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Empirical insights on the dynamics of SPS trade costs: The role of regulatory convergence and experience in EU dairy trade

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ABSTRACT

With its influence on the world stage, the EU's Farm to Fork initiative seeks to extend sustainable and fair food production practises globally, in part, by encouraging convergence with EU food standards (i.e., sanitary and phytosanitary measures-SPS). Harmonisation clauses have been found empirically to encourage trade, but no quantifiable estimates exist on the trade effects of SPS regulatory convergence. This paper examines this issue for the dairy industry, a highly regulated sector with significant sustainability concerns attached. Furthermore, the cost-saving effects arising from closer regulations and 'experience' (i.e., accumulated years of foreign trade track-record), are compared. Employing a 3-year interval panel starting in 2010, a structural gravity equation that includes domestic trade is estimated with a flexible empirical approach that evinces asymmetric trade impacts for specific bilateral trade routes. Results indicate a trade depressing effect for SPS measures, estimated as a global average 10.4% Ad-valorem Equivalent (AVE). Moreover, at the global level, converging regulatory frameworks generate larger trade gains than experience, where a 1% rise in regulatory convergence is equivalent to 5 years of positive trade and a 14% reduction of the AVE. The reduction of trade frictions prompted by harmonisation and experience does not, however, outweigh SPS trade costs. Exporters to the EU face a higher SPS AVE than that faced by the EU (10.1% vs 9.3%). On average, exporters to the EU also benefit from a 9% saving due to experience, although cost savings from regulatory convergence are only reported for larger exporters to the EU, whose consolidated position in EU markets also grants them even greater than average benefits from years of accumulated experience.

1. Introduction

Under the auspices of the European Green Deal (EC, 2019), the European Commission has set out an ambitious agenda under 10 key actions to transform European markets into a socially and environmentally responsible model of sustainable growth and prosperity. From the perspective of the Common Agricultural Policy (CAP), specific proposals within the Green Deal have been tabled such as the Farm-to-Fork strategy (F2F) (EC, 2020a) and the EU Biodiversity strategy (EC, 2020b). Taking a holistic view of the food supply chain, the F2F strategy posits a six-point plan covering issues relating to (*inter alia*) sustainable production and consumption, food security and healthy diets. Moreover, these ideas also extend to trade. By mobilising the weight of its influence, the EU seeks to ensure fair trade and a level playing field that respects animal welfare, food safety and environmental concerns (e.g., use of pesticides, fight against antimicrobial resistance). Ultimately, a clear policy goal is to consolidate these trade practises by actively engaging in coalitions with willing partners, whilst simultaneously

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limiting EU single market access to those third countries that engage in questionable land management and production practises.

With a focus on the EU's trade relations, the current paper closely examines the issue of regulatory heterogeneity with third country partners in behind the border Sanitary and Phytosanitary (SPS) measures.[1] Viewed as necessary instruments to ensure (*inter alia*) food safety and sustainable production practices, some commentators (Disdier et al., 2008; Kee et al., 2009) have noted that the burden of compliance costs with SPS measures (as well as other technical regulations) may not fall equally on different trade partners, with potentially disproportionate impacts on poorer countries. On the other hand, it has also been suggested that the 'demand enhancing' effects ascribed to quality assurance associated with said instruments could even offset compliance costs, resulting in net trade gains (Bureau, Marette and Schiavina, 1998; Beghin, Disdier and Marette, 2015).

This paper posits two key objectives. Firstly, it seeks to establish whether SPS regulatory convergence generates a net beneficial impact on trade values (i.e., does convergence outweigh the cost of implementing said measures?), and if not, to establish by how much the SPS induced trade costs can be alleviated by closer regulatory frameworks. As a second objective, this research aims to assess whether the SPS trade effect can be modulated by the exporter's track-record in the destination market. Therefore, this aim relates to 'learning-by-doing' (Peterson et al., 2013) and 'reputation' (Jouanjean et al., 2015) propositions as exporters accumulate 'experience' in complying with the importer's trading regulations, gradually facilitating exports to said destination.

To examine these two broad objectives, the focus is on the EU dairy sector, motivated by a number of factors. Firstly, EU dairy is a key export-oriented activity, with significant market penetration. Since the 2015 abolition of the EU quota, greater export market opportunities have been presented to competitive EU dairy producers. Indeed, EU dairy exports to third countries have increased 15% between 2012 (the initial year of the phasing-out of quota) and 2020 (own calculations based on ComTrade), driven, in large part, by significant captive markets in Asia for high value EU dairy products (OECD/FAO, 2022). Secondly, from an environmental and animal welfare perspective the dairy sector is a significant player, with the result that sustainability standards are expected to become even more relevant in the policy agenda. Finally, and related to the previous point, dairy trade is highly regulated; 98% of the product lines (defined at HS 6-digit level) covering 99% of trade is affected by SPS measures, well above the average for agri-food sectors (88% of lines and 90% of trade covered by SPS measures) (own calculations based on Gourdon (2014)).[2]

The paper differs from many previous empirical studies in five main aspects. Firstly, by harvesting the UNCTAD TRAINS NTMs global database (UNCTAD, 2018a), across both time and space, a detailed panel of SPS measures on bilateral trade in the period 2010–2020 is constructed (as in Peci and Sanjuán, 2020). Indeed, a panel dataset is better suited to mitigate possible trade policy endogeneity issues exhibited in the numerous cross-section empirical applications. Secondly, the 4-digit NTM categories defined by the global database are used as the building block for computing both the number of measures and regulatory overlap, and a count variable is employed instead of the traditional presence/absence of NTMs (i.e. dummy approach). A novel feature of this approach (vis-à-vis previous studies mostly focused on Maximum Residue Limits (MRLs) of particular substances) is the greater coverage of SPS categories (e.g., MRLs, packaging and labelling, hygiene, production and post-production requirements and conformity assessment), with the aim of revealing a congruence in the regulatory agendas of different trade partners. Thirdly, in contrast to most applications, the empirical approach allows for specific bilateral trade effects of food standards and their *a priori* conjectured modulating influences, acknowledging possible asymmetrical effects, by following the specific country characteristics approach by Kee and Nicita (2022). Fourthly, the paper contributes to the literature on food standards harmonisation but departs from the stand-alone evaluation of Preferential Trade Agreements (PTA) harmonisation clauses (eg. Disdier et al., 2015), drawing more closely from the literature on regulatory heterogeneity indexes (eg. Winchester et al., 2012). Further empirical evidence on the trade beneficial role of regulatory harmonisation is provided, with estimates of specific cost-savings in terms of ad-valorem equivalents (AVE).[3] Finally, following Heid et al. (2021), a structural gravity equation including both international and domestic trade flows is estimated. Thus, the empirical model not only gains theoretical consistency, but also the trade impact of non-discriminatory policies (e.g., SPS measures applied by an importer to all its trade partners) can be identified in a structural gravity model where outward and inward multilateral resistance terms (Anderson and van Wincoop, 2004) are fully accounted for by time-varying exporter and importer fixed effects. The paper addresses the calculation of domestic trade in highly sectoral disaggregated data.

The rest of this paper is structured as follows. Section 2 summarises the literature review of this specific topic. Section 3 presents the empirical framework, based on the gravity equation, explaining the model specification. Section 4 explains the data, covering a description of NTMs and mediating indicators. Section 5 presents the estimation results and calculates specific bilateral trade-elasticities and AVEs. Section 6 concludes.

2. Related literature

The increasing policy relevance of Non-Tariff Measures (NTMs) is reflected by the inclusion of specific provisions in PTAsto encourage cooperation and reduce regulatory heterogeneity. As a result, 85% of the 276 PTAs notified to the World Trade Organisation (WTO) up to 2016 contain some form of SPS provisions (Stone and Casalini, 2020).

In one strand of the empirical trade literature, the existence of the so-called deep integration clauses in PTAs (i.e., harmonisation, mutual recognition and recognition of conformity assessment procedures), typically signalled by dummy variables in a gravity specification, have been found to reduce significantly the trade-costs associated with SPS and TBT measures in agricultural trade (Cadot and Gourdon, 2016; Disdier et al., 2019). In the context of economic development, however, Disdier et al. (2015) find that harmonisation provisions in PTAs only facilitate trade between Southern and Northern countries when such harmonisation is proposed on the basis of international rather than regional standards.

Trade costs associated with behind-the-border NTMs can be broadly classified into (i) specification, (ii) conformity assessment and (iii) information costs (OECD, 2016). Closer regulatory frameworks may therefore contribute significantly to abate these three types of NTM related costs. In this sense, a second strand of the literature focuses on 'quantifying' the impact of regulatory heterogeneity on trade and/or trade costs. Most of the literature using 'indices' of regulatory

[1] SPS, together with Technical Barriers to Trade (TBT) and pre-shipment inspections are defined as Technical Non-Tariff Measures (NTMs). Some of the SPS and TBT measures are also identified as "behind the border" as they relate to standards and regulations implemented by importing countries and that affect also the domestic production. NTMs is a much broader concept that encompass any measure different from tariffs, that can affect quantities traded, prices or both (UNCTAD, 2019).

[2] Kee et al. (2009) estimates an Ad-Valorem Equivalent (AVE) of technical NTMs at 46% for dairy, while the average in agri-food products is estimated at 27%. More recent estimates by Cadot, Gourdon and van Tongeren (2018), however, places dairy in an intermediate range, with a nonetheless non-negligible AVE of technical NTMs of 26.4%.

[3] The Ad-Valorem Equivalent of NTMs (AVE) is generally defined as the tariff that induces the same percent change in trade as the NTM (UNCTAD/WTO, 2012).

heterogeneity focuses on MRLs for one or several pesticides for a particular sector where the stringency of such measures have particular pertinence. Although the index formula adopts different specifications across studies, a common denominator is that it is usually symmetric (i.e. equal value for a pair of countries, irrrespectively of who is the exporter or importer) (Drogué and DeMaría, 2012; Vigani, Raimondi and Olper, 2012). Winchester et al. (2012) broaden both the SPS and sectoral scope to cover both quantitative and qualitative SPS measures related to food safety in general, whilst relaxing the index symmetry. The heterogeneity index then enters as a stand-alone explanatory variable in a gravity equation, with the general finding that regulatory differences in MRLs have a negative impact on trade, the magnitude of which, however, may not be uniform across countries (Drogué and DeMaría, 2012). In contrast, examining the case of seafood, Chen and Wilson (2017) include regulatory heterogeneity as a moderator of the MRL trade impact, concluding that harmonisation does not outweigh the negative MRLs trade effect.

Based on the global UNCTAD TRAINS NTM inventory, Cadot, Gourdon and van Tongeren (2018) and UNCTAD, 2017 build heterogeneity indicators counting the number of NTM-categories shared by the importer and exporter, named, regulatory similarity and regulatory overlap, respectively. The main difference is that the latter is asymmetric, thereby allowing for regulatory heterogeneity to impact differently on the exporter and the importer. Both studies use a price-gravity equation to estimate directly the AVE of technical NTMs. Cadot, Gourdon and van Tongeren (2018) cover all traded products in 80 countries, finding a negative correlation (not tested statistically) between the trade costs induced by technical NTMs and the degree of regulatory convergence. An update on agricultural products is provided by Gourdon et al. (2020) with identical conclusions. UNCTAD, 2017 restrict the analysis to agricultural trade between Mercosur and the EU and within-Mercosur, finding a significant trade-cost mitigating effect of regulatory overlap, while interestingly, such a mitigating effect is not found when the destination market is the EU.

In the context of EU concerns regarding fair trade discussed in section 1, a closer and more stringent regulatory framework is envisaged within the provisions of its specific bilateral preferential trade agreements with third countries. While harmonisation of food standards has been proven to foster intra-EU trade in the process of building the single market (de Frahan and Vancauteren, 2006), the evidence on the trade impact of convergence toward EU standards is still under scrutiny (e.g. UNCTAD, 2017). As an example, Curzi et al. (2018) evaluate the stringency of EU standards on pesticides and veterinary drugs against the international values established by the Codex Alimentarius in 2014 (as proposed by Li and Beghin, 2014), finding that the EU is comparatively the most rigorous. Further analysis conducted with a gravity equation shows that the stringency of EU rules reduces agricultural imports, especially from developing countries, while the EU is well equipped to reach destination markets irrespective of their level of standards restrictiveness. Nonetheless, it is argued in the literature that rigorous standards applied by exporters may stimulate quality upgrading (Maertens and Swinnen, 2009; Olper, Curzi and Pacca, 2014), and this is confirmed by Curzi et al. (2018), even within the group of developing countries. Similarly, Hejazi, Grant and Peterson (2022) using a bi-directional heterogeneity index on a comprehensive set of pesticides and their MRLs in fruits and vegetables, find that USA exports to the EU are severely hampered (by 14%) by the more stringent regulations in the EU.

On the issue of a trader's 'track record' introduced in section 1, Dutt et al. (2022) empirically assesses the role of 'experience' (i.e., number of years that the exporter has traded with a particular importer) in reducing unobserved trade costs, some of which can be ascribed to NTMs. The authors estimate that on average, a 1% increase in bilateral experience, increases bilateral (global) trade by 0.42% and reduces trade costs by 0.10%. Similarly, Peterson et al. (2013) reveal that the negative trade impact of specific SPS treatments required by the USA on its imports of fruits and vegetables diminishes as exporters accumulate experience complying with the treatments.

3. Empirical framework

3.1. The gravity equation

The impact of NTMs on trade has traditionally been studied in the context of the gravity equation. Empirical in its conception, the gravity equation has gained theoretical support and currently is viewed as consistent with various international trade theories (Bergstrand, Larch and Yotov, 2015).

From an estimation standpoint, the Poisson pseudo-maximum likelihood (PPML) has been consolidated as the preferred estimator (Santos Silva and Tenreyro, 2006). The PPML not only allows for the estimation of the gravity model in its theoretical multiplicative form preserving the inclusion of zero-trade values, but also avoids inconsistent coefficient estimates in the presence of heteroscedasticity, even when data is not pure count (Wooldridge, 2002).

Our structural baseline gravity model can be expressed as:

$$m_{ijht} = \exp\left[\alpha_0 + \beta_1 t_{ijht} + BORDER_{ij} + \gamma_{sit} + \gamma_{sjt} + \gamma_{ij} + \varepsilon_{ijht}\right] \quad (1)$$

where m_{ijht} are imports of country j from country i in sector h (defined at HS 6-digit level) in year t. The variable t_{ijht} is bilateral trade costs, specific to each sector HS6 and year, and is modelled as a function of tariffs and non-tariff measures:

$$t_{ijht} = \beta_{TAR} TAR_{ijht} + \boldsymbol{\beta_{NTM,ij} NTM_{ijht}} \quad (2)$$

Empirically, $TAR_{ijht} = \ln\left(1 + AdV_{ijht}\right)$ where AdV_{ijht} is the bilateral applied ad-valorem tariff (in percentage).

Following Murina and Nicita (2017) and Peci and Sanjuán (2020), the NTM variable enters the model as a count variable (i.e., number of SPS measures), as opposed to the approach of using a dummy that only records the (non)presence of NTMs (e.g. Disdier et al., 2008; Kee et al., 2009). Given the exponential specification, the coefficient on the continuous NTM variable $\boldsymbol{\beta_{NTM}}$ is a semi-elasticity (Cameron and Trivedi, 2010), otherwise interpreted as the proportional change in bilateral trade when the NTM changes by one unit (i.e., one additional SPS measure). Using a count variable for NTMs assumes that each additional unit has an equal impact on trade, which can be considered as a limitation.[4] With a dummy variable, on the other hand, the trade impact is evaluated by comparing between the presence and absence of the NTM.[5] Nonetheless, the broader the definition of SPS measures covered, the lower is the variability of the NTM dummy variable and consequently the identification of the NTM impact becomes seriously compromised (see section 4.5. for further details).

Additionally, equation (1) includes an array of country and sector specific characteristics proxied with fixed effects. Country-pair fixed effects are recommended by Anderson and Yotov (2016) to control for the potential endogeneity of trade policies (i.e., NTM regulations), in particular due to omitted variable and selection bias. As a result, traditional controls for bilateral trade frictions like geographical, cultural or historical linkages, as well as additional controls for trade policies with little or no time variation like Regional Trade Agreements, are dropped from the estimation.

NTMs are imposed per sector h by each importer j, and while some specific NTMs are clearly discriminatory even within the SPS chapter (e.g., prohibitions due to disease outbreaks), others may well be non-discriminatory and applied equally across exporters. In a structural

[4] Exploring alternative ways to model the count of NTMs to allow for non-linearities in their trade impact is beyond the scope of this paper.

[5] More precisely, the proportional trade change due to the presence of NTMs is $\exp(\boldsymbol{\beta_{NTM}}) - 1$.

gravity equation, the theoretical ‘multilateral resistance terms’ (i.e., relative prices) (Anderson and van Wincoop, 2003) are proxied by importer (exporter)-sector-year FE (Feenstra, 2016), leading to multicollinearity with the non-discriminatory NTM. In this context, Heid et al. (2021) strongly recommend including domestic trade to preserve consistency with trade theory and to allow for the identification of the trade impact of the non-discriminatory policy, given that such a policy will be null for domestic trade flows. Thus, our baseline model (1) includes both, international ($i \neq j$) and domestic ($i = j$) trade flows, where observations for international trade flows are signalled with a dummy variable ($BORDER_{ij}$), in combination with exporter (importer)-sector-year FE.

As noted below (see section 3.5.), specific exporter (importer) – HS6 – year effects are embedded in the trade shares and interacted with the NTM variable. Consequently, additional country-HS6-year FE might be redundant. Thus instead, the baseline model includes exporter (importer) – HS4 – (i.e. s = HS4) year FE to control for specific demand or supply shocks that affect the broader sector defined at HS4 level.

3.2. Regulatory overlap

We test for the hypothesis that the stringency of the NTMs depends not only on the intensity of their application by the importer but also on the degree of convergence of the regulatory framework between importer and exporter (Cadot et al., 2015, 2018). The Regulatory Overlap (RO) is defined as the proportion of NTMs applied by the importer that the exporter also applies to its imports, which in the absence of origin discrimination, will be the same as those applied domestically (UNCTAD, 2017). Based on the UNCTAD TRAINS Global database on NTMs (UNCTAD, 2018a), the operationalisation of the bilateral RO is defined as the proportion of 4-digit NTM categories applied by the importer j that are also applied by the exporter i to each product h in year t:

$$RO_{ijht} = \frac{\sum_{k=1}^{Kj} dd_{ijht}^{k} \times do_{ijht}^{k}}{\sum_{k=1}^{Kj} dd_{ijht}^{k}} \quad (3)$$

where k denotes the category of NTMs at the 4-digit level of disaggregation and Kj the total number of 4-digit categories applied by the importer j to the exporter i in sector h (HS 6-digit) and year t; dd_{ijht}^{k} (do_{ijht}^{k}) takes a value of 1 if the importing country j (exporting country i) applies NTMs of category k to country i (j) in product h and year t.

RO is bounded between 0 and 1, from a total lack of coincidence to perfect overlap. If the importer does not apply any NTM (i.e. $dd_{ijht} = 0$ for all k) the resulting missing value is replaced by one, as the exporter does not need to face any additional regulation to update their products or processes to access market j (UNCTAD, 2017). Finally, RO is not symmetric, as the number and composition of 4-digit categories may differ between the importer and exporter. This offers additional insight, since compared with the regulatory distance indicators (e.g., Cadot et al., 2015, 2018) the RO indicator is better suited to address the asymmetry in market access conditions or regulatory convergence.

3.3. Experience

Following Dutt et al. (2022) the cumulative experience in trade in a specific sector h between two countries i and j is defined as the number of years previous to the current period with positive trade in that sector:

$$EXP_{ijt}^{h} = \sum_{p=1}^{t} DT_{ij,t-p}^{h} \quad (4)$$

where $DT_{ij,t-p}^{h}$ is 1 when trade between exporter i and importer j in sector h and year t-p is not null, and zero otherwise.[6] This definition, at country-pair-sector level allows to exploit variation in experience within country-pairs across sectors and over time.

3.4. Bilateral specific incidence of NTMs, and the moderating effect of RO and EXP

Even if NTMs are imposed unilaterally, they might have a different impact on different exporters. To account for this possible heterogeneous trade impact, we follow the ‘indirect characteristics’ approach by Kee and Nicita (2022) and Cadot, Gourdon and van Tongeren (2018) such that both the exporter and importer sectoral trade shares are interacted with the NTM variable. Alternatively, Bratt (2017) and Niu et al. (2018), following the initial proposal by Kee et al. (2009), use country factor endowments (the ratios of agricultural land, capital and labour over GDP) as conditioning factors of overall country comparative advantage. In comparison with alternative proposals where the NTM variable is interacted with every importer (route) (defined as dummy variables) (e.g., Ghodsi et al., 2016), the indirect characteristics approach avoids the high computational burden that arises from using a large number of NTM-FE interactions.

Consequently, the variable NTM in equation **(2)** is augmented by interacting the NTM variable with the world trade share of the exporter i (SHR_{iht}) and the importer j (SHR_{jht}), in sector h and year t:

$$\beta_{NTM,ij} \bullet NTM_{ijht} = \beta_{NTM} \bullet NTM_{ijht} + \beta_{NTM,i} \bullet NTM_{ijht} \bullet SHR_{iht} + \beta_{NTM,j} \bullet NTM_{ijht} \bullet SHR_{jht} \quad (5)$$

By replacing the trade shares by average values for the exporter/importer of interest, one obtains specific country semi-elasticities or NTM trade impacts.

The use of trade shares allows one to subsume in a single variable, specific country and sectoral conditions at the highest level of sectoral disaggregation, resulting in an acceptable compromise between theoretical consistency and operability.

Subsequently, the specification in **(2)** is augmented by introducing Regulatory Overlap and Experience as moderators of the NTM trade impact, by interacting these variables with the NTM variable as well as the trade shares in order to allow for specific bilateral effects:

$$\beta_{MOD,ij} \bullet MOD_{ijht} = \beta_{MOD,i} \bullet NTM_{ijht} \bullet MOD_{ijht} \bullet SHR_{ih} + \beta_{MOD,j} \bullet NTM_{ijht} \bullet MOD_{ijht} \bullet SHR_{jh} \quad (6)$$

where MOD = RO, EXP.

A positive coefficient of the β_{MOD} coefficient implies that the similitude of regulations between trade partners or the bilateral experience mitigates the *a-priori* expected negative impact of NTMs, and that this attenuation is more intense the larger the exporter and/or importer if accompanied by positive $\beta_{MOD,i}$ and $\beta_{MOD,j}$ coefficients.

In this more complex specification, the average NTM semi-elasticity expression includes equations (5) and (6), which can be evaluated at mean values of the trade shares, RO and EXP variables in the sample or particular bilateral routes. Similarly, the average semi-elasticity of the moderating variable RO or EXP in equation (6) can be evaluated at mean values of the NTM variable. By multiplying the semi-elasticities by average values of the respective variables (NTM, RO or EXP) we get the scale-free elasticity.

[6] Dutt et al (2022) transform the expression in 4 with the inverse hyperbolic sine function, which renders a variable similar to the log transformation but that preserves the zero values. We opted for keeping the non-transformed series as the interpretation as a semi-elasticity is straightforward and is in coherence with the count treatment of the NTM variable.

4. Data

4.1. NTMS data

The Global UNCTAD NTMs database (UNCTAD, 2018a)[7] is an inventory of compulsory regulations, with a high sectoral granularity (HS 6-digit) and wide country coverage (92 countries, including the EU as a single entity). The SPS chapter we use in the paper is one of 16 in which NTMs are classified, which is further disaggregated into categories defined up to 4-digits,[8] and recorded for each reporter *j* in each HS 6-digit sector *h*.

These measures can be imposed unilaterally to any partner or bilaterally to specific countries or regions, and we carefully account for both when calculating the number of measures faced by country *i* when exporting to country *j* as recommended by Penello Rial (2019). The database informs about the regulations in place in the year of data collection, covering the years 2012 to 2018, with a majority of data collected in 2016 and 2018, indicating in which year the regulation started and ceased to apply. We use these starting and ending dates to build a time series for the application of NTMs (as in Peci and Sanjuán, 2020; Santeramo and Lamonaca, 2022). This is not a perfect measure, though, as those measures that started to apply after or ceased to apply before the year of data collection, are not recorded. For this reason, we limit our timespan to a period close to the range of collecting dates: 2010–2020.

Out of the 34 possible 4-digit SPS categories, we focus on behind the border SPS regulations that could be subject to harmonisation and which are also applied domestically (Vogt, 2021): maximum residue limits (NTM code A2); packaging and labelling (A3); hygiene (A4); production and post-production (A6); conformity assessment (A8 – excluding A860 or quarantine). Theoretically, these SPS measures are non-discriminatory (i.e., applied equally across exporters), although the empirical data reveals a degree of variability.[9]

The RO index provides a homogeneous metric that can be helpful to understand general regulatory patterns and their broad similarity. That said, the definition of a 4-digit NTM category can still encompass a large variety of instruments or specific requirements. Take for instance MRLs (A2) that consist of only two possible 4-digit categories defined in the UNCTAD classification (UNCTAD, 2019), where the substances regulated (i.e., veterinary medicines, antibiotics, pesticides) and their maximum limits (i.e., parts per million), can differ significantly between trade partners.

4.2. Domestic trade

An essential requirement for applying the structural gravity approach (Yotov et al., 2016) is the use of domestic trade. Usually, this is calculated as the difference between domestic production and exports. This calculation can be challenging, however, when dealing with highly disaggregated data, either because of a scarcity of databases that record both production and export observations, or simply, the lack of detailed observations on production.[10] FAO[11] and EUROSTAT Europroms (European production and market statistics)[12] provide data for production at certain level of agrifood sectoral disaggregation. The FAO data is restricted though to two out of the 21 HS6 products in our definition of dairy which account for a mere 5% of dairy trade (in 2010–2020). This is logical, as only primary agricultural production is considered by FAO data. The EUROSTAT database, on the other hand, covers up to 16 HS6 dairy products, but the geographical coverage is limited to EU Member States, EFTA and EU candidate countries.

A more promising alternative chosen here, is the GTAP database. Despite the sectoral aggregation (i.e., dairy is one single sector named *mil*), the GTAP database provides a variable (*outputdisp*) that splits, for each exporter, year and sector, the value of output into domestic sales (*dom*) and *exports*. In a similar way to Narayanan et al. (2010), we calculate the ratio of domestic trade (*dom*) to *exports* (for each exporter and year) for the aggregated *mil* sector and apply this same ratio to the HS6 value of exports (per exporter and year). The GTAP data is available for the years 2004, 2007, 2011, 2014 and 2017 (current version 11).

4.3. Trade and tariff data

The dairy sector covers 21 HS 6-digit product lines, 20 of which are within section 04 (milk, yoghurt, butter and cheese), and one in section 21 (i.e., ice-cream), in perfect correspondence with the GTAP composition, in order to favour consistency between domestic and international flows.

The chosen sample includes 67 exporters and 96 importers (Table S1 in Supplementary Material) covering key-players in international dairy trade and specific regions selected either because of on-going bilateral trade negotiations with the EU (ASEAN, USA and Mercosur), or due to the observed and/or potential growth of their markets (India or China).

Data on bilateral trade flows (in value, million US dollars) come from UN Comtrade accessed through WITS.[13] Regionally speaking, dairy trade is very concentrated. The EU is the largest exporter, accounting for 33% of global trade in the period 2010–2020, followed by New Zealand (25%) and the USA (11%). The main global importers are ASEAN and China, each accounting for around 12% of world trade, while extra-EU imports are limited to around 3%. ASEAN, China and USA are the main destinations for the EU, accounting for around 9% of extra-EU exports each. Important regional markets for the EU are located in the Middle East and North Africa, and East Asia and Pacific regions, which absorb 24% and 13% of extra-EU exports, respectively, with Saudi Arabia and Hong-Kong as the main representatives in each region.

Tariff data are taken from CEPII (MAcMap-HS6, updated by Fontagné et al., 2022). CEPII tariffs are provided at the HS6 level and correspond to effectively applied tariffs, that is, the lowest tariff granted by a reporter to a partner for the considered product, which will be the most-favoured nation tariff unless a preferential tariff exists. Likewise, both specific tariffs and tariff rate quotas are considered in the final calculation of the ad-valorem equivalents (see Guimbard et al., (2012) for details). Tariff-rate quotas are particularly relevant in dairy trade, where major players, like the EU or USA, make use of them as well as in other regions in our sample (e.g., Tunisia in North Africa, or Malysia and Thailand in the ASEAN).[14] The CEPII tariff data are available for three-

[7] This version of data was downloaded from the UNCTAD webpage in November 2021.

[8] Along the paper, the terms 'measures' or 'number of 4-digit categories' are used interchangeably. Whenever SPS measures are mentioned in methods and results, they refer strictly to those behind the border regulations defined in section 4.2.

[9] There are actually 19 importers in our sample that, within each HS6 sector and year, vary their SPS application across exporters (excluding domestic trade). Cross-exporter variation is mainly concentrated in conformity assessment rules (SPS of category A8).

[10] WIOD and CEPII PROD databases have been successfully used to support the 'border approach', which is seen as an empirical precursor of the 'structural gravity' coined by Yotov et al. (2016). However, in both data sets, food is only represented as a single sector.

[11] https://data.apps.fao.org/catalog/dataset/value-of-agricultural-production-global-national-annual-faostat.

[12] https://ec.europa.eu/eurostat/web/prodcom/data.

[13] WITS (World Integrated Trade Solutions) is a World Bank databases platform https://wits.worldbank.org/.

[14] https://tao.wto.org/ExportReport.aspx?RT=TQ.

year time intervals, between 2001 and 2016.

4.4. Further considerations on data

The chosen sample period is a compromise between the NTM data, where we require that the initial date is close to the collection year, and the time-series availability of domestic trade flows and tariffs. To reconcile the available years of data in both GTAP and CEPII databases, we have assigned the domestic/export ratios observed in 2011, 2014 and 2017 in GTAP to the trade and tariff observations in 2010, 2013 and 2016, respectively. Thus, the final sample constructs three three-year intervals between 2010 and 2016.

Although interval data is used to accommodate both the use of domestic trade and CEPII tariffs, we keep the definition of Experience on a continuous scale, and to avoid the loss of the first year of observations in this three-year-interval panel, we included bilateral trade data from 2009 in the calculations. Therefore, by 2016, the maximum experience accumulated is 7 years.

Following Heid, Larch and Yotov (2021) the NTM variable and tariffs are set to zero in domestic trade observations, while by construction, RO equals 1. As for Experience, we assume that an exporter accumulates as many years of positive internal trade as the maximum observed for each HS6 sector across destinations.

Intra-EU trade is excluded from the analysis, as it is assumed that either perfect harmonisation or mutual recognition of NTM regulations are in place. Moreover, with the large weight of intra-EU trade as a proportion of world dairy trade (around 51%), this would likely bias the results. After excluding intra-EU trade, the selected sample accounts for 66% of world trade and 75% of trade between countries in the NTM database in the analysed period. The panel is perfectly balanced, as each combination importer-exporter-HS6 appears exactly 3 times (i.e. years), and the number of zero-trade values is substantial (64%).

4.5. Data description

Behind the border SPS measures are present in 87% of the observations of our sample when including domestic trade, which rises to 91% when only international trade is considered. A count SPS variable, on the other hand, provides a larger variability. Thus, on average, 5.86 measures are applied per observation (i.e., per exporter, importer, HS6 sector and year), with a standard deviation of 4.10 when including domestic trade.[15]

Table 1 presents some descriptive statistics of the variables used in the estimation. For a better comparison between those imposed and faced by the EU, domestic trade is excluded.[16]

In the sample, an average of 6.17 SPS measures are applied between each pair of countries, sector and year. Compared with this global average, the EU applies a higher number of measures (8.21), while it faces a lower number of measures (5.95).

The average RO in the sample is 0.59, while as an importer (exporter), this index is slightly lower (higher) at 0.50 (0.64) for the EU. Consequently, there is a large margin of action to achieve closer regulatory frameworks. Figure S1 illustrates in more detail the asymmetry of the RO indicator using the EU as example.

The average experience in the sample is 1.69 years, while the EU has a slightly longer experience as an exporter, 1.76 years. Exporters to the EU, however, have been exporting over less time, 1.16 years. In 2016, the accumulated years of positive trade reaches 2.77 years, being significantly higher for the EU as an exporter (2.90) than that as an importer (1.86). A more detailed description of bilateral experience is presented in Table S2.

5. Results

5.1. Estimation results

Table 2 presents the results of the baseline model in the first column. The model specifications M2 and M3 show the modulating effects of the RO and EXP (equation (6) and are presented in the second and third column, respectively. The model specification M4 in column 4 controls simultaneously for regulatory overlap and experience.

The coefficient estimates and resulting semi-elasticities and elasticities are consistent across models. The border coefficient is large and highly significant, denoting that the volume of international trade is significantly lower than domestic trade. The tariff coefficient is negative as expected although barely significant. In agreement with most of the literature, but in contrast with recent advocates of NTMs as trade catalysers, a trade depressing effect of SPS measures is observed. This result, however, could be related to the level of aggregation, as Peci and Sanjuán (2020) find opposite signs of influence for 4-digit NTM disaggregation.

Interestingly, the negative impact of SPS on bilateral trade is attenuated the larger the exporter's (supported by models without RO) and importer's market shares, or the more dominant the position of the country in the global trade of a specific product line. Thus, the results support the interpretation that, in the absence of other mechanisms such as regulatory similarity, the larger the exporter's trade share the easier it is to comply with the importeŕs regulations, and consequently the smaller is the trade loss due to SPS measures (Kee and Nicita, 2022). This result can also be related to the fact that countries with a larger trade share also have larger exporting firms, which suffer less from restrictive SPS measures (Curzi et al., 2020).

Importantly, the coefficients on the interaction with the importer's market share are of a greater magnitude than those with the exporter's market share (either significant or null). This supports the idea that regulatory enforcement on the part of large importers shapes worldwide NTM patterns, since there are few options for exporters to divert trade despite the regulatory burden they face (Kee and Nicita, 2022).

If exporters align SPS measures with importers, this is found to encourage trade, where this effect is stronger when the exporter is larger (the interaction term, NTM × RO × SHR_i, is positive and significant, $p < 0.01$). Thus, when an exporter faces the same number of SPS measures in two different destination markets, trade will be more intense with that importer with whom the exporter shares a higher proportion of regulations, *ceteris paribus*.

Once a destination market is accessed, accumulated experience by repeated shipments over time significantly alleviates the initial negative trade impact of SPS measures, and this effect grows as a function of the size of the importer (the interaction term, NTM × EXP × SHR_j, is positive and significant, $p < 0.01$).

Looking at the average semi-elasticities in Table 2 (M3), one additional SPS measure reduces trade by 11.7%, which translates into a trade elasticity of −0.69 (evaluated at mean values). In the absence of regulatory overlap, the SPS trade reducing impact would be more intense, 13.9%, while the trade reducing impact would be 10.6% when a perfect overlap of regulations is exhibited. In other words, converging SPS regulations favour, but do not outweigh, the negative trade impact of the SPS measures imposed by the importer.

Increasing the number of years that an exporter has been exporting to a destination market in a specific sector by 1%, increases bilateral trade with that market in that sector by 0.038%. Despite the differences

[15] An additional concern relates to the possible correlation between tariffs and the number of SPS measures as both enter as explanatory variables. In our sample, this correlation is positive but low (+0.06), and accordingly, we do not observe a clear complementarity or substitutability amongst these two policy variables. More evidence is usually found with non-technical measures (UNCTAD, 2018b; UNCTAD/WTO, 2012, chapter 2), or with Specific Trade Concerns due to SPS measures (Curzi et al., 2020).

[16] Including domestic trade observations, reduce the averages for SPS and tariffs, increases RO and experience and notably trade.

Table 1
Descriptive statistics of the variables used in estimation.

	Full sample			EU as importer			EU as exporter		
	Mean	Std.dev.	Max	Mean	Std.dev.	Max	Mean	Std.dev.	Max
SPS	6.17	4.09	18	8.21	2.42	15	5.95	4.25	18
SPS RO	0.59	0.31	1	0.50	0.25	1	0.64	0.27	1
EXP	1.69	1.89	7	1.16	1.49	7	1.76	1.96	7
EXP in 2016	2.77	2.43	7	1.86	2.00	7	2.90	2.50	7
Trade (m_{ijht})	1.01	13.53	2348.02	0.29	5.19	262.61	0.78	8.53	884.33
TAR	0.20	0.28	2.40	0.29	0.18	0.73	0.21	0.30	1.80
N	81,564			8179			34,101		
Domestic Trade	351.6	1814.3	65876.8	256.7	793.3	9737.5	256.7	793.3	9737.5

Notes: Trade in million USD. Period of analysis include years 2010, 2013 and 2016. Domestic trade observations are excluded in the computation of the statistics in the sample. For completedness, last row includes the average value of domestic trade.

Table 2
Estimation results for behind the border SPS measures.

	Baseline	M1: RO	M2: EXP	M3: RO + EXP
TAR	−0.542	−0.544	−0.579	−0.577*
	(0.367)	(0.357)	(0.358)	(0.347)
NTM	−0.166***	−0.163***	−0.163***	−0.162***
	(0.033)	(0.034)	(0.034)	(0.035)
NTM × SHRi	0.608***	−0.165	0.491***	−0.165
	(0.075)	(0.226)	(0.088)	(0.222)
NTM × SHRj	2.539***	2.479***	1.612***	1.830***
	(0.257)	(0.416)	(0.235)	(0.390)
NTM × RO × SHRi		1.307***		1.208***
		(0.340)		(0.341)
NTM × RO × SHRj		−0.003		−0.393
		(0.536)		(0.526)
NTM × Exp × SHRi			0.024**	0.012
			(0.010)	(0.011)
NTM × Exp × SHRj			0.235***	0.227***
			(0.047)	(0.047)
Border	−7.277***	−7.209***	−7.235***	−7.184***
	(0.700)	(0.689)	(0.697)	(0.689)
Semi-elasticity [1]				
NTM	−0.116***	−0.111***	−0.121***	−0.117***
	(0.033)	(0.034)	(0.033)	(0.035)
NTM (at RO = 0)		−0.137***	–	−0.139***
		(0.034)		(0.035)
NTM (at RO = 1)		−0.097***	–	−0.106***
		(0.035)		(0.035)
NTM (at EXP = 0)				−0.123***
				(0.035)
NTM (at EXP = 7)				−0.101***
				(0.035)
RO		0.227***	–	0.177***
		(0.061)		(0.063)
EXP			0.024***	0.021***
			(0.004)	(0.004)
Elasticity [2]				
NTM	−0.685	−0.656	−0.713	−0.691
RO	–	0.138	–	0.107
EXP	–	–	0.042	0.038
Observations	85,393	85,393	85,393	85,393
R^2	0.867	0.867	0.867	0.867

Notes: Robust standard errors clustered by exporter-importer-sector HS6 in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All models include exporter-HS4 sector-year, importer-HS4 sector-year and exporter-importer FE. R^2: is the McFadden pseudo R^2. Estimation is conducted in Stata, using the command *ppmlhdfe* by Correia, Guimarães and Zylkin (2020). [1] Semi-elasticities (or coefficients) calculated at mean values of the interacted variables (unless indicated otherwise), using the *margins* command in Stata, standard errors calculated with the Delta method in parentheses. [2] Elasticities obtained by multiplying the semi-elasticity by the average NTM, RO or EXP, respectively (including domestic trade) (see Section 3).

in the treatment of experience, sectors and time period covered, the latter estimate coincides with Dutt et al. (2022, p. 25) when evaluating experience with sectoral disaggregated data. In the absence of previous experience, one additional SPS measure reduces trade by 12.3%, which is 0.5 percentage points more than at the mean experience of 1.69 years, whilst after 7 years, the SPS trade reducing impact shrinks to 10.1%. Thus, over the time frame of the data, the negative trade impact of SPS measures cannot be compensated by a full track-record of 7 years. This result contrasts with the more optimistic finding by Peterson et al. (2013) who report that the exporters must 'treat'[17] five times before the trade-restrictive nature of SPS applied by the USA on fruits and vegetables imports, vanishes.

These results are complemented with further sensitivity experiments shown in the Supplementary online material (Table S4). Firstly, the estimation is conducted only on international trade flows; and second, TRAINS tariffs are used instead of CEPII tariffs. The exclusion of domestic trade is not found to lead to significant differences in the magnitudes of the semi-elasticities to bilateral variables like RO and EXP. However, the semi-elasticity with respect to the NTM is affected, changing from −0.117 (with domestic trade) to −0.158 (without domestic trade), which would lead to an increase in the estimation of the AVE from 10.43% to 14.09%, respectively. On the other hand, only minor differences in semi-elasticities are observed when using TRAINS tariffs.

The directional causality from NTM to trade requires the NTM to be exogeneous. The rich array of fixed effects in our panel context, drastically reduces the possible endogeneity due to omitted variable and selection biases (Baier and Bergstrand, 2007; Raimondi et al., 2020; Curzi and Huysmans, 2021). Reverse causality, however, may be present, as argued in previous research (Baier and Bergstrand, 2007; Egger et al., 2011). For example, food safety concerns are likely to be of greater concern where trade is more intense, although it may be argued that more intense trade flows imply more import competition with local producers, who in turn may lobby to adopt more protective regulations (Trefler, 1993).

As a robustness check, two approaches are used. First, following Baier and Bergstrand (2007), a one period lead of the NTM variable is included additionally to the contemporaneous value of the NTM. A lack of significance of the lead variable in our fixed effects panel model would imply strict exogeneity (Wooldridge, 2002). In other words, if trade was causing NTMs, then there would be a significant correlation between the future value of NTM and current trade. To keep the model simple, the specification only includes the NTM contemporaneous and the lead NTM.

Second, as performed by Fontagné et al., (2022) when examining tariffs, a check is performed on whether changes in the NTM variable have an effect on trade changes before the NTM actually changes for the first time. If this were the case, then there would be evidence of reverse causality as the effect (i.e., trade volume) would be preceding the cause (i.e., imposition of the NTM). In other words, "the presence of such pre-event trends, or "pre-trends," is taken as evidence against the strict

[17] We establish this comparison under the notion that positive trade values are only observed when the exporter complies with the importer's rules.

exogeneity of the policy change" (Freyaldenhoven et al., 2019, p.3307). To this end, we calculate the first differences of both the NTM and trade, per exporter, importer and sector HS6 and identify the first year when the NTM changes ($t = \tilde{t}$); we then calculate the average rate of change for the NTM after $\tilde{t}$ and of trade before $\tilde{t}$; and finally, we run a regression of the average trade rates over average NTM rates, controlling for alternative sets of fixed effects.

To maximise the number of observations, we conduct this analysis in the continuous period 2010–2020. Results of both approaches are presented in Table S5 of the online supplementary material and provide evidence in favour of non-reverse causality.

5.2. Ad-Valorem equivalents of NTMs and the savings triggered by RO and EXP

By using the NTM, RO and EXP elasticities estimated in here (based on M3 in Table 2 and presented in Table S3) and the tariff elasticities borrowed from Fontagné, Guimbard and Orefice (2022), we calculate the AVE as the tariff equivalent to the proportional change in trade derived from a 1% change in the respective variable. Fontagné, Guimbard and Orefice (2022) estimate these tariff elasticities at HS 6-digit level.[18] The average tariff elasticity for the 21 HS6 sectors within our dairy definition is −6.934. Additionally, we calculate the AVE for one extra year of experience (using the experience semi-elasticity). The resulting AVEs are presented in Table 3, and to contextualise these values, the last column includes the average applied tariff.

For the full sample (bottom row Table 3), the AVE for behind the border SPS measures is 10.4%, or 18 percent points lower than the average applied tariff, 28.5%(last column in Table 3). With only two exceptions (ASEAN and New Zealand), the bilateral AVEs of SPS measures faced by the EU are less restrictive than the applied tariff.

The SPS applied by the EU on its imports generates an AVE slightly below the sample average, of 10.12%. Compared to the literature, both the overall sample and the EU SPS AVEs averages are closer to the estimate by Kee and Nicita (2022) of 17.2% for technical measures,[19] [20]

Further levels of regulatory convergence to the importer would lead to a saving in the SPS AVE of 1.50 percent points in the full sample, and one additional year of positive trade, a reduction of 0.30 percent points (i.e. a 14.4 and 2.9% over the average SPS AVE, for RO and experience, respectively). In general, we find that closer regulatory frameworks have a more intense effect on trade-costs savings than experience. Thus, on average, the trading cost saving arising from a 1% increase in the approximation to the importer's SPS regulatory framework is equivalent to the savings observed after 5 years of trading with the importer (2.9% increase in the number of years). This observation is not, however, the case for the EU.

As an exporter, the EU faces an average SPS AVE (9.35%), slightly lower than what it imposes on its imports (10.12%), whilst this asymmetry manifests itself more dramatically in terms of regulatory convergence. Thus, the EU as an exporter benefits from a reduction in the AVE of 2.75 percent points.The benefit to the EU of approaching the regulations of its trade partners (2.75 percent points) is reinforced in the case of those destinations with whom the EU is negotiating or envisaging deeper integration agreements, like India, ASEAN or North Africa, with trade cost savings between 3.3 and 4.7 percent points.

With only two exceptions (see below), we fail to find significant trade cost savings when exporters approach the SPS regulatory framework of the EU. This result concurs with UNCTAD, 2017 and appears to reflect the presence of additional hidden trade costs when exporting to the EU that a closer SPS regulatory framework cannot mitigate. Only in the case of the two large dairy exporters, USA and New Zealand, do we find evidence of an increase in their exports to the EU when approaching their SPS regulations, with respective induced AVE savings of 5.04 and 9.07 percent points (i.e., halving and offsetting the SPS trade costs). The persistence of trade frictions for smaller exporters when converging to EU standards concurs with Disdier et al. (2015) who find superior trade benefits from international rather than regional harmonisation with Northern countries.

Similarly, this asymmetry in bilateral EU trade costs savings is also observed with respect to experience, but in this case, exporters to the EU benefit more than the EU as an exporter. Thus, increasing by 1% the track record with the EU, generates an average trade cost saving of 0.92

Table 3
Ad-Valorem Equivalents for SPS measures across different importers/exporters and savings due to RO and EXP.

EU as importer					
Exporting Region	SPS AVE (%)	AVE savings RO (percent points)	AVE savings EXP (percent points)		Tariff (%)
			EXP (1%)	EXP (1 year)	
ASEAN	10.35	0	−0.90	−1.04	38.01
CAN	11.22	0	−0.94	−0.92	40.49
CHN	13.65	0	−0.53	−0.64	40.97
IND	10.30	0	−0.95	−1.04	42.24
JPN	11.53	0	−0.98	−0.92	36.11
MERCO	10.11	0	−0.87	−1.00	40.77
NAFR	7.60	0	−0.74	−1.18	20.73
NZL	0	−9.07	−1.60	−1.01	40.01
RoW	10.69	0	−1.17	−0.92	30.83
USA	7.28	−5.04	−1.47	−0.82	39.53
ALL	10.12	0 [0%]	−0.92 [9.09%]	−0.77 [7.60%]	35.34
EU as exporter					
Importing region	**SPS AVE (%)**	**AVE savings RO (percent points)**	**AVE savings EXP (percent points)**		**Tariff (%)**
			EXP (1%)	**EXP (1 year)**	
ASEAN	11.28	−3.27	−0.44	−0.26	9.23
CAN	9.71	−2.01	−0.28	−0.15	230.38
CHN	0	0	−1.50	−0.73	12.52
IND	17.72	−4.71	−0.27	−0.14	33.45
JPN	2.49	−1.57	−0.39	−0.16	109.39
MERCO	5.40	−2.38	−0.12	−0.08	16.60
NAFR	15.83	−3.26	−0.38	−0.24	34.37
NZL	25.39	−3.81	−0.36	−0.22	1.87
RoW	8.38	−2.64	−0.40	−0.23	27.76
USA	16.44	−3.42	−3.14	−1.46	22.04
ALL	9.35	−2.75 [29.4%]	−0.46 [4.92%]	−0.26 [2.78%]	30.52
Full sample	**10.43**	**−1.50 [14.38%]**	**−0.52 [4.98%]**	**−0.30 [2.88%]**	**28.49**

Notes: SPS AVE for 1% increase in the number of SPS measures; AVE savings RO for 1% increase in regulatory overlap with the importer; AVE savings EXP: EXP (1%) and EXP (1 year) measures the AVE of increasing bilateral trade experience with the importer 1% and 1 year, respectively. AVE calculations based on elasticities (semi-elasticity for EXP (1 year)) in Table S3. Mean values used in the computation of elasticities exclude domestic trade flows. AVEs based on non-significant semi-elasticities are replaced by 0. In brackets, AVE savings with respect to SPS AVE.

[18] Fontagné et al. (2022) as well as other internationally accepted tariff elasticities (as GTAP, by Hertel et al., 2007) based the tariff elasticity estimation on cross-country variation, rendering values remarkably higher than the ones observed when only temporal variation is contemplated (as in our estimation).

[19] This figure is obtained by averaging the unilateral AVE at the HS6 level for technical measures reported in the accompanying database to Kee and Nicita (2022), for a common set of 31 importers and HS6 sectors.

[20] Many other different estimates can be consulted in the literature, which are based upon variants of the gravity model, and which vary significantly in terms of data sources, model specifications and sectoral aggregations. For instance, Ghodsi et al. (2016) report a global NTM AVE of 4.6% and Cadot, Gourdon and van Tongeren (2018) of 2.6% for SPS measures, both in the dairy sector.

percent points (around 9% over SPS AVE), while in the opposite direction this saving is 0.46 percent points (around 5% over SPS AVE). Moreover, there is a degree of heterogeneity across trade partners, with the biggest exporters benefiting relatively more with increasing years of positive trade with the EU, in the same way that the EU also benefits further from consolidating markets with the main importers like ASEAN, Japan, China, or the USA. The largest exporters and importers also show a longer trade track-record with the EU, and consequently our results seem consistent with increasing returns to experience.

6. Conclusions and policy implications

Focusing on trade in the dairy sector, this paper employs a structural gravity equation to explore the extent to which closer SPS regulatory frameworks as well as consolidating bilateral trade relationships, trigger trade cost savings. Methodologically, the paper builds upon recent literature where both regulatory overlap (UNCTAD, 2017) and experience (Dutt et al., 2022) indicators are evaluated. Deviating from these papers, however, our treatment allows for specific bilateral trade effects to assess the potential variability and asymmetry of their impact across trade partners. Importantly, our model specification includes domestic trade. The analysis is based on a panel dataset that covers bilateral trade between 67 exporters and 96 importers, in the period 2010–2016, whilst the geographical focus is that of the EU.

Measured as an ad valorem equivalent (AVE), we find that the EU's SPS trade costs are close to the average (around 10%). The results also show that the negative impact on trade arising from SPS regulatory costs declines the larger the size of the importer or exporter (measured in terms of its world trade share). For example, as a large player, the EU benefits from lower related costs as an exporter. Compliance costs with EU SPS rules are not homogeneous across trade partners, and large dairy exporters enjoy lower trade costs than small dairy exporters. This result is consistent with Murina and Nicita (2017), who find a clear indication of the trade dampening effect of the EU's SPS regulatory framework on agricultural products from low-income countries, as well as Curzi et al. (2018), for specific residues regulations.

The results also exhibit an SPS trade cost asymmetry effect in dairy trade. For example, owing to a larger share of SPS measures already implemented in the domestic market, the EU benefits from a saving of 2.7 percent points when exporting, while exporters to the EU dairy market do not receive any additional discount. Consequently, increasing the convergence towards EU standards, which is expected under the auspices of the Farm to Fork strategy to lead to more sustainable food chains globally, may not have a significant impact on EU imports and may not contribute to alleviate compliance costs with stringent EU SPS rules. Only those countries already consolidated within the EU dairy market and complying with stringent EU rules, such as New Zealand or the USA, are well positioned to enjoy further SPS trade cost reductions. Indeed, these results are aligned with UNCTAD, 2017 who also find a non-significant impact of converging to EU regulations for agricultural exports from Mercosur. Similarly, Disdier et al. (2015) observe that converging to Northern regional standards does not facilitate trade from developing to developed countries.

It is possible that co-existing red-tape procedures and thorough enforcement of compliance requirements evaluated at the border (e.g., system of refusals at the border for safety reasons), may be an additional factor explaining why harmonising standards to the EU level is not enough to offset additional (hidden) trade costs. In this sense, previous work on the impact of reputation (Jouanjean et al., 2015) sheds light on the relevance of reputational spillovers in the enforcement of food safety measures at the border. Our results on the role of experience provide additional support to this thesis. Although the trade benefit associated with years of experience in the foreign market is not found to outweigh the SPS regulatory trade cost, increasing the number of years of trade activity with the EU enhances bilateral exports (one extra year increases bilateral trade by 2.1% and reduces the SPS induced trade costs by 7.6%), rendering the EU as a more advantageous destination than the average. This suggests that the barriers to entry to the EU dairy market are particularly high at the outset, although the asymmetric benefits attached to large dairy exporters to the EU, which have also been in the EU market for longer, reveal that cost reductions may be potentially steep for early entrants. These results on the aggregate level for EU trade seem to point out toward increasing returns to experience, while further research on micro firm data would be needed to confirm this hypothesis.

In contrast, at the global level, converging regulatory frameworks lead to larger trade gains than those generated by experience, where a 1% rise in regulatory SPS measures convergence is equivalent to 5 years of positive trade and a 14.4% reduction of the ad-valorem equivalent trade cost. Consequently, these results support the 'general' causality between the harmonisation of SPS measures and the reductions in trade frictions.

On a cautionary note, the qualitative nature of NTM data makes it difficult to compute a more precise metric for regulatory stringency and heterogeneity, and further research could aim at improving these indicators. Furthermore, our empirical approach only contemplates convergence to the importer's regulatory framework and not harmonisation to international standards, which given the qualitative nature of the NTM data, would require a tailored definition. Finally, the introduction of non-linear trade effects of NTMs within the model specification would enhance our understanding on the optimal number and coverage of NTMs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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