

Gnangnon, Sèna Kimm

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Effect of the duration of membership in the World Trade Organization on Trademark Applications

Author: Sèna Kimm GNANGNON¹

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Abstract

This article has examined the effect of the duration of the membership in the World Trade Organization (WTO) on the submission of trademarks by countries' residents. The analysis has 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, utilized for 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 relatively to trademarks, notably 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 trademarks applications, but to a lesser extent than patents filings.

Keywords: Duration of WTO membership; Residents' trademark applications; Trade costs; Aid for Trade.

JEL Classification: O34; F14; F35.

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¹ Economist at the World Trade Organization (WTO). E-mail for correspondence: kgnangnon@yahoo.fr

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 the membership in the WTO influences positively and significantly trade flows (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 the mere membership in the WTO, but rather on the duration of such a membership. For example, Gnanangnon (2021) has investigated the effect of membership duration on the utilization of non-reciprocal trade preferences, and Gnanangnon (2022) has considered how such duration affects investment-oriented remittances 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 the 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 right² (IPR) that can be filed by individuals, firms, or other actors, and is granted by official specialized authorities (e.g.,

² 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 could be found online at: https://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm

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, Ch. 2: 54). The registration for a trademark builds on three criteria, including distinctiveness, no misleading or immoral character, and (intent to) use in market (WIPO, 2004). Trademark registration fees³ 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 novelty⁴ (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., Moisé et al. 2012) have demonstrated that the implementation of this Agreement could contribute to significantly reducing the overall trade costs⁵, 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

³ 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 substantial decrease in trademarks filing fees. In contrast, a recent study by Rassenfosse (2020) has revealed, using a larger sample of countries (42 countries) that price-elasticity of the demand for trademarks is low, which suggests that higher fees hardly reduce demand.

⁴ It is important to note here that a 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).

⁵ 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.

been instrumental in bring 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; Cali and te Velde, 2011). The other components of total AfT flows, notably aid flows allocated to develop economic infrastructure will help reduce the hard infrastructural-related trade costs (e.g., Cali and te Velde, 2011; Tadesse et al., 2021; Vijil and Wagner, 2012).

The present paper investigates the effect of the 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 WTO member) on trademark applications, notably 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 issue could appropriately be addressed in future research. Existing studies on the determinants of trademark applications (e.g., Fink et al., 2005; Fink et al., 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 these studies that used firms-level data or 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 emerge 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 relatively to patent applications in relatively advanced economies. These findings reflects the fact that as countries spend more time as WTO members, they tend to experience a higher submission of patents relatively to trademarks, notably 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 patents 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 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. Theoretical discussion

This section first discusses the rationale for submitting trademarks (including relatively 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, soft innovations) being commercialized, as well as non-technological types of innovations (those that could not be protected by patents - such as services innovations⁶ 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. (2021), trademarks allow 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 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 trademarks assets to complement⁷ technological assets, including patents (e.g., Götsch and Hipp 2012; Greenhalgh and Rogers 2012; Mendonça et al., 2004; Schmoch, 2003).

⁶ For example, according to Castellacci (2008), a few number of innovators is engaged in patent application in service industries as well as in personal goods industries.

⁷ According to Llerena and Millot (2020), the complementarity or substitutability between trademarks and patents depends on market characteristics, notably 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 long life cycles of technologies. Similarly, Thoma (2019) 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.

According to Flikkema et al. (2015: p9-10), 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, protection of a slogan, for patent substitution purposes after patent expiry. The pursue 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 relatively 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 organisational 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), brand creation for foreign markets, or to substitute for patents and prolong market dominance after patent expiry⁸. 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

⁸ 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).

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 trademarks applications can be higher than the number of patent applications. Conversely, defensive patenting entails for a firm to apply 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 relatively 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 policy. This is achieved through the commitments by WTO Members to reducing and binding tariff rates, and to limiting the utilization of non-tariff trade barriers (e.g., Chowdhury et al., 2021; Koopman et al., 2020; Mansfield and Reinhart, 2008). The benefits for a country of entering into international trade agreements, notably 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, notably those with weak institutions. Limão and Maggi (2015) have shown that trade agreements constrain risk-averse governments' behaviour during periods of uncertainty. Furthermore, the transparency provisions included in the majority of WTO agreements and decisions allows for greater clarity on countries' trade policy, and contributes to enhancing the predictability and stability of trade policy. WTO Members are required to disclose their trade regulations and notify changes to these regulations⁹ (e.g., Chowdhury et al., 2021). The fulfilment 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 DSU¹⁰). 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

⁹ 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

¹⁰ '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

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, that include here traditional border measures (including tariffs), and non-tariff trade policy measures (e.g., Milner, 1996; Anderson and van Wincoop, 2004; Arvis et al., 2016). Non-tariff trade policy measures (that account significantly for trade costs, given the significant tariff liberalization by countries since the inception of the WTO) relates 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: p691) 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 trade¹¹, and may discourage the filing of trademarks, notably by firms involved in international trade activities. The WTO can contribute to reducing trade costs by facilitating¹² 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,

¹¹ See for example, Anderson and Marcouiller (2002); Hoekman and Nicita (2011); Noureen and Mahmood (2022); Papalia and Bertarelli (2015) and Yanase and Tsubuku (2022).

¹² 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 could be obtained online at: https://www.wto.org/english/tratop_e/tradfa_e/tradfa_e.htm

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 border¹³. de Melo and Wagner (2016: p938) 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."

Yet, 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; Cali and te Velde, 2011; de Melo and Wagner, 2016; Helble et al., 2012; Hillbery and Zhang, 2018; Hoekman and Nicita, 2010; 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., Cali and te Velde, 2011; Tadesse et al., 2021; Vijil and Wagner, 2012). Besides, numerous empirical studies¹⁴ (e.g., Moisé and Sorescu, 2013; Novy, 2013; Papalia and Bertarelli, 2015) have also reported a strong trade costs reduction effect of trade facilitation (considered in a large sense). As far as the TFA effects are concerned, Moisé 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 studies¹⁵ 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 clearance¹⁶. 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

¹³ This involves the multiple documents that should be completed, the inspections by different agencies, customs formalities, and fees and charges.

¹⁴ A literature review on the trade costs effect soft trade facilitation, including the WTO trade facilitation is provided by Beverelli et al. (2015) and Hoekman and Shepherd (2015).

¹⁵ 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).

¹⁶ It is important to underline here that Dutt et al. (2013) have obtained that the positive of the WTO membership on the extensive product margin of trade works essentially through fixed trade costs reduction and not the variable trade costs.

of the TFA could increase the number of products exported (export product diversification at the extensive margins) by up to 16.7% and an increase in the number of export destinations by product 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 would 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 policy and measures to unilaterally reduce trade costs. Consequently, they could experience lower trademarks submissions than WTO members.

Against this background, we formulate the following ***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 relatively to other intellectual property forms, notably patents, to protect new product innovations. In this scenario, the ratio of trademark applications to patents applications by residents will decline over time (this is reflected in an increase in the ratio of residents' patents counts to residents' trademark applications). Gallié and Legros (2012) have shown that firms' propensity of using 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 patents 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 by the owner of a trademark to confirm that the trademark is still in commercial use through the renewal of the mark registration, shortens the lifecycle of trademarks. For example, Millot (2009) has found that the absolute majority of the United States' marks 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 technologies capital may actually experience a shorter trademark lifecycle. In the same vein, Melnyk

et al. (2014) have found for trademarks in the United States software security industry that larger and more innovative companies often have a short duration of their trademarks earlier, while older companies tend to opt for the prolongation of a trademark. Additionally, Castaldi (2018) has argued that firms might not trademark at all their innovations 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 of constraints imposed by collaborative innovation) to explain why innovators might not trademark at all, all their valuable inventions. 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 trademark¹⁷ 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 partners¹⁸ 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 forgoing, we formulate the following ***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 relatively 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).

¹⁷ 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).

¹⁸ According to Athreye and Fassio (2020: p136), "*a large proportion of modern day innovators are service firms who innovate through collaboration with suppliers and clients.*"

3. Empirical strategy

This section lays out the model specification (sub-section 1) and presents the appropriate econometric approach to estimate this model (sub-section 2).

3.1. Model specification

To analyse 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; Fink et al., 2021; Zolas et al., 2017), as well as 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 control 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").

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 represented the bulk of trademark registrations. Mangani (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).

Financial development

A 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 to apply for a higher number of trademarks (and/or alternatively for other intellectual property forms such as patents).

FDI inflows

FDI inflows are associated with higher trademark applications (Gnangnon, 2019, 2020; Zolas et al. (2017). For example, Zola 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.

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:

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

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 "25" in 2019. As this variable contains many zeros, and displays a skewed distribution, it has been transformed using the following formula (see Yeyati et al. 2007): $DURWTO = \text{sign}(DURWTO1) * \log(1 + |DURWTO1|)$ (where $|DURWTO1|$ refers to the absolute value of the variable "DURWTO1").

Appendix 1 contains the description and source of all variables used in the analysis, and Appendix 2 reports the standard descriptive statistics on these variables. Appendix 3 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 endeavour to join the WTO and reform its trade regime. The same rationale applies for the other control variables.

α_1 to α_7 are coefficients that will be estimated. μ_i are country-fixed effects (time invariant 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 nonnegative 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 are 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 & 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 94749.04, while its mean is 24530.95 (see Appendix

2). 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.

It is also worth providing at this stage of the analysis, 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 equals 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: $DURWTO = sign(DURWTO1) * \log(1 + |DURWTO1|)$ (where $|DURWTO1|$ refers to the absolute value of the variable "DURWTO1". Hence, a 1 year increase in the value of "DURWTO1" means an increase in the values of "DURWTO" by 0.693 year ($= \log(2)$) - 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 [$= \exp(1) - 1$].

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 to 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.

[Insert Table 1, here]

Let us now take up results in Table 1. We present in column [1] of this Table, the outcomes of the estimation of the baseline model (1). Results in column [2] of the same Table are obtained

by estimating a specification of model (1) where the variable "DUMWTO" has been replaced with the dummy "WTO", which takes the value of 1 in years during which a country has been 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.

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 a one more year as WTO member (i.e., an increase in the value of "DURWTO" by 0.693 year) generates a rise in the trademark count submitted by countries' residents by 12% ($= 0.693 \times 17.35$). Similarly, results in column [2] of the same Table reveals 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 amount 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.

Control variables exhibit similar coefficients (in terms of magnitude, sign, and statistical significance) across the two columns [1] and [2]. 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 the regulatory quality do not affect significantly 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 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 [3] 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, 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 Appendix 1 for details on the computation of this indicator).

Results in column [3] 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 [3]. We can, therefore deduce that trade costs constitute a channel through which the duration of the WTO membership affects trademarks 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 as trademarks tend to be far cheaper than most other statutory forms of intellectual property, 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 induces a higher number of trademark applications, including relatively to patent applications, particularly in developing countries. Outcomes in column [4] of Table 1 confirm the latter interpretation. They are obtained by running a regression similar to the one whose results are reported in column [3], but where here the dependent variable "TRMARK" is replaced with the ratio of the total trademarks applications by residents of a country in a year to the total patents 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 relatively to the number of patent applications. We note from this column of the Table that the coefficient of the trade costs 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 [3] of Table 1), but it also leads to a higher number of trademark applications relatively to patent applications (see column [4] of Table 1). Regarding control variables, we observe that the increase in the ratio of trademark counts relatively 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 relatively 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.

[Insert Table 2, here]

We now consider 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}]*[Log(GDPC)_{t-1}]" variables).

Therefore, we present in Figure 1, at the 95 per cent 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 US\$ 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 US\$ 11190 [= exponential (9.322758)]. It is not statistically significant when the real per capita income is comprised between US\$ 5320.5 and US\$ 11190.

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 at 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 lower than tend to US\$ 5320.5. in this group of countries, the lower the real per capita income, the greater is 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 per cent 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 trademarks applications. In fact, this marginal impact is always positive and significant, but declines as the real per capita income increases.

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, LDCs¹⁹ 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. Results in columns [3] and [4] are 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"

¹⁹ Further information on LDCs could be obtained online at: <https://www.un.org/ohrrls/content/least-developed-countries>

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 a one more year as 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% (= $0.693 \times 100 \times (0.7423 - 1)$) in HICs, and an increase in trademark applications by 11.14% (= $0.693 \times 100 \times (1.1607 - 1)$) 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 a one more year spent as WTO member by LDC members generate, on average, a rise in trademark applications by 46.92% [(= $0.693 \times 100 \times (1.677 - 1)$)] 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 at the benefit of patent applications) as they expand their WTO membership duration. These findings definitely confirm those in column [1] of Table 2.

Landlocked developing countries face higher trade costs than other countries due to specific trade bottlenecks, of which, a heavy dependence on transport corridors and trade logistics of neighbouring 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 group²⁰. The list of landlocked developing countries (LLDCs) is designated by the United Nations²¹. We undertake this empirical exercise by estimating a variant of model (1) that includes the dummy variable "LLDC" (which represents

²⁰ The recent WTO report titled "Easing Trade Bottlenecks in Landlocked Developing Countries" has identified trade bottlenecks in LLDCs, and provided recommendations on steps that are needed 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).

²¹ The list is accessible online at: <https://www.un.org/ohrrls/content/list-lldc>

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 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 patents applications for the same set of countries. Results of this estimation are provided in column [6] of Table 2. We obtain in column [5] of this Table 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 relatively 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 the 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 LLDCs 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).

[Insert Table 3, here]

We now turn to results in Table 3. Findings in Table 2, notably those in columns [1] and [2] suggest that countries with greater economic sophistication (that reflects a high degree of technological innovation) may submit a higher number of patents relatively to trademarks, for multiple reasons put forth in section 2 (see for example, Castaldi and Mendonça, 2022; Gallié and Legros, 2012). Mangani (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 complexity²² is positively associated with technological complexity (e.g., Ivanova et al., 2017). Given that the membership in the WTO contributes to trade upgrading, and promotes exports at the extensive product margin²³ (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 patent²⁴ applications) in countries that experience greater economic complexity. If these theoretical expectations are confirmed empirically, then they will lend support to 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 dependent variable. We present in column [2] of Table 3 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 (" $[DURWTO_{t-1}] * [ECI_{t-1}]$ ") is negative and significant at the 1% level. Taken together, these outcomes suggest that as countries enjoy a greater economic sophistication, they tend to submit fewer trademarks. We display in Figure 3, at the 95 per cent 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, decreases as the level

²² It measures the complexity of national economies in terms of product groups, i.e., sophisticated export products (e.g., Hidalgo and Hausmann, 2009; Sweet et al., 2015).

²³ 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.

²⁴ Ivanova et al. (2017) have found a positive correlation between economic complexity and patent complexity.

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 Appendix 2), the membership duration exerts yet 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 is 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) 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 becoming highly sophisticated. These findings tend to confirm our previous outcomes that developing countries (i.e., less sophisticated countries) tend to submit greater trademarks 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}]*[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 per cent 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 statistically nil for degrees of economic complexity higher or equal to 2.38. Thus, the duration of WTO membership exerts induces a higher submission of patents than trademarks as countries improve the sophistication of their economies, but for high levels 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 relatively to patent applications, while relatively advanced economies (i.e., those that enjoy relatively high degree of economic sophistication) tend to submit a higher number of patents relatively to trademark counts as the duration of their WTO membership rises. These findings lend support to hypothesis 2.

[Insert Table 4, here]

We now examine outcomes in Table 4, which aims 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 empirically this hypothesis, we find useful to examine how the duration of WTO membership affects trademark applications through its effect of trade facilitation insofar as our theoretical argument in section 2 rests on the hypothesis that the WTO could affect trademark applications through trade costs 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" has not been lagged (with one-year) because this is an international agreement adopted by consensus of all WTO members, and 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 are 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 being here 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.

Estimates in column [1] of Table 4 shows 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 yet 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}]*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 trademarks counts by 13.86% [$= 0.693 \times 100 \times (1.145 - 1)$] before the adoption of the TFA, and by 10.05% [$= 0.693 \times 100 \times (1.002 - 1)$] after the adoption of the TFA. How could one explain this surprising outcome? Does these findings mean that longstanding WTO members had submitted fewer trademarks relatively 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 our 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}]*[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 per cent 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 costs²⁵ 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 the overall trade costs lower 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

²⁵ According to statistics reported in Appendix 2, values of the indicator of the overall trade costs range between 83 and 505.8.

submission of trademarks by their residents. These findings lend support to hypothesis 1, and in this regard, provides an affirmative answer to the question raised above. They may suggest that countries tend to submit a higher number of patents relatively 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 that allow 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 closed 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 relatively to the number of patents applied in countries that face higher trade costs. Figure 6 shows, at the 95 per cent 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)].

Overall, outcomes in Table 4 show 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 relatively to patent applications when they face higher trade 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 relatively 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 relatively 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 performed 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 relatively to patent applications), through the channel of trade costs. In the meantime, as noted in section 2, AfT flows²⁶, in particular AfT interventions for the build-up of economic infrastructure and AfT interventions related to trade policy and regulation contributes 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 that 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 empirically this issue, we restrict the panel dataset to the sub-sample of AfT recipient-countries, with spanning over the period 2002-2019 (as AfT disbursements data is available only from 2002). The list of AfT recipient countries is provided in Appendix 3a. 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

²⁶ See Appendix 1 for details on the various components of total AfT flows.

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) whose results are presented in columns [2] to [5] of Table 5, but now with the variable "RATIO" as 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 the trademark applications by 9.7% [(= 0.693*100*(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 to 10, display at the 95 per cent 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 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 amounts²⁷ ranging between US\$ million 2.188 [= exponential (14.59853)] and US\$ million 43.33 [= exponential (17.58445)]. It is negative and significant for total AfT amounts lower than US\$ million 2.188, and positive and significant for total AfT higher than US\$ million 43.334. Thus, countries that receive amounts of total AfT flows higher than US\$ million 43.334 experience a positive effect of their membership duration on trademark applications, and the greater the AfT flows, the higher is the magnitude of this positive effect.

²⁷ In the sub-sample of AfT countries, values of total AfT flows range between US\$ 21987 and US\$ million 3,820 (see Appendix 2).

The marginal effect of the duration of WTO membership on trademark applications is positive and significant for amounts of AfT²⁸ for economic infrastructure higher than US\$ 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 AfT²⁹ for productive capacities lower than US\$ 243394.8 [= exponential (12.40244)], otherwise, it is positive and significant for values of AfT flows for productive capacities higher than US\$ million 14,82 (= (exponential (16.51145))), and statistically nil for values of AfT flows for productive capacities comprising between than US\$ 243394.8 and US\$ million 14,82. Finally, the higher the amounts of AfT³⁰ flows for trade policy and regulation, the greater is 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 US\$ 54636.64 [= exponential (10.90846)]. Otherwise (for amounts of AfT for trade policy and regulation lower than US\$ 54636.64), 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 analyses³¹ 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 on 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 equally trademarks and patents so as to protect their innovative products. The amounts of the AfT above which the marginal effect of the duration of WTO membership on the ratio of trademark counts to patent counts are US\$ million 669,2 [=

²⁸ In the sub-sample of AfT countries, values of AfT flows for economic infrastructure range between US\$ 16819 and US\$ million 3,300 (see Appendix 2).

²⁹ In the sub-sample of AfT countries, values of AfT flows for building productive capacities range between US\$ 5168 and US\$ million 1,950 (see Appendix 2).

³⁰ In the sub-sample of AfT countries, values of AfT flows for trade policy and regulation range between US\$ 25 and US\$ million 282 (see Appendix 2).

³¹ These graphs have not been presented here to save space, and could be obtained upon request.

exponential (20.32154)] for total AfT flows, US\$ million 462,4 [= exponential (19.95203)] for AfT flows related to economic infrastructure, US\$ million 474,9 [= exponential (19.97864)] for AfT flows for productive capacities, and US\$ million 61,183 [(= exponential (17.92938))] for AfT flows for trade policy and regulation.

Overall, 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 (relatively 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 8 non-overlapping sub-periods of 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 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 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 2 so as to avoid the proliferation of instruments. Note that in all these 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 to 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 a one more year of WTO membership is associated with an increase in the number of trademark 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*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 is 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 is 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 relatively 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 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(AfT/TOT)"] in column [5] of Table 6. The graphical analysis³² 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 rise. For amounts of total AfT higher lower than US\$ million 6,057 [= 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 US\$ million 6,057, 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 US\$ 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. It ensues that a better regulatory quality policy encourages the submission of a higher number of patents relatively to trademarks.

6. Conclusion

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 trademark submitted by countries' residents. Such an effect is expected to take place primarily through the channel of trade costs. The analysis has revealed that the effect of the duration of WTO membership on trademark 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 relatively 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

³² This graph has not been presented here to save space, and could be obtained upon request.

higher AfT flows lead yet 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 not only such a membership, but more importantly its duration contributes significantly to explaining the development of trademark applications, including relatively to patent applications. The study has also revealed that AfT flows play an essential role in promoting the trademark applications in developing countries, and particularly in encouraging innovation by also spurring patent filings.

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TABLES and APPENDICES

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 | RATIO |
|--|--------------------------|--------------------------|-------------------------|--------------------------|
| | (1) | (2) | (3) | (4) |
| DURWTO _{t-1} | 0.160*** (0.0372) | | 0.128*** (0.0383) | 0.501*** (0.0600) |
| WTO _{t-1} | | 0.377*** (0.0500) | | |
| Log(TRCOST) _{t-1} | | | 0.156** (0.0792) | 0.332** (0.139) |
| Log(GDPC) _{t-1} | 0.330*** (0.0319) | 0.324*** (0.0314) | 0.360*** (0.0330) | 0.218*** (0.0524) |
| FINDEV _{t-1} | 0.000195 (0.000356) | 0.000123 (0.000353) | 0.000527 (0.000353) | -0.00177** (0.000871) |
| REGQUAL _{t-1} | 0.0367 (0.0321) | 0.0381 (0.0318) | 0.00486 (0.0322) | 0.117* (0.0661) |
| FDI _{t-1} | 0.00102*** (0.000378) | 0.00104*** (0.000378) | 0.00115** (0.000458) | 0.00140 (0.000883) |
| Log(POP) | 0.257*** (0.0192) | 0.260*** (0.0190) | 0.262*** (0.0218) | 0.364*** (0.0345) |
| HUM _{t-1} | 0.287*** (0.0513) | 0.308*** (0.0518) | 0.251*** (0.0520) | 0.698*** (0.0854) |
| Constant | -5.920*** (0.439) | -6.127*** (0.434) | -6.854*** (0.725) | -10.20*** (1.216) |
| Observations - Countries | 1,881 - 124 | 1,881 - 124 | 1,756 - 120 | 1,497 - 114 |
| Log likelihood | -14623.738 | -14603.186 | -13642.518 | -5009.3658 |
| Wald Chi2 (P-value) | 2221.29 (0.0000) | 2257.58 (0.0000) | 1879.24 (0.0000) | 379.96 (0.0000) |
| Overdispersion test (LR test of alpha = 0): Chi2 statistic (P-value) | 1.5e+07 (0.0000) | 1.4e+07 (0.0000) | 1.4e+07 (0.0000) | 1.9e+05 (0.0000) |

Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust Standard Errors are in parenthesis. Time dummies have been included in the regressions.

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}]*[Log(GDPC) _{t-1}] | -0.151*** | -0.0286 | | | | |
| | (0.00917) | (0.0199) | | | | |
| [DURWTO _{t-1}]*HIC | | | -0.447*** | | | |
| | | | (0.0275) | | | |
| [DURWTO _{t-1}]*LDC | | | | 0.424*** | | |
| | | | | (0.0494) | | |
| [DURWTO _{t-1}]*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*** | 9.68e-05 |
| | (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 | 1,881 - 124 | 1,598 - 118 | 1,881 - 124 | 1,881 - 124 | 1,881 - 124 | 1,598 - 118 |
| Log likelihood | -14495.818 | -5457.0621 | -14490.621 | -14583.972 | -14613.998 | -5433.7496 |
| Wald Chi2 (P-value) | 2193.45 (0.0000) | 385.99 (0.0000) | 2386.35 (0.0000) | 2289.76 (0.0000) | 2173.95 (0.0000) | 427.01 (0.0000) |
| Overdispersion test (LR test of alpha = 0): Chi2 statistic (P-value) | 1.5e+07 (0.0000) | 2.1e+05 (0.0000) | 1.4e+07 (0.0000) | 1.4e+07 (0.0000) | 1.5e+07 (0.0000) | 2.1e+05 (0.0000) |

Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust Standard Errors are in parenthesis. Time dummies have been included in the regressions.

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}]*[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 | 1,701 - 116 | 1,485 - 112 |
| Log likelihood | -13348.57 | -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) | 1.4e+07 (0.0000) | 1.7e+05 (0.0000) |

Note: **p*-value<0.1; ***p*-value<0.05; ****p*-value<0.01. Robust Standard Errors are in parenthesis. 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 |
|---|---------------------|---------------------|---------------------|---------------------|
| | (1) | (2) | (3) | (4) |
| TFA | 0.522*** | 0.651*** | | |
| | (0.0556) | (0.109) | | |
| DURWTO _{t-1} | | 0.135*** | -1.848*** | -2.297*** |
| | | (0.0349) | (0.373) | (0.810) |
| [DURWTO _{t-1}]*TFA | | -0.133*** | | |
| | | (0.0212) | | |
| [DURWTO _{t-1}]*[Log(TRCOST) _{t-1}] | | | 0.341*** | 0.477*** |
| | | | (0.0643) | (0.138) |
| [Log(TRCOST) _{t-1}] | | | -0.797*** | -1.008** |
| | | | (0.196) | (0.408) |
| Log(GDPC) _{t-1} | 0.353*** | 0.341*** | 0.328*** | 0.204*** |
| | (0.0316) | (0.0317) | (0.0339) | (0.0526) |
| FINDEV _{t-1} | 0.000283 | 0.000197 | 0.000577 | -0.00157* |
| | (0.000355) | (0.000355) | (0.000358) | (0.000867) |
| REGQUAL _{t-1} | 0.0461 | 0.0278 | 0.00539 | 0.130* |
| | (0.0325) | (0.0321) | (0.0322) | (0.0662) |
| FDI _{t-1} | 0.000993*** | 0.00104*** | 0.00102** | 0.00131 |
| | (0.000377) | (0.000378) | (0.000459) | (0.000880) |
| Log(POP) | 0.242*** | 0.262*** | 0.236*** | 0.349*** |
| | (0.0189) | (0.0190) | (0.0222) | (0.0347) |
| HUM _{t-1} | 0.270*** | 0.266*** | 0.196*** | 0.640*** |
| | (0.0509) | (0.0519) | (0.0534) | (0.0876) |
| Constant | -5.724*** | -6.013*** | -0.716 | -2.125 |
| | (0.437) | (0.434) | (1.373) | (2.609) |
| Observations - Countries | 1,881 - 124 | 1,881 - 124 | 1,756 - 120 | 1,497 - 114 |
| Log likelihood | -14634.191 | -14607.145 | -13628.332 | -5003.4234 |
| Wald Chi2 (P-value) | 2190.84 (0.0000) | 2251.57 (0.0000) | 1793.59 (0.0000) | 385.48 (0.0000) |
| Overdispersion test (LR test of alpha = 0): Chi2 statistic (P-value) | 1.5e+07 (0.0000) | 1.5e+07 (0.0000) | 1.3e+07 (0.0000) | 1.9e+05 (0.0000) |

Note: **p*-value<0.1; ***p*-value<0.05; ****p*-value<0.01. Robust Standard Errors are in parenthesis. 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*** (0.0428) | -1.005*** (0.185) | -0.432*** (0.115) | -0.600*** (0.170) | -0.0668 (0.107) | 2.227*** (0.439) | 1.806*** (0.302) | 1.649*** (0.465) | 0.777*** (0.242) |
| [DURWTO _{t-1}]*[Log(AfTTOT) _{t-1}] | | 0.0618*** (0.0101) | | | | -0.102*** (0.0236) | | | |
| [DURWTO _{t-1}]*[Log(AfTINFRA) _{t-1}] | | | 0.0324*** (0.00645) | | | | -0.0833*** (0.0168) | | |
| [DURWTO _{t-1}]*[Log(AfTPROD) _{t-1}] | | | | 0.0421*** (0.00960) | | | | -0.0735*** (0.0260) | |
| [DURWTO _{t-1}]*[Log(AfTPOL) _{t-1}] | | | | | 0.0148** (0.00698) | | | | -0.0328** (0.0164) |
| Log(AfTTOT) _{t-1} | | -0.161*** (0.0288) | | | | 0.210*** (0.0690) | | | |
| Log(AfTINFRA) _{t-1} | | | -0.0892*** (0.0171) | | | | 0.192*** (0.0466) | | |
| Log(AfTPROD) _{t-1} | | | | -0.0807*** (0.0278) | | | | 0.120 (0.0761) | |
| Log(AfTPOL) _{t-1} | | | | | -0.0165 (0.0193) | | | | 0.0564 (0.0449) |
| Log(GDPC) _{t-1} | 0.134*** (0.0488) | 0.111** (0.0515) | 0.119** (0.0508) | 0.138*** (0.0513) | 0.189*** (0.0508) | 0.161** (0.0730) | 0.154** (0.0731) | 0.173** (0.0719) | 0.119 (0.0731) |
| FINDEV _{t-1} | 0.000980 (0.000864) | 0.000541 (0.000873) | 0.000640 (0.000871) | 0.000727 (0.000878) | 0.001000 (0.000876) | -0.000845 (0.00149) | -0.00105 (0.00149) | -0.000849 (0.00148) | -0.00189 (0.00153) |
| REGQUAL _{t-1} | 0.119** (0.0490) | 0.178*** (0.0503) | 0.174*** (0.0504) | 0.150*** (0.0504) | 0.0863 (0.0531) | 0.118 (0.0822) | 0.106 (0.0828) | 0.129 (0.0851) | 0.244*** (0.0930) |
| FDI _{t-1} | 0.00660** (0.00336) | 0.00578* (0.00331) | 0.00540 (0.00332) | 0.00582* (0.00333) | 0.00683** (0.00338) | -0.0134** (0.00678) | -0.0137** (0.00676) | -0.0138** (0.00669) | -0.0145** (0.00659) |
| Log(POP) | 0.282*** (0.0282) | 0.299*** (0.0288) | 0.297*** (0.0285) | 0.281*** (0.0287) | 0.261*** (0.0301) | 0.540*** (0.0511) | 0.511*** (0.0497) | 0.534*** (0.0511) | 0.518*** (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 (0.0000) | 1216.24 (0.0000) | 1167.26 (0.0000) | 1171.54 (0.0000) | 1073.44 (0.0000) | 266.43 (0.0000) | 265.84 (0.0000) | 252.49 (0.0000) | 238.33 (0.0000) |
| Overdispersion test (LR test of alpha = 0): Chi2 statistic (P-value) | 3.7e+06 (0.0000) | 3.7e+06 (0.0000) | 3.7e+06 (0.0000) | 3.6e+06 (0.0000) | 3.5e+06 (0.0000) | 1.4e+05 (0.0000) | 1.3e+05 (0.0000) | 1.4e+05 (0.0000) | 1.3e+05 (0.0000) |

*Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust Standard Errors are in parenthesis. Time dummies have been included in the regressions. The regressions cover the period of 2002-2019, as AfT disbursements data is only available from 2002.*

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*** |
| | | | | | (0.0125) |
| 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(TRCOSTS) | | | -1.235*** | | |
| | | | (0.0716) | | |
| DURWTO*Log(TRCOSTS) | | | 0.345*** | | |
| | | | (0.0270) | | |
| DURWTO*Log(AfT*TOT) | | | | 0.0168** | -0.110*** |
| | | | | (0.00673) | (0.0166) |
| Log(AfT*TOT) | | | | -0.0509*** | 0.218*** |
| | | | | (0.0140) | (0.0493) |
| FINDEV | -0.000140 | -1.99e-05 | 7.69e-05 | 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) |
| 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 parenthesis. The variables "DURWTO", "TRCOST", "AfT*TOT", "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.

Appendix 1: 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 | <p>This is the transformed indicator of a country's duration of WTO membership. Let us denote "DURWTO1" 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" 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 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 is the duration of the membership in the WTO.</p> <p>As the variable "DURWTO1" contains many zeros, and has a skewed distribution, it has been transformed using the following formula (see Yeyati et al. 2007): $DURWTO = sign(DURWTO1) * \log(1 + DURWTO1)$, where $DURWTO1$ refers to the absolute value of the variable "DURWTO1".</p> | <p>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/orig6_e.htm)</p> |
| TRCOST | <p>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.</p> <p>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.,</p> | <p>Author's computation using the UNESCAP-World Bank Trade Cost Database. Accessible online at: https://www.unescap.org/resources/escap-world-bank-trade-cost-database</p> |

| | | |
|-----------------------------------|--|--|
| | <p>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, currencies as well as cumbersome import or export procedures. Higher values of the indicator of average overall trade costs indicate higher overall trade costs.</p> <p>Detailed information on the methodology used to compute the bilateral comprehensive trade costs could be found in Arvis (2011, 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</p> | |
| ECI | <p>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 applying the methodology in described in Hausman and Hidalgo (2009). Higher values of this index reflect greater economic complexity.</p> | <p>MIT's Observatory of Economic Complexity (https://oec.world/en/rankings/eci/hs6/hs96)</p> |
| AfTTOT, AfTINFRA, AfTPROD, AfTPOL | <p>"AfTTOT" is the total real gross disbursements of total Aid for Trade.</p> <p>"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.</p> <p>"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.</p> | <p>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): <u>Aid for Trade for Economic Infrastructure ("AfTINFRA")</u>, which includes transport and storage (210), communications (220), and energy generation and supply (230); <u>Aid for Trade for Building Productive Capacity ("AfTPROD")</u>, 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</p> |

| | | |
|--------|--|--|
| | | <u>Aid for Trade policy and regulations ("AFTPOL")</u> , which includes trade policy and regulations and trade-related adjustment (331). |
| GDPC | Real per capita Gross Domestic Product (constant 2015 US\$). | 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 non-tariff 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 (see Miller et al., 2021) |
| 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 |
| 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 is extracted from World Bank Governance Indicators developed by Kaufmann et al. (2010) and updated recently. See online at: https://info.worldbank.org/governance/wgi/ |

Appendix 2: Descriptive statistics on variables used in the analysis over the annual period 1996-2019

| Variable | Observations | Mean | Standard deviation | Minimum | Maximum |
|----------|--------------|-------------|--------------------|---------|---------------|
| TRMARK | 1,881 | 24530.950 | 94749.040 | 1.000 | 1997058.000 |
| RATIO | 1,599 | 91.759 | 261.848 | 0.250 | 4857.000 |
| DURWTO | 1,881 | 13.480 | 7.318 | 0.000 | 25.000 |
| TRCOST | 1,733 | 286.393 | 66.351 | 82.978 | 505.828 |
| ECI | 1,703 | 0.283 | 0.955 | -2.196 | 2.482 |
| AfTTOT | 987 | 293,000,000 | 479,000,000 | 21987 | 3,820,000,000 |
| AfTINFRA | 985 | 178,000,000 | 336,000,000 | 16819 | 3,300,000,000 |
| AfTPROD | 987 | 111,000,000 | 185,000,000 | 5168 | 1,950,000,000 |
| AfTPOL | 960 | 4994045 | 17,500,000 | 25 | 282,000,000 |
| GDPC | 1,880 | 16327.190 | 19394.120 | 191.572 | 92123.710 |
| FINDEV | 1,869 | 62.075 | 49.300 | 1.616 | 304.575 |
| REGQUAL | 1,654 | 0.326 | 0.919 | -2.244 | 2.261 |
| FDI | 1,880 | 5.644 | 18.514 | -40.330 | 449.083 |
| HUM | 1,881 | 2.681 | 0.652 | 1.065 | 4.352 |
| POP | 1,881 | 56,700,000 | 173,000,000 | 255068 | 1,370,000,000 |

Appendix 3a: List of the 124 countries used in the analysis along with the duration of their WTO membership as at 2019 (end-year of the period under analysis)

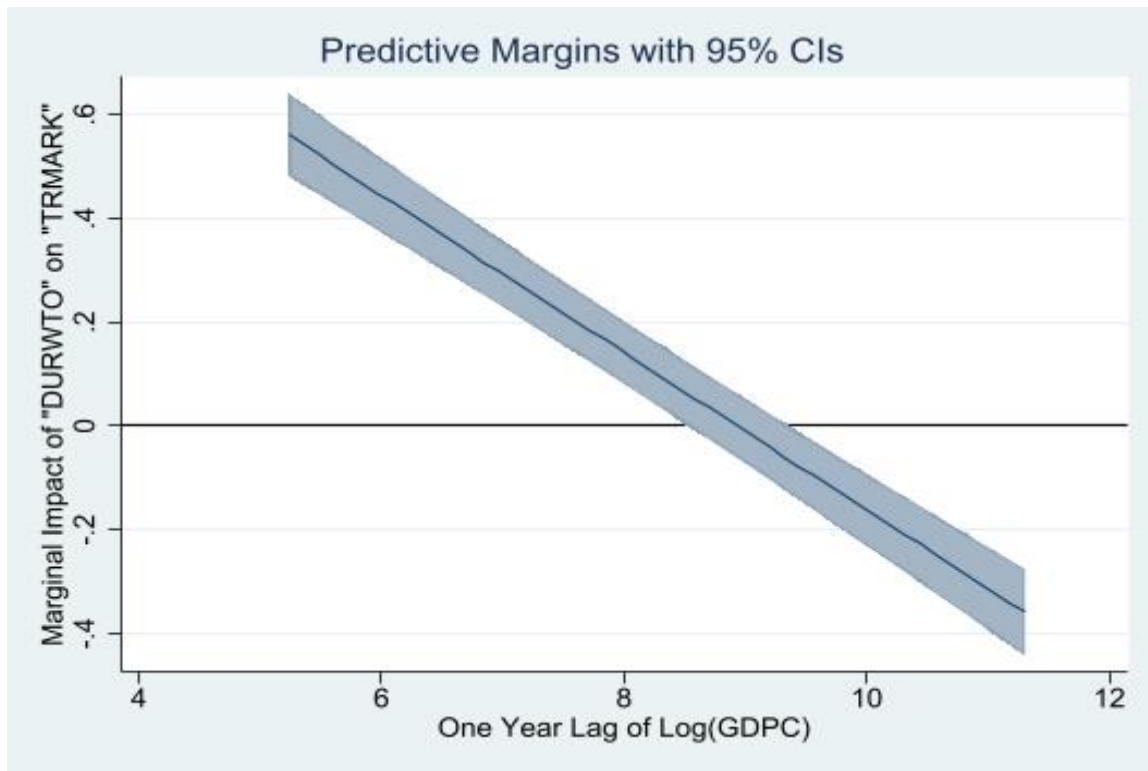
| Country | Duration of Membership in 2019 | Country | Duration of Membership in 2019 | Country | Duration of Membership in 2019 | Country | Duration of Membership in 2019 |
|----------------------|--------------------------------|----------------------|--------------------------------|------------------|--------------------------------|----------------------|--------------------------------|
| 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 |
| 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 "**".*

Appendix 3b: List of countries used in the sub-samples of HICs, LLDCs and LDCs

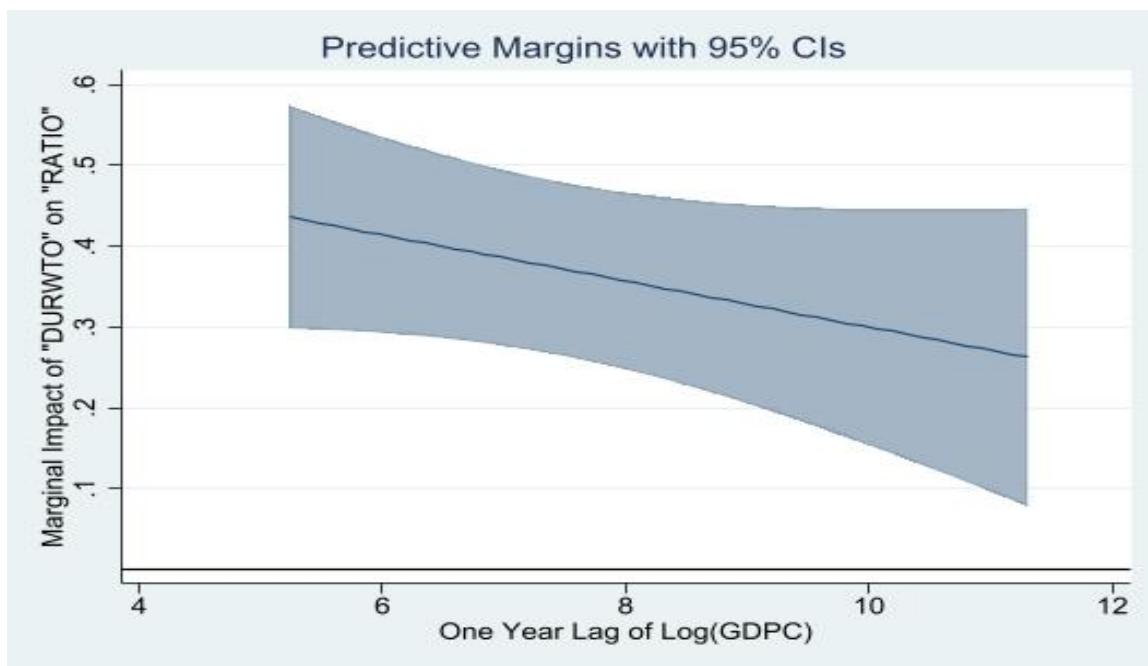
| HICs | | LLDCs | LDCs |
|----------------------|----------------------|-----------------|--------------|
| Australia | Kuwait | Armenia | Angola |
| Austria | Latvia | Bolivia | Bangladesh |
| Bahrain | Lithuania | Botswana | Burkina Faso |
| Barbados | Macao SAR, China | Burkina Faso | Cambodia |
| 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 | | |

Figure 1: Marginal Impact of "DURWTO" on "TRMARK" for varying levels of the real per capita income



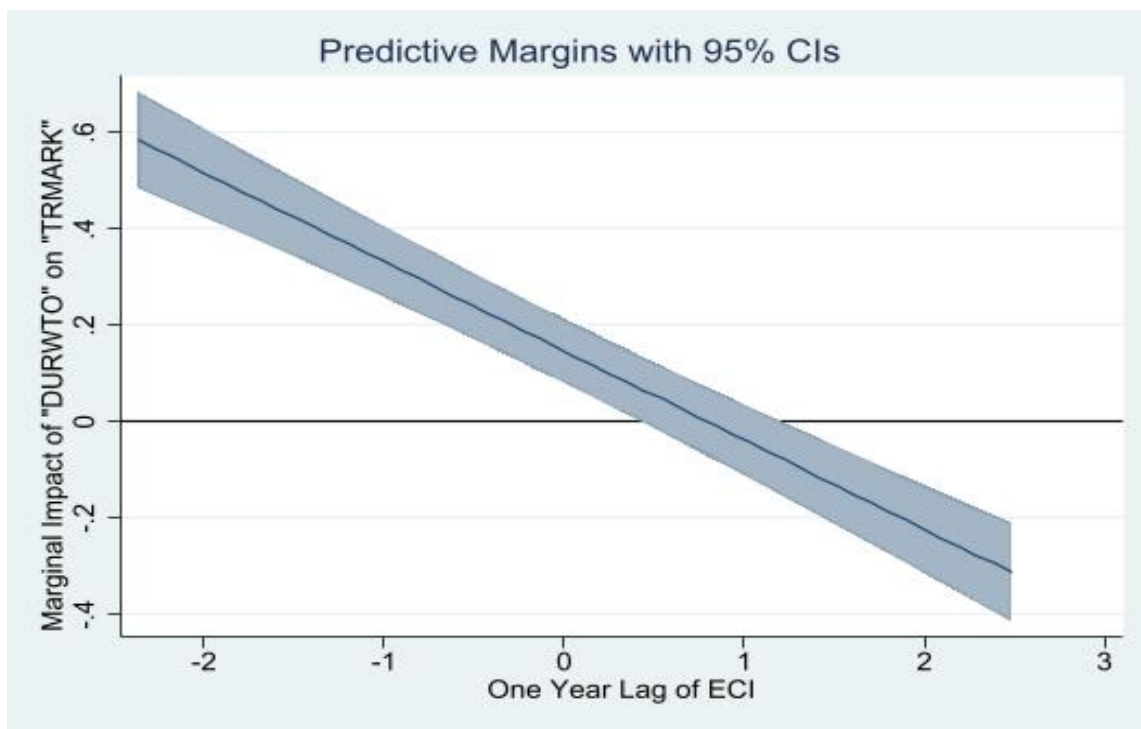
Source: Author

Figure 2: Marginal Impact of "DURWTO" on "RATIO" for varying levels of the real per capita income



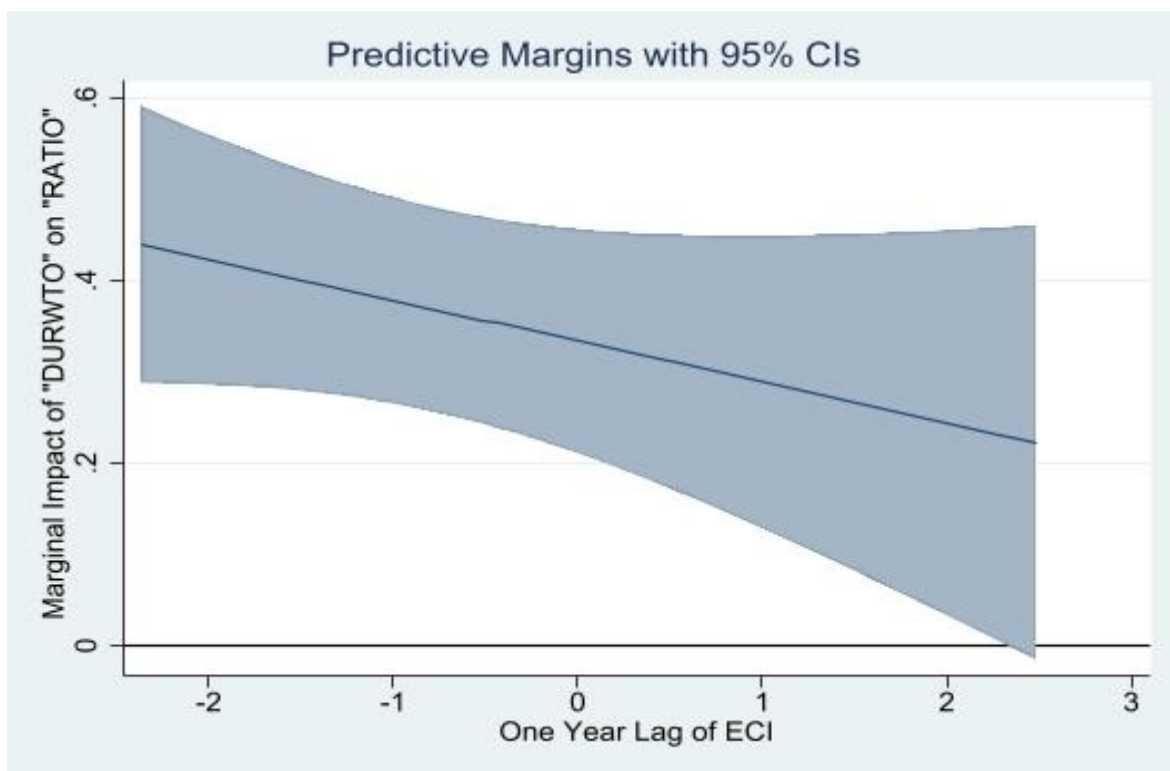
Source: Author

Figure 3: Marginal Impact of "DURWTO" on "TRMARK" for varying levels of economic complexity



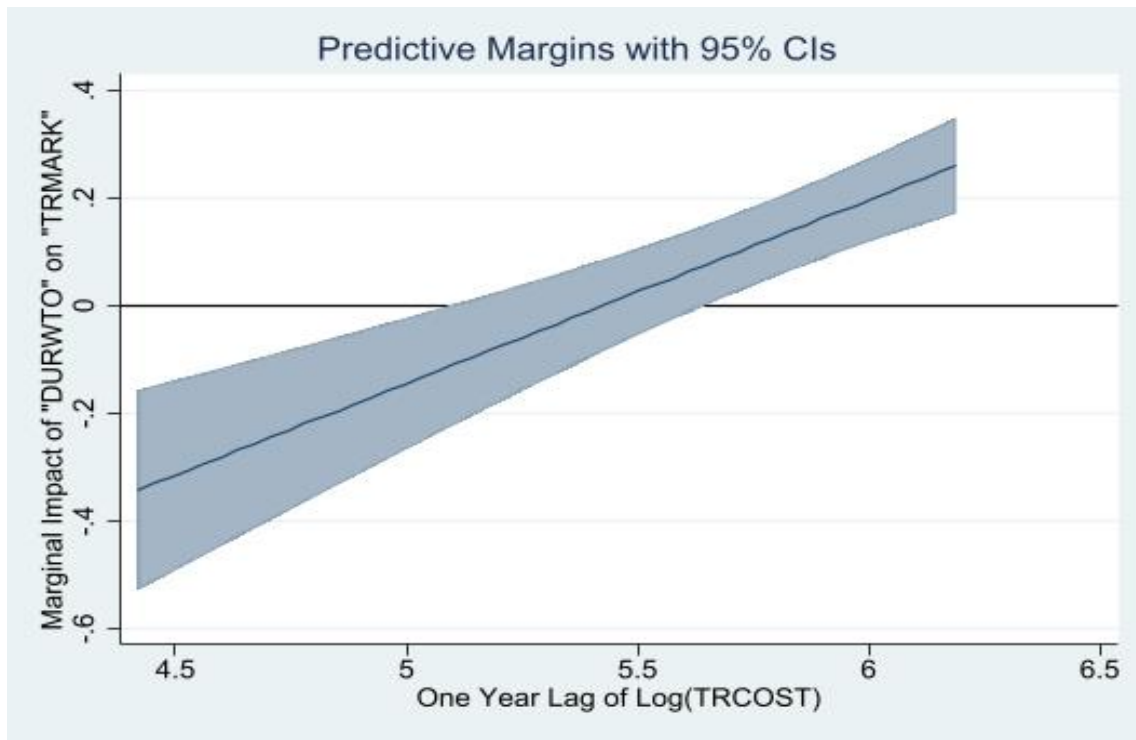
Source: Author

Figure 4: Marginal Impact of "DURWTO" on "RATIO" for varying levels of economic complexity



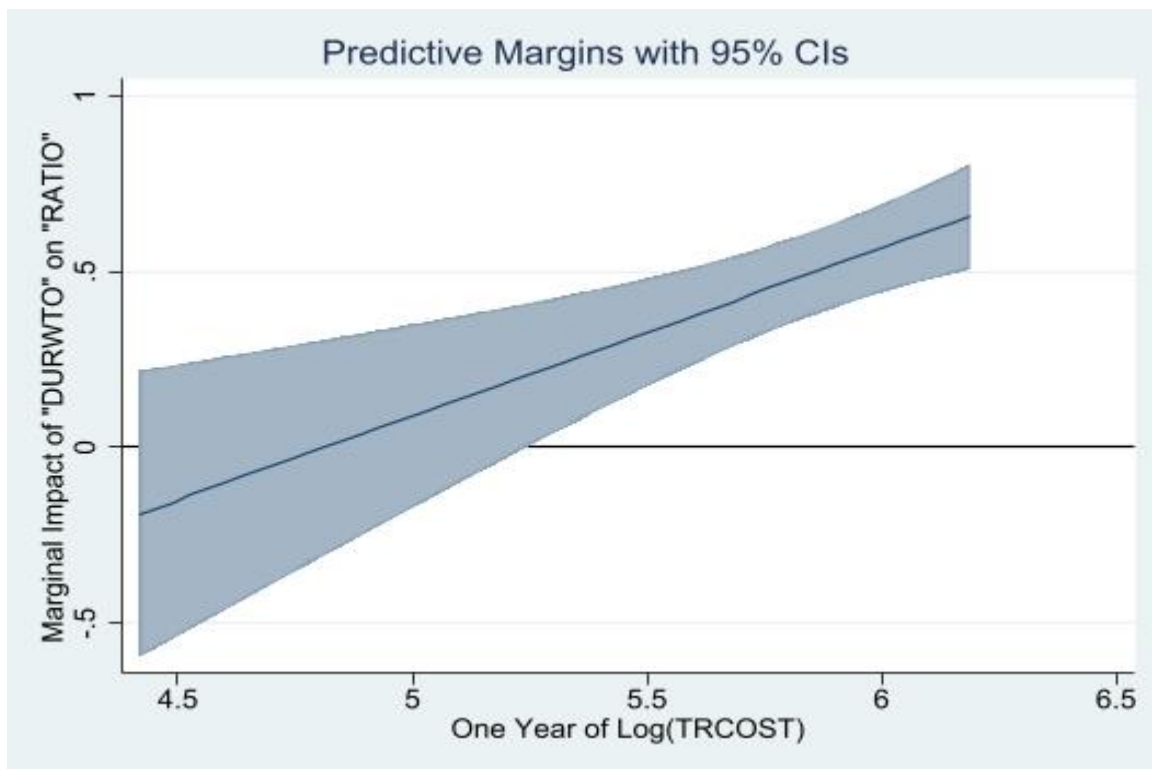
Source: Author

Figure 5: Marginal Impact of "DURWTO" on "TRMARK" for varying levels of the overall trade costs



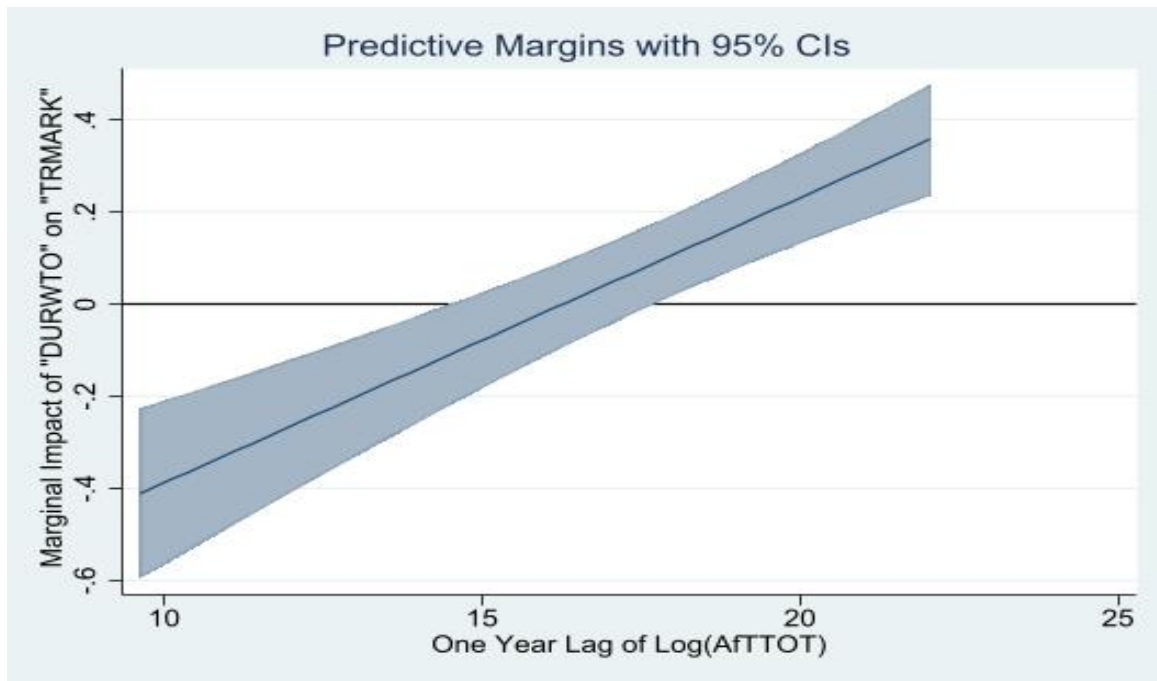
Source: Author

Figure 6: Marginal Impact of "DURWTO" on "RATIO" for varying levels of the overall trade costs



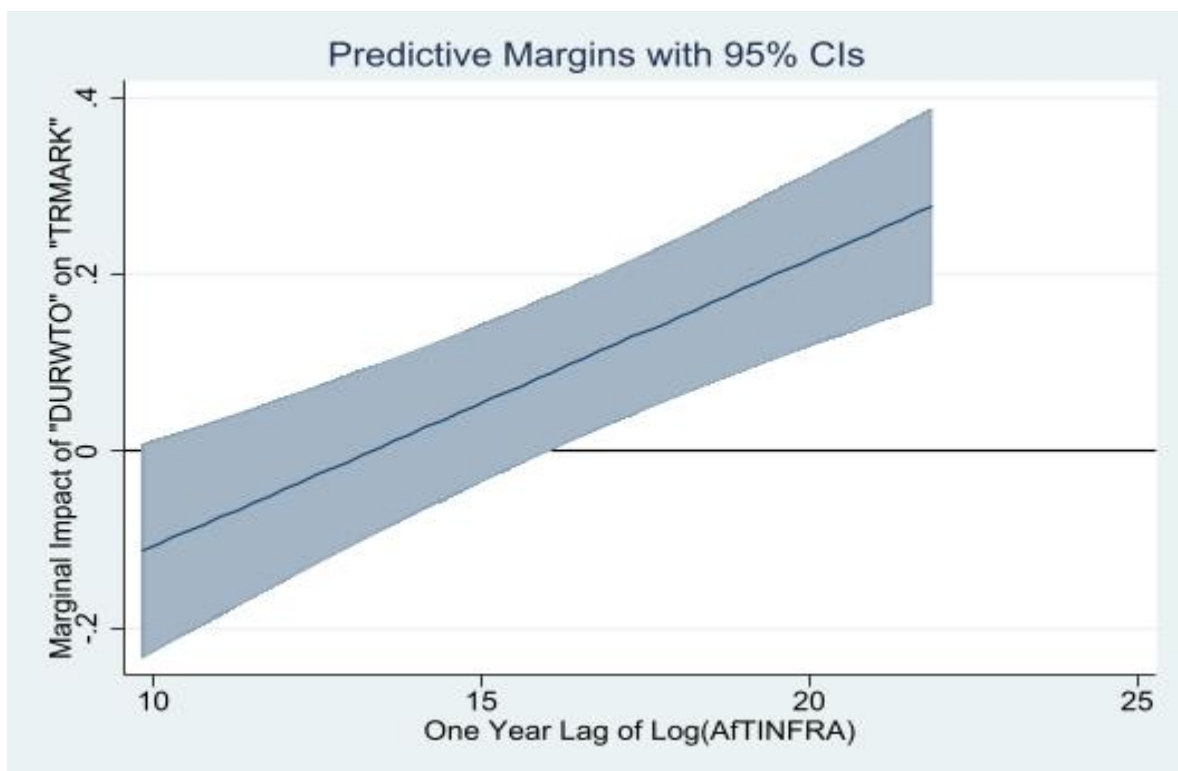
Source: Author

Figure 7: Marginal Impact of "DURWTO" on "TRMARK" for varying amounts of total Aft



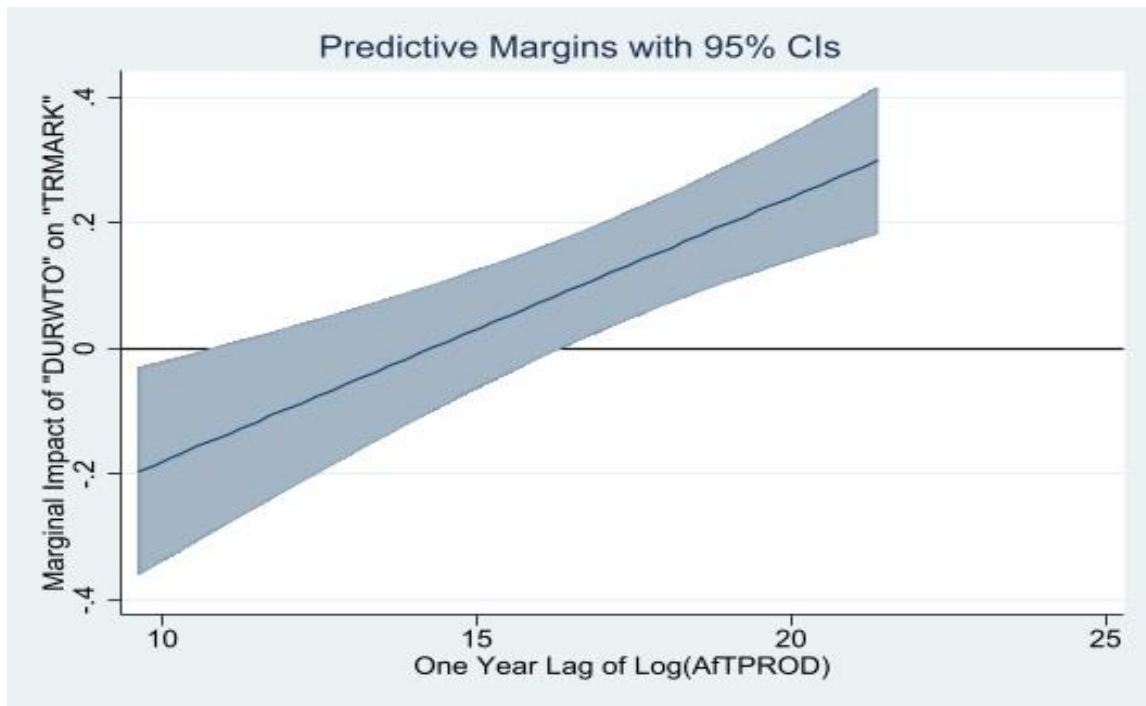
Source: Author

Figure 8: Marginal Impact of "DURWTO" on "TRMARK" for varying amounts of Aft for economic infrastructure



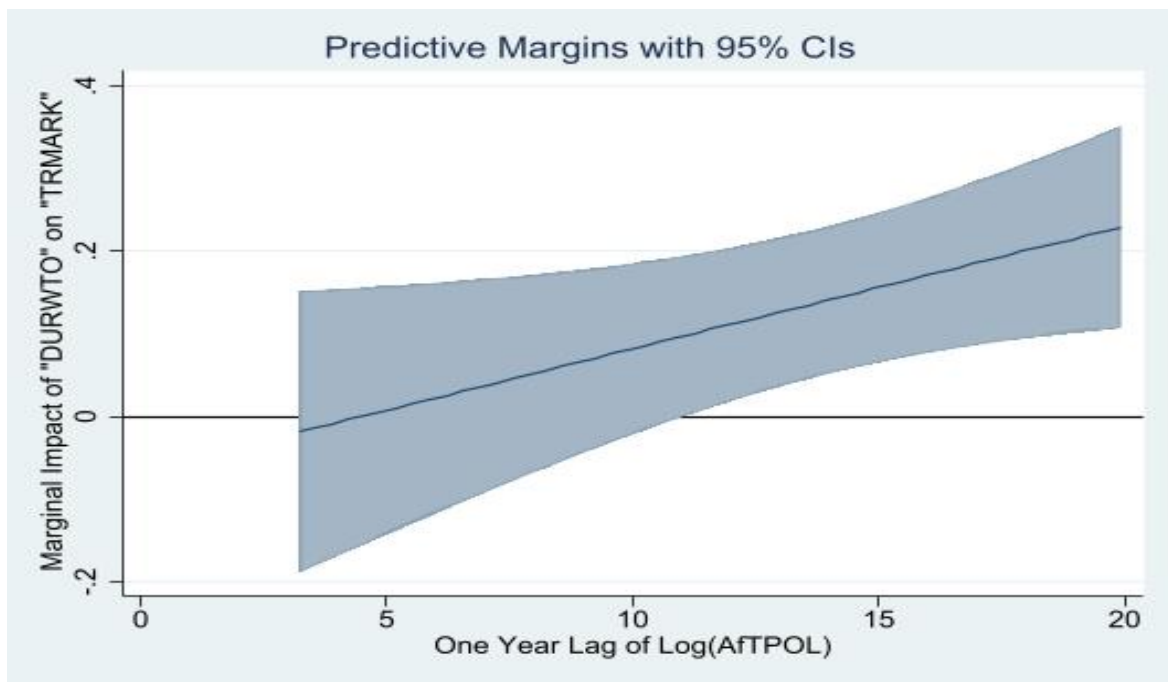
Source: Author

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