report titled "Easing Trade Bottlenecks in Landlocked Developing Countries" has identified trade bottlenecks in LLDCs and provided recommendations on steps that need to be taken to ease these trade bottlenecks, including how the WTO could be instrumental in that regard (for example, recommendations were provided concerning the use of provisions embedded in the TFA of which the capacity building, the use of Trade Policy Reviews to ease these trade bottlenecks, is one).

[20] The list is accessible online at https://www.un.org/ohrlls/content/list-lldcs (Accessed on 17 June 2023).

[21] It measures the complexity of national economies in terms of product groups, i.e., sophisticated export products (e.g., Hausmann and Hidalgo 2009; Sweet et al. 2015).

[22] For example, Dutt et al. (2013) have obtained that the membership in the WTO has increased the extensive margin of exports by 25% but reduced the intensive margins of exports. Dutt (2020) has demonstrated empirically that while the WTO membership has exerted a positive impact on both the extensive and intensive margins of trade over time, the impact on the former is higher than the impact on the latter.

[23] Ivanova et al. (2017) have found a positive correlation between economic complexity and patent complexity.

[24] According to statistics reported in Table A2, values of the indicator of the overall trade costs range between 83 and 505.8.

[25] See Table A1 for details on the various components of total AfT flows.

[26] In the sub-sample of AfT countries, values of total AfT flows range between USD 21,987 and USD million 3820 (see Table A2).

[27] In the sub-sample of AfT countries, values of AfT flows for economic infrastructure range between USD 16,819 and USD million 3300 (see Table A2).

[28] In the sub-sample of AfT countries, values of AfT flows for building productive capacities range between USD 5168 and USD million 1950 (see Table A2).

[29] In the sub-sample of AfT countries, values of AfT flows for trade policy and regulation range between USD 25 and USD million 282 (see Table A2).

[30] These graphs have not been presented here to save space and can be obtained upon request.

[31] This graph has not been presented here to save space and can be obtained upon request.

[32] We observe that the values of the real per capita income among Article XII Members range from USD 355.15 to USD 21,399.1.

[33] Values of the real per capita income among Article XXVI Members range from USD 294.1 to USD 71,974.44.

[34] Values of the real per capita income among Non-Article XXVI Members range from USD 355.15 to USD 92,123.71.

[35] Values of the real per capita income among Non-Article XXVI Members (excluding Article XII Members) range from USD 481.1 to USD 92,123.71.

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