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The Impact of Regulatory Divergence in Non-Tariff Measures on the Cross-Border Investment of Multinationals[*]

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Abstract*:* *In this paper, we study the effects of international regulatory convergence in non-tariff measures on the cross-border investment of multinational firms. We verify two main research hypotheses derived from the modified knowledge-capital model of the multinational enterprise. The first hypothesis postulates that when regulatory divergence with numerous regulatory measures in the destination emerges, trade cost also increases – stimulating horizontal multinational activity. The second hypothesis states that regulatory convergence could reduce the trade costs between the two trading partners, facilitating vertical multinational activity. To verify these hypotheses, we use firm-level data from the Orbis database for 2004–2020 and the Poisson pseudo-maximum likelihood (PPML) estimation technique. Our estimation results for the full sample of firms show that greater regulatory divergence is negatively associated with the extent of multinational activity. In addition, the convergence of technical barriers to trade seems more important than the convergence of sanitary and phytosanitary measures. Moreover, more productive firms can overcome problems associated with both technical barriers to trade and sanitary and phytosanitary distances. Finally, we find significant heterogeneity across sectors that varies according to technology intensity.*

Keywords: foreign direct investment, knowledge-capital model of multinational firms, non-tariff measures, regulatory divergence, technical barriers to trade, sanitary and phytosanitary measures

JEL Classifications: C-21, C-23, F-13, F-14, F-21, F-23

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1. Introduction

Cross-border investment by multinational enterprises (MNEs) has become a strategy to gain benefits from the geographical dispersion of production and supply. Through foreign direct investment (FDI), MNEs have managed for a long time to reorganise their network of operations by sourcing their intermediate inputs and supplying their products crossing numerous borders. This has built the network of global value chains (GVCs) over the years, enabling MNEs to make larger profits by lowering their costs and increasing their revenues. Furthermore, this phenomenon has allowed MNEs to evolve to have an expansive network of ownership, experienced managerial skills, agglomerated knowledge and know-how, access to financial resources in numerous countries, and the ability to develop novel technologies. However, with the recent coronavirus disease (COVID-19) pandemic and border closures, the demand and supply routes of MNEs and GVCs have been significantly disrupted. In addition, intensified geopolitical tensions between China and the United States as well as the Russian invasion of Ukraine, which have interrupted both trade and investment linkages, exacerbated this disturbance. Supply shortages in high-tech intermediate inputs of production (e.g. semiconductors) or primary commodities (e.g. grains and livestock feed), which are used in many other industries, have caused supply bottlenecks – pressurising prices and inflation across the globe. Meanwhile, regulatory non-tariff measures (NTMs) such as technical barriers to trade (TBTs) and sanitary and phytosanitary (SPS) measures have targeted traded goods. During 2020–2021, 18 members of the World Trade Organization (WTO) notified 46 TBTs, citing COVID-19 in their measure description while citing protection of human health or safety as objectives in the majority of their keywords. During the same period, 18 members imposed 51 SPS measures, citing COVID-19 in all their measure descriptions while citing animal diseases, plant health, or food safety in most of their keywords as major objectives. This suggests the important role of these trade policy measures in regulating trade during great shocks such as the global pandemic. This paper studies the impact of regulatory divergence in NTMs on FDI at the firm level during 2004–2020.

While the impact of regulatory NTMs on trade has been widely studied in the literature, only a few papers (Ghodsi, 2020; Adarov and Ghodsi, 2022; Ghodsi and Jovanovic, 2022) have been devoted to studying their effects on FDI. For instance, several papers have studied their impact on trade values (Disdier, Gaigné, and Herghelegiu, 2018; Bao and Qiu, 2010, 2012; Winchester et al., 2012, Blyde, 2022); trade volumes (Kee, Nicita, and Olarreaga, 2009; Beghin, Disdier, and Marette, 2015; Ghodsi et al., 2017; Bratt, 2017; and Niu et al., 2018); trade prices (Cadot and Gourdon, 2016); and quality (Disdier, Gaigné, and Herghelegiu, 2018; Fałkowski, Curzi, and Olper, 2019; Curzi et al., 2020; Ghodsi and Stehrer, 2022; Ghodsi, 2023; Fiankor, Curzi, and Olper, 2021; Yue, 2022). Furthermore, only a few papers in the literature have studied the impact of regulatory convergence on trade (Piermartini and Budetta, 2009; Cadot et al., 2015; Cadot and Ing, 2015, Knebel and Peters, 2019; Nabeshima and Obashi, 2021; Inui et al., 2021). The main motivation behind these studies is that convergence in the use of NTMs classified in the same administrative or procedural categories defined by the United Nations Conference on Trade and Development (UNCTAD) Multi-Agency Support Team (MAST) nomenclature could be a good proxy for the harmonisation of standards. However, the objectives of regulatory NTMs that are cited in the NTMs notified to the WTO could provide better insights for policymakers targeting specific goals by imposing TBTs and SPS measures. The keywords mentioned in the TBTs and SPS measures notified to the WTO will be used to show the objectives of these regulatory measures. Therefore, regulatory divergence in the objectives of NTMs will be calculated as the main variable affecting FDI in this study, while divergence in NTMs based on their administrative or procedural classification provided by MAST will be used as a robustness check.[4]

Harmonisation of standards and mutual recognition could significantly reduce trade costs related to compliance, which could stimulate trade. The most important example of this phenomenon is the single market of the European Union (EU), in which trade in goods flows with the least friction due to the harmonisation of standards and regulations imposed at the EU level, and mutual recognition of regulations imposed independently by individual member states. Nevertheless, the literature lacks a study of the impact of regulatory divergence on cross-border investments.

Therefore, we tackle this issue by providing an answer to the following research question: how does regulatory divergence within TBTs and SPS measures affect cross-border investment across the globe? The regulatory divergence is measured according to the objectives of regulatory NTMs, which are cited as keywords of NTMs notified to the WTO. Regulatory divergence is also calculated across the three-digit administrative and procedural classes of TBTs and SPS measures classified by MAST, following the literature. Furthermore, the operating revenues (turnover) and total assets of foreign-owned

[4] The objectives of regulatory NTMs might differ from their administrative classification in MAST.

subsidiaries that are ultimately owned by foreign MNEs are the dependent variables, which are measures of the multinational activity of MNEs.

The conceptual framework used in the study is in line with the modified knowledge-capital (KC) model proposed by Markusen (2002, 2013) and developed by Bergstrand and Egger (2007, 2013), Ramondo and Rodríguez-Clare (2013), and Tintelnot (2017). The KC model explains how trade costs could affect the likelihood of MNEs investing in a country. Based on these models, the following hypotheses will be tested in the analysis.

One major hypothesis follows the 'tariff-jumping' motivation behind FDI (Blonigen, Tomlin, and Wilson, 2004) or horizontal FDI (Markusen, 1984) under which MNEs intend to obtain access to a foreign market via FDI to circumvent the large cost of exporting. Therefore, regulatory convergence or similarity between trading partners may reduce trade costs and could stimulate trade. However, when regulatory divergence with numerous regulatory measures in the destination emerges, the trade cost also increases – stimulating horizontal FDI. This suggests that firms invest abroad to supply the foreign market when trade costs increase.

The second hypothesis follows the 'resource seeking' motivation behind FDI (Dunning, 1993, 1998) or 'export-platform' FDI (Ekholm, Forslid, and Markusen, 2007) in which MNEs intend to have access to more efficient means of production to export their finished goods to another country or the home country. Therefore, regulatory convergence or similarity between trading partners may stimulate such FDI, and regulatory divergence may reduce FDI. This is because regulatory convergence could reduce trade costs between the two trading partners, facilitating vertical fragmentation of production, which motivates the MNE to move parts of its production chain abroad. Therefore, this study helps us understand the role of regulatory divergence in shaping investments at the firm level across GVCs. Furthermore, regulatory divergence and compliance with new regulatory measures may also increase the fixed costs of technological change or/and bureaucratic procedures (Ghodsi, 2023). This will further hamper FDI activities in countries with more stringent regulations.

This study first provides a descriptive analysis of both regulatory NTMs and FDI during 2004–2020, which illustrates how these two important issues have evolved over the years. Second, unlike earlier studies on regulatory convergence (Piermartini and Budetta, 2009; Cadot et al., 2015; Cadot and Ing, 2015; Knebel and Peters, 2019; Nabeshima and Obashi, 2021; Inui et al., 2021), which construct a measure across all NTM classifications, this study shows divergence in the objectives of TBTs and SPS measures and their heterogeneous effects on FDI. Third, an econometric analysis studies how regulatory divergence in these NTMs affects the turnover and total assets of foreign-owned firms in the global economy. In fact, the results of the empirical study show how regulatory divergence in either of these two NTMs affects FDI and in which direction. Furthermore, the importance of firm heterogeneity is explored by controlling for the relevant variables on the size and productivity of firms to draw conclusions about the effectiveness of regulatory convergence across firm characteristics. The results can inform policymakers on how to target regulatory divergence and which of these two regulatory measures could achieve more FDI.

The results of the analysis provide guidance to policymakers that are seeking to attract more FDI. When the objectives of policies are to foster the presence of MNEs in a country, the empirical evidence suggests how to adjust trade policies in terms of regulatory NTMs. Recent literature (Adarov and Ghodsi, 2022; Ghodsi and Jovanovic, 2022) has shown that the trade costs associated with regulatory NTMs significantly affect the decision of MNEs to invest abroad. However, the impact of regulatory divergence on such decisions has not yet been studied in the literature. The current phase of globalisation indicates that firms and MNEs which are heavily involved in GVCs could benefit more from trade liberalisation, harmonisation of standards, and mutual recognition. Through regulatory similarity or convergence, policymakers could substantially reduce trade costs. This would hypothetically intensify interlinkages across GVCs, which could further stimulate FDI by foreign MNEs. The regulatory divergence during the COVID-19 pandemic might indicate a breaking pattern of GVC linkages, and less cross-border investment by MNEs.

The paper is organised as follows. In the next section we discuss our analytical framework, which is based on the modified KC model of MNEs. Then we describe the data set and provide stylised facts in section 3. The empirical methodology is discussed in section 4. In section 5, the estimation results are reported and interpreted. The paper ends with policy recommendations and directions for future research in section 6.

2. Theoretical Framework

While many theories have been proposed to explain the internationalisation of production, two distinct reasons why a firm should go multinational have been distinguished in the literature: market seeking and efficiency seeking. According to the 'market-seeking motivation', MNEs are vehicles to overcome distance and higher costs of foreign market access. FDI undertaken to serve local markets is often called horizontal FDI and refers to producing abroad roughly the same goods and services as in the parent country. According to the ‘efficiency-seeking motivation’, firms internationalise production and become multinationals to obtain inputs at a lower cost. FDI undertaken with the aim of reducing production costs is called vertical FDI, as it involves slicing production processes and locating different production blocs in countries where factors used intensively in these blocs are relatively cheap.

To explain FDI between similar countries, several models of horizontally integrated MNEs have been developed. Early examples of this approach include models developed by Krugman (1983) and Markusen (1984), which were later extended, *inter alia*, by Horstmann and Markusen (1987); Brainard (1993); Markusen and Venables (1998, 2000); Helpman, Melitz, and Yeaple (2004); Sinha (2010); Collie (2011); and Cieślik and Ryan (2012). Theoretical modelling of horizontally integrated MNEs involves a trade-off between the saving in variable costs of exporting, such as transport costs and tariffs, and the additional fixed costs of setting up a new plant in the host country. The theory predicts that given moderate to high trade costs, horizontally integrated MNEs prevail in equilibrium when countries are similar in size and relative factor endowments. With falling transportation and communication costs, an increasing part of MNE activity is explained by the efficiency-seeking motive. The first models of a vertically integrated MNE were developed by Helpman and Krugman (1985). These models were later extended by, *inter alia*, Zhang and Markusen (1999), Markusen and Venables (2000), and Markusen (2002).

Initially, models of horizontally and vertically integrated MNEs were regarded as two separate literature strands. The next step in the development of the MNE theory was focused on combining the horizontal and vertical approaches into an integrated framework. By integrating efficiency- and market-seeking reasons for FDI, Markusen (1996, 1997, and 2002) introduced the KC model to explain both vertical and horizontal FDI. The key economic insight of the KC model is that firms own knowledge-based assets that generate firm-level scale economies. These assets are created using skilled labour (human capital) and may include research and development activities, organisational structures, managerial skills, etc.

In the KC model, firms are allowed to build headquarters services separate from the production process. Built on a 2x2x2 framework, the model involves two goods with plant- and firm-level scale economies; and two countries with different relative endowments of skilled and unskilled labour, different country sizes, high and low transport costs, and an optional FDI ban. In this framework, firms can choose amongst national, horizontal, and vertical strategies.

The type of firm that emerges in equilibrium depends on the parameter values. When trade costs were high and FDI was prohibited, only national firms existed in both countries. National firms would still exist over most of the parameter space, even when trade was liberalised with FDI remaining prohibited. FDI liberalisation would first lead to the existence of horizontal MNEs, while both trade and FDI liberalisation allowed vertical MNEs to exist as long as factor endowments and factor prices were different. Hence, according to Markusen (2002), horizontal MNEs were more common than vertical MNEs, which only existed for a few host countries in certain industries. He concluded that similarities in market size, factor endowments, and transport costs were the key determinants of horizontal FDI, while differences in skilled labour endowments were the main drivers of vertical FDI.

In subsequent years, the KC model was extended in many directions. These extensions include, *inter alia*, studies by Bergstrand and Egger (2007, 2013); Markusen and Strand (2009); Markusen and Stähler (2011); and Chen, Horstmann, and Markusen (2012). However, the most important recent extension of the KC model is the incorporation of physical capital in addition to human capital. This allowed a direct comparison of the KC model with the earlier models of horizontally and vertically integrated MNEs in which relative factor endowments were measured only by international differences in physical capital to labour ratios.

The knowledge-and-physical-capital (KAPC) model proposed by Bergstrand and Egger (2007, 2013) is an extension of Markusen's 2x2x2 framework, which addressed two important issues. First, they were sceptical about Markusen's argument (1996) that MNEs completely displace trade in two countries with identical absolute and relative factor endowments and, other things being equal, the horizontal MNE's foreign affiliate sales completely displace national firms with identical productivity and trade between the two countries. The fact that both the EU and the United States have the largest intra-industry bilateral FDI flows, as well as intra-industry trade flows, suggests the coexistence of national exporters and horizontal MNEs. Second, regarding the empirical approach to FDI determinants, they claimed that even though the cross-country pattern of FDI is quite well explained by the gravity relationship, virtually no formal N-country (N>2) theoretical frameworks have been provided to take into account the existence of a third country in the gravity equation of aggregate bilateral FDI.

To address both issues, the KAPC model has the following properties. First, besides existing skilled and unskilled labour, the model has a third factor – physical capital, assuming that headquarters (plant) set-ups require human (physical) capital. Therefore, national exporting firms can co-exist with horizontal MNEs in pairs of countries with identical relative and absolute factor endowments. Even when two countries converge in size, with skilled labour being not the only factor used to set up both plants and firms, skilled labour is not completely displaced from plant set-ups to firm set-ups. Compared with the 2x2x2 model of Markusen and Venables (2000) where national exporting firms and horizontal MNEs could co-exist under a unique combination of trade costs, investment costs, and plant-to-firm set-up costs ratio, this three-factor framework, by adjusting the relative price of human to physical capital, allows for a wider range of combinations.

Second, a third country called the 'rest of the world' was introduced in the KAPC model to explain the complementary responses of bilateral trade, FDI, and foreign affiliate sales to changes in a pair of countries' characteristics in a typical gravity equation. In a two-country world, especially when the countries are of similar economic size, gross multilateral and bilateral trade (or FDI) are identical, so national exporting firms and horizontal MNEs would substitute one another, depending on trade and investment costs. The existence of a third country with physical capital mobility allows two countries' trade and FDI to co-vary positively with increases in economic similarity. Now, the complementary effect with endogenously adjusted relative prices of physical to human capital replaces the substitution effect with exogenous trade and investment costs.

Another difference between the KAPC model and the KC model is that it offers an alternative manner to distinguish between horizontal and vertical FDI. Assuming 'headquarters (plants) use skilled labour (physical capital) relatively intensively in their setups' (Bergstrand and Egger, 2013: 953), given the single-plant structure of vertical MNEs, vertical MNE headquarters will be more abundant than horizontal MNE headquarters in countries that are abundant in skilled labour relative to physical capital and vice versa. If physical capital is controlled for, MNE headquarters can be prominent in both relatively skilled-labour-abundant and skilled-labour-scarce home countries. In this case, the KAPC model broadens the context for vertical FDI to appear and helps to find evidence for vertical motivations in FDI activity, which the KC model fails to do. In summary, the KAPC model seems to be more powerful than the KC model in capturing real FDI activity. Therefore, in this paper we use this model as our analytical framework.

3. Statistical Data and Stylised Facts

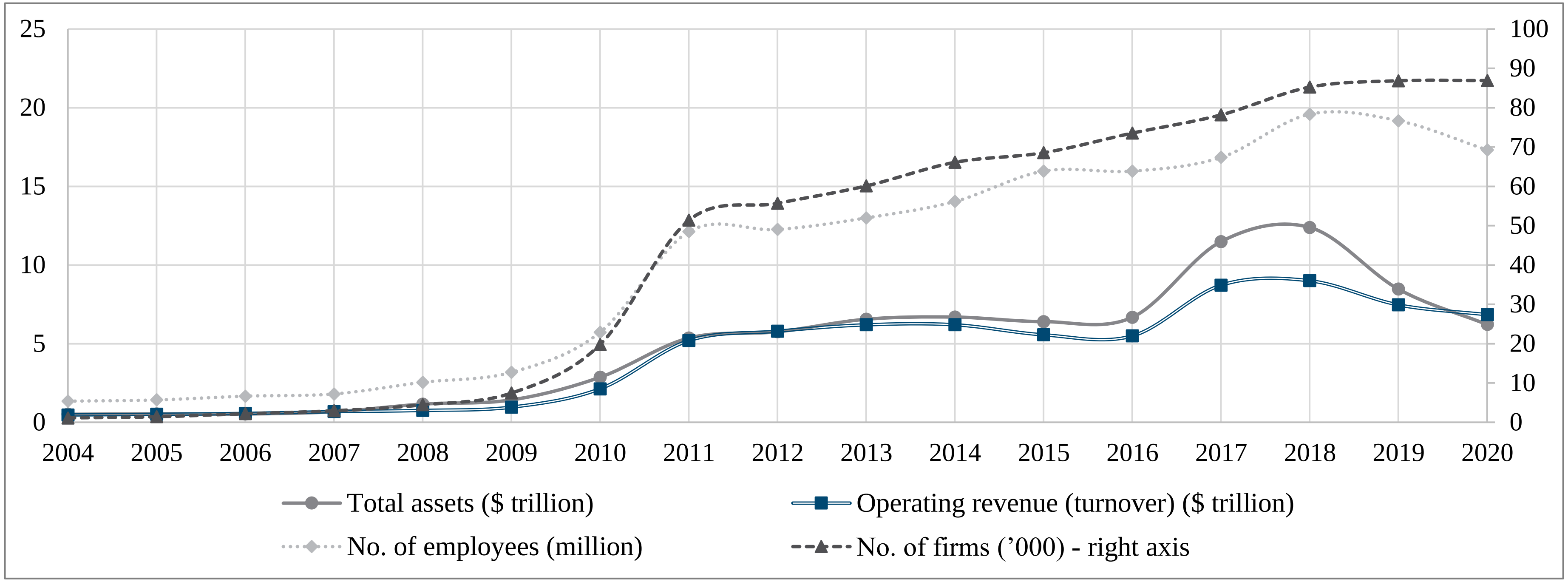
3.1. Firm-level Data

This study is based on the FDI data at the firm level. FDI at the firm level is defined as subsidiaries with ownership of at least 50.01% by a foreign firm. Such a foreign MNE is referred to in the data as the global ultimate owner (GUO), which owns the subsidiary either directly or through another subsidiary.[5] The main source of the data is the Orbis database provided by Bureau van Dijk Electronic Publishing GmbH. We use two measures of multinational activity: (i) operating revenue (turnover) and (ii) total assets of firms that are ultimately owned by foreign MNEs across the globe during 2004–2020. Since the study focuses on the impact of regulatory convergence in NTMs that is imposed on trade in goods, the firm-level data are limited to subsidiaries operating in non-services sectors as identified as their core and primary activities in the database.

Figure 1 presents the development of aggregate values of indicators of global foreign-owned subsidiaries in non-services sectors during 2004–2020. As observed on the right vertical axis, the number of foreign-owned subsidiaries in non-services sectors across the globe increased from about 1,200 firms in 2004 to about 87,000 firms in 2020. Their total assets recorded in the data increased from $0.5 trillion in 2004 to a peak of $12.38 trillion in 2018. According to the data presented in the UNCTAD (2019) investment report, this amounted to 38% of global FDI inward stock and 11% of the total assets of foreign affiliates in all sectors in 2018. Nevertheless, there is a gradual reduction afterwards to $8.5 trillion in 2019 and $6.2 trillion in 2020, which could be due to the global slowdown caused by the COVID-19 pandemic in 2020 and missing data points in more recent years. The turnover of foreign-owned subsidiaries also increased from $0.47 trillion in 2004 to a peak of $9 trillion in 2018, which is about 10% of the world's gross domestic product (GDP) in the same year and 33% of the sales of foreign affiliates in all sectors reported by UNCTAD (2019). The aggregate turnover of these firms is then reduced to $7.5 trillion in 2019 and $6.85 trillion in 2020. These internationalised firms employed 19.6 million people in 2018, which is about 26% of employment by foreign affiliates in all sectors reported by UNCTAD (2019) for the same year.

[5] It is important to note that special purpose entities that usually do not employ labour but mainly serve an accounting purpose are not included in the analysis.

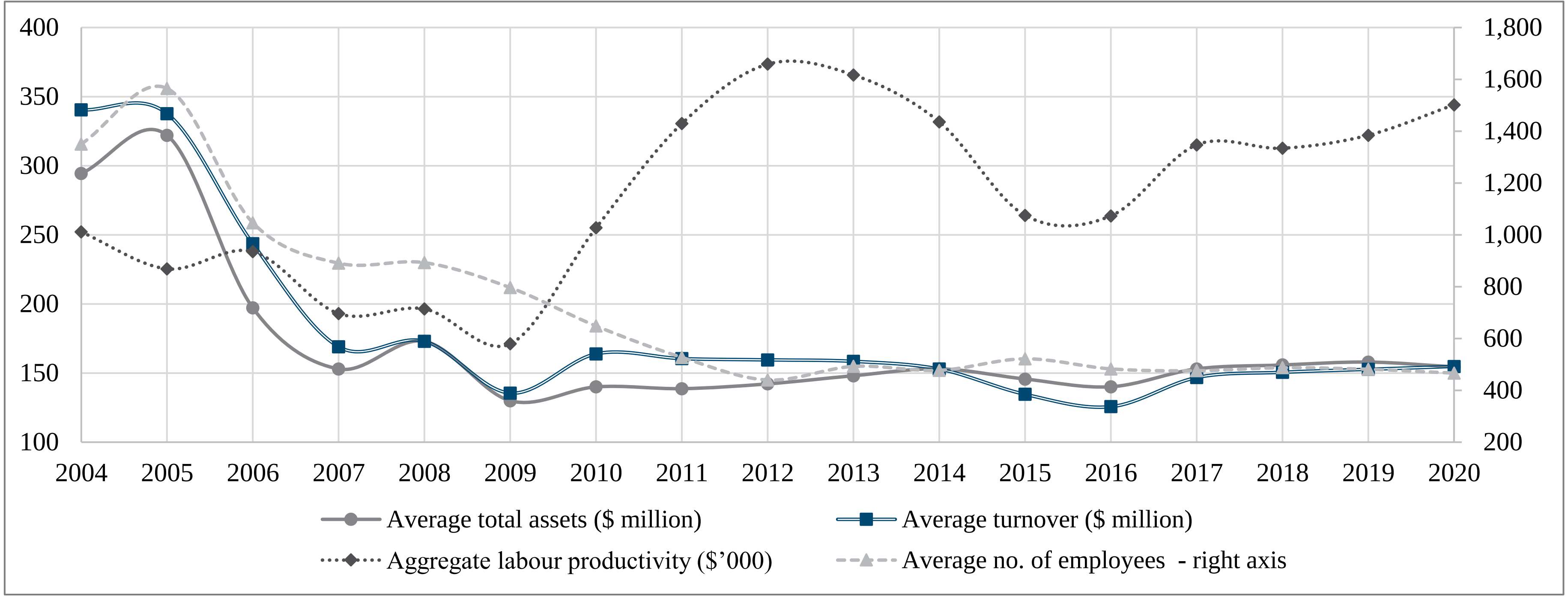
Figure 1: Development of Aggregate Values of Indicators of Global Foreign-Owned Subsidiaries in Non-Services Sectors, 2004–2020



Source: Bureau van Dijk (2022), Orbis. https://login.bvdinfo.com/R0/Orbis (accessed September–November 2022); authors' elaboration.

Figure 2 presents the development of the average values of indicators of foreign-owned subsidiaries in non-services sectors used in the study sample during 2004–2020. As observed, the few firms that were available in the earlier years in the sample of study were usually larger in terms of capital, turnover, and employment. The average assets of firms in 2005 totalled $322 million, the largest during the period, which gradually decreased to a low of $130 million in 2009 and then hovered at an average of $148 million. The average operating revenue of foreign-owned firms in the study sample was $340 million, peaking in 2004 and gradually falling to a low of $126 million in 2016. The average number of employees peaked at more than 1,565 in 2005 but fell to a low of 440 in 2012, as shown on the right vertical axis of Figure 2. However, by increasing the number of foreign-owned firms, the average labour productivity increased over time, which could be a sign of becoming more competitive. In fact, the lowest labour productivity was $171,000 at the end of the financial crisis in 2009. The average productivity was $213,000 during 2004–2009 and $316,000 during 2010–2020. The peak of labour productivity was $373,000 in 2012.

Figure 1: Development of Average Values of Indicators of Foreign-Owned Subsidiaries in Non-Services Sectors Used in the Study Sample, 2004–2020



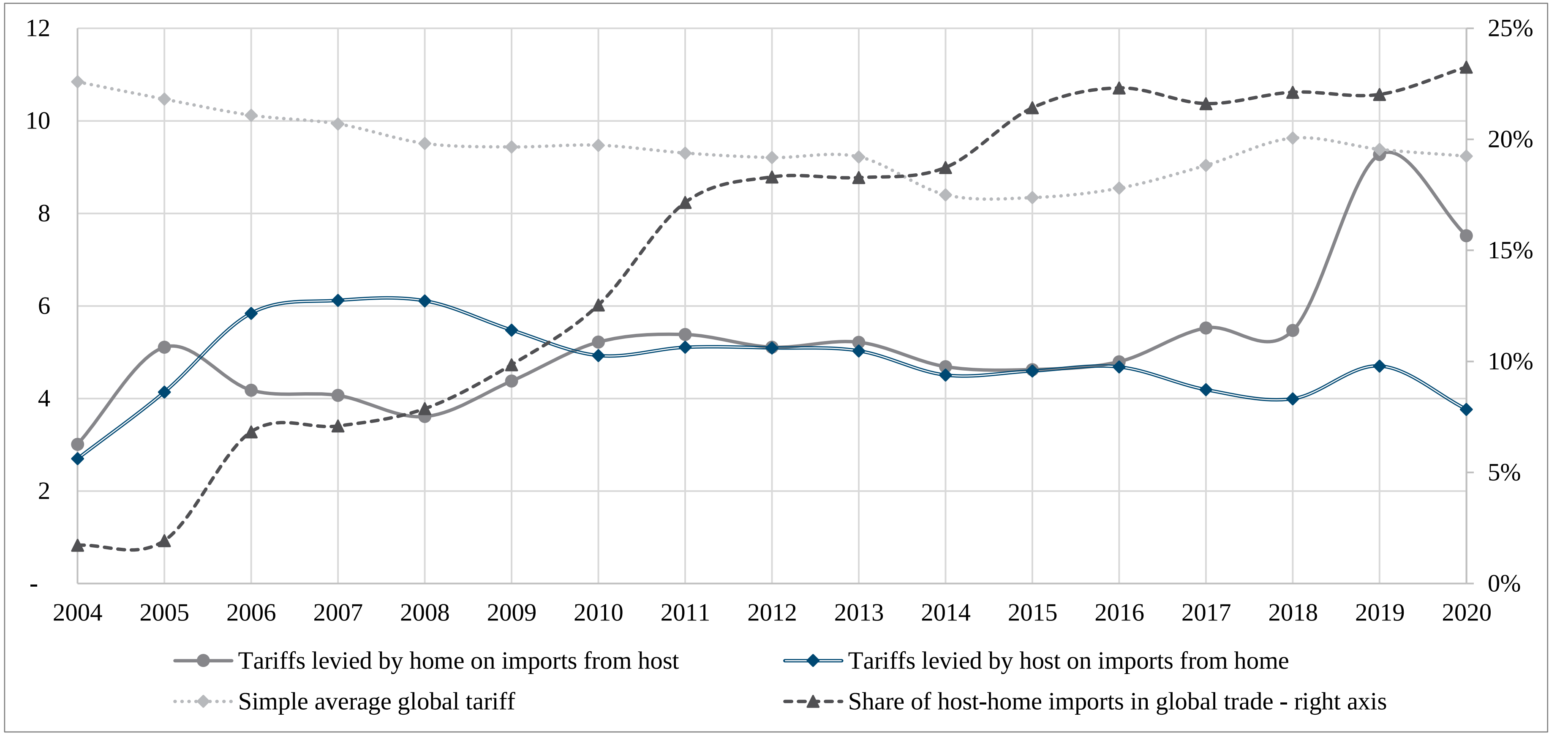
Source: Bureau van Dijk (2022), Orbis, https://login.bvdinfo.com/R0/Orbis (accessed September–November 2022; authors' elaboration.

3.2. Tariffs as Traditional Trade Policy Measures

Tariffs, as the traditional trade policy measures, are collected from the World Integrated Trade Solution (WITS), which provides tariffs from two sources: the UNCTAD Trade Analysis Information System (TRAINS) and the WTO Integrated Database (IDB). All tariffs at the six-digit level of the Harmonized System (HS), including those levied on zero trade flows, are averaged at the Nomenclature of Economic Activities (NACE) two-digit sectors using the appropriate concordance tables. The priority of tariffs used is first on effectively applied tariff rates, then preferential tariff rates, then MFN tariffs.

Figure 3 illustrates the development of tariffs between home and host countries in the study sample, the share of the sample's bilateral imports in global imports, and the average global tariffs during 2004–2020. As observed, due to the liberalisation of trade and the enlargement of the WTO, the average global tariffs levied on all available six-digit tariff lines (including those with zero trade values) generally decreased over time from 10.84% in 2004 to 9.24% in 2020. However, the tariffs levied on products averaged over the bilateral sectors in the sample of study show a different pattern. In fact, tariffs levied by the home country on imports from the host country increased from a low of 3.01% in 2004 to 9.27% in 2020. Although these are lower on average than all available global tariffs, they have increased substantially over time. Nonetheless, tariffs levied by the host on imports from the home country increased from a low of 2.69% in 2004 to a peak of 6.12% at the beginning of the financial crisis, and then gradually decreased to 3.76% in 2020. One can already observe that the liberalisation of trade towards host economies is linked to the expansion of the total assets of foreign-owned subsidiaries. This is an indication of vertical integration of production across the globe, which facilitated the GVC by lowering tariffs. However, as also shown in Figure 3, the bilateral sectors in the sample of study cover only a small share of global bilateral trade. The share of trade in the bilateral sectors under the FDI analysis only accounted for 1.7% of global trade in 2004, but increased over the years to 23% in 2020. This shows that this amount of FDI is related to a low value of global trade. Therefore, FDI could be a substitute for trade. It also shows that more bilateral sectors have been invested in by foreign MNEs, expanding to at least one quarter of global trade in 2020. However, it is important to note that gigantic intra-country trade, such as China's internal trade or intra-EU trade, are not included in the sample of FDI study here. Moreover, some large country-pair trade, such as US–Mexico trade, is not included in the firm-level sample of FDI.

Figure 2: Tariffs Between Home and Host Countries, Share of Sample's Bilateral Imports in Global Imports, and Global Tariffs, 2004–2020



Source: World Bank (2022), WITS, 2022. https://wits.worldbank.org/ (accessed 19 August 2022); authors' elaboration.

3.3. Regulatory Divergence in NTMs

The main sources of data on NTMs are the WTO Integrated Trade Intelligence Portal (I-TIP) notifications database and the UNCTAD TRAINS data (UNCTAD, n.d.). The WTO I-TIP data provide detailed information on the regulatory NTMs imposed by members of the WTO on all trading countries, targeting various products at the six-digit level of the HS. The UNCTAD TRAINS data provide information on the regulatory NTMs imposed by many countries across the globe and 93 countries, including the EU as a single economy, against all trading partners.

UNCTAD regulatory measures are classified by the administrative and procedural classes defined by MAST. Therefore, studying the NTM data provided by UNCTAD could provide insights on how procedural and administrative NTMs are applied by countries over the years. Earlier research using the NTM database provided by UNCTAD classified NTMs based on their MAST classification. These classes of TBTs and SPS measures are presented in Tables A3 and A4 in the appendix, respectively. However, the database does not provide comprehensive coverage across all countries over all years. As noted below, the database has breaking points in 2011 and 2016 as thousands of regulations expired during these 2 years.

Therefore, the benchmark database used in the analysis is the one obtained from the WTO, while robustness checks are done using the UNCTAD NTM data. Following Ghodsi et al. (2017), the WTO notifications data are further improved by finding the HS codes for notifications lacking them. Furthermore, each notification cites certain keywords that indicate the objectives of the measure rather than its procedure or administration class. Therefore, these objectives are more insightful for policymakers targeting specific goals by imposing regulatory NTMs. These keywords could be categorised by the keyword classes in Tables A1 and A2 in the Appendix for TBTs and SPS measures, respectively. As observed, the database has 32 objectives in TBT notifications and 64 objectives in SPS notifications. It is important to note that one NTM notification could cite several keywords that falls into several objectives presented in those tables. Figures A1 and A2 in the appendix also show the number of TBT and SPS notifications, citing each of those keyword classes in 2021. The figures show heterogeneity in the objectives targeted by regulatory NTMs.

The regulatory divergence in each bilateral two-digit NACE sector is calculated using the detailed objectives cited as keywords of NTM notifications that target products at the six-digit HS level in the benchmark specification and as detailed three-digit MAST classes in the robustness check. Appropriate concordance tables are used to link six-digit HS products to two-digit NACE sector levels. Following Cadot et al. (2015), a variable on regulatory divergence is measured for each NTM. To construct a measurement on distance in regulatory NTMs at the NACE two-digit sector s, which includes six-digit HS products h, a binary variable $I_{jht}^{\tau c}$ is first defined that indicates whether importing country j has a regulatory NTM of type τ (i.e., $\tau \in \{TBT, SPS\}$) on product h in year t in force with an objective c[6] cited in the keyword of the WTO notifications (or within the three-digit class of MAST for UNCTAD NTMs). The regulatory divergence between two trading partners i and j in that regulatory measure τc is then defined as $RD_{ijht}^{\tau c} = \left|I_{jht}^{\tau c} - I_{iht}^{\tau c}\right|$. The aggregation of regulatory divergence over all classes for a traded sector s between importing country j and exporting country i in year t then yields the regulatory divergence, which is calculated as follows:

$$D_{ijst}^{\tau} = \sum_{c}^{HC_{h,\tau}} \frac{RD_{ijht}^{\tau c}}{HC_{h,\tau}}, \quad \tau \in \{TBT, SPS\} \tag{1}$$

where $C_{h,\tau}$ is the total number of classes of NTMs of type τ that are imposed globally on product h and H is the total number of six-digit HS products in sector s. This index converges to unity when the two trading partners impose TBTs or SPS measures that cover different NTM classes, indicating the full divergence, and converges to zero when the two trading partners impose TBTs and SPS measures in the same classes. Therefore, distance in regulatory NTMs increases with this index. To calculate this measure, all trade flows (including zero trade values) in all six-digit tariff lines are taken into consideration. Otherwise, the measure would be biased towards available tariff lines, on which lower trade costs are presumably incurred.[7]

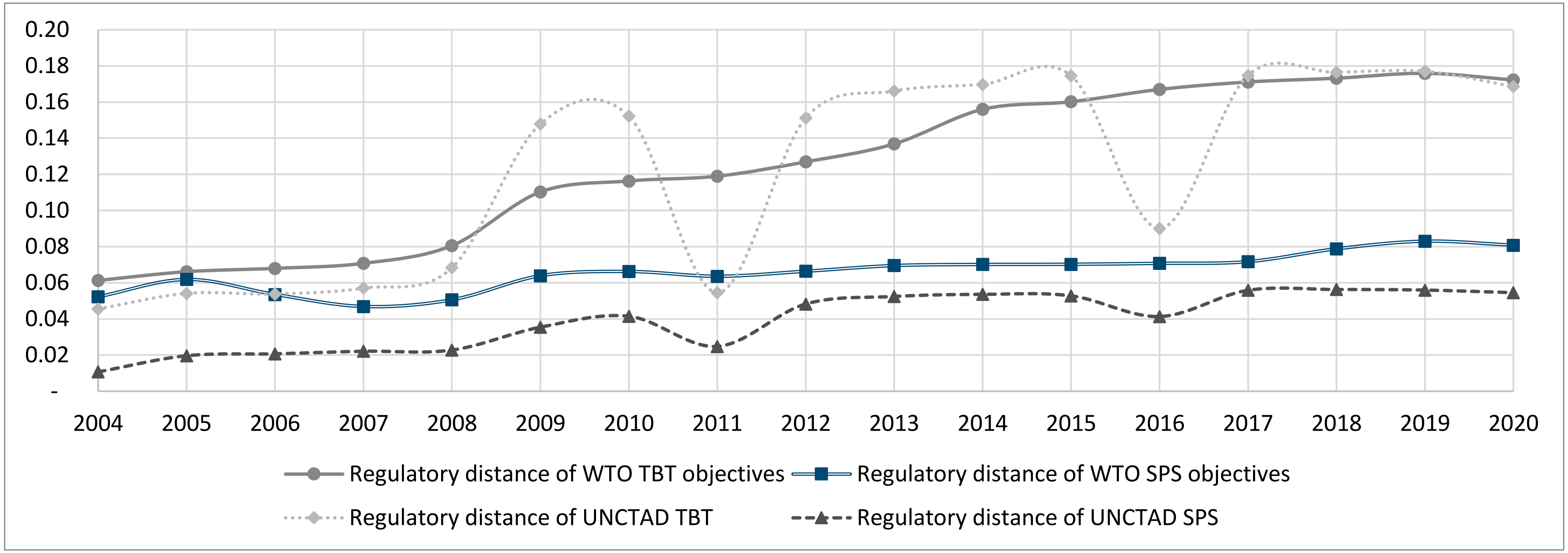
Figure 4 presents the development of average regulatory divergence between home and host countries in the sample of study during 2004–2020, using the regulatory NTMs compiled from both sources. As observed, the proliferation of regulatory NTMs over the

[6] The regulatory measures imposed on a six-digit product are usually of a similar nature. However, some other measures are generally imposed on all products. For instance, labelling is a general TBT imposed on all goods, but its detailed information for specific goods differs. For instance, the maximum residue levels of certain substances are unique to specific goods. For example, aflatoxin maximum residue levels could be mostly for nuts targeted by SPS measures, and the information on its compliance should be elaborated on its label mandated by a TBT. However, aflatoxin can also affect livestock feed, so SPS measures and TBTs may also target meat or dairy products that are affected by aflatoxin along their supply chains.

[7] This means that the data are collected through a strongly balanced panel database of 198 importing countries, 238 exporting countries, 5,130 six-digit products, and 17 years, giving a total of 4,109,684,040 observations.

years has led to an increase in regulatory divergence amongst countries. In 2004, only about 25% of non-zero trade flows were targeted by TBT notifications while the proliferation of these TBTs led to coverage of about 49% of non-zero trade flows that were targeted by these regulatory measures. Therefore, although many countries imposed NTMs on an expanding number of products, their objectives or administrative use became very heterogeneous – leading to larger regulatory divergence over the years. It is important to note that this is even though many NTMs are imposed in earlier years and remain in force in later years. No TBTs in WTO notifications have an end year to be disregarded from the sample of analysis. Furthermore, one can observe that the regulatory divergence in TBTs is in general larger than that in SPS measures. This is mainly because the number of lines affected by SPS measures over the period was much smaller than the number of lines targeted by TBTs. In 2004, only about 8.7% of non-zero trade values were affected by SPS measures, compared with about 18.7% of non-zero trade values in 2020. However, regulatory divergence in TBTs in recent years has been very similar for both data sources. Nonetheless, one can observe a large drop in the regulatory divergence of NTMs collected from the UNCTAD TRAINS database. This is mainly because many regulations from this source have an end year in 2011 and 2016. In fact, 25,588 TBTs end in 2011 and 110,340 TBTs end in 2016, which causes a large drop in regulatory divergence in TBTs. A similar pattern exists for SPS measures, indicating a drop in these 2 years. Due to this braking point in the data collected from UNCTAD, the data collected from WTO notifications are used in the benchmark econometrics analysis, while the data collected from UNCTAD are used in the robustness check.

Figure 3: Regulatory Divergence Between Home and Host Countries in the Sample of Study, 2004–2020



SPS = sanitary and phytosanitary, TBT = technical barrier to trade, UNCTAD = United Nations Conference on Trade and Development, WTO = World Trade Organization.

Sources: WTO (2022), WTO I-TIP. https://epingalert.org/ (accessed 20 June 2022); UNCTAD (2022), UNCTAD TRAINS I-TIP. https://trainsonline.unctad.org/bulkDataDownload (accessed 19 September 2022); authors' elaboration.

4. Empirical Methodology

Information on the sector of activity, location of the firm, and location of its foreign owner allows us to have a variable on the total assets $K_{fgijs\varrho,t}$ invested in firm f and a variable on its turnover $Y_{fgijs\varrho,t}$, while firm f is active in sector s in host country j and is owned by a GUO g in home country i in sector ϱ in year t. As noted earlier, this includes all subsidiaries in the global economy operating in non-services sectors that have a foreign GUO that owns at least 50.01% of the ownership of the subsidiary. This is how FDI activity is defined in the analysis. These two variables are then estimated in equations, including regulatory divergence in TBTs D_{ijst}^{TBT} and in SPS measures D_{ijst}^{SPS} that target the trade flows in sector s between the two trading partners i and j. Control variables are also included in the model, which are the size of subsidiary f in terms of the number of its employees l_{ft} in year t; its labour productivity $prod_{ft}$ in year t; tariffs imposed by the host country j on imports in sector s from home country i in year t as T_{jist}; tariffs imposed by the home country i on imports in sector s from host country j in year t as T_{ijst}; three main variables derived from the theories of the KC model, comprising the similarity in the size of the two countries GDP_{jit}^{sim}; the difference in the human capital of both countries HC_{jit}^{dif}, and the difference in the capital to labour ratio of both countries KL_{jit}^{dif} in year t; and six sets of fixed effects γ as follows:

$$\begin{aligned} Y_{fgijs\varrho,t+1} = EXP\ [&\gamma + \gamma_1 D_{ijst}^{TBT} + \gamma_2 D_{ijst}^{SPS} + \gamma_3 prod_{ft} \times D_{ijst}^{TBT} + \gamma_4 prod_{ft} \times D_{ijst}^{SPS} \\ &+ \gamma_5 \operatorname{arc} T_{jist} + \gamma_6 \operatorname{arc} T_{ijst} + \gamma_7 prod_{ft} + \gamma_8 l_{ft} + \gamma_9 GDP_{jit}^{sim} \\ &+ \gamma_{10} HC_{jit}^{dif} + \gamma_{11} KL_{jit}^{dif} + \gamma_f + \gamma_g + \gamma_{ist} + \gamma_{jst} + \gamma_{ijs} + \gamma_{\varrho t}] \\ &+ \nu_{fgijs\varrho,t+1} \end{aligned} \tag{2}$$

where instead of turnover $Y_{fgijs\varrho,t+1}$, another model estimates the capital $K_{fgijs\varrho,t+1}$ of subsidiary f in host country j in sector s that is owned by GUO g in home country i that is active in sector ϱ in year $t+1$ in Equation (2); γ_f and γ_g control for the subsidiary- and GUO-fixed effects; γ_{ist}, γ_{jst}, γ_{ijs}, and $\gamma_{\varrho t}$ are respectively the home-sector-time, host-sector-time, home-host-sector, and the sector of GUO-time fixed effects, which control for the multilateral resistance terms of trade policy measures following the gravity literature (Yotov et al., 2016). Home-sector-time and host-sector-time fixed effects also control for any other factors in the sector of the home country and the host country, respectively, such as demand and supply shocks, which vary over the years. Home-host-sector fixed effects control for any time-unvarying relations in the sector between the two trading partners, and similarities and differences in cultural characteristics, language, history, and geographical distance. The sector of GUO-time fixed effects also controls for time-varying changes in the sector of the headquarters.

The equation suggests that the independent variables are lagged for 1 year to control for the potential endogeneity bias due to the simultaneity bias. Therefore, Equation (2) shows us how regulatory divergence in TBTs and SPS measures in achieving similar objectives affects the investment decision of MNEs during the period of analysis. Since these regulatory NTMs are imposed only on trade in goods, subsidiaries operating in non-services sectors are included in the analysis. This means that agricultural, mining, and manufacturing sectors are included in the sample.

The difference in human capital HC_{jit}^{dif} is simply the logarithm of absolute value in the difference in human capital of both countries. The difference in capital endowment KL_{jit}^{dif} is simply the logarithm of absolute value in the difference in physical capital stock in relation to the number of employees of both countries. The data on these country-level variables are collected from the 2021 edition of the Penn World Table 10.0 provided by Feenstra, Inklaar, and Timmer (2015). Furthermore, the similarity in size of the two countries GDP_{jit}^{sim} is calculated as follows:

$$GDP_{jit}^{sim} = log\left[\left(\frac{GDP_i}{GDP_i + GDP_j}\right) \times \left(\frac{GDP_j}{GDP_i + GDP_j}\right)\right] \tag{3}$$

When countries i and j are identical in size, similarity is maximized ($GDP_i = GDP_j \leftrightarrow GDP_i = \frac{1}{2} \times (GDP_i + GDP_j) \leftrightarrow GDP_{jit}^{sim} = \frac{1}{4}$). As discussed in the aforementioned theoretical framework, one can identify whether horizontal or vertical FDI is more dominant in the data based on the estimation results on these relative country-level variables. For instance, when the coefficient of the size similarity in GDP is positive, it would suggest the dominance of horizontal FDI. When the coefficient of difference in the physical capital to labour ratio is positive, one can argue for the dominance of vertical FDI. Controlling for these two (GDP_{jit}^{sim} and KL_{jit}^{dif}), when the coefficient of difference in human capital becomes positive, the abundance of vertical FDI between knowledge-intensive headquarters and subsidiaries could be concluded. Therefore, the coefficients of these variables inform us about the dominance of types of FDI and the horizontal versus vertical GVC positioning of subsidiaries with respect to their parent. It is important to note that in about 12% of subsidiary–GUO relations in the estimated sample, the core four-digit NACE sectors of both the subsidiary and GUO are identical. However, the vertical integration could take place even within this detailed four-digit sector. For example, a GUO like Mercedes Benz Group is active in the manufacture of motor vehicles (NACE code 2910) and has subsidiaries in the same sector in 12 countries in the sample of our study. However, these subsidiaries are specialised in the production of different parts and components that are used in the final assembly in another country. Thus, by using the sectors of activity, one cannot easily draw a conclusion on the type of FDI or the GVC positioning of subsidiaries with respect to parent firms.

Furthermore, robustness tests will be carried out on the sample of firms with 100% ownership in the subsidiary where the information is available.[8] To explore various aspects of firm heterogeneity, the main variables of regulatory divergence will be interacted with the productivity variable to see how the regulatory divergence in NTMs could affect the decision of foreign MNEs to increase the total assets of their subsidiaries or to boost their turnover. This may better explain how the mechanisms behind NTM–FDI linkages could work across different types of firms. Furthermore, robustness checks will be run on the sample of firms active in a separate group of sectors based on their technology intensity in addition to the agricultural sector. The definitions of technology intensity of sectors at the NACE two-digit level are borrowed from Eurostat (n.d.). Furthermore, as noted above, because of harmonisation and mutual recognition of regulations and standards within the EU, intra-EU relations are excluded from the sample of analysis. Robustness checks, including intra-EU relations, are available from the authors upon request.

The model is estimated using the Poisson pseudo-maximum likelihood (PPML) estimation technique following the gravity literature (Yotov et al., 2016; Santos Silva and Tenreyro, 2006; and Correia, Guimarães, and Zylkin, 2019a, 2019b). This estimation technique is robust against heteroscedasticity. Furthermore, since there are zero and positive values in the dependent variables, this technique is the most appropriate technique applied in the literature (Mullahy and Norton, 2022). The estimation sample includes more than 100 zero values in total assets and more than 1,000 zero values in turnover. Additionally, PPML

[8] For some firms, ownership information is not available, but Orbis identifies that the major share of the subsidiary firm (i.e. more than 50.01%) is owned by the GUO either directly or indirectly through another subsidiary.

works with high-dimensional fixed effects efficiently (Correia, Guimarães, and Zylkin 2020) as Equation (2) includes many sets of fixed effects.

In a robustness check, the sample of estimation excludes all ownership relationships between the subsidiary and the foreign GUO that are done through a mergers and acquisitions (M&A) deal during the period. The data on M&A deals between the two firms are downloaded from the Amadeus and Orbis Crossborder Investment databases, provided by Bureau Van Dijk Electronic Publishing GmbH. These results are reported in Table A7 in the appendix.

Furthermore, countries may pursue economic integration via preferential trade agreements (PTAs). In fact, some PTAs have special provisions on TBTs and SPS measures that lead to harmonisation, mutual recognition, or ease of conformity assessment amongst signatories, which stimulates trade and integration in value chains. In a robustness check, PTAs with provisions on TBTs and SPS measures are included in the analysis. These variables are also interacted with the TBT and SPS divergence to infer conclusions. The results of these robustness checks are shown in Table A8 in the appendix. Data on deep PTAs are borrowed from the World Bank Deep Trade Agreements database (Hofmann, Osnago, and Ruta, 2017) and updated for more recent years by the authors. The maximum value of this variable in the data equals 4, which is for EU member states, indicating four different agreements that were signed over time which deepened the integration between these countries.

In another set of robustness checks, the estimations are run on the samples of country-pair groups. Country-pair groups are based on the host–home relations. Country groups are separated into developed countries, developing countries, the Association of Southeast Asian Nations (ASEAN) Member States,[9] and the whole world. Developed economies include the EU-27[10] plus the Organisation for Economic Co-operation and Development (OECD) countries excluding Columbia, Costa Rica, and Mexico. The results of estimations on the samples of these country-pair groups are reported in Table A9 in the appendix.

In addition to PPML, robustness tests are run using the normal ordinary least squares (OLS) and difference-in-difference generalised method of moments (GMM) (Arellano and

[9] The 10 ASEAN Member States are Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam.

[10] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998; Roodman, 2009; Hayakawa, 2009). However, as the dependent variables include zero values, arcsine log transformation is used instead of natural logarithm following the literature (Mullahy and Norton, 2022). Furthermore, one could be interested in the analysis of flows of FDI rather than of FDI stocks measured in total assets of the subsidiaries. Therefore, in additional estimated specifications, the arcsine log transformation of the first difference in total assets of the subsidiaries is used as the dependent variable. Moreover, to control for the potential endogeneity bias, a difference GMM is used to estimate both total assets and turnover of subsidiaries. The results of these robustness checks are reported in Table A10 in the appendix.

5. Estimation Results

In this section, we discuss the following sets of our estimation results. First, we report our baseline results for the full sample of firms from all non-services industries in Table 1. Then, in Tables 2–6 we discuss the estimation results obtained for specific manufacturing sectors composed of two-digit industries that differ with respect to technology intensity: (i) high-tech, (ii) medium-high-tech, (iii) medium-low-tech, and (iv) low-tech and agricultural sectors.

In the first column of Table 1, we report the estimation results obtained from the specification in which we used the total turnover of foreign affiliates as our main measure of multinational activity. The TBT distance variable is statistically significant at the 1% level and displays the expected negative sign. At the same time, the SPS distance variable is significant at the 10% level and displays the expected negative sign. This means that our first measure of multinational activity is negatively associated with greater regulatory divergence in terms of both TBTs and SPS measures. In other words, according to the coefficient of the first column to the left in Table 1, when a full convergence in regulatory TBTs on a given bilateral sector (i.e. $D_{ijst}^{TBT} = 0$) turns into a full divergence (i.e. $D_{ijst}^{TBT} = 1$), it is expected that the turnover of foreign subsidiary will decrease by 1.64%,[11] while according to the second column, the full divergence is expected to decrease the total assets of that subsidiary by about 7.65%.[12] Such a reduction in FDI activity in foreign-owned

[11] That is, equal to $100 \times (exp^{-4.11})$.

[12] That is, equal to $100 \times (exp^{-2.57})$.

subsidiaries that are active in the GVC network of MNEs could be either due to the increased trade costs or fixed costs of technological change and/or bureaucratic procedures induced by regulatory divergence as described in Ghodsi (2023). The interaction terms between firm productivity and the TBT and SPS distance variables are positive and statistically significant at the 1% and 10% levels, respectively. This means that the more productive firms are, the more able they are to overcome problems associated with both the TBT and SPS divergence. The estimated parameters on the home and host country tariffs display positive signs and are statistically significant at the 5% and 10% levels, respectively. These results support the horizontal nature of multinational activity. Both firm productivity and employment variables display positive signs and are statistically significant at the 1% level. This suggests that more productive and larger firms are more involved in international production. The estimated parameter on the GDP similarity measure is positive and statistically significant at the 5% level, which supports the horizontal nature of multinational activity. Finally, the difference in relative human capital endowments is statistically significant at the 5% level while the estimated parameter on the capital to labour ratio is not statistically significant at any of the usually accepted levels of significance. This means that only human capital endowment seems to matter for vertical multinational activity.

Table 1: Benchmark Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Non-Services Sectors, 2004–2020, Using WTO NTM Notifications

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-4.11***	-2.57***	-3.49***	-2.55***
	(0.82)	(0.50)	(0.73)	(0.57)
D^{SPS}_{ijst}	-1.19*	-0.025	-0.26	0.86
	(0.72)	(0.57)	(0.95)	(0.76)
$prod_{ft} \times D^{TBT}_{ijst}$	0.46***	0.25***	0.40***	0.23***
	(0.088)	(0.052)	(0.075)	(0.057)
$prod_{ft} \times D^{SPS}_{ijst}$	0.10*	-0.026	0.13**	-0.016
	(0.058)	(0.034)	(0.059)	(0.032)
$\mathrm{arc}\,T_{ijst}$	0.14*	0.16**	0.67***	1.02***
	(0.082)	(0.075)	(0.24)	(0.22)
$\mathrm{arc}\,T_{jist}$	0.28**	0.33***	0.019	1.03***
	(0.12)	(0.12)	(0.28)	(0.33)
$prod_{ft}$	0.17***	0.040***	0.20***	0.035***
	(0.028)	(0.012)	(0.016)	(0.010)

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
l_{ft}	0.46***	0.18***	0.49***	0.12***
	(0.029)	(0.015)	(0.023)	(0.026)
GDP^{sim}_{jit}	0.14**	0.13	0.21*	0.19
	(0.064)	(0.095)	(0.11)	(0.12)
HC^{dif}_{jit}	0.015**	0.023***	0.019*	0.014*
	(0.0063)	(0.0061)	(0.011)	(0.0085)
KL^{dif}_{jit}	-0.0058	-0.021***	-0.0016	-0.0096
	(0.0044)	(0.0058)	(0.0071)	(0.0070)
Constant	18.0***	20.8***	17.4***	20.1***
	(0.41)	(0.32)	(0.36)	(0.36)
Observations	165,262	164,436	64,785	64,635
Pseudo R-squared	0.989	0.990	0.987	0.990
AIC	1.21429e+12	1.18961e+12	3.81645e+11	2.60726e+11

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

In the second column, we report the estimation results obtained from the specification in which we used the alternative measure of multinational activity, i.e. the value of total assets. In this case, there are some notable differences compared with the first set of results. Now, only the TBT divergence variable is statistically significant at the 1% level and displays the expected negative sign, while the SPS divergence variable is no longer statistically significant. The interaction term between the TBT distance and firm productivity remains statistically significant at the 1% level and displays the expected positive sign. At the same time, the interaction term between the SPS divergence and firm productivity is no longer significant. The estimated parameters on both home and host country tariffs display positive signs and are statistically significant at the 1% and 5% levels. Both firm productivity and employment display positive signs and remain statistically significant at the 1% level. The GDP similarity measure is not statistically significant. Both measures of difference in relative factor endowments are statistically significant at the 1% level, but the difference in the capital to labour ratio displays a counterintuitive negative sign.

In the third and fourth columns, we report the estimation results obtained for the subsample of firms that are 100% foreign-owned. These columns are the direct counterparts of the first and second columns. In both cases, we note that only the TBT divergence variable is statistically significant at the 1% level and displays the expected negative sign, while the SPS divergence variable is not statistically significant. The interaction term between the TBT divergence and firm productivity is statistically significant at the 1% level and displays the expected positive sign in both columns. However, the interaction term between the SPS distance and firm productivity is significant only in the third column, where the dependent variable is the volume of sales of subsidiaries, which is similar to the result reported in the first column. Interestingly, the estimation results show that the parameters on the home and host country tariffs display positive signs and are both statistically significant only when the dependent variable is the value of total assets. Like the results reported in the first two columns, the firm productivity and employment display positive signs and are statistically significant at the 1% level. The GDP similarity measure is statistically significant only when the dependent variable is the volume of sales, which is similar to the result reported in the first column. Finally, the difference in relative human capital endowments is statistically significant at the 10% level in both columns, while the estimated parameter on the capital to labour ratio is not statistically significant in any of the columns. This means that vertical multinational activity is driven only by the relative human capital endowments.

Estimation results using the regulatory divergence in administrative and procedural NTM classes defined by MAST on the whole sample of foreign-owned subsidiaries in non-services sectors are presented in Table A5 in the appendix. The results are generally similar to the results presented in Table 1. However, the variables on regulatory divergence in TBTs and SPS measures are not statistically significant on the sample of all firms. The variable of regulatory divergence in TBTs is negative and statistically significant at the 1% level when the sample includes only subsidiaries with a 100% ownership share for both turnover and total assets. The variable of regulatory divergence in SPS measures is positive and statistically significant at the 5% level for the total assets of firms owned 100% by foreign MNEs, which indicates a tariff-jumping motive behind these procedural and administrative SPS measures. The interaction between the regulatory divergence in TBTs and productivity of the subsidiary is statistically significant and positive for the models, including firms with 100% foreign ownership. This indicates that, when the productivity of the subsidiary increases, the firm will be able to comply with procedural and administrative TBTs and thus increase its turnover and total assets. This means that more productive firms are able to compensate some parts of the direct negative impact of regulatory divergence in TBTs. The results for the other variables remain very similar to the results presented in Table 1.

Table A6 in the appendix presents the results of the benchmark estimation when labour productivity is not interacted with the regulatory divergence variables. It indicates that the variables of regulatory divergence in either of the two NTMs are statistically insignificant. Since the Akaike information criterion (AIC) has much smaller statistics in the models presented in Table 1, the results including the interaction terms are econometrically preferred over the results excluding them. This suggests the importance of firm heterogeneity and labour productivity of foreign-owned subsidiaries in defining their turnover and total assets in response to regulatory divergence.

Table A7 in the appendix reports the estimation results on total assets and turnover of global foreign-owned subsidiaries in non-services sectors, excluding the ownership relations that are done through M&A deals. The sample size shrinks slightly after the exclusion of M&A deals during the period. However, the results remain consistent with the benchmark results shown in Table 1.

Table A8 shows the estimation results on total assets and turnover of global foreign-owned subsidiaries in non-services sectors, including PTAs with NTM provisions. While these results remain consistent with the benchmark results, one can observe that deep PTAs with TBT provisions stimulate total assets of foreign subsidiaries while deeper PTAs with SPS provisions reduce the total assets of foreign subsidiaries in a statistically significant way. These effects are less significant for the turnover of foreign subsidiaries. Furthermore, the interaction of PTAs with NTM variables indicates that when countries have deeper integration of PTAs with TBT provisions, the divergence in their regulatory TBTs causes a larger negative impact on FDI than the main effect of TBT convergence on total assets shown in the first row. This negative impact is partially reduced by the larger productivity of the subsidiary. This indicates that when GVCs are negatively affected by regulatory divergence in TBTs, leading to smaller total assets or turnover of subsidiaries, firms with larger productivity may reduce some parts of such a negative impact. However, the net effect of regulatory divergence remains negative and larger, especially for countries integrated by deeper PTAs.

Table A9 in the appendix displays the estimation results on total assets and turnover of global foreign-owned subsidiaries in non-services sectors by country-pair groups. For the estimations on turnover, the coefficient of regulatory divergence in TBTs is significant and negative only for developed host economies and developing home economies with a much larger magnitude than the benchmark estimation presented in Table 1. Again, larger productivity of the subsidiary partially reduces this negative impact. The regulatory divergence in TBTs has a significant positive impact on the turnover of global subsidiaries of GUOs originating in ASEAN Member States. Furthermore, the tariffs imposed by the home country in ASEAN against the host country have a negative impact on the total assets of the subsidiaries. This shows that investment increases when trade from the host country to the home country becomes costlier, which undermines the vertical integration in production.[13] A similar pattern is observed on the positive impact of the divergence in SPS measures on the turnover of subsidiaries of GUOs in ASEAN. This indicates a tariff-jumping FDI by ASEAN MNEs investing in other parts of the world. Such a horizontal FDI by ASEAN MNEs is also acknowledged by the strong positive coefficient of size similarity. One can also observe that subsidiaries of ASEAN MNEs with larger productivity could better circumvent the trade barriers related to the regulatory divergence in both types of NTMs, which reduces their turnover due to tariff-jumping motives. It is important to note that a similar pattern is observed for the total assets of subsidiaries owned by GUOs located in ASEAN. However, regulatory divergence in TBTs shows negative and significant coefficients on the total assets of subsidiaries in both developed and developing economies when their GUOs are in the developed economies. This indicates the importance of vertical integration in the GVCs of such FDI relations. The regulatory divergence in SPS measures, however, acts as a tariff-jumping motive for the total assets of subsidiaries in developing economies when the GUOs are in the developed economies, while the opposite is the case for the total assets of firms in developed economies that are owned by GUOs in developed economies.

Finally, Table A10 presents the robustness estimation results on the total assets and turnover of global foreign-owned subsidiaries in non-services sectors using OLS and GMM.

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[13] These GUOs are in Indonesia (11), Malaysia (61), the Philippines (9), Singapore (142), Thailand (54), and Viet Nam (30). Furthermore, 22 countries (including four ASEAN Member States) are hosts to 529 foreign subsidiaries in the sample of this estimation. Most of the subsidiaries are in China (220), Viet Nam (89), Russia (80), and the United Kingdom (47). The positive significant coefficients of regulatory divergence in both TBTs and SPS measures indicate that the FDI originating in ASEAN is dominated by horizontal FDI rather than vertical FDI. However, only 28% of the subsidiaries in the sample are active in the same two-digit NACE sectors as their GUO’s sectors of activity. This may additionally suggest that, although the sectors of the subsidiaries and GUOs are different for 72% of the sample, they are still horizontal FDI. This means that the increased regulatory divergence leads to more investment in the subsidiaries to comply with such regulations, which also leads to larger turnover due to larger demand for higher-quality products. The aggregated total assets of subsidiaries of ASEAN GUOs averaged over 2010–2020 are $42.12 billion, while the turnover is $38.4 billion.

While the regulatory divergence in TBTs has a negative impact on the total assets of all non-services subsidiaries, like in Table 1, it has a positive impact on their turnover. Furthermore, regulatory divergence in SPS measures now has a positive impact on the total assets of subsidiaries. For the total assets of subsidiaries with 100% ownership by foreign GUOs, regulatory divergence in TBTs has a negative coefficient, which is statistically significant at the 5% level. Columns 5 and 6 show the estimation results on the flows of FDI or the change in the total assets of subsidiaries of all non-services firms and those with 100% ownership, respectively. One can also observe that the R-squared for flows of FDI (stock of FDI in first differences) is much smaller than the R-squared for the estimation of stock of levels of FDI. Regulatory divergence in neither type of NTM has any significant impact on FDI flows. However, the interaction of productivity and these regulatory measures yield significant coefficients. The last two columns in Table A10 present the results of GMM estimations on the turnover and total assets of all non-services subsidiaries. As observed, regulatory divergence in TBTs has a negative impact on total assets, which are statistically significant only at the 10% level. This negative impact is partially reduced when the subsidiary is more productive.

5.1. Heterogenous Results Across Sectors

In the remaining tables, we report the estimation results obtained for specific manufacturing sectors, which differ regarding technology intensity and the agricultural sector. These results reveal a great deal of heterogeneity across sectors. In most of these results, the variable of regulatory divergence is statistically significant and negative, like the results for all manufacturing sectors. However, the impact becomes statistically insignificant for sectors with lower technology. This indicates that divergence in TBTs is more costly for the high-tech and most importantly the medium-high-tech sectors, as shown in Tables 2 and 3.

Table 2: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in High-Tech Manufacturing Sectors, 2004–2020, Using WTO NTM Notifications

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-7.61***	-5.61**	-3.03	0.74
	(1.96)	(2.25)	(1.93)	(1.81)
D^{SPS}_{ijst}	-3.94*	-1.24	-6.64**	-7.87***
	(2.08)	(1.64)	(3.10)	(2.57)
$prod_{ft} \times D^{TBT}_{ijst}$	0.78***	0.35	0.47***	0.041
	(0.19)	(0.22)	(0.15)	(0.11)
$prod_{ft} \times D^{SPS}_{ijst}$	0.22	0.029	0.078	0.091
	(0.14)	(0.12)	(0.17)	(0.13)
arc T_{ijst}	-3.29**	-2.46	-2.03	1.38
	(1.48)	(2.19)	(2.32)	(1.97)
arc T_{jist}	1.67*	-0.27	-0.034	0.84
	(0.97)	(0.92)	(1.25)	(1.14)
$prod_{ft}$	0.089*	0.015	0.19***	0.099***
	(0.047)	(0.055)	(0.036)	(0.026)
l_{ft}	0.43***	0.17***	0.47***	0.16***
	(0.038)	(0.022)	(0.041)	(0.020)
GDP^{sim}_{jit}	0.54***	0.52***	0.42	1.26***
	(0.16)	(0.20)	(0.30)	(0.33)
HC^{dif}_{jit}	0.028	0.016	0.14***	0.11***
	(0.022)	(0.016)	(0.046)	(0.025)
KL^{dif}_{jit}	-0.0071	-0.044***	-0.0051	0.049*
	(0.015)	(0.015)	(0.026)	(0.026)
Constant	20.6***	23.6***	18.7***	21.6***
	(0.81)	(0.89)	(1.10)	(1.07)
Observations	19,218	18,809	8,417	8,197
Pseudo R-squared	0.984	0.987	0.979	0.980
AIC	4.49417e+11	3.39011e+11	1.76075e+11	8.82273e+10

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

According to Table A11 in the appendix, the total assets of foreign-owned firms of the high-tech sectors and medium-high-tech sectors in the sample are the largest across all sectors. In fact, the foreign-owned firms in the manufacture of high-tech computer, electronic and optical products or the digital manufacturing sector, which is an important engine of the modern economy, receive investment totalling $572 billion per annum – more than 15% of the total assets in the sample of study. The foreign-owned firms in this high-tech sector also earn the largest total turnover, at $823 billion, which is about 22.5% of the turnover of the whole sample per annum. In terms of employment, foreign subsidiaries in this sector employ the greatest number of employees, at 3.5 million, which is about 28% of the annual employment in the whole sample. These indicators show the importance of the high-tech and medium-high-tech sectors, which are significantly affected by the regulatory divergence in TBTs. Furthermore, as Table 3 shows, the negative impact of regulatory divergence in TBTs on the turnover and total assets of foreign-owned subsidiaries is partially offset by larger productivity of subsidiaries. This is especially the case in medium-high-tech manufacturing sectors such as the manufacture of motor vehicles, trailers, and semi-trailers.

Table 3: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Medium-High-Tech Manufacturing Sectors, 2004–2020, Using WTO NTM Notifications

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-3.26**	-3.86***	-3.29***	-2.50***
	(1.32)	(0.82)	(0.87)	(0.68)
D^{SPS}_{ijst}	3.06	0.098	2.23	5.02**
	(2.76)	(1.47)	(2.60)	(2.20)
$prod_{ft} \times D^{TBT}_{ijst}$	0.39***	0.36***	0.41***	0.22***
	(0.15)	(0.092)	(0.090)	(0.074)
$prod_{ft} \times D^{SPS}_{ijst}$	-0.17	-0.19**	-0.16	-0.17*
	(0.26)	(0.095)	(0.12)	(0.088)
$\text{arc}\,T_{ijst}$	-0.71	-0.32	1.58*	1.54**
	(0.58)	(0.53)	(0.83)	(0.65)
$\text{arc}\,T_{jist}$	0.27	1.29***	-0.11	1.52***
	(0.45)	(0.42)	(0.62)	(0.56)
$prod_{ft}$	0.19***	0.020	0.20***	0.018
	(0.041)	(0.016)	(0.021)	(0.017)
l_{ft}	0.52***	0.19***	0.53***	0.10**
	(0.031)	(0.044)	(0.023)	(0.045)
GDP^{sim}_{jit}	-0.19**	-0.15	0.089	-0.60***
	(0.086)	(0.095)	(0.13)	(0.14)
HC^{dif}_{jit}	0.022***	0.023***	0.0056	-0.0069
	(0.0081)	(0.0086)	(0.0098)	(0.010)
KL^{dif}_{jit}	-0.0076	-0.012*	-0.0036	-0.029***
	(0.0065)	(0.0073)	(0.0088)	(0.0089)
Constant	16.5***	19.7***	16.8***	18.5***
	(0.59)	(0.41)	(0.40)	(0.42)
Observations	56,189	55,007	21,941	21,501
Pseudo R-squared	0.987	0.987	0.988	0.988
AIC	3.72432e+11	3.67447e+11	1.13193e+11	9.09405e+10

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

Regulatory divergence in SPS measures negatively affects the turnover and total assets of foreign-owned subsidiaries with 100% foreign ownership in a statistically significant manner. It also negatively affects the turnover of foreign-owned subsidiaries in medium-low-tech manufacturing sectors in a statistically significant way, as shown in Table 4.

Table 4: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Medium-Low-Tech Manufacturing Sectors, 2004–2020, Using WTO NTM Notifications

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-2.73*	-1.19	-1.76	1.74
	(1.64)	(1.59)	(1.84)	(1.61)
D^{SPS}_{ijst}	-13.7***	-2.14	-13.9***	-0.71
	(3.33)	(2.64)	(4.80)	(3.10)
$prod_{ft} \times D^{TBT}_{ijst}$	0.29*	0.12	0.0092	0.094
	(0.17)	(0.15)	(0.17)	(0.085)
$prod_{ft} \times D^{SPS}_{ijst}$	1.94***	-0.18	1.42***	-0.64***
	(0.37)	(0.22)	(0.52)	(0.19)
$\text{arc}\,T_{ijst}$	0.84	1.60**	3.14***	0.82
	(0.61)	(0.63)	(0.79)	(0.76)
$\text{arc}\,T_{jist}$	-0.078	-0.82*	0.38	0.17
	(0.44)	(0.47)	(0.72)	(0.79)
$prod_{ft}$	0.071	0.036	0.20***	0.038***
	(0.058)	(0.026)	(0.050)	(0.014)
l_{ft}	0.31***	0.076***	0.52***	0.067***
	(0.095)	(0.021)	(0.043)	(0.015)
GDP^{sim}_{jit}	0.14	-0.26*	0.34*	-0.084
	(0.12)	(0.15)	(0.18)	(0.21)
HC^{dif}_{jit}	-0.019**	0.041***	-0.048***	-0.032**
	(0.0092)	(0.010)	(0.013)	(0.016)
KL^{dif}_{jit}	0.00073	-0.028***	0.019**	0.0061
	(0.0076)	(0.0087)	(0.0095)	(0.012)
Constant	19.1***	20.4***	17.2***	19.1***
	(0.92)	(0.47)	(0.68)	(0.50)
Observations	33,468	33,296	13,372	13,326
Pseudo R-squared	0.991	0.992	0.990	0.993
AIC	1.54958e+11	1.81350e+11	3.46375e+10	2.68665e+10

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, , WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

Regulatory divergence in SPS measures increases the total assets of subsidiaries with 100% foreign ownership in the medium-high-tech manufacturing sectors and low-tech manufacturing sectors in a statistically significant manner, as shown in Table 5. This motivates the tariff-jumping hypothesis behind regulatory divergence in SPS measures, which usually pursue hygiene objectives. It is no coincidence that low-tech manufacturing sectors, such as the manufacture of food products, which provide consumer goods, should be positively affected by regulatory divergence in SPS measures. One would expect SPS measures to be dominantly imposed on agricultural and food products. However, these measures are also imposed on manufactured goods. As Figure A3 in the appendix also shows, regulatory divergence in SPS measures is also large and dominant in the manufacture of basic pharmaceutical products, which is a high-tech sector. The manufacture of chemicals and chemical products is also targeted by a large number of SPS measures, which increases the regulatory divergence in this set of goods.

Estimation results on the total assets and turnover of global foreign-owned subsidiaries in agricultural sectors are reported in Table 6. These results show that the regulatory divergence in SPS measures is more important than TBTs. Such divergence leads to lower turnover and total assets of subsidiaries in a very significant manner when all agricultural firms are included in the sample. However, greater productivity could reduce such a negative impact only on the turnover of subsidiaries. When the sample shrinks to subsidiaries with 100% ownership, the divergence in SPS measures cause a tariff-jumping motive for FDI in agricultural firms. Furthermore, there is a significant positive impact of regulatory divergence in TBTs on the total assets of firms in agricultural sectors, which indicates a tariff-jumping motive behind FDI.

Table 5: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Low-Tech Manufacturing Sectors, 2004–2020, Using WTO NTM Notifications

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-1.80	-0.099	-4.29***	-0.46
	(1.65)	(0.81)	(1.62)	(0.93)
D^{SPS}_{ijst}	0.31	1.37**	1.15	1.99***
	(0.73)	(0.61)	(1.08)	(0.77)
$prod_{ft} \times D^{TBT}_{ijst}$	0.17	0.0052	0.38**	0.000014
	(0.17)	(0.084)	(0.17)	(0.088)
$prod_{ft} \times D^{SPS}_{ijst}$	-0.063	-0.13***	-0.0018	-0.10***
	(0.059)	(0.045)	(0.072)	(0.038)
$\text{arc}\,T_{ijst}$	0.15*	0.16**	0.72***	0.99***
	(0.083)	(0.074)	(0.25)	(0.24)
$\text{arc}\,T_{jist}$	0.14	0.18*	-0.23	1.53***
	(0.10)	(0.10)	(0.22)	(0.40)
$prod_{ft}$	0.31***	0.17***	0.24***	0.11***
	(0.020)	(0.014)	(0.024)	(0.014)
l_{ft}	0.58***	0.29***	0.44***	0.15***
	(0.037)	(0.016)	(0.034)	(0.017)
GDP^{sim}_{jit}	0.49***	0.035	0.26	0.20
	(0.12)	(0.15)	(0.21)	(0.19)
HC^{dif}_{jit}	0.0040	0.015	-0.030	-0.023
	(0.012)	(0.013)	(0.024)	(0.023)
KL^{dif}_{jit}	-0.0052	-0.0043	-0.0045	0.014
	(0.0077)	(0.0098)	(0.015)	(0.016)
Constant	16.8***	18.1***	16.9***	18.3***
	(0.40)	(0.42)	(0.60)	(0.51)
Observations	39,786	39,727	14,979	14,989
Pseudo R-squared	0.991	0.991	0.992	0.994
AIC	1.32262e+11	1.43726e+11	3.26428e+10	2.42464e+10

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

Table 6: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Agricultural Sectors, 2004–2020, Using WTO NTM Notifications

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-0.60	3.25**	-3.39	2.32
	(1.82)	(1.57)	(3.56)	(2.31)
D^{SPS}_{ijst}	-8.79***	-6.04***	8.04***	3.78**
	(2.01)	(2.29)	(2.70)	(1.71)
$prod_{ft} \times D^{TBT}_{ijst}$	0.049	-0.21	0.52	-0.28
	(0.21)	(0.18)	(0.42)	(0.30)
$prod_{ft} \times D^{SPS}_{ijst}$	0.87***	0.27	-0.034	0.022
	(0.19)	(0.22)	(0.26)	(0.13)
$\text{arc}\,T_{ijst}$	1.28	3.40***	-3.05**	-2.91***
	(1.24)	(1.16)	(1.39)	(1.09)
$\text{arc}\,T_{jist}$	-1.04	3.03*	-15.9***	-0.88
	(1.90)	(1.61)	(3.12)	(1.90)
$prod_{ft}$	0.17***	0.072	0.13**	0.11**
	(0.045)	(0.050)	(0.060)	(0.046)
l_{ft}	0.58***	0.16***	0.57***	0.14***
	(0.031)	(0.037)	(0.069)	(0.046)
GDP^{sim}_{jit}	-0.58**	-1.29***	0.28	2.16***
	(0.29)	(0.49)	(0.89)	(0.81)
HC^{dif}_{jit}	-0.013	0.022	0.48**	0.47***
	(0.085)	(0.083)	(0.19)	(0.14)
KL^{dif}_{jit}	-0.061***	-0.068***	0.18**	0.038
	(0.023)	(0.017)	(0.079)	(0.052)
Constant	15.5***	15.3***	14.1***	21.3***
	(0.93)	(1.47)	(2.58)	(2.16)
Observations	11,342	11,893	4,267	4,553
Pseudo R-squared	0.987	0.974	0.991	0.984
AIC	9.21007e+09	2.66007e+10	1.11280e+09	2.28264e+09

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

6. Conclusion and Policy Implications

In this paper, we have studied the effects of international regulatory convergence in NTMs on the cross-border investment of multinational firms. We verified two main research hypotheses derived from the modified KC model of the MNE. The first hypothesis postulated that when regulatory divergence with numerous regulatory measures in the destination emerges, trade cost also increases – stimulating horizontal multinational activity. The second hypothesis stated that regulatory convergence could reduce trade costs between the two trading partners, facilitating vertical multinational activity. To verify these hypotheses, we used firm-level data from the Orbis database for the recent 2004–2020 period and the PPML estimation technique of the gravity model. Our estimation results for the full sample of foreign-owned firms active in all non-services sectors showed that greater regulatory divergence is negatively associated with the extent of multinational activity. In addition, TBT convergence seemed more important than SPS measure convergence. Moreover, more productive firms were more able to overcome problems associated with both the TBT and SPS distances. Finally, we found significant heterogeneity across sectors that vary according to technology intensity.

The empirical evidence in this paper provides informative insights for policymakers. Regulatory NTMs such as TBTs and SPS measures are frequently used by policymakers to regulate the import markets when the market fails to automatically adjust for negative externalities related to bad products or harmful production procedures. The study shows that due to the proliferation of both TBTs and SPS measures with heterogenous objectives or procedural characteristics, divergence in these regulatory measures has increased over the years. Indeed, such divergence has resulted in less FDI. The total assets and turnover of foreign-owned subsidiaries in non-services sectors that are heavily involved in GVCs have been negatively affected by the divergence in these regulatory NTMs. This regulatory divergence has effectively disturbed the sourcing of intermediate inputs of production across the GVCs, resulting in less vertical FDI across the globe. To improve the linkages across GVCs and to stimulate vertical FDI, policymakers are advised to pursue the harmonisation of standards that reduce divergence in regulatory NTMs. As the evidence presented here indicates, when full divergence in TBTs imposed on bilateral sectors turns into full convergence, one should expect the total assets of foreign-owned subsidiaries to increase by 7.65%. This impact is reported to be heterogenous across sectors based on their technology intensity. Furthermore, the productivity of the foreign-owned subsidiary could also reduce the negative impact of regulatory divergence on the activities of foreign-owned firms. This provides additional guidance to policymakers. In fact, the competitiveness of these firms should be additionally supported by providing training and education to their employees, or by encouraging innovation.

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Appendices

Table A1: TBT Keywords and Keyword Classes in WTO Notifications

TBT Keyword No.	TBT Keywords	Keyword Class
1	Consumer information	1: Consumers
2	Consumer protection	
3	Crime protection	
4	Human health	
5	Prevention of deceptive practices and consumer protection	
6	Protection of human health or safety	
7	Safety	
8	Food additives	2: Food
9	Food standards	
10	Genetically modified organisms	
11	Nutrition information	
12	Organic agriculture	
13	Conformity assessment	3: Trade
14	Harmonization	
15	Labelling	
16	Trade facilitation	
17	Quality requirements	4: Quality
18	Biofuels	5: Environment
19	Plant health	
20	Protection of animal or plant life or health	
21	Protection of the environment	
22	NA	6: Other
23	Other	
24	Cost saving and increasing productivity	7: Market
25	Metrology	
26	Packaging	
27	Electromagnetic compatibility	8: ICT
28	Telecommunication/Radiocommunication	
29	Animal feed	9: Animals
30	Animal health	
31	Animal welfare	
32	National security requirements	10: National

ICT = information and communication technology, N/A = not applicable, TBT = technical barrier to trade, WTO = World Trade Organization.
Source: WTO (2022), WTO I-TIP. https://epingalert.org/ (accessed 20 June 2022).

Table A2: List of SPS Keywords and Keyword Classes in WTO Notifications

SPS Keyword No.	SPS Keywords	Keyword Class
1	Food safety	1: Consumer
2	Human health	
3	Protect humans from animal/plant pest or disease	
4	Aflatoxins	2: Tolerance limits
5	Allergens	
6	Contaminants	
7	Dioxins	
8	Feed additives	
9	Food additives	
10	Heavy metals	
11	Irradiation	
12	Maximum residue limits (MRLs)	
13	Mycotoxins	
14	Ochratoxin	
15	Pesticides	
16	Polychlorinated biphenyls	
17	Tolerance exemption	
18	Toxins	
19	Veterinary drugs	
20	Animal diseases	3: Animal diseases
21	Animal feed	
22	Animal health	
23	Animal welfare	
24	Avian Influenza	
25	Bluetongue	
26	Bovine spongiform encephalopathy (BSE)	
27	Classical swine fever	
28	Foot and mouth disease	
29	Fruit fly	
30	H1N1 influenza	
31	Invasive species	
32	Nematode	
33	Newcastle disease	
34	Pests	
35	Scrapie	
36	Transmissible spongiform encephalopathy (TSE)	
37	Zoonoses	

SPS Keyword No.	SPS Keywords	Keyword Class
38	Citrus canker	4: Plant health
39	Fungi	
40	Plant diseases	
41	Plant health	
42	Plant protection	
43	Protect territory from other damage from pests	
44	Sudden oak death	
45	Regionalization	5: Regionalization
46	Territory protection	
47	Certification	6: Market
48	Control and inspection	
49	HACCP plan requirements	
50	Labelling	
51	Packaging	
52	Traceability	
53	Wood packaging/ISPM15	
54	Equivalence	7: Other
55	Seeds	
56	Bacteria	8: Microbiological
57	Escherichia coli	
58	Listeria monocytogenes	
59	Salmonella	
60	Beverages	9: Beverages
61	Biological control agents	10: Biological
62	Biotechnology	
63	Genetically modified organisms	
64	Pharmaceutical products	11: Pharmaceutical

HACCP = hazard analysis and critical control points, SPS = sanitary and phytosanitary, WTO = World Trade Organization.
Author: WTO (2022), WTO I-TIP. https://epingalert.org/ (accessed 20 June 2022).

Table A3: Three-Digit TBT Subgroups in MAST Classification, 2019

Three-digit TBT Subgroup No.	Three-digit TBT Subgroup	Two-digit TBT Subgroup
B14	Authorization requirements for importing certain products	B1 Import authorization/licensing related to TBTs
B15	Authorization requirements for importers	
B19	Import authorization/licensing related to TBTs not elsewhere specified	
B21	Tolerance limits for residues of or contamination by certain substances	B2 Tolerance limits for residues and restricted use of substances
B22	Restricted use of certain substances	
B31	Labelling requirements	B3 Labelling, marking, and packaging requirements
B32	Marking requirements	
B33	Packaging requirements	
B41	TBTs regulations on production processes	B4 Production or post-production requirements
B42	TBT regulations on transport and storage	
B49	Production or post-production requirements not elsewhere specified	
B6	Product identity requirements	B6 Product identity requirements
B7	Product quality, safety, or performance requirements	B7 Product quality, safety, or performance requirements
B81	Product registration/approval requirements	B8 Conformity assessment related to TBTs
B82	Testing requirements	
B83	Certification requirements	
B84	Inspection requirements	
B85	Traceability requirements	
B89	Conformity assessment related to TBTs not elsewhere specified	
B9	TBT measures not elsewhere specified	B9 TBT measures not elsewhere specified

MAST = Multi-Agency Support Team, TBT = technical barrier to trade.
Source: UNCTAD (2022), UNCTAD TRAINS I-TIP.
https://trainsonline.unctad.org/bulkDataDownload (accessed 19 September 2022).

Table A4: List of Three-Digit SPS Subgroups in MAST Classification, 2019

Three-digit SPS Subgroup No.	Three-digit SPS Subgroup	Two-digit SPS Subgroup
A11	Prohibitions for SPS reasons	A1 Prohibitions/restrictions of imports for SPS reasons
A12	Geographical restrictions on eligibility	
A13	Systems approach	
A14	Authorization requirement for SPS reasons for importing certain products	
A15	Authorization requirement for importers for SPS reasons	
A19	Prohibitions or restrictions of imports for SPS reasons, not elsewhere specified	
A21	Tolerance limits for residues of or contamination by certain (non-microbiological) substances	A2 Tolerance limits for residues and restricted use of substances
A22	Restricted use of certain substances in foods and feeds and their contact materials	
A31	Labelling requirements	A3 Labelling, marking, and packaging requirements
A32	Marking requirements	A3 Labelling, marking, and packaging requirements
A33	Packaging requirements	A3 Labelling, marking, and packaging requirements
A41	Microbiological criteria of the final product	A4 Hygienic requirements related to SPS conditions
A42	Hygienic practices during production related to SPS conditions	
A49	Hygienic requirements not elsewhere specified	
A51	Cold or heat treatment	A5 Treatment for elimination of plant and animal pests and disease-causing organisms in the final product or prohibition of treatment
A52	Irradiation	
A53	Fumigation	
A59	Treatments to eliminate plants and animal pests or disease-causing organisms in the final product not elsewhere specified or prohibition of treatment	
A61	Plant-growth processes	

A62	Animal-raising or -catching processes	A6 Other requirements relating to production or post-production processes
A63	Food and feed processing	
A64	Storage and transport conditions	
A69	Other requirements relating to production or post-production processes not elsewhere specified	
A81	Product registration and approval requirement	A8 Conformity assessment related to SPS conditions
A82	Testing requirements	
A83	Certification requirements	
A84	Inspection requirements	
A85	Traceability requirements	
A86	Quarantine requirements	
A89	Conformity assessment related to SPS conditions not elsewhere specified	
A9	SPS measures not elsewhere specified	A9 SPS measures not elsewhere specified

MAST = Multi-Agency Support Team, SPS = sanitary and phytosanitary.
Source: UNCTAD (2022), UNCTAD TRAINS I-TIP.
https://trainsonline.unctad.org/bulkDataDownload (accessed 19 September 2022).

Table A5: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Non-Services Sectors, 2004–2020, Using UNCTAD NTMs

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-1.02*	-0.048	-1.90***	-0.93***
	(0.59)	(0.39)	(0.45)	(0.36)
D^{SPS}_{ijst}	-0.095	-0.057	-0.22	0.72**
	(0.55)	(0.32)	(0.52)	(0.34)
$prod_{ft} \times D^{TBT}_{ijst}$	0.077	-0.0050	0.17***	0.078**
	(0.062)	(0.040)	(0.043)	(0.031)
$prod_{ft} \times D^{SPS}_{ijst}$	0.023	0.027	0.034	-0.045
	(0.057)	(0.032)	(0.051)	(0.030)
$\mathrm{arc}\, T_{ijst}$	0.15*	0.17**	0.68***	1.01***
	(0.083)	(0.077)	(0.24)	(0.22)
$\mathrm{arc}\, T_{jist}$	0.27**	0.30**	-0.12	0.92***
	(0.12)	(0.12)	(0.28)	(0.33)
$prod_{ft}$	0.24***	0.078***	0.26***	0.065***
	(0.021)	(0.011)	(0.013)	(0.013)
l_{ft}	0.46***	0.17***	0.49***	0.12***
	(0.029)	(0.015)	(0.023)	(0.025)
GDP^{sim}_{jit}	0.13**	0.14	0.21*	0.22*
	(0.064)	(0.094)	(0.11)	(0.12)
HC^{dif}_{jit}	0.017***	0.022***	0.023**	0.014*
	(0.0063)	(0.0061)	(0.011)	(0.0084)
KL^{dif}_{jit}	-0.0041	-0.020***	0.00029	-0.0072
	(0.0043)	(0.0058)	(0.0072)	(0.0070)
Constant	17.4***	20.4***	17.0***	19.9***
	(0.36)	(0.32)	(0.36)	(0.37)
Observations	165,262	164,436	64,785	64,635
Pseudo R-squared	0.988	0.990	0.987	0.990
AIC	1.22271e+12	1.19281e+12	3.82665e+11	2.61380e+11

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, UNCTAD = United Nations Conference on Trade and Development.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

Table A6: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Non-Services Sectors, 2004–2020, Using WTO NTM Notifications, Without Interaction Terms

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	0.065	-0.26	0.089	-0.45
	(0.19)	(0.19)	(0.30)	(0.29)
D^{SPS}_{ijst}	-0.52	-0.46	0.85	0.41
	(0.43)	(0.46)	(0.67)	(0.67)
$\mathrm{arc}\,T_{ijst}$	0.15*	0.16**	0.70***	1.03***
	(0.083)	(0.076)	(0.24)	(0.22)
$\mathrm{arc}\,T_{jist}$	0.27**	0.32***	-0.12	0.98***
	(0.12)	(0.12)	(0.28)	(0.33)
$prod_{ft}$	0.25***	0.078***	0.28***	0.075***
	(0.017)	(0.0081)	(0.013)	(0.012)
l_{ft}	0.46***	0.17***	0.49***	0.12***
	(0.030)	(0.015)	(0.023)	(0.025)
GDP^{sim}_{jit}	0.14**	0.14	0.23**	0.22*
	(0.065)	(0.095)	(0.11)	(0.12)
HC^{dif}_{jit}	0.017***	0.023***	0.022**	0.015*
	(0.0063)	(0.0062)	(0.011)	(0.0085)
KL^{dif}_{jit}	-0.0033	-0.020***	0.0013	-0.0082
	(0.0044)	(0.0058)	(0.0072)	(0.0071)
Constant	17.3***	20.5***	16.7***	19.8***
	(0.34)	(0.31)	(0.36)	(0.37)
Observations	165,262	164,436	64,785	64,635
Pseudo R-squared	0.988	0.990	0.987	0.990
AIC	1.22352e+12	1.19281e+12	3.83734e+11	2.61516e+11

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

Table A7: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Non-Services Sectors Excluding Relations that are done with M&A Deals, 2004–2020, Using WTO NTMs

Dep. var.	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-3.93***	-2.65***	-2.93***	-2.91***
	(0.84)	(0.51)	(0.70)	(0.54)
D^{SPS}_{ijst}	-1.24*	0.12	0.55	1.36*
	(0.75)	(0.54)	(0.91)	(0.78)
$prod_{ft} \times D^{TBT}_{ijst}$	0.44***	0.27***	0.36***	0.30***
	(0.091)	(0.053)	(0.072)	(0.052)
$prod_{ft} \times D^{SPS}_{ijst}$	0.089	-0.027	0.086	-0.025
	(0.059)	(0.035)	(0.056)	(0.036)
$\text{arc}\, T_{ijst}$	0.13	0.16**	0.69***	0.95***
	(0.084)	(0.078)	(0.24)	(0.23)
$\text{arc}\, T_{jist}$	0.19	0.31***	-0.11	1.23***
	(0.12)	(0.12)	(0.28)	(0.40)
$prod_{ft}$	0.16***	0.041***	0.20***	0.044***
	(0.029)	(0.013)	(0.017)	(0.0095)
l_{ft}	0.45***	0.18***	0.48***	0.16***
	(0.030)	(0.011)	(0.023)	(0.011)
GDP^{sim}_{jit}	0.16**	0.10	0.18	0.18
	(0.065)	(0.10)	(0.12)	(0.13)
HC^{dif}_{jit}	0.013*	0.022***	0.023*	0.023**
	(0.0066)	(0.0067)	(0.013)	(0.0098)
KL^{dif}_{jit}	-0.0065	-0.021***	0.0011	-0.011
	(0.0047)	(0.0066)	(0.0081)	(0.0081)
Constant	18.2***	20.5***	17.2***	19.7***
	(0.42)	(0.33)	(0.38)	(0.34)
Observations	157,504	156,766	61,017	60,908
Pseudo R-squared	0.988	0.989	0.987	0.989
AIC	1.11807e+12	1.09867e+12	3.32123e+11	2.21952e+11

AIC = Akaike information criterion, Dep. var. = dependent variable, M&A = mergers and acquisitions, NTM = non-tariff measure, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.

Source: Authors' estimations.

Table A8: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Non-Services Sectors, Including PTAs with NTM Provisions, 2004–2020, Using WTO NTMs

Dep. var.	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
D^{TBT}_{ijst}	-4.15***	-3.95***	-2.58***	-2.06***	-3.52***	-3.02***	-2.52***	-1.43**
	(0.82)	(0.86)	(0.50)	(0.52)	(0.72)	(0.76)	(0.57)	(0.58)
D^{SPS}_{ijst}	-1.13	-0.81	0.034	0.38	-0.22	0.27	0.83	0.67
	(0.72)	(0.70)	(0.57)	(0.54)	(0.95)	(0.96)	(0.76)	(0.77)
$prod_{ft} \times D^{TBT}_{ijst}$	0.46***	0.43***	0.25***	0.21***	0.40***	0.37***	0.23***	0.16***
	(0.088)	(0.092)	(0.052)	(0.054)	(0.075)	(0.077)	(0.057)	(0.057)
$prod_{ft} \times D^{SPS}_{ijst}$	0.10*	0.11*	-0.026	0.0034	0.14**	0.073	-0.018	-0.019
	(0.058)	(0.061)	(0.034)	(0.034)	(0.059)	(0.060)	(0.032)	(0.033)
$\mathrm{arc}\,T_{jist}$	0.11	0.10	0.14*	0.085	0.64***	0.69***	1.12***	1.07***
	(0.082)	(0.083)	(0.075)	(0.077)	(0.24)	(0.25)	(0.22)	(0.23)
$\mathrm{arc}\,T_{ijst}$	0.21*	0.22*	0.27**	0.32***	-0.030	-0.062	1.23***	1.25***
	(0.12)	(0.12)	(0.12)	(0.12)	(0.29)	(0.29)	(0.33)	(0.33)
$prod_{ft}$	0.16***	0.17***	0.040***	0.046***	0.20***	0.21***	0.035***	0.041***
	(0.028)	(0.029)	(0.012)	(0.012)	(0.016)	(0.017)	(0.010)	(0.010)
l_{ft}	0.46***	0.46***	0.18***	0.17***	0.49***	0.49***	0.12***	0.12***
	(0.028)	(0.029)	(0.015)	(0.015)	(0.023)	(0.023)	(0.026)	(0.025)
GDP^{sim}_{jit}	0.13**	0.13**	0.12	0.14	0.21*	0.21*	0.21*	0.27**
	(0.064)	(0.064)	(0.095)	(0.095)	(0.11)	(0.11)	(0.12)	(0.12)
HC^{dif}_{jit}	0.013**	0.015**	0.021***	0.021***	0.019*	0.019*	0.014	0.012
	(0.0064)	(0.0064)	(0.0061)	(0.0061)	(0.011)	(0.011)	(0.0085)	(0.0085)
KL^{dif}_{jit}	-0.0037	-0.0046	-0.020***	-0.021***	-0.00042	-0.00033	-0.011	-0.012*
	(0.0044)	(0.0044)	(0.0058)	(0.0058)	(0.0069)	(0.0069)	(0.0070)	(0.0070)
PTA^{TBT}_{jit}	0.12	0.87*	0.34***	1.41***	-0.0082	1.27**	0.40***	2.04***
	(0.15)	(0.45)	(0.11)	(0.28)	(0.14)	(0.53)	(0.11)	(0.37)

Dep. var.	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$Y^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$	$K^{100\%}_{fgijs\varrho,t+1}$
PTA^{SPS}_{jit}	-0.18	-0.24	-0.39***	-0.66***	-0.016	-0.73*	-0.34***	-1.17***
	(0.15)	(0.41)	(0.11)	(0.25)	(0.13)	(0.44)	(0.11)	(0.20)
$PTA^{TBT}_{jit} \times D^{TBT}_{ijst}$		-2.90**		-4.69***		-2.56		-6.80***
		(1.41)		(1.42)		(1.77)		(2.06)
$PTA^{SPS}_{jit} \times D^{SPS}_{ijst}$		-0.46		0.35		-3.03**		0.64
		(1.16)		(1.05)		(1.19)		(0.81)
$PTA^{TBT}_{jit} \times prod_{ft}$		-0.091**		-0.12***		-0.14***		-0.18***
		(0.041)		(0.028)		(0.052)		(0.041)
$PTA^{SPS}_{jit} \times prod_{ft}$		0.011		0.045*		0.085**		0.11***
		(0.038)		(0.026)		(0.041)		(0.020)
$PTA^{TBT}_{jit} \times prod_{ft} \times D^{TBT}_{ijst}$		0.35**		0.48***		0.24		0.63***
		(0.15)		(0.15)		(0.19)		(0.23)
$PTA^{SPS}_{jit} \times prod_{ft} \times D^{SPS}_{ijst}$		0.021		-0.13		0.34***		-0.11
		(0.13)		(0.11)		(0.13)		(0.085)
Constant	18.0***	17.9***	20.8***	20.7***	17.3***	17.2***	20.1***	20.2***
	(0.41)	(0.42)	(0.32)	(0.32)	(0.36)	(0.37)	(0.36)	(0.35)
Observations	165,262	165,262	164,436	164,436	64,785	64,785	64,635	64,635
Pseudo R-squared	0.989	0.989	0.990	0.990	0.987	0.987	0.990	0.990
AIC	1.21381e+12	1.21244e+12	1.18926e+12	1.18721e+12	3.81626e+11	3.81168e+11	2.60618e+11	2.58899e+11

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, PTA = preferential trade agreement, WTO = World Trade Organization.
Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.
Source: Authors' estimations.

Table A9: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Non-Services Sectors by Country-Pair Groups, 2004–2020, Using WTO NTMs

	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$
Host-Home	**Developed-developed**	**Developing-developed**	**Developed-developing**	**ASEAN - World**	**World-ASEAN**	**Developed-developed**	**Developing-developed**	**Developed-developing**	**ASEAN - World**	**World-ASEAN**
D_{ijst}^{TBT}	-2.30	-0.37	-21.6***	3.98	13.5***	-2.88*	-1.40**	-3.11	-1.83	6.78***
	(2.91)	(0.87)	(5.58)	(3.52)	(3.88)	(1.55)	(0.55)	(2.46)	(1.71)	(2.49)
D_{ijst}^{SPS}	-1.15	1.33	5.94	-2.96	4.19*	-2.44*	1.65**	2.64	-3.17	2.89*
	(1.54)	(0.86)	(6.62)	(3.34)	(2.15)	(1.40)	(0.72)	(4.75)	(2.10)	(1.54)
$prod_{ft} \times D_{ijst}^{TBT}$	0.33	0.13	2.62***	-0.70**	-1.31***	0.36**	0.18***	0.69***	-0.063	-0.65***
	(0.32)	(0.081)	(0.60)	(0.32)	(0.39)	(0.16)	(0.049)	(0.23)	(0.14)	(0.24)
$prod_{ft} \times D_{ijst}^{SPS}$	0.0096	0.15**	-0.16	0.23	-0.52***	-0.064	0.048	-0.20	-0.19	-0.37***
	(0.15)	(0.067)	(0.35)	(0.25)	(0.17)	(0.11)	(0.036)	(0.19)	(0.18)	(0.12)
$\mathrm{arc}\,T_{ijst}$	0.057	0.083	1.65	4.24	0.53	0.25	0.27***	2.14	24.2*	3.77***
	(0.12)	(0.075)	(2.18)	(15.7)	(0.98)	(0.16)	(0.060)	(1.46)	(12.7)	(1.11)
$\mathrm{arc}\,T_{jist}$	0.38	0.45***	5.87***	-0.076	-0.45	0.65	0.44***	8.61***	-0.35	-3.99
	(0.42)	(0.16)	(2.19)	(0.73)	(3.31)	(0.43)	(0.15)	(2.16)	(0.62)	(3.25)
$prod_{ft}$	0.26**	0.19***	-0.29**	0.38***	0.63***	0.041	0.038***	-0.12***	0.13***	0.29***
	(0.10)	(0.020)	(0.14)	(0.057)	(0.080)	(0.035)	(0.014)	(0.037)	(0.026)	(0.039)
l_{ft}	0.61***	0.43***	0.31***	0.43***	0.83***	0.23***	0.17***	0.061***	0.16***	0.36***
	(0.049)	(0.021)	(0.065)	(0.061)	(0.057)	(0.018)	(0.015)	(0.020)	(0.030)	(0.025)
GDP_{jit}^{sim}	0.35**	-0.13	0.48		4.11***	1.31***	-0.14	0.99**		-0.73
	(0.17)	(0.089)	(0.35)		(1.21)	(0.49)	(0.100)	(0.43)		(2.32)
HC_{jit}^{dif}	0.014*	0.22***	-0.097***	0.12**	0.043	0.028***	0.18***	-0.10***	-0.14***	0.067**
	(0.0072)	(0.051)	(0.033)	(0.058)	(0.031)	(0.0075)	(0.035)	(0.028)	(0.042)	(0.030)

	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$Y_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$	$K_{fgijs\varrho,t+1}$
Host-Home	**Developed-developed**	**Developing -developed**	**Developed-developing**	**ASEAN - World**	**World-ASEAN**	**Developed-developed**	**Developing -developed**	**Developed-developing**	**ASEAN - World**	**World-ASEAN**
$\boldsymbol{KL_{jit}^{dif}}$	-0.00021	0.042***	-0.12***	0.44**	-0.17***	-0.020***	-0.054***	-0.000053	0.70***	-0.073*
	(0.0044)	(0.014)	(0.042)	(0.20)	(0.057)	(0.0075)	(0.012)	(0.021)	(0.17)	(0.041)
Constant	17.2***	15.9***	24.3***	10.5***	25.4***	23.9***	19.2***	22.9***	9.87***	16.1***
	(1.27)	(0.38)	(2.02)	(2.27)	(3.52)	(1.27)	(0.34)	(0.91)	(2.10)	(6.16)
Observations	78,855	47,197	14,877	3,080	2,783	77,799	47,006	14,951	3,088	2,749
Pseudo R-squared	0.992	0.984	0.994	0.996	0.988	0.991	0.985	0.995	0.998	0.994
AIC	4.07556e+11	2.73066e+11	6.27212e+10	6.63604e+09	1.80772e+10	5.91441e+11	2.01143e+11	4.91429e+10	3.35192e+09	1.16598e+10

AIC = Akaike information criterion, Dep. var. = dependent variable, NTM = non-tariff measure, WTO = World Trade Organization.
Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects.
Source: Authors' estimations.

Table A10: Estimation Results on Total Assets and Turnover of Global Foreign-Owned Subsidiaries in Non-Services Sectors Excluding Using OLS and GMM, and First Difference of Total Assets, 2004–2020, Using WTO NTMs

	1- OLS	2- OLS	3- OLS	4- OLS	5- OLS	6- OLS	7- GMM	8- GMM
Dep. var.	$\mathrm{arc}\,Y_{fgijs\varrho,t+1}$	$\mathrm{arc}\,K_{fgijs\varrho,t+1}$	$\mathrm{arc}\,Y^{100\%}_{fgijs\varrho,t+1}$	$\mathrm{arc}\,K^{100\%}_{fgijs\varrho,t+1}$	$\mathrm{arc}\,\Delta K_{fgijs\varrho,t}$	$\mathrm{arc}\,\Delta K^{100\%}_{fgijs\varrho,t}$	$\mathrm{arc}\,Y_{fgijs\varrho,t}$	$\mathrm{arc}\,K_{fgijs\varrho,t}$
D^{TBT}_{ijst}	4.20***	-0.87**	2.69	-1.56**	2.71	8.32	14.1	-12.9*
	(1.08)	(0.42)	(1.67)	(0.71)	(5.91)	(10.6)	(11.7)	(7.05)
D^{SPS}_{ijst}	0.28	1.03**	0.81	0.15	0.45	-15.0	-3.96	16.4
	(1.16)	(0.46)	(2.34)	(0.82)	(7.32)	(13.1)	(16.2)	(10.7)
$prod_{ft} \times D^{TBT}_{ijst}$	-0.49***	0.059	-0.37**	0.0095	-0.77*	-1.60**	-1.41	2.19***
	(0.12)	(0.042)	(0.18)	(0.069)	(0.46)	(0.77)	(1.23)	(0.66)
$prod_{ft} \times D^{SPS}_{ijst}$	0.18*	0.0052	0.26*	0.037	1.04***	1.95***	-0.17	-1.50
	(0.096)	(0.035)	(0.15)	(0.060)	(0.37)	(0.59)	(1.96)	(1.23)
$\mathrm{arc}\,T_{ijst}$	0.43*	0.30	1.56***	1.34***	-2.45	1.64	-1.51	-4.45**
	(0.23)	(0.22)	(0.56)	(0.40)	(2.41)	(5.42)	(3.38)	(2.12)
$\mathrm{arc}\,T_{jist}$	-0.58	-0.089	0.040	0.42	-6.46*	-18.3*	-4.71*	-2.21
	(0.56)	(0.19)	(0.57)	(0.42)	(3.50)	(10.4)	(2.69)	(2.34)
$prod_{ft}$	0.58***	0.11***	0.50***	0.11***	-0.87***	-0.81***	1.05***	-0.051
	(0.023)	(0.0071)	(0.035)	(0.011)	(0.070)	(0.11)	(0.18)	(0.084)
l_{ft}	1.10***	0.36***	0.95***	0.32***	-2.51***	-2.38***	1.22***	0.43***
	(0.021)	(0.0092)	(0.031)	(0.015)	(0.13)	(0.23)	(0.16)	(0.11)
GDP^{sim}_{jit}	0.15	-0.028	0.32	0.033	-4.15***	-5.02*	-0.98	1.61**
	(0.15)	(0.081)	(0.27)	(0.15)	(1.50)	(2.88)	(0.63)	(0.66)
HC^{dif}_{jit}	-0.018*	0.0074	-0.025	0.011	-0.042	0.53*	-0.073	-0.080
	(0.010)	(0.0057)	(0.016)	(0.0099)	(0.16)	(0.29)	(0.27)	(0.22)
KL^{dif}_{jit}	0.013	0.0062	0.043*	0.022***	-0.26**	-0.055	0.18	0.026

	1- OLS	2- OLS	3- OLS	4- OLS	5- OLS	6- OLS	7- GMM	8- GMM
Dep. var.	**arc** $\boldsymbol{Y_{fgijs\varrho,t+1}}$	**arc** $\boldsymbol{K_{fgijs\varrho,t+1}}$	**arc** $\boldsymbol{Y^{100\%}_{fgijs\varrho,t+1}}$	**arc** $\boldsymbol{K^{100\%}_{fgijs\varrho,t+1}}$	**arc** $\boldsymbol{\Delta K_{fgijs\varrho,t}}$	**arc** $\boldsymbol{\Delta K^{100\%}_{fgijs\varrho,t}}$	**arc** $\boldsymbol{Y_{fgijs\varrho,t}}$	**arc** $\boldsymbol{K_{fgijs\varrho,t}}$
	(0.011)	(0.0052)	(0.024)	(0.0082)	(0.11)	(0.20)	(0.22)	(0.12)
$\boldsymbol{Y_{fgijs\varrho,t-1} \wedge K_{fgijs\varrho,t-1}}$							0.040	0.12***
							(0.071)	(0.020)
$\boldsymbol{Y_{fgijs\varrho,t-2} \wedge K_{fgijs\varrho,t-2}}$							0.0069	-0.0039
							(0.020)	(0.017)
Constant	10.9***	15.5***	11.5***	15.4***	5.30	2.40	1.78	12.2***
	(0.43)	(0.22)	(0.73)	(0.39)	(4.01)	(7.48)	(3.13)	(3.16)
Observations	167,016	164,455	65,681	64,652	159,359	62,779	250,423	256,236
R-squared	0.921	0.961	0.933	0.969	0.409	0.446		
Adjusted R-squared	0.896	0.948	0.902	0.955	0.205	0.183		
AIC	495751.6	266362.0	193097.9	100133.7	1226563.8	476933.9		
P AR(1) in first differences							0.033	0
P AR(2) in first differences							0.345	0.599
P Sargan test of overid. Restrictions							0.227	0.667
P Hansen test of overid. Restrictions							0.535	0.09

AIC = Akaike information criterion, Dep. var. = dependent variable, GMM = generalised method of moments, NTM = non-tariff measure, OLS = ordinary least squares, WTO = World Trade Organization.

Notes: Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01. Estimations include subsidiary γ_f, GUO γ_g, home-sector-time γ_{ist}, host-sector-time γ_{jst}, home-host-sector γ_{ijs}, and sector of GUO-time $\gamma_{\varrho t}$ fixed effects. For GMM estimation on $\boldsymbol{Y_{fgijs\varrho,t}}$, instruments for first differences equation: Difference in L(2/3).($\boldsymbol{prod_{ft}}$, and $\boldsymbol{l_{ft}}$); instruments for levels equation: year-fixed effects, and $max\{\boldsymbol{PTA^{TBT}_{jit}}, \boldsymbol{PTA^{SPS}_{jit}}\}$. For GMM estimation on $\boldsymbol{K_{fgijs\varrho,t}}$, instruments for first differences equation: Difference in L(2/3).($\boldsymbol{K_{fgijs\varrho,t-1}}$, $\boldsymbol{prod_{ft}}$, and $\boldsymbol{l_{ft}}$); instruments for levels equation: year-fixed effects, and $max\{\boldsymbol{PTA^{TBT}_{jit}}, \boldsymbol{PTA^{SPS}_{jit}}\}$.

Source: Authors' estimations.

Table A11: Summary Statistics on Indicators of Foreign-Owned Firms in the Sample of Study Averaged Over the Period by NACE Two-Digit Sector

Technology Category	**NACE**	**Description**	**Total Assets** ($ billion)	**Turnover** ($ billion)	**No. of Employees** ('000)	**No. of Firms**	**Average Total Assets** ($ million)	**Average Turnover** ($ million)	**Simple Average Labour Productivity** ($'000)	**Average No. of Employees**	**Aggregate Labour Productivity** ($'000)
Agriculture	01	Crop and animal production, hunting	29	19	143	1,756	17	11	141	81	131
Agriculture	02	Forestry and logging	3	1	5	94	32	15	859	56	266
Agriculture	03	Fishing and aquaculture	3	2	5	120	24	20	322	38	527
Mining	05	Mining of coal and lignite	174	77	94	100	1,738	769	9,173	937	821
Mining	06	Extraction of crude petroleum and gas	183	115	49	208	881	555	11,809	237	2,342
Mining	07	Mining of metal ores	127	58	187	176	721	331	4,714	1,060	313
Mining	08	Other mining and quarrying	32	13	37	356	90	35	229	105	336
Low-tech	10	Manufacture of food products	227	264	920	2,249	101	117	1,567	409	287
Low-tech	11	Manufacture of beverages	112	73	294	495	227	147	2,336	595	246

Technology Category	NACE	Description	Total Assets ($ billion)	Turnover ($ billion)	No. of Employees ('000)	No. of Firms	Average Total Assets ($ million)	Average Turnover ($ million)	Simple Average Labour Productivity ($'000)	Average No. of Employees	Aggregate Labour Productivity ($'000)
Low-tech	12	Manufacture of tobacco products	20	33	51	47	429	707	1,520	1,090	649
Low-tech	13	Manufacture of textiles	21	20	178	449	47	45	688	397	115
Low-tech	14	Manufacture of wearing apparel	15	14	183	540	29	27	554	338	79
Low-tech	15	Manufacture of leather and products	4	6	201	197	18	30	407	1,019	30
Low-tech	16	Manufacture of wood and of products, except furniture	13	11	61	555	24	20	304	110	179
Low-tech	17	Manufacture of paper and paper products	111	86	311	538	207	159	1,307	578	276
Low-tech	18	Printing and reproduction of recorded media	6	6	40	298	21	21	532	135	157
Medium-low-tech	19	Manufacture of coke and refined	83	103	33	103	805	1000	9,218	316	3,169

Technology Category	**NACE**	**Description**	**Total Assets** ($ billion)	**Turnover** ($ billion)	**No. of Employees** ('000)	**No. of Firms**	**Average Total Assets** ($ million)	**Average Turnover** ($ million)	**Simple Average Labour Productivity** ($'000)	**Average No. of Employees**	**Aggregate Labour Productivity** ($'000)
		petroleum products									
Medium-high-tech	20	Manufacture of chemicals and chemical products	342	316	657	2,262	151	140	2,114	291	481
High-tech	21	Manufacture of basic pharmaceutical products	293	211	373	629	466	336	1,832	593	566
Medium-low-tech	22	Manufacture of rubber and plastic products	102	105	492	1,770	58	60	945	278	215
Medium-low-tech	23	Manufacture of other non-metallic mineral products	115	72	303	1,044	110	69	3,608	290	238
Medium-low-tech	24	Manufacture of basic metals	182	157	505	640	284	246	1,021	789	312
Medium-low-tech	25	Manufacture of fabricated metal products,	104	94	493	2,014	52	47	742	245	191

Technology Category	**NACE**	**Description**	**Total Assets** ($ billion)	**Turnover** ($ billion)	**No. of Employees** ('000)	**No. of Firms**	**Average Total Assets** ($ million)	**Average Turnover** ($ million)	**Simple Average Labour Productivity** ($'000)	**Average No. of Employees**	**Aggregate Labour Productivity** ($'000)
		except machinery									
High-tech	26	Manufacture of computer, electronic and optical products	572	823	3,500	2,519	227	327	5,359	1,389	235
Medium-high-tech	27	Manufacture of electrical equipment	155	172	796	1,434	108	120	2,469	555	216
Medium-high-tech	28	Manufacture of machinery and equipment n.e.c.	241	241	868	2,963	81	81	1,248	293	278
Medium-high-tech	29	Manufacture of motor vehicles, trailers, and semi-trailers	291	444	1,215	1,793	162	248	3,104	677	366
Medium-high-tech	30	Manufacture of other transport equipment	74	49	205	431	171	114	1,713	477	240
Low-tech	31	Manufacture of furniture	6	7	59	288	20	23	354	207	110

Technology Category	**NACE**	**Description**	**Total Assets** ($ billion)	**Turnover** ($ billion)	**No. of Employees** ('000)	**No. of Firms**	**Average Total Assets** ($ million)	**Average Turnover** ($ million)	**Simple Average Labour Productivity** ($'000)	**Average No. of Employees**	**Aggregate Labour Productivity** ($'000)
Low-tech	32	Other manufacturing	84	76	329	1,097	77	70	1,650	300	232

NACE = Nomenclature of Economic Activities, n.e.c. = not elsewhere classified.
Source: Bureau van Dijk (2022), Orbis. https://login.bvdinfo.com/R0/Orbis (accessed September–November 2022); authors' elaboration.

Table A12: Summary Statistics on Indicators of Foreign-Owned Firms in the Sample of Study Averaged Over the Period by Host Economy

ISO3	**Host**	**Total Assets** ($ billion)	**Turnover** ($ billion)	**No. of Employees** ('000)	**No. of Firms**	**Average Total Assets,** ($ million)	**Average Turnover** ($ million)	**Simple Average Labour Productivity** ($'000)	**Average Number of Employees**	**Aggregate Labour Productivity** ($'000)
AUS	Australia	363.13	210.90	383.24	539	674	391	7,125	711	550
AUT	Austria	27.66	32.79	71.21	193	143	170	849	369	460
BEL	Belgium	118.85	99.23	80.25	427	278	232	986	188	1,237
BGD	Bangladesh	0.76	0.64	5.26	8	95	81	226	658	123
BGR	Bulgaria	4.90	4.59	40.18	236	21	19	109	170	114
BRA	Brazil	0.03	0.02	0.19	2	16	11	116	94	114
CHE	Switzerland	0.20	0.15	0.61	2	102	76	303	303	251
CHL	Chile	0.39	0.28	1.72	2	194	141	180	858	165
CHN	China	888.88	1,123.58	5,206.49	5,147	173	218	7,269	1,012	216
CYP	Cyprus	1.40	0.63	7.05	2	701	316	78	3,527	90
CZE	Czech Republic	29.59	39.16	156.87	596	50	66	211	263	250
DEU	Germany	231.97	275.43	539.16	1,773	131	155	976	304	511
DNK	Denmark	15.86	10.33	23.33	93	171	111	1,453	251	443
EGY	Egypt	0.24	0.23	0.88	2	119	114	1,048	438	261
ESP	Spain	81.77	78.71	151.01	770	106	102	497	196	521
EST	Estonia	0.71	0.79	5.93	48	15	16	148	124	133
FIN	Finland	15.54	14.45	35.70	162	96	89	1,159	220	405
FRA	France	92.69	114.43	251.84	1,139	81	100	434	221	454
GBR	United Kingdom	529.49	440.29	822.14	2,400	221	183	1,011	343	536
GHA	Ghana	0.07	0.10	1.15	2	37	48	84	573	84

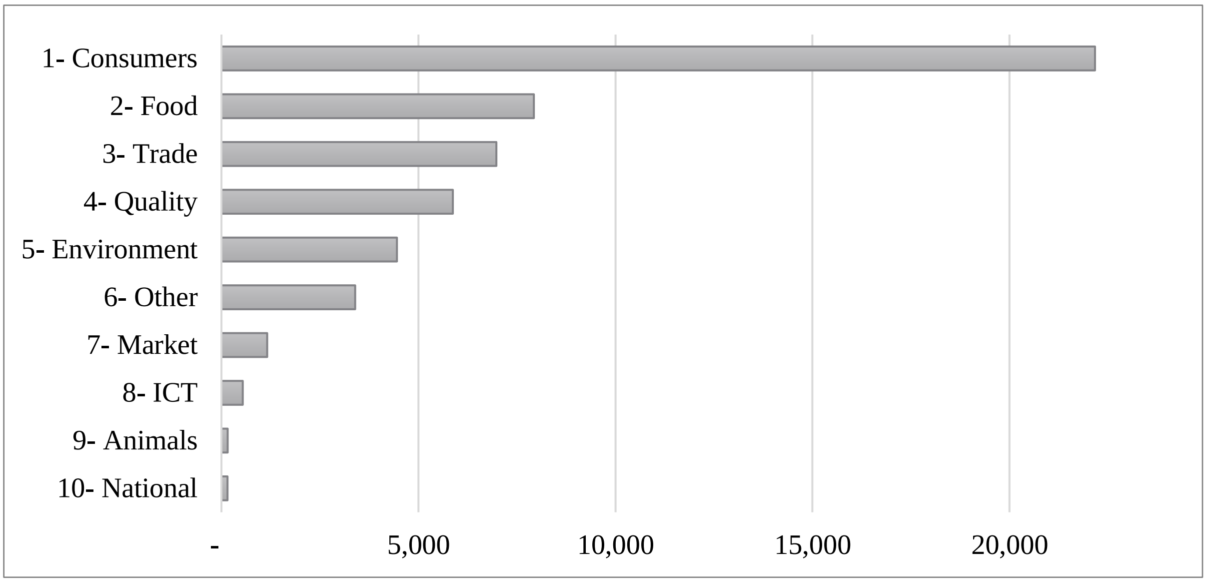
ISO3	Host	Total Assets ($ billion)	Turnover ($ billion)	No. of Employees ('000)	No. of Firms	Average Total Assets, ($ million)	Average Turnover ($ million)	Simple Average Labour Productivity ($'000)	Average Number of Employees	Aggregate Labour Productivity ($'000)
GRC	Greece	0.80	0.70	1.57	15	54	47	318	104	448
HKG	Hong Kong	145.95	122.44	659.79	51	2,862	2,401	413	12,937	186
HRV	Croatia	5.69	4.71	30.91	272	21	17	163	114	153
HUN	Hungary	24.27	26.50	95.41	206	118	129	1,861	463	278
IDN	Indonesia	21.42	20.25	101.66	28	765	723	596	3,631	199
IND	India	37.49	41.66	164.62	71	528	587	445	2,319	253
IRL	Ireland	185.21	99.41	46.95	209	886	476	4,684	225	2,118
ISL	Iceland	2.70	2.05	4.86	21	129	98	639	232	422
ISR	Israel	3.22	1.50	3.59	4	804	375	283	898	418
ITA	Italy	127.51	117.36	222.54	1,618	79	73	461	138	527
JPN	Japan	16.75	16.87	31.05	60	279	281	483	517	543
KAZ	Kazakhstan	25.55	16.42	146.46	51	501	322	131	2,872	112
KOR	Rep. of Korea	69.86	83.07	132.74	486	144	171	906	273	626
LKA	Sri Lanka	0.13	0.32	1.75	2	65	161	201	875	184
LTU	Lithuania	1.94	1.77	13.66	90	22	20	115	152	130
LUX	Luxembourg	2.63	6.36	6.21	11	239	578	977	564	1,024
LVA	Latvia	0.88	1.17	5.99	230	4	5	93	26	196
MDA	Moldova	0.48	0.45	7.94	27	18	17	115	294	56
MEX	Mexico	0.39	0.30	2.34	9	44	33	142	260	129
MLT	Malta	0.48	0.45	2.34	8	60	56	1,853	292	194
MYS	Malaysia	16.44	27.36	126.56	122	135	224	404	1,037	216
NGA	Nigeria	3.85	2.86	12.36	11	350	260	211	1,124	231

ISO3	Host	Total Assets ($ billion)	Turnover ($ billion)	No. of Employees ('000)	No. of Firms	Average Total Assets, ($ million)	Average Turnover ($ million)	Simple Average Labour Productivity ($'000)	Average Number of Employees	Aggregate Labour Productivity ($'000)
NLD	Netherlands	112.77	125.44	135.43	336	336	373	5,145	403	926
NOR	Norway	54.83	34.77	48.26	337	163	103	690	143	721
PAK	Pakistan	3.12	5.40	22.57	20	156	270	297	1,129	239
POL	Poland	40.14	53.63	241.63	646	62	83	280	374	222
PRT	Portugal	6.31	6.45	30.77	225	28	29	311	137	210
ROU	Romania	12.68	15.01	126.12	910	14	16	101	139	119
RUS	Russia	135.83	132.47	792.08	2,614	52	51	276	303	167
SGP	Singapore	0.35	0.64	9.01	3	117	214	820	3,003	71
SVK	Slovak Republic	15.13	25.53	77.49	280	54	91	287	277	329
SVN	Slovenia	4.17	4.02	18.15	67	62	60	237	271	222
SWE	Sweden	40.68	49.74	86.27	434	94	115	462	199	576
TUR	Turkey	2.98	3.14	15.34	20	149	157	263	767	204
TWN	Taiwan	0.70	0.52	2.04	3	235	175	285	680	257
TZA	Tanzania	0.33	0.26	0.64	2	163	128	406	320	401
UKR	Ukraine	29.14	26.69	364.75	3,209	9	8	63	114	73
USA	United States	98.85	54.92	185.92	36	2,746	1,526	325	5,165	295
VNM	Viet Nam	56.08	81.06	787.37	875	64	93	921	900	103
ZAF	South Africa	12.73	10.59	37.32	3	4,242	3,529	239	12,440	284

ISO = International Organization for Standardization.

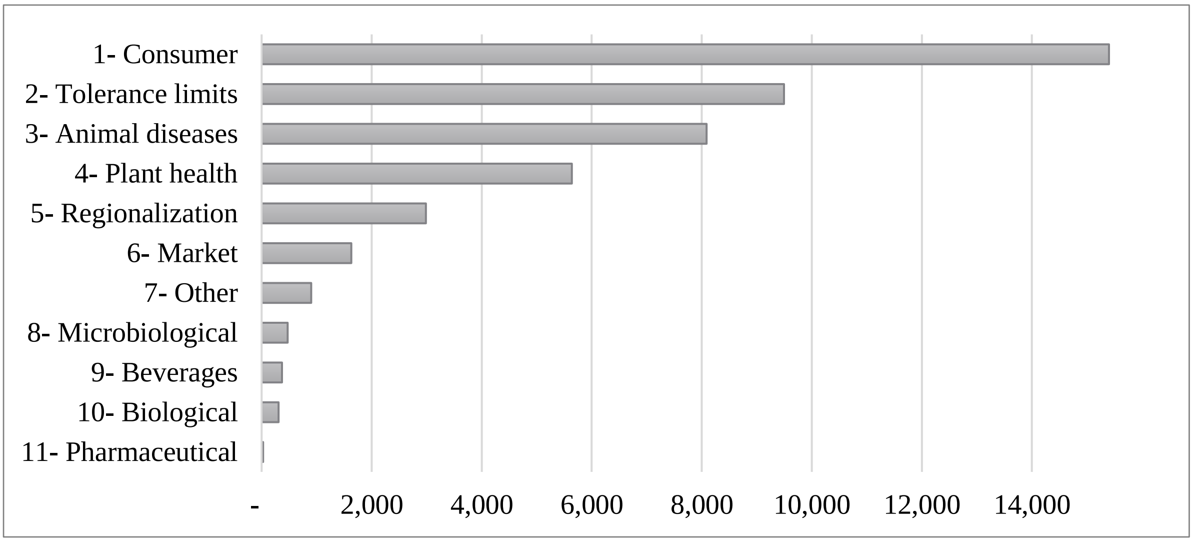
Source: Bureau van Dijk (2022), Orbis. https://login.bvdinfo.com/R0/Orbis (accessed September–November 2022); authors' elaboration.

Figure A1: Number of TBT Notifications (Based on Keyword Class) in Force in 2021 Globally



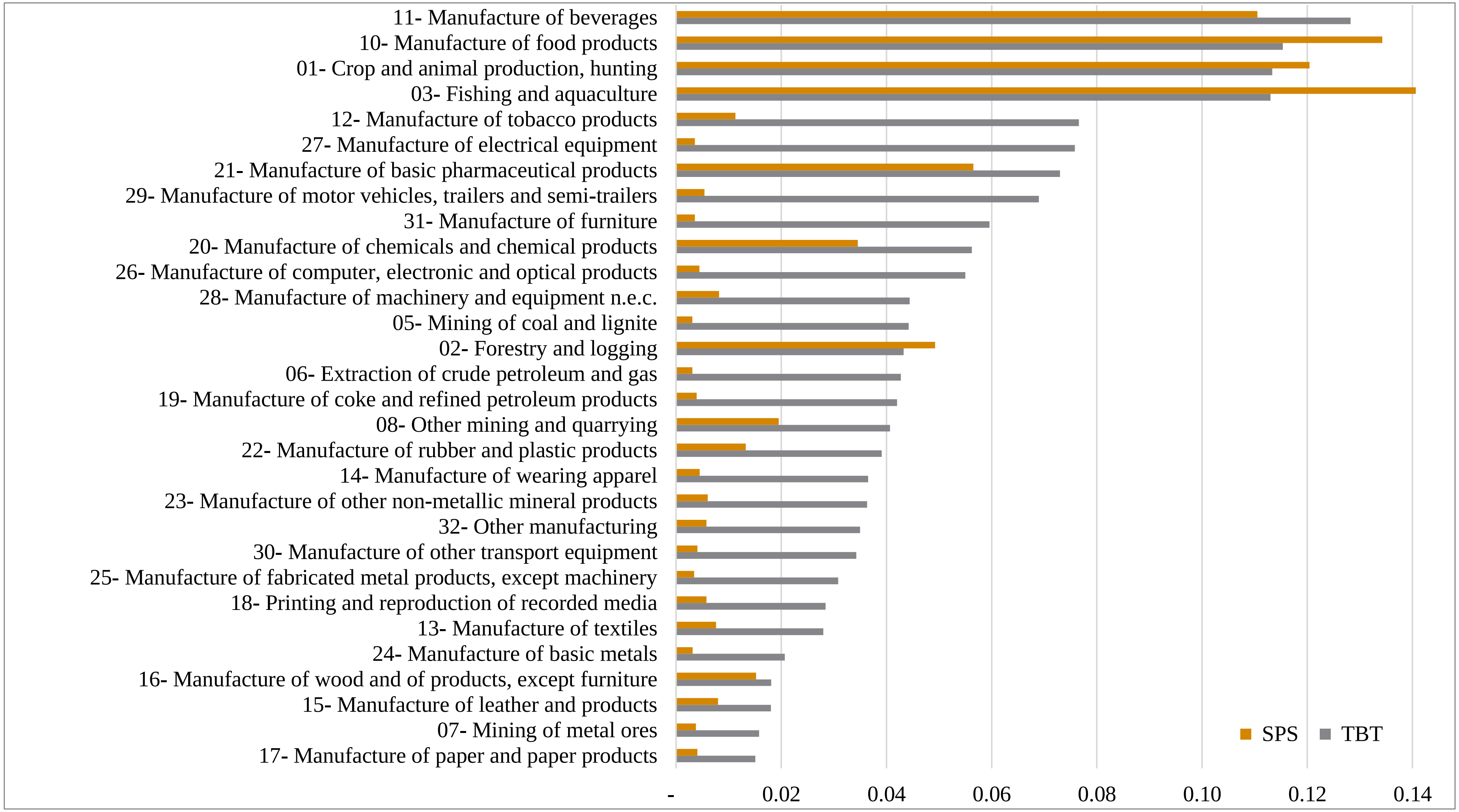
ICT = information and communication technology, TBT = technical barrier to trade.
Source: WTO (2022), WTO I-TIP. https://epingalert.org/ (accessed 20 June 2022); authors' elaboration.

Figure A2: Number of SPS Notifications (Based on Keyword Class) in Force in 2021 Globally



SPS = sanitary and phytosanitary.
Source: WTO (2022), WTO I-TIP. https://epingalert.org/ (accessed 20 June 2022); authors' elaboration.

Figure A3: Global Regulatory Divergence in TBT and SPS Across NACE Sectors Averaged over 2004–2020



NACE = Nomenclature of Economic Activities, SPS = sanitary and phytosanitary, TBT = technical barrier to trade.
Source: WTO (2022), WTO I-TIP. https://epingalert.org/ (accessed 20 June 2022); Authors' elaboration.

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