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The international trade impacts of Geographical Indications: Hype or hope?

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ABSTRACT

The European Geographical Indication quality scheme (GI) is supposed to enhance local expertise and support spatially-embedded products worldwide. Currently, the effect of GIs on trade is controversial. In general, GIs seem to support international trade, but the literature has not reached a consensus. We aim to identify and summarise heterogeneous results from existing research using a meta-analysis approach. Our results confirm that GIs positively affect trade, even after controlling for the effects of various characteristics of the studies, the methodology adopted, and publication impacts.

1. Introduction

The Geographical Indication (GI) quality scheme guarantees the distinctiveness of a product embedded in the environmental characteristics and cultural know-how of a given region (Vaquero-Piñeiro, 2021; World Trade Organization (WTO), 1994). More precisely, GI is a sign used on agri-food products that have a specific geographical origin and possess qualities and a reputation essentially (Protected Geographical Indications—PGI) or exclusively (Protected Designation of Origin—PDO) due to spatially embedded natural and human factors (EU Reg. No.2012/1151, food; EU Reg. No.2013/1308, wine; EU Reg. No.2019/787, spirit; EU Reg. No.2014/251, aromatised wines).

On 1 January 2020, the EU GI scheme included 3,286 registered GIs (EC, 2020); according to the most recent EU Report (2021), in 2017 the value of GI exports accounted for EUR 31.42 billion: 42 % of the GI's sales (20 % for intra-EU trade and 22 % for extra-EU) and 90 % of GI exports are generated by wines or spirits (EC, 2021).

During the Uruguay Round, with the 1995 multilateral TRIPs Agreement, GIs were introduced for the first time into international trade treaties by setting the minimum standards that every WTO Member State must respect. According to art. 22, Members shall provide the legal means for interested parties to prevent any use which constitutes an act of unfair competition and a misleading designation or presentation of a good (Art. 22).[1] Additional protection is only explicitly provided for two categories of GIs: wine and spirits (Art. 23). This form of certification has attracted attention across the world, and several countries have used bilateral agreements to protect their high-quality agricultural products and foodstuff. Nowadays, more than 200 bilateral and multilateral World Intellectual Property Organization (WIPO) and World Trade Organization (WTO) agreements include GI regulations.

The primary users of this quality scheme are the southern EU Member States, which register seven times more food GIs per capita than other EU countries (Huysmans and Swinnen, 2019).[2] Italy and France are in the lead in terms of numbers and revenues (EC, 2020). The GIs from these countries feature prominently in the most recent European Union trade agreements (Huysmans, 2020).

GIs are treated as a Non-Tariff Measure (NTM) related to intellectual property rights in trade (UNCTAD, 2019; Saavedra-Rivano, 2012).[3] At the national level, countries adopt different approaches to protect GIs.

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[1] TRIPs Article 22 states that GIs are " […] indications which identify a good as originating in the territory of a Member State, or a region or locality in that territory, where a given quality, reputation or other characteristics of the good is essentially attributable to its geographic origin.".

[2] Following Huysmans and Swinnen (2019), southern' countries are France, Greece, Italy, Portugal, Spain, Bulgaria, Croatia, Cyprus, Malta, Romania, and Slovenia.

[3] In global markets, according to trade barriers classification (UNCTAD 2019), GIs can be therefore thought as Non-Tariff Measures (NTMs) working at the same time as different technical and non-technical measures. However, due to the varying nature and complexity of GIs, it is difficult to classify GIs as a single type of NTMs and the debate is still open (Chambolle et al., 2005). GIs operate at the same time as: (i) non-preferential rules of origin; (ii) quota (given the maximum amount of production fixed by codes of practice); (iii) barriers to trade, (iv) intellectual property rights, (v) trademarks; and (vi) technical barriers.

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The EU provides the most comprehensive scheme: GIs are included in the EU system of intellectual property rights, legally protecting them against imitation and misuse by a *sui generis* regime (Ribeiro de Almeida, 2020; Gangjee, 2020).[4] In the revision of the EU GIs policy planned for 2022, this "property right" nature of GIs could increase due to the outsourcing of some competencies of the Commission's DG AGRI on the matter in favour of the European Union Intellectual Property Organization (EUIPO).[5]

China, which has recently signed the EU-China Agreement for the protection of GIs (March 2021), is the extra-EU country with the most registered GIs and adopts two separate regimes: collective trademarks or *sui generis* rights (Ferrante, 2021; Hu, 2020; Song, 2018; Farley, 2017). Australia implemented a *sui generis* registration system for wines but not for food products (Kneller, 2020; Van Caenegem and Nakano, 2020). In July 2020, a new Russian GI law took force based on the EU system and the Geneva Act of the Lisbon Agreement (Zappalaglio and Mikheeva, 2021). Although most WTO Members have a separate system of protection for GIs, the TRIPs agreement does not require Members to implement a specific protection system. For instance, the USA decided to continue protecting GIs as trademarks through the United States Patent and Trademark Office (USPO) register and under the United States trademark law (Le Goffic and Zappalaglio, 2017; Josling, 2006).[6]

Becoming a GI could provide competitive benefits for agri-food products in domestic and global markets (Raimondi et al., 2020; Sorgho and Larue, 2018). Products are differentiated based on geographical origin (Verbeken and Roosen, 2009), an attribute difficult to reproduce and presumed to be a quality cue that distinguishes them from their conventional counterparts and preserves them from fraud and unfair competition (Menapace and Moschini, 2012).

Literature on whether and to what extent obtaining GI certification increases trade and territorial openness is quite controversial, with some studies finding significant positive effects, others insignificant effects, and yet others even negative effects. At present, we are far from a consensus on the real effects of GIs on international trade (Chilla et al., 2020).

This lack of agreement can be partly explained by a severe data constraint regarding data on GIs and trade at detailed levels. In the European Union, eAmbrosia is the official register that, for each GI, provides general legal information, regulation documents and the GI specification. However, it does not include any additional data on other important variables such as production, added value or trade flows.[7] GIview, the new World Intellectual Property Organization (WIPO) database, contains only technical information.[8] To address this issue, existing research is often based on case studies with data often collected ad hoc. This might be a significant driver of heterogeneity in the results, together with different foci (e.g., products, areas) or methodologies (e.g., gravity models, causal approaches) of the studies.

Examining existing results provided by the literature, this paper aims to discuss the heterogeneity in the importance of GIs for trade through a *meta*-analytic approach. In this way, we explain how the GIs' effect varies according to specific factors related to different characteristics of different studies, such as research design, methodological issues and publication process.

Born in the medical field, *meta*-analysis is a technique for investigating the state-of-the-art of existing literature by identifying patterns and sources in heterogeneous results coming from studies that supposedly investigate the same phenomenon (Hunt, 1997). Despite some constraints due to the number of examinable papers, this approach has become more and more popular in economics (Havranek et al., 2020) and agri-food literature (Deselnicu et al., 2013; Lagerkvist and Hess, 2011).[9] For instance, Deselnicu et al. (2013) use this methodology to explain the differences in the GI premium price variations, Santeramo and Lamonaca (2019) the effects of non-tariff measures on agri-food trade, and (Santeramo et al., 2020) the heterogeneity in the relative importance of consumers' attitude toward region-of-origin.

Our study confirms that GIs lead to an increase in intra- and extra-EU trade, regardless of the measure used to capture the presence of GIs. Impact estimates tend to be higher for studies analysing the wine sector or PGI productions. Estimates from simple cross-section analyses point in the same direction, even though these studies control for less observable variation than more sophisticated models (e.g. panel, IV). Shortcomings in data accuracy and econometric approaches bring about additional sources of estimation bias.

Our main contribution is to provide the first overview of the effects of GIs on international trade starting from the evidence provided by the literature so far. Results support the literature according to which GIs represent a relevant policy tool for agri-food productions when competing in global markets since the GI scheme promotes international trade and territorial openness. From a policy perspective, this paper provides evidence that policymakers should invest more in protecting agri-food products linked to local characteristics and historical know-how, like GIs, especially in specific cases such as wine-growing (Cicia et al., 2013). In fact, with limited resources (the GI scheme does not absorb a significant share of any heading of the EU budget) the EU is allowing its rural areas to participate in global markets leveraging on local peculiarities: the GI scheme allows local productions to be differentiated and not substitutable by standardized and space-blind productions that dominate global flows.

2. Literature review

Among studies discussing the role of GIs in international trade, a large group involves systematic reviews of legal documents (Calboli, 2021; Goebel and Groeschl, 2014) and the nature of trade agreements acknowledging GIs (e.g., Prescott et al., 2020; Saavedra-Rivan, 2012). The majority of these studies discuss the differences in approaches taken by countries, illustrating the nature of legal and economic issues and the potential dynamics triggered by different trade agreements (see, among others, Ferrante, 2021; Zappalaglio and Mikheeva, 2021; Calboli, 2021; Huysmans, 2020; Josling, 2006).

Studies investigating the ex-post effects of GIs on international trade can be classified into two groups. The first group includes studies using qualitative approaches, such as interviews, desk research and case study analysis. Focusing on Asia-Pacific countries, Calboli and Ng-Loy (2017)

[4] According to the definition provided by World Intellectual Property Organization (WIPO), the term *sui generis* is used in intellectual property law to describe a regime designed to protect rights that fall outside the traditional patent, trademark, copyright, and trade-secret doctrines. What makes an intellectual property right system a *sui generis* one is the modification of some of its features to properly accommodate the special characteristics of its subject matter, and the specific policy needs which led to the establishment of a distinct system.

[5] More information regarding the current status of the legal proposal is available at: https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-revision-of-geographical-indications-(refit).

[6] The US Trademark Law mentions four types of marks: trademarks; service marks; certification marks and collective marks. Under this regime, it is possible to protect GIs as certifications, collective marks or trademarks. According to the regulations, GIs can also be viewed as a geographic subset of trademarks serving the same function as trademarks. More information is available at: https://www.uspto.gov/ip-policy/trademark-policy/geographical-indications.

[7] eAmbrosia centralised information on GIs previously held on three databases: DOOR, e-Spirit-Drinks and e-Bacchus.eAmbrosia database available at: https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/geographical-indications-register/.

[8] GIview database available at: https://www.tmdn.org/giview/.

[9] The *meta*-analysis approach would require a large number of experiments and replications for validation purposes, which are uncommon in economics, explaining the difficulty to conduct *meta*-analyses in this field.

Table 1
Meta analysis.

	Studies using dummies for GIs		Studies using the number of GIs	
	WLS model (1)	WLS PEESE model (2)	WLS model (3)	WLS PEESE model (4)
1/Standard error β_0	0.272*** (0.000)		0.033*** (0.0009)	
1/Standard error^2 β_0		0.195** (0.067)		0.054* (0.023)
Intercept β_1	−0.000** (0.000)	−0.000** (0.000)	−0.0001** (0.000)	−0.000 (0.000)
R-squared	0.931	0.350	0.004	0.085
Observations	195	195	304	304
No. of studies	8	8	7	7
Wild bootstrap cluster (pvalue)	0.004	0.017	0.000	0.018

Notes: WLS weights: PCC precision (1/ SEPCC) in column (1) and (3); PCC precision squared (1/ $SEPCC^2$) in column (2) and (4). All the models have robust (paper clustered) standard errors in parenthesis.
Wild bootstrap-test: null imposed, 999 replications, clustering by papers and bootstrap clustering by papers; Webb weights.
***p < 0.01; **p < 0.05; *p < 0.1.

illustrate the potential trade benefits but also the related problems of GI protection for local and national development, concluding that GIs do not *per se* constitute a magic recipe. Caenegem and Nakano (2020) propose a similar study for King Island (Tasmania), whereas Lertdhamtewe (2014) discusses the protection of GIs in Thailand. Chilla (2020) uses a series of expert interviews, together with secondary statistic comparisons, to investigate the economic effects of three PGIs acknowledged in the Free State of Bavaria in Germany. Belletti et al. (2007) conduct a case study analysis to investigate the role of GIs in the internationalization of small-medium scale agri-food firms from Tuscany, Italy. They depict a variegated and complex situation confirming that GIs cannot be assumed as a "magic" solution, and conclude that the role of collective organisations (such as Consortia) is crucial.

The second group is composed of econometric studies that evaluate the effects of GIs on different trade outcomes, such as unit value, trade flows (value and volume) and extensive margins, i.e. the probability of exporting (among others, Agostino and Trivieri (2014); Duvaleix et al. (2018)). Although they reach a substantial consensus on the overall effect of GI on trade (Raimondi et al., 2020; Josling, 2006), some heterogeneity emerges. Agostino and Trivieri (2014) find that GIs have a positive impact on both (i) bilateral trade export values and (ii) the extensive margin (i.e. new trade routes) for wines produced in Italy, France and Spain. They also provide evidence of an additional effect on the probability of exporting, although volumes only increase in the case of high-income destination markets. Sorgho and Larue (2014) find that the total volume of trade increases only if both importing and exporting countries have GI products, whereas a trade-diverting effect arises for importing countries without GIs. Controversial results are also highlighted by Leufkens (2017) concerning the monetary value of agricultural exports and the role of GIs in creating bilateral trade between the EU and third countries. In the case of wine and spirits, GIs support bilateral trade when these products are highly protected; in the case of food, additional effects exist only in tandem with lower protection levels. By investigating the role of destination markets, Sorgho and Larue (2018) find that GIs can either increase or decrease trade flows due to local consumers' preferences.

Researchers have also found positive effects when looking at specific products or GI types. Torok and Jambor (2016) find evidence that GIs influence European comparative advantages in the ham trade and the global beer trade (Torok et al., 2020). In the French cheese industry, Duvaleix et al. (2018) show positive effects of PDOs on the extensive margin of trade, but no impact on the intensive margin. For Italian firms, as highlighted by Curzi and Olper (2012), PDOs increase export intensity (i.e. the ratio of exports to total sales) and the number of export destinations. This evidence finds support in the study of Raimondi et al. (2020), which investigates the impacts of GIs on intra- and extra-EU trade margins and unit values, differentiating between the presence of GIs in exporter/importer countries. They confirm that, in 15 European countries, while exporters always benefit from the presence of GIs, GIs tend to be a trade-reducing measure for importers. These impacts are similar for intra-EU and extra-EU trade. In addition, GIs have increasing effects on prices. Questioning whether GIs have implications for trade at the firm level in the cheese and butter sectors, Duvaleix et al. (2021) corroborate these results finding that PDOs (i) increase export prices by 11.5 % on average and (ii) benefit from better access to European markets and countries with similar quality schemes. Conversely, being a PDO does not lead to exporting higher volumes.

The literature is unanimous in identifying that GIs lead to premium pricing. Brooks (2003) estimates a premium for GIs on wine's import value and finds that Italian and French wines benefit the most. Schamel (2007) finds that GIs increased the relative export price of foreign-origin speciality ham by around 20–30 %. The research by Mulik and Crespi (2011) confirms the benefits of the per-unit export price of protecting local GIs. Focusing on wine bilateral exports towards emerging markets, Agostino and Trivieri (2014) demonstrate that GIs achieve the goal of a price premium in the BRICS countries, with Italian and Spanish GI wines lagging behind their French counterparts. Indeed, looking at the effects of GIs on perceived quality in foreign countries, Duvaleix et al. (2018 and 2021) confirm that GIs succeeded in exporting higher quality.

Mancini (2013) is the only study investigating GIs' role in shaping global value chain participation. By focusing on cheese-dairy productions in Nicaragua and, in particular on the GI Queso Chontaleño, the author finds the unexpected result that GIs can increase the marginalisation of small rural producers rather than supporting their international competitiveness.

The focus on the effect of being acknowledged as a GI on trade patterns (i.e., import/export values and volumes) is therefore predominant. Given that GIs are not automatically included in the list of certified products recognised by extra-EU countries, more recent literature has started discussing GI's presence in trade agreements.

Huysmans (2020) estimates the probability of a GI to be listed in the agreement and concludes that trade agreements are more likely to protect GIs with higher sales values and coming from South European countries. In addition, Jambor et al. (2020) find that the absolute number of GIs does not seem relevant in supporting the willingness to establish a trade agreement, especially at the regional level. This result is confirmed by Curzi and Huysmans (2022), who assess how being listed in a trade agreement can reinforce GIs' effects on trade. Moreover, looking at the cheese sector, they conclude that, in the EU, the legal protection of GIs does not generally lead to significant additional exports above and beyond the general export-promoting effects of the Free Trade Agreement.

From an empirical standpoint, given the pioneering role of the EU in protecting GIs, most of the studies evaluating the effectiveness of such policy scheme focus on European GIs. Official data on GIs are also mainly provided by EU institutions, even in the case of non-EU products.

Methodologically, several papers use the gravity model framework, panel data estimations and conduct the analysis at the country level.[10] This is a severe limitation, given the rules of assignment for GIs: the so-called region of origin refers to an area of specific neighbouring municipalities, which is significantly smaller and distinct from provinces or regions. For all EU and non-EU GIs, legal documents and Product Specifications containing the list of Local Administrative Units (LAUs) included within the production area are available, together with information on product type, GI type, legal status, the product category and

[10] Mulik and Crespi (2011) look at the longest period, from 1970 to 2003.

important dates, only in pdf/html format (e-Ambrosia).[11]

Data on market prices, production and international trade for agriculture and rural development are constantly updated by Eurostat, but figures on GIs are not always included and, when they exist, they are provided only for a few specific EU agri-food products aggregated at the country or sectoral level.[12] The wine sector is the only one for which the EU has provided data on trade value and volume aggregated for the product category (no-GI, PDO and PGI) from 2003 onwards, but available only at the country level.[13] Some national surveys managed by local authorities or producers' organisations exist, but they tend to release aggregated data, for a limited number of years, with privacy disclosures and without a common format.[14] In the case of the EU, for instance, the Farm Accountancy Data Network (FADN), the European official data source for farms' income and business activities, does not report coherent data on GIs either, since questions on GIs are not mandatory.[15]

The majority of authors address this lack of data at the regional level by focusing on the country level, losing local heterogeneity (e.g., urban–rural, economic structure, farms' average performances) or by limiting the analysis to specific case studies, dealing with the most well-known GIs and performant countries mainly in the EU MSs (e.g., Macedo et al., 2020; (Emlinger and Lamani, 2020)Emlinger and Lamani, 2018). Sometimes country-sector dynamics are investigated by combining data on product and national trade flows, as in Curzi and Huysmans (2022) and Leufkens (2017). The dairy sector is the most investigated, particularly the French one.

3. Meta-analysis: data, empirical strategy and results

In this section, we explore the drivers of the heterogeneous estimates of the impact of GIs on trade in the existing literature. We perform a *meta*-analysis, which allows us to integrate and summarize all comparable estimates and quantify their average effect (Stanley and Doucouliagos, 2019).

3.1. Data

We collect English-language published and unpublished papers from online databases for academic articles (e.g., Google Scholars, Scopus, Web of Science, Econopapers and others) by using a set of *ad hoc* keywords related to GIs and international competitiveness (see Table A1 and A2 in the Appendix for more details on search criteria). In addition to peer-reviewed papers, we review cross-references and cross-cited papers, national and international reports, working papers and conference contributions. We consider only studies explicitly focusing on GIs, excluding papers generically discussing local agri-food systems, given that local is a relative concept with different declinations and nuances (Bowen and Mutersbaugh, 2014), and contributions discussing non-agri-food GIs ((European Commission, 2019).[16] We do not set time limits in the bibliographic search; the final search was performed in September 2021.

We also exclude studies that did not report the necessary information for the *meta*-analysis (e.g., standard error and the number of observations) and papers that explored the impact of GIs on binomial variables (i.e. extensive margins). These papers capture indeed a different effect of GIs that is outside the scope of this paper.

Our final sample is composed of 15 quantitative studies providing 512 point estimates measuring the strength of the GI-trade relationship (all selected articles include more than one observation). Table A3 in the Appendix reports the list of the papers and the measure used to capture the trade effect.

The first paper was published in 2003, with a constant and increasing interest in the topic over time; the majority of them have been published after 2012, the year of the EU reform for GI foodstuff. All of the papers have more than one author. Almost 60 % of all estimates capture GIs through continuous variables (i.e., the number of GIs). All remaining estimates use dummies coded 1 if the observation benefits from at least one GI labelling (6 papers). 292 estimates (60 %) are statistically significant. Around 90 % of estimates are computed at the national level. Seven papers (47 % of the estimates) focus on the wine sector, due to its long tradition of GI certification (Ugaglia et al., 2019), while the dairy sector is the food sector most investigated. Only 2 studies look at the heterogeneous effect of GI on trade distinguishing between different food sectors. Papers investigate the international effects of GIs in terms of different trade measures: quantity (26 %), total trade value (52 %) and unit trade value (23 %).

3.2. Meta-analysis

Given that the papers analyzed in the *meta*-analysis consider different outcome variables, to obtain comparable estimates, we standardize the effect sizes by calculating the partial correlation coefficient (PCC), a metric commonly used in economic *meta*-analyses (Brada et al., 2021; Bruno and Cipollina, 2017; Doucouliagos, 2005):

$$r_{ij} = \frac{t_{ij}}{\sqrt{(t_{ij}^2 + df_{ij})}} \quad (1)$$

with t_{ij} and df_{ij} being the *t*-value and the degrees of freedom of the ith estimate in the jth paper. By construction, the distribution of PCC ranges from −1 to 1. Standard errors of PCC are therefore calculated as:

$$SE_{PCC} = \sqrt{(1 - r_{ij}^2)/df_{ij}} \quad (2)$$

In our case, by using the PCC rather than the estimates' coefficient, we can analyse all available studies on the effects of GIs on trade within a single framework, regardless of the specification of trade effect used. In other words, we can simultaneously examine studies that investigate the effects of GIs on different trade outcomes (for details see Table A3).

The first step of our analysis is to regress the PCCs of estimated coefficients on the respective standard errors by applying the following conventional *meta*-regression analysis (MRA):

$$PCC_{ij} = \beta_0 + \beta_1(SE_{PCCij}) + \varepsilon_{ij}, \ (\text{OLS model})$$

where PCC is the partial correlation coefficient of estimate *i* of study *j*, $SEPCCi_j$ is its related standard error, and ε_{ij} is the error term.

The *meta*-regression Ordinary Least Squares (OLS) model, also

[11] LAU are a subdivision of the NUTS-3 regions covering the whole economic territory of the Member States. More information is available at: https://ec.europa.eu/eurostat/web/nuts/local-administrative-units.

[12] Database available at: https://ec.europa.eu/eurostat/data/database.

[13] Database available at: https://agridata.ec.europa.eu/extensions/DataPortal/.

[14] The main strength is to report the updated list of GIs registered in the EU, however, the drawback is that data are categorized in text format (i.e. pdf or html), which is not suitable for quantitative analysis. These data may require huge effort to extract information and transform them into a machine-readable format. For instance, in Italy, the national statistical office (ISTAT) provides the number of farmers and agri-food processors involved in the GI production by product category at the NUTS-3 level from 2004 onwards. This information is also available at the municipality level, but only for 3 years (2014, 2015 and 2016) and without GI category differentiation https://asc.istat.it/ASC/).

[15] Member States decide whether to include questions on GI productions. MSs that have decided to include them are Spain and Italy.

[16] An example is the craft products called "Olinalá" made by the Olinalá people of Mexico following special techniques and skills, using wood from the aloe tree which is native to the region. (WIPO, 2016).

known as the "Egger test", provides the Funnel asymmetry test —FAT (H1: $\beta_1 \neq 0$) for detecting asymmetries in the results, which could be a hint of publication impact (Egger et al., 1997). In the absence of publication impact, the magnitude of the reported effect will vary randomly around the "true" value, independent of its standard error, and β_1 will be equal to zero.[17] In addition, with the Precision effect test—PET (H1: $\beta_0 \neq 0$), the OLS model verifies whether there is a genuine empirical effect remaining after potential publication selection and β_0 may be considered an ideal average of the estimates of the effect.

Accounting for heteroskedasticity leads to the weighted version of the OLS model, i.e. the Weighted Least Squares (WLS) model (Stanley and Doucouliagos, 2019; Stanley, 2008):

$$PCC_{ij}/SE_{PCCij} = t_{ij} = \beta_0/SE_{PCCij} + \beta_1 + \varepsilon_{ij}. \text{ (WLS model)}$$

where PCC_{ij} / $SEPCC_{ij}$, the outcome variable, refers therefore to the partial correlation coefficient of estimate *i* of study *j* weighted by its related standard error. Estimations for the WLS model are provided in columns (1) and (3) in Table 1.

Following the literature (Stanley and Doucouliagos, 2019; Stanley et al., 2015; Stanley and Doucouliagos, 2014; Deselnictu et al. 2013), to deal with potential bias due to other differences in the estimates we are analyzing (e.g. empirical settings), we replace the SE in the WLS model with their associated variance $SEPPC_{ij}^2$ (precision-effect estimate with standard error—PEESE):

$$PCC_{ij}/SEPPC_{ij}^2 = t_{ij} = \beta_0/SEPCC_{ij}^2 + \beta_1 + \varepsilon_{ij}. \text{ (WLS PEESE model)}$$

The outcome variable is now the partial correlation coefficient for estimate *i* of study *j* weighted by the square of its related standard error: estimations are provided by column (1) and column (3) in Table 1. The PEESE MRA model allows us to obtain a better estimate of the size of the genuine effect corrected for asymmetry.

Finally, since each paper reports more than one estimate, we need to take into consideration that estimates within one study are not statistically independent, and pooling different estimates into a large sample does not solve within-study and between-study heterogeneity (Cipollina and Salvatici, 2010). To solve this issue, we follow the common approach of treating the data set as a panel (Bruno and Cipollina, 2017) and using cluster standard errors. However, given the low number of clusters, we also implement a wild cluster bootstrap to obtain a more accurate cluster-robust inference (Roodman et al., 2019; Colin Cameron et al. 2008).

Some studies measure the presence of GIs through dichotomous data, whereas others measure it through count data. The estimated coefficient of the GI dummy refers to the total effect while the estimated effect size of the GI number can be interpreted as an elasticity. As usual in the literature, we perform separate *meta*-regressions for the two subgroups (Higgins et al. 2022; Cipollina and Salvatici, 2010). As a robustness test we also replicate the analysis by considering all the observations in a unique sample and controlling for dummy *vs* count data through a GI dummy indicator (=1 if paper use GI dummy, 0 otherwise). This is possible since we are using PCC standardization, rather than the real coefficient estimates as the dependent variable. Since the coefficient associated with the GI dummy indicator turns out to be not significant, the test suggests that there is no significant difference between studies (Table A6). As a further robustness test, our models are replicated also by using a random-effects panel MRA and a multilevel mixed-effect approach (Table A6 in the Appendix) (Stanley and Doucouliagos, 2015).[18]

Table 2
Meta-regression analysis with control variables - WLS PEESE estimations.

	Studies using dummies for GIs (1)	Studies using the number of GIs (2)
1/Standard error^2	0.17400* (0.11600)	0.02020** (0.004600)
β_0		
Dummies for GIs		
PDO	−0.00001*	–
	(0.00001)	
PGI	0.00001***	–
	(0.00001)	
Wine	0.00002**	0.00031***
	(0.00011)	(0.00010)
Dairy	−0.00001 (0.00000)	−0.00001** (0.00000)
Italy and France	0.00004 (0.00002)	–
Importers recognizing GIs	−0.00000	−0.00000***
	(0.00000)	(0.00000)
Intra-EU trade	0.00011 (0.00000)	−0.00000***
		(0.00000)
Dummies for empirical setting		
Cross-section analysis	0.00008***	0.00076*** (0.00008)
	(0.00005)	
Number of years under analysis in panel data estimations	0.00001***	0.00004*** (0.00000)
	(0.00000)	
No country-sectorial focus	0.00011	−0.00011***
	(0.00018)	(0.00000)
Dummies for trade outcome (dependent variable)		
Unit value	0.00002***	−0.00001***
	(0.00000)	(0.00001)
Volumes	0.000021***	−0.00001***
	(0.00000)	(0.00001)
Product value share	0.00002***	−0.00002***
	(0.00000)	(0.00001)
Product categories share	0.00002***	−0.00000***
	(0.00000)	(0.00001)
Methodological dummies		
OLS	0.00020 (0.00010)	0.00011* (0.00011)
Published	−0.00003***	−0.00004***
	(0.00020)	(0.00000)
Intercept	Yes	
R-squared	0.587	0.708
Observations	195	304
No. of studies	8	7

Notes: WLS weights: PCC precision squared (1/ $SEPCC^2$). All the models have robust (paper clustered) standard errors in parenthesis.
***p < 0.01; **p < 0.05; *p < 0.1.
Given the PEESE construction, as recalled in footnote 19, the magnitude of coefficients may be very low and this is the reason why Table 2 reports a number of decimals higher than usual.

3.2.1. Meta analysis results

Our findings provide evidence of a positive effect of GIs on trade, for both papers using dummies to account for the presence of GIs and studies using continuous variables (Table 1, column 2 *vs* column 4). To interpret the results, we start from the FAT coefficient (β_1) which is almost always statistically significant in both cases. This means that the apparent asymmetry of the funnel graph is confirmed by estimations and

[17] Researchers and reviewers would be predisposed to seek statistically significant results or desire results that conform to prior theoretical expectations, or both. A preference for publishing statistically significant and positive results could indeed influence the magnitude of the effect (we will properly test publication impact in the following sections). Although it is true that the peer-review process can greatly affect the magnitude of the estimated effect, whether or not this impact should be considered a bias is a moot point. Accordingly, following Cipollina and Salvatici (2010) we refer to a general publication impact rather than a bias. We will properly test publication impact in the following sections.

[18] In the *meta*-analysis literature random-effects are commonly used instead of fixed-effects to address heterogeneity and account for both within-study and between-study variability. At the same time, multilevel mixed effects models are used to accommodate within-study dependence across estimates whether the groupings in estimations are nested (estimations nested in papers) (Stanley and Doucouliagos, 2015).

that is potentially due to the publication impact.[19] The significance of β_0 shows that, despite potential publication selection, there is evidence of a genuine effect of GIs on trade with an ideal average of the estimates of the effect that is positive in all cases.

The significance of our results is also confirmed after performing the wild cluster bootstrap.

3.3. Multiple meta-regression analysis

As a second step, we perform a multiple *meta*-regression analysis by including in the basic MA model (model 3) a set of control variables to better identify what elements are driving the heterogeneous impacts of GIs on trade. In this way, potential biases are filtered out (see Table A4 in the Appendix for the definition of the variables and descriptive statistics).[20] We, therefore, augment Model 3 to include a control matrix accounting for papers' characteristics (Stanley, 2005). Selecting these features is particularly challenging. We aim to control for the highest number of papers' characteristics, but it may lead to multi-collinearity among controls and therefore we had to discard some variables (in accordance with the VIF test).[21] Our final set of explanatory variables can be divided into two groups: the first includes variables regarding the characteristics of the GIs under analysis, while the second refers to the methodological approach.

The first group include dummies for papers distinguishing between types of GIs (*PDO* and *PGI* dummies) or not (GI dummy). Although sometimes PGIs' sale values overweight PDOs' sale values, it is also true that the majority of very well know GIs are PDOs and they are also the most exported (e.g. Parmigiano Reggiano DOP). Considering all the GI types together can therefore generate different estimates.

In evaluating the trade effects of GIs it is also relevant to avoid comparing products with structural differences, such as agricultural products, wine and foodstuff, and with different relevance for the GI market. For instance, since the dairy and wine sectors are leaders in the GIs market, studies explicitly focusing on them can obtain different results. Wines have always been a milestone of agri-food exports, driven by historical (e.g. the USA) as well as second-tier markets (e.g. China and Russia). Due to their intrinsic linkage with the *terroir*, the informal interactions between natural and human factors of the region of origin become a fundamental part of the intangible value of this production (Haeck et al., 2019; Cross et al., 2011). In addition, wines have long shelf lives, are quite easy to export from a packaging and logistics point of view and are characterized by higher value-added. Furthermore, wine is one of the two categories of GIs TRIPs explicitly mentions. For these reasons, we include dummies for studies explicitly focusing on the wine and dairy sectors (*Wine* and *Dairy* dummies).

Italy and France are the EU countries with the highest number of GIs. Huysmans and Swinnen (2019) provide evidence of the geographical concentration in these countries, and Huysmans (2020) underlines the higher probability that their GIs will be recognised in trade agreements. Therefore we introduce the dummies for these countries (*Italy and France* dummies). Recently there has been a long debate concerning the importance of including GIs in bilateral trade agreements. Given that GIs are not automatically recognised by all extra-EU countries (Curzi and Huysmans, 2022), they need to be explicitly listed in bilateral agreements. Given that not all contributions take into consideration this aspect, control for this difference by including the dummy labelled *Importers recognizing GIs*. At the same time, focusing on intra-EU trade eliminates several confounding factors related to (1) trade barriers as well as (2) GI policy declination, given that they are the same for all of them. We include a specific *Intra-EU* dummy variable to consider these aspects, and evaluate if there is any difference for estimations that focus on intra-EU trade flows.[22]

Analyses performed at different geographic levels can generate drastically different results. For instance, using country-level data implies territorial aggregation far from the level at which the GI policy is established (i.e., municipality), but the majority of studies are not conducted at a more granular territorial level (e.g., regions). Conversely, not considering sectoral differentiation might omit product heterogeneity. To account for these issues, we include a dummy for papers not providing details at both the geographical and sectoral levels (*No country-sectoral* focus dummy).

Some studies use cross-section estimations, which cannot control for time-invariant determinants, unlike panel data models, while others use a very short time span. For this reason, we include a dummy called *Cross-section analysis* for cross-sectional studies and the number of years under analysis for panel data studies. In addition, we consider an *OLS* methodological dummy for papers using OLS estimations since they do not assess endogeneity issues.

Acknowledging a product as a GI can have multiple impacts on global markets. One hypothesis is that exports and their economic values increase after the GI certification. However, while the idea that GIs are likely to have an upward impact in terms of value (e.g., premium pricing) is quite reasonable, the effects in terms of export volumes are less predictable, since a substitution between national and international markets may occur. This may be the case in the wine sector, where the yield per hectare for GI wines is fixed by product specifications and the supply curve is relatively price inelastic in the short run. Although we use the PEESE correction to compare estimates with different outcomes, the differences in the choice of outcome variables remain a potential source of heterogeneity in estimations' results. For this reason, we include dummies for different outcomes in our model (*Dummies for trade outcome*).

In order to detect the existence of publication impact, which was hinted at by the results from the model (1), we introduce a *Published* dummy equal to one for published papers (Salvatici and Cipollina, 2010; Stanley, 2005).[23] To account for between- and within correlation, we clustered standard errors at the level of the study (as in the case of simple *meta*-analysis) (Abadie et al., 2017) .

3.3.1. Multiple meta-analysis regression results

Even after controlling for the various characteristics of the studies, the methodology adopted and publication impacts, our findings indicate a positive effect of GIs on trade (Table 2), confirming what emerged from the basic *meta*-analysis (Table 1). The wild cluster bootstrap test confirms our results.

[19] In column (4), WLS PEESE for papers using continuous variables, the FAT coefficient (β1) is slightly above 0.1. In this paper the low magnitude of some estimates is due to how we construct the PPC and its standard error:.$PCC = \frac{SEoftheoriginalestimation}{(SEoftheoriginalestimation^2 + Numberofobservations)^{1/2}}$ $SEPCC = \left(\frac{(1-PCC^2)}{Numberofobservations}\right)^{1/2}$

[20] The complete list of the information coded for each study and estimate is available upon request.

[21] Among the variables that we had to discard from our sample, we have variables related to the functional forms used by each paper. The reason is that the majority of the papers use the same functional form and, consequently variables accounting for them suffer for multicollinearity issues.

[22] We would have controlled also for studies considering intra-national flows, which are particularly relevant for GIs with little international recognition, but great recognition nationally. From a methodological perspective, including intra-national and international sales reduces bias in gravity models (Yotov et al, 2016; Yotov, 2012). However, intra-national flows are not considered by papers covered by the *meta*-analysis for the lack of viable data and, therefore, diversion effects of domestic sales to international markets cannot s be identified if gravity is estimated with international trade flows only.

[23] One of the main limitations of the *meta*-analysis is the arbitrary selection of the studies (Ashenfelter et al., 1999). On the one hand, published papers should be more precise and reliable in terms of external validity and credibility; on the other journals could be more prone to publish "optimistic" and statistically significant results.

It is worth recalling that we are more interested in the significance of explanatory variables' coefficients than in their magnitude. Indeed, MRA allows us to investigate the reasons why we observe heterogeneity in the empirical results, rather than estimate the "true" value of the parameter under investigation (Bruno and Cipollina, 2017). The magnitude of coefficients may be, in fact, very low due to PEESE construction (see footnote 19).

Let us analyse the main results, starting from papers using the number of GIs (column 1). Our results suggest that, while the effect tends to be higher in studies focusing on the wine sector, the sign associated with studies looking at the dairy sector is lower (as signed by the negative sign). Especially for some products, such as wines, the individual reputation (e.g., winery names and grape variety) can prevail over the GI (Pomarici et al., 2021; Costanigro et al., 2010; (Anderson, 2004)). Accounting for intra-EU trade is significant, and negative, suggesting that this scheme is more relevant for extra-EU trade. Apparently, the signalling role of the GI is even more important when trade is not facilitated by market integration. The mutual recognition of GIs seems also to be relevant and the magnitude of estimates is lower when papers control for it.

As far as empirical settings, we find positive and statistically significant coefficients associated with the dummy for cross-sectional analysis, suggesting that results from cross-section estimations may be affected by the exclusion or mismeasurement of specific variables. The number of years over which the studies are conducted is also significant, and positive, suggesting that not only it is relevant to observe the phenomenon over time but also that the effect of GIs on international trade may rise over the years under analysis. The hypothesis that misleading results can be driven by the lack of appropriate data, not considering both geographical and sectoral details seem to be confirmed, at least when papers look at the number of GIs. This evidence suggests that considering sectoral and territorial dimensions allows avoiding the underestimation of the effects of GIs, which should differ among sectors and territories. Among the possible approaches to measuring trade effects, product value share is the outcome associated with the lowest estimated effect. Notwithstanding the well-known methodological problems, using OLS estimation does not seem very important due to the low magnitude and level of significance.

After controlling for papers' characteristics, the coefficient on *Published* is statistically significant and negative, suggesting that the peer-review process plays a role in excluding the highest (and possibly less realistic) results. The presence of asymmetry highlighted in Table 2 can be now at least partially explained by the presence of publication impact.

Looking at papers using dummy variables (column 2), we can control for three additional papers' characteristics: focus on PDOs, PGIs or the leading countries in GI productions. The estimates that refer to PDOs tend to be lower, while in the case of PGIs they tend to be higher. This can be due to the fact that PGI certification is less demanding as not every part of the production, processing and preparation must take place within a specific area. In this sense, the production process is more flexible compared to PDOs, and more aligned with standard agri-food productions and international market dynamics. In addition, even though PDOs should signal higher quality levels, the difference between PDOs and other types of GIs may not be perceived by foreign consumers and, therefore, PDOs may be unable to capture larger premiums in international markets (Menapace and Moschini, 2014). The higher effect for papers focusing on the wine sector is confirmed, while now there is no evidence of differences for papers looking at the dairy sector. Looking at papers focusing on the leading countries in GI productions (Italy and France) or intra-EU trade, these variables are not significant.

The dummy cross-section confirms the potential upward bias generated by the availability of a time dimension, validating the assumption that choosing a valid time span is crucial for correctly evaluating the analysed effects (Agostino and Trivieri, 2014). The relevance of the number of years under analysis is also confirmed, while not considering geographical and sectoral details become insignificant. For this group, estimates tend to be slightly higher in papers using unit values, while using OLS models does not significantly change the estimation of GIs effects. A significant and negative coefficient for the dummy *Published* also emerges in this case, confirming the presence of a publication impact.

In conclusion, correcting for publication selection and controlling for papers' characteristics slightly reduces the average effect of GIs on trade estimated by the MRA, but a positive effect remains evident for both papers measuring GIs through dummies (column 1) and analysis accounting for the number of GIs (column 2).

4. Conclusions and policy implications

In this paper, we have summarized and explained the great heterogeneity in the empirical results in economic studies investigating the effects of GIs on trade performing a *meta*-analysis. This is the first attempt to verify and explain the differences in estimating the GI trade effects, rather than simply tabulate findings. Our results indicate that the effect of GIs on trade is positive, even after controlling for the different GIs' foci, the methodology adopted, and publication selection. Although there is evidence of publication selection (published papers averagely conclude for more limited impacts), there is also evidence of a genuine positive trade effect beyond publication impact.

Our findings highlight the importance of some research characteristics in explaining the variation in reported estimates. In particular, higher impacts are estimated by papers using dummies to account for GIs and, therefore, capturing only GI status. In addition, our results show that these effects might be larger in papers focusing on the wine sectors or PGI products. Papers using cross-sectional analysis, which capture the effect with less accuracy and potential misspecification, provide estimates showing upward effects. At the same time, other characteristics such as focusing on the leading countries of the GI market and intra-EU flows, accounting for the fact that importers officially recognised GIs in bilateral trade agreements and, from a methodological perspective, using OLS estimations, seem to not bring spurious results.

The general optimism about the effectiveness of GIs in international markets is therefore confirmed even if, in practice, it might be more or less substantial in some markets and for some GI types. Thanks to the endorsement of local forms of production and embedded characteristics on a global scale, GIs represent a relevant policy tool for the internationalisation of agricultural products and the territorial openness of their region of origin. Indeed, one of the main empirical regularities that characterize exporters is that they are more productive than non-exporters. This may be due to the importance of learning from foreign markets both directly, through buyer–seller relationships, and indirectly, through increased competition from foreign producers. Moreover, it is well-known that exporters generate external benefits to other firms, either by acting as a conduit for knowledge that they acquire through trade or by making it easier for domestically oriented firms to break into foreign markets.

The positioning of GIs in international markets and their inclusion in international agreements should be of key importance for policymakers. Territorial policies aimed at supporting local assets such as cooperation, institutional linkages and private entrepreneurship are needed at the local level, in order to preserve embedded production systems and stimulate collective actions. At the international level, the role of the European GI scheme in the global market should be supported by increasing political efforts for the inclusion of GI productions in international agreements. Although the positive effects on trade could be mainly driven by GIs with high individual products' reputations (e.g., Bordeaux wine DOP and Parmigiano Reggiano DOP continue to be the most exported agri-food products in the GI market), the GI scheme may be relevant to increasing the international reputation and competition of less known agri-food products. GIs work, in fact, as a collective measure, a collective quality sign that helps those products that cannot incur the

fixed (and sunk) costs required to establish an individual reputation. For these products, GIs are an opportunity to defend themselves from international standardization, fraud and unfair competition.

The interest in this field is likely to increase in the future due to the strong efforts of the EU to have its products institutionally acknowledged with GIs and the first legislative proposal for the revision of the EU GIs systems. Some issues remain open in GI economics and research efforts should be dedicated to addressing them. Opening to future research, it will be crucial to disentangle the role of GIs accompanied by specific trade agreements as well as the different effects of being a GI versus being a GI officially included in trade agreements (following Curzi and Huysmans 2022). Furthermore, the real added value for less-known products should be better investigated to understand to what extent GIs play a role in creating a new competitive collective reputation, rather than corroborate individual ones. Lastly, efforts should be dedicated to improving data availability and adopting advanced methodologies to estimate internationalisation effects and net causal impacts at the territorial level reflecting the level of assignment of the GIs (e.g., local areas including single municipalities).

Disclosure statement

No potential conflict of interest was reported by the authors.

CRediT authorship contribution statement

Fabrizio De Filippis: Supervision, Writing – review & editing. **Mara Giua:** Conceptualization, Investigation, Writing – review & editing. **Luca Salvatici:** Conceptualization, Investigation, Writing – review & editing, Project administration, Funding acquisition. **Cristina Vaquero-Piñeiro:** Conceptualization, Investigation, Formal analysis, Data curation, Writing – original draft.

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

See Fig. A1 and Tables A1-A7.

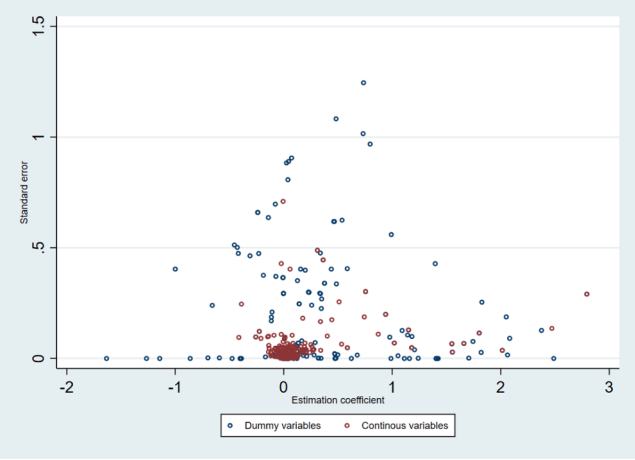

Fig. A1. Funnel graph of individual estimates. *Notes:* Asymmetry in the funnel graph is the mark of publication selection impact. In the absence of publication bias, the diagram has to reassemble an inverted funnel, wide at the bottom for small sample studies and narrowing as it rises.

Table A1
Research criteria for the systematic literature review.

Document type	Academic papers and official reports explicitly on GIs English-language Peer-reviewed Published and unpublished papers
Topic fields	Abstract, title or subject of the paper
Keywords	Geographical Indication* OR Protected Designation of Origin OR Protected Geographical Indication AND trade, export*, import*, international*, WTO, TRIPS, FTA, Free Trade Agreements, GVC, Global Value Chain* Geographical Indicaton* AND trade
Subject excluded	Studies on other quality schemes and quality certifications
Time span	All years (September 2021)

Table A2
Research criteria for *Meta*-analysis studies.

Document type	Academic papers and official reports explicitly on the trade effects of GIs English-language Peer-reviewed Published and unpublished papers
Topic fields	Abstract, title or subject of the paper
Keywords	Geographical Indication* OR Protected Designation of Origin OR Protected Geographical Indication AND trade, export*, import*, international*, WTO, TRIPS, FTA, Free Trade Agreements, GVC, Global Value Chain* Geographical Indicaton* AND trade
Subject excluded	Studies on other quality schemes and quality certifications; studies on GIs' internationalization effects different from trade flows and stocks
Time span	All years (September 2021)

Table A3
Sample study.

	Paper	Dependent variable (trade effect)	Time span	GI variable
1	Agostino and Trivieri (2014)	• Trade flow – value Trade flow - quantity	1995–2009	Dummy
2	Agostino and Trivieri (2016)	• Trade flow – value Trade flow - quantity	2010–2013	Dummy
3	Brooks (2003)	Trade unit value	1992–1998	Dummy
4	Curzi and Huysmans (2022)	• Trade flow – valueProduct share (categories set that are exported with positive trade flows) Intensive margin - value share Trade unit value	2004–2019	Number
5	Curzi and Olper (2012)	Intensive margin - value share	2001–2006	Dummy
6	Duvaleix et al. (2021)	• Trade unit value Trade flow - quantity	2013	Dummy
7	Hoerl and Hess (2017)	Comparative advantage	2002–2015	Number
8	Leufkens (2017)	Trade flow – value	1996–2010	Number
9	Lubinga et al. (2020)	Trade flow – value	1996–2015	Number
10	Mulik and Crespi (2011)	Trade unit value	1970–2003	Number
11	Raimondi et al. (2016)	• Trade flow – quantityProduct share (categories set that are exported with positive trade flows) Trade unit value Trade flow – value	1996–2004	Dummy
12	Raimondi et al. (2020)	• Overall trade value – 2 digit Intensive margin - value shareExtensive margin (categories set that are exported with positive trade flows) – product share Trade unit value Overall trade value – 6 digit Trade flow value	1996–2014	Number
13	Sorgho and Larue (2014)	Trade flow – quantity	1999–2009	Number
14	Sorgho and Larue (2018)	Trade flow – value	2009	Number
15	Duvaleix et al. (2018)	• Trade unit value Trade flow – quantity	2012	Dummy

Table A4
Explanatory variables.

Variable	Description	Mean	Std	Min	Max	Estimations
Dummies for GIs						
PDO	Dummy variable coded 1 if the study focuses on PDOs, 0 otherwise	0.103	0.305	0	1	0 = 459 1 = 53
PGI	Dummy variable coded 1 if the study focuses on PGIs, 0 otherwise	0.055	0.227	0	1	0 = 484 1 = 28
GI	Dummy variable coded 1 if the study focuses on GIs, 0 otherwise	0.842	0.365	0	1	0 = 81 1 = 431
Wine	Dummy variable coded 1 if the analysis focus on the wine productions, 0 otherwise	0.478	0.500	0	1	0 = 267 1 = 245
Dairy	Dummy variable coded 1 if the analysis focus on the dairy productions, 0 otherwise	0.251	0.434	0	1	0 = 383 1 = 129
Italy or France case studies	Dummy variable coded 1 if the analysis focuses on Italy or France, 0 otherwise	0.183	0.387	0	1	0 = 418 1 = 94
Importer	Dummy variable coded 1 if papers controlling for importers, 0 otherwise	0.240	0.428	0	1	0 = 389 1 = 123
Intra-EU trade	Dummy variable coded 1 if papers control for intra-EU trade, 0 otherwise	0.150	0.357	0	1	0 = 435 1 = 77
Dummies for empirical setting						
No country-sectoral focus	Dummy variable coded 1 for paper nor providing details at both the geographical and sectoral level, 0 otherwise	0.634	0.481	0	1	0 = 187 1 = 325
Cross-sectional data	Dummy variable coded 1 for papers using cross-sectional data	0.215	0.411	0	1	0 = 402 1 = 110
Number of years (panel data)	Interaction between a dummy variable coded 1 if the analysis is conducted by using panel data (0 otherwise) and the number of years under analysis (continuous variable)	10.98	7.832	0	34	
Trade outcome	Factorial variable accounting for different trade outcome (dependent variable)	2.01	1.12	1	5	
OLS	Dummy variable coded 1 for OLS estimations, 0 otherwise	0.168	0.374	0	1	0 = 426 1 = 86
GI indicator dummy	Dummy variable coded 1 for papers using dummy, 0 otherwise	0.39	0.488	0	1	0 = 312 1 = 200
Published	Dummy variable coded 1 if the study has been published, 0 otherwise	0.757	0.428	0	1	0 = 124 1 = 388

Table A5
Partial Correlation Coefficient (PCC).

Variable	Mean	Std. Dev.	Min	Max
PCC	0.0001903	0.0008855	0	0.0138942
Standard error PCC	0.0047332	0.0113524	5.45e-07	0.0327783

Table A6
meta-analysis – GI indicator.

	WLS OLS model (1)	WLS PEESE model (2)
1/Standard error β_0	0.036*** (0.001)	
1/Standard error^2 β_0		0.115** (0.039)
Intercept β_1	0.000 (0.000)	−0.000** (0.000)
GI indicator dummy	0.001 (0.000)	−0.000 (0.000)
NR-squared	0.003	0.200
Observations	499	195
Wild bootstrap cluster (pvalue)	0.001	0.000

Notes:. Robust (paper clustered) standard errors in parenthesis. Models have been estimated with the constant.
Multilevel mixed effects models consist of fixed effects and random effects. GI indicator dummy = 1 if paper accounts for GI by dummy variables, 0 otherwise. ***p < 0.01; **p < 0.05;*p < 0.1.

Table A7
meta-analysis – robustness check.

	Studies using dummies for GIs		Studies using continuous variables (number) for GIs	
	RE panel *meta*-regression analysis model (1)	Multilevel mixed-effect model (2)	RE panel *meta*-regression analysis model (3)	Multilevel mixed-effect model (4)
1/Standard error β_1	0.305*** (0.0103)	0.308*** (0.017)	0.036*** (0.002)	0.036*** (0.041)
Intercept β_0	−0.000 (0.00002)	−0.000 (0.00003)	0.000 (0.0000)	0.000 (0.00003)
GI dummy indicator				
R-squared	0.086		0.194	
Observations	195	195	304	304
No. of studies	8	8	7	7

Notes: Robust (paper clustered) standard errors in parenthesis. Models have been estimated with the constant.
Multilevel mixed effects models consist of fixed effects and random effects. GI indicator dummy = 1 if paper accounts for GI by dummy variables, 0 otherwise. ***p < 0.01; **p < 0.05;*p < 0.1.

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