Trade Policies: a booster dose for Innovation!

Maria Cipollina*, Federica Demaria**, Filomena Pietrovito***

Abstract
In the last decades a wide range of preferential trading schemes have been actively engaged in order to promote a process of economic development and industrialization, as well as integration in the world trading system. However, generous preferential schemes are often accompanied by complex rules, firstly related to product standards or quality, or other technical conditions, which are seen as a major obstacle for exporters. In this context, innovation becomes one of the key determinants of entering in foreign markets protected by such trade barriers. Most innovating sectors are more likely to break through non-tariff measures and enhance the overall quantity and quality of exports, and then gain a competitive advantage. The main goal of this paper is to assess if there exists an empirical evidence of a positive impact on trade of standards through the innovation. Results show that the most innovating sectors characterized by a high number of barriers, in terms of product quality, are those exporting more.

JEL Classification: F12, F13, F14, O24, O30
Keywords: standards, quality, innovation, manufactured products, gravity equation.

* University of Molise – Italy. cipollina@unimol.it
** University of Calabria – Italy. demariaf@unical.it
*** University of Molise – Italy. filomena.pietrovito@unimol.it
1. Introduction

Over the last decades, in the context of decreasing tariffs due to multilateral and bilateral agreements, Non Tariff Measures (NTMs) have been increasing. It is largely acknowledged that in sectors characterized by restrictive NTMs generous preferences do not seem to be important in increasing trade. Indeed, NTMs are often used to protect the domestic market in place of the classical policy instruments. A controversial empirical evidence on the trade effects of standards exists and a clear prediction on their impacts on trade cannot be found. The literature suggests indeed that standards may have negative or positive effects. On the one hand facing higher requirements in foreign markets reduces trade, on the other hand information on quality may increase the confidence of consumers and foster trade.

In this context the way to overcome NTMs and promote the competitiveness of foreign products in a given area is a crucial issue for foreign producers who have to necessarily comply with national and international standards. Thus, NTMs may play a strategic role in influencing firm’s production process. Most notably, the net effect on trade depends on the producers’ ability to innovate and complying with the requirements imposed both at national and at international level.

A serious problem in NTMs regards the aspect of fixed cost component in order to adapt product to any requirement or to a new technical requirement. Two related aspects are indeed necessary: (i) some initial investment, independently from the level of exports and (ii) some adjustment over time. These costs, in the same way as tariffs, produce barriers to trade affecting its volume and the decision on the convenience to export in certain markets or not. Entering into international market implies indeed some costs varying across sectors, countries and products. Only firms showing a best performance, i.e. firms able to readily implement the requirements imposed by foreign countries will be able to face a market with very high barriers and, at the same time, to benefit from the preferential trade agreements (PTAs) advantages.

Firms exposed to foreign demand have larger incentives to innovate; at micro level, recent advances in international trade show a strong linkages between export and innovation activity. But if firms aim to export products protected by complex rules, the innovation becomes one of the key determinant to entry in foreign markets. After making the innovation choice, in addition to serving the domestic market, firms have also to export. In presence of restrictions related to product standards, countries that innovate are more likely able to face to the complex rules, often linked to preferential schemes, and then gain a competitive advantage.

The spirit of the self-selection mechanism in the Melitz (2003)’s model is that the productivity level influences the exporting behavior of firms. In other words, only ex-ante more productive firms self-select into international markets. This implies that firms investing in
innovation end up in being more competitive in the international markets. Rodrik (1988) and Yeaple (2005) point out that the incentives for a firm to invest in technology rises with the size of the final market they are going to serve. This implies that trade liberalization induces firms to innovate more. These theories would work well if firms were operating in a market without NTMs.

In this framework, the first contribution of this paper is to provide an extension of the theoretical framework of Helpman, Melitz and Yeaple (2004): for many traded products NTMs, in particular standards and regulations, define the import requirements whereby foreign products can be sold on domestic markets. These kind of measures are likely to play a much larger role than tariffs, so that tariff preferences alone are not sufficient to facilitate the access in foreign markets. In presence of NTMs the firm-level decision of whether or not to export depends crucially on the decision to invest in innovation. Innovation is indeed one of the key determinants of entering in foreign markets protected by complex rules. Firms invest resources in innovation to improve the product quality. A successful firm responsible for quality improvement is likely to profitable export, and to become more profitable in domestic market.

Then, a second contribution of the paper is to provide an assessment of the trade effects of NTMs and, as previously said, verify if standards can be used to support innovation and competitiveness. From an empirical point of view, in this work we want to show that there is a strong linkage between trade and trade policies, in particular NTMs, through innovation. The main questions we want to answer are: Are protection measures a barrier to export? Can standards be used to support foreign competition through the innovation?

From a methodological point of view, we use a gravity model in order to test our hypothesis. We construct a large dataset including 13 manufacturing sectors at the 3 digit ISIC level, 75 exporting countries and 93 importing countries over the period 1994-2001. Data on exports are provided by the UN Comtrade database, data on NTMs are provided by the TradeProd (Cepii) and data on innovation are drawn from the NBER database. As a measure of innovation we adopt the number of utility patents granted by the US Patent Office.

At aggregate level our results shows that NTMs might be an incentive to innovate, since more innovating sectors are able to overcome barriers in terms of product quality and therefore to export more. Furthermore, the analysis by destination country reveals how the effect of the innovation is strongly related to the degree of development of the exporting countries.

The article is structured as follows. After reviewing the most influential literature on NTMs and exports and on innovation and exports (Section 2), we propose the theoretical model in Section 3. In Section 4 we introduce the gravity equation, the estimation technique and the data description in Section 4. The results are described in Section 5. Section 6 concludes.
2. Literature review

This section is organized in two sub-sections providing a brief review of the literature related to the impact of non-tariff measures on exports and the literature analyzing the impact of innovation on exports.

2.1 Non-Tariff Measures and exports

NTMs can be defined as policy measures, other than tariffs, that can create economic effect on international trade in goods by changing quantities traded, prices, or both (MAST, 2008). They may be used as instruments to achieve policy objectives, such as protection of domestic producers. The impact of these measures on export is debatable: they may be trade restricting, trade enhancing or neutral. On the one hand, production costs may increase in order to meet the requirement of importing countries and, at the same time, trade may reduce (Chen and Mattoo, 2004; Moenius, 2006a). On the other hand, requirements by the importing countries may influence consumer confidence, thereby reducing transaction costs and fostering trade (Clougherty and Grajek, 2008; Fontagné et al, 2005; Moenius, 2004; Moenius 2006b). In the first case, these measures may cause market entry problems being obstacles to trade, different from tariffs, aiming at restricting imports or exports.

Different methods related to the measurement of NTMs exist. A binary choice variable, namely “count measures” represents a first indicator (Disdier, Fontagné, and Mimouni, 2008; de Frahan and Vancauteren, 2006; Fontagné et al., 2005; Moenius, 2004). This term is equal to one if a country-pair on a given product line in a specific year has a specific measure, and zero otherwise. The advantage of using the count measures (frequency and coverage indexes) is the simplicity of their computation. The only necessary information is the product line and country specific knowledge of the existence of measures. However, the use of this measure is controversial because it does not provide any information about the severity or the stringency of the standards. In fact, a high number of NTMs does not mean trade creating or trade diverting effects. The presence of NTMs, indeed, does not imply their effective implementation.

Regulations and standards can be also measured by using the stringency of their requirements. Quantitative information, such as Maximum Residuals Levels of pesticides or contaminants, is used (Disdier and Marette, 2010; Xiong and Beghin, 2011; Droguè and DeMaria, 2012; Winchester et al. 2012). Another possibility is to derive tariff equivalents which determine the equivalent tariff rate reproducing the changed import level and the altered domestic prices induced by the respective measures.
The literature has much discussed on the use and on the effects of standards\(^1\) finding that their impact varies depending on destination markets and sectors of economic activity. Concerning the destination markets, several studies find that standards limit market access particularly for developing countries (DCs) and Least Developed Countries (LDCs) towards developed countries and their impact can be more restrictive than tariffs. Concerning sectors, some studies find that in agricultural products, standards may constrain exports. On the contrary, in manufactured products, standards tend to increase trade.

Moenius (2004) examines the impacts of standards by using the information of Perinorm\(^2\) in a large data set covering 471 4-digit SITC sectors in 12 OECD countries. Overall, results including all SITC categories and three standards variables (count of standards in country \(A\) that are different in country \(B\); count of standards in country \(B\) that are different in \(A\); a count of standards in \(A\) that equal in country \(B\) and vice-versa) show that NTMs promote trade. Moreover, results differ depending on sectors considered: \((i)\) on food, beverages, crude materials and mineral fuels country-specific importer standards act as a barrier to trade, and \((ii)\) on oils, chemicals, manufacturing, machinery country-specific importer standards seem to support imports into that country.

Fontagné et al (2005) analyze the impact of NTMs on a sample of 161 group of products, manufacturing and agricultural, for 114 exporting countries and 61 importing countries by using all notified barriers at HS6 digit level to WTO by checking also for tariffs. A negative impact of these measures on trade are mainly found for agricultural products, while manufactured products report an insignificant or positive impact. Similarly, Disdier et al (2008) evaluate the trade impact of NTMs notified by OECD importing countries on agricultural products. Three different variables as NTMs are used. The first indicator of NTMs is a dummy variable equal to one if the importing country notifies at least one barrier at the HS6 digit level; the second indicator is a frequency index, and finally a third dial is an ad valorem equivalent. Dataset includes 154 importing countries, 183 exporting countries and 690 products at HS6 digit level in 2004. On the one hand, results show that OECD exporters are not significantly affected by these measures in their exports to other OECD members; on the other hand, DCs and LDCs exporting to OECD countries are negatively affected by the regulations. In addition, the negative impact of sanitary and phytosanitary measures (SPS) and technical barriers to trade (TBTs) is stronger when exports to the EU market are considered. Stringency measures, such as the MRLs of pesticides and contaminants, have been used to analyze

\(^1\) Standards can be defined as technical documents that set out and define criteria, methods and practices covering features of products and referring to the characteristics related to the quality and safety of products. There is an important difference between standards and regulations. In fact, while complying with standards is voluntary, complying with technical regulations is mandatory by law.

\(^2\) Perinorm is a database containing information on the standards published by the principal national and international standards authorities.
their effects on agricultural sector (Otzuki et al., 2001; Xiong and Beghin, 2012; Disdier and Marette, 2010). Results of these works show how regulations on standards negatively affect bilateral trade flows. Finally, other measures such as composite indexes, have been used in the works of Drogué and Demaria (2012) and Vigani et al. (2011). Both studies suggest that the similarity on regulations may promote bilateral trade flows.

2.2 Innovation and exports

This paper is also related to the literature analyzing the impact of innovation on exports. Innovation is usually interpreted as an indicator of the non-price competitiveness of a nation’s products (Buxton et al., 1991). Innovation activity, as a potential explanation for trade performances, has attracted the attention of several empirical studies at the country-level, as well as at the more disaggregated industry- and firm-level.

Several studies have shown how openness to trade is a key determinant for technological progress. Studies at the macroeconomic level agree on the idea that country’s exports are positively associated with knowledge accumulation and innovative activities. For example, in a seminal paper, Wakelin (1998) finds a positive relationship between innovation and bilateral trade performance between OECD members. Similarly, considering creativity and its four components (innovation, technology, technology transfer, and business startups), Di Pietro and Anoruo (2006) use simple cross-country regression analysis to test whether these determinants have any impact on the total value of a country’s exports and on its composition. They find that the promotion of creativity may be a way to enhance exports. In a country-specific study on Australia, Salim and Bloch (2009) show that business expenditure on R&D Granger-causes exports.

Most notably, this paper is closely related to sector-level studies adopting a technology-based perspective as their starting point and suggesting that innovative industries will be net exporters rather than net importers, and that innovators will face lower price and higher income elasticities. In the existing studies the impact of innovation on sector trade is treated in two ways: the direct impact of being an innovative industry; and the role of spillovers of innovations from other industries.

In a seminal paper, Greenhalgh (1990) examines the UK net exports for 31 sectors and uses SPRU innovation data finding that in half the sectors considered net exports gained from either intra-sectoral or inter-sectoral innovation. In a subsequent extension of the original analysis, Greenhalgh et al. (1994) consider innovation effects on both net export volumes and export prices using both patents and other innovations data. In general terms, these measures produce results that are similar to the earlier study, suggesting a positive effect from the innovation measures on trade volumes in the UK. In a similar vein, Wakelin (1998) adopts an approach from the technology gap
tradition in examining sectoral trade flows for 22 industries and nine OECD countries. This study relates relative export flows to relative technology investments (R&D, patents, and SPRU innovation rates in the UK). In accordance to Greenhalgh (1990), this study allows for both intra-sectoral and inter-sectoral spill-overs from innovation on trade.\(^3\) Wakelin (1998)’s results also provide general support for a positive relationship between innovation and export flows, although this result is sensitive to the use of different technology and innovation indicators.

Anderton (1999, 1999a) also considers the impact of R&D and patenting activity on trade (and prices) arguing that both technology indicators are considered proxies for the quality and/or variety of goods produced. Specifically, Anderton (1999) estimates this impact for six industrial sectors in the UK. Both measures of technological activity are found to have significant negative effects on import volumes but much weaker effects on export volumes and import prices. In a more specific exercise, Anderton (1999a) considers bilateral trade between the UK and Germany and focuses on import volumes and values using similar technology variables. Anderton (1999a) finds some evidence that relative R&D expenditure and patenting activity are more important in high-technology intensity industries.

As pointed out by many micro-level studies, R&D and innovation, involving the introduction of new products or the improvement of a firm’s existing product range, play a key part in helping a firm to sustain or improve its market position (Roper and Love, 2002). Firm level studies of the trade-innovation relationship focus on export volume or more specifically on export propensity i.e. the proportion of firms’ sales which are exported. Some studies in this strand of the literature adopt the view that studies based solely on R&D intensity to explain the probability of exporting and the export intensity may be misleading and that using a range of innovation indicators may be more appropriate (Wakelin, 1998a; Sterlacchini 1999; Harris and Moffat, 2011). In general, these studies find that being an innovator significantly reduces both the probability of exporting and export propensity. Among innovative firms, however, the greater the number of innovations the more likely a firm is to be exporting. Other studies focus on the different impact of product and process innovation and find similar results (Roper and Love, 2002; Bekaer and Egger, 2007; Cassiman et al., 2010; Damijan Kostevc and Polanec, 2010).

\(^3\) For example, innovation in engineering sectors such as machinery, may have a direct benefit for machinery exports but may also generate spill-over benefits for the export potential of other manufacturing sectors.
3. Theoretical Framework

Following Helpman-Melitz-Yeaple model (2004), we assume $N$ countries indexed by $i$ that use labour to produce a homogeneous product in sector 1, with one unit of labour per one unit of output, and differentiated products in $H$ sectors. Assuming that the homogeneous good is freely traded, the wage rate equals 1 in every country. Firms in each sector $h$ engage a monopolistic competition.

Starting from preferences modeled similarly to the Dixit/Stiglitz approach, the utility function is given:

$$U = (1 - \sum_{h=1}^{H} \beta_h) \log z + \sum_{h=1}^{H} \beta_h \log \left( \int_{v \in V_h} x_h(v)^{\alpha_h} dv \right)$$

(1)

where a fraction of $1 - \sum_{h=1}^{H} \beta_h$ of income is spent on the homogeneous good $z$, a fraction $\beta_h$ is spent on differentiated good $x$ with variety $v$ from sector $h$, $V_h$ is the set of all potential varieties in sector $h$, and $\alpha$ is the usual love-of-variety parameter with the elasticity of substitution being $\sigma = 1/(1 - \alpha) > 1$.

These preferences generate a demand function:

$$x_h(v) = \frac{\beta E}{\int p(x)^{1-\sigma} dx} p(v)^{-\sigma}$$

(2)

where $E$ is the consumer’s expenditure on all products.

As in Helpman-Melitz-Yeaple (2004), firms set the monopolistic price as a mark, determined by the substitution parameter $\alpha$, over marginal costs $a$, depending on labour per unit of output and the wage rate which is normalized at 1. Therefore, for domestically sold products:

$$p = \frac{a}{a}$$

(3)

If the firm chooses to export the consumer price for imported products from country $j$ becomes:

$$p^* = \frac{\tau^{ij} a}{a}$$

(4)

where $\tau^{ij} > 1$ is the iceberg-transport cost to export products from country $i$ to country $j$.

Firms that produce only in the home country face the fixed overhead labour costs $f_D$, while firms that export bear additional fixed costs $f_X$ per foreign market (with $f_X > f_D$). Operating profits from serving the domestic market are:

$$\pi^D_i = a^{1-\sigma} A^i - f_D$$

(5)

where $A^i = (1 - \alpha) \int \frac{\beta E}{\int p(x)^{1-\sigma} dx} p(v)^{-\sigma} \alpha^{\sigma-1}$.

While, under the assumption of the same demand levels in countries $i$ and $j$ ($A^i = A^j$), the additional operating profits from exporting to country $j$ are:

$$\pi^{ij}_X = (\tau^{ij} a)^{1-\sigma} A^i - f_X$$

(6)
Since $\sigma > 1$ the variable $a^{1-\sigma}$ can be used as a productivity index. Firms with productivity levels greater than $\left(a_X^{ij}\right)^{1-\sigma}$ can export profitably.

Trade policies that reduce or eliminate tariff barriers on imports decrease trade costs, as a result the cut-off productivity level at which exporters just break even decreases (Figure 1).

However for many traded products non-tariff barriers, such as administrative burdens, restrictive sanitary and phytosanitary regulations, are likely to play a much larger role than tariffs, so tariff preferences alone are not sufficient to access foreign markets. Firms exposed to foreign demand have larger incentives to innovate, but if firms produce products protected by complex rules the innovation becomes one of the key determinant to entry in world market. The innovation in a sector takes the form of an improvement by the multiple $\mu > 1$, so the $\kappa$-th innovation raises the quality from $\mu^{\kappa-1}$ to $\mu^\kappa$.

Suppose that restrictive non-tariff barriers require that a product originated in country $i$ may be associated to a quality $\left(\mu_v^i\right)^\kappa$. This implies that the consumption of $x_h(n)$ physical units originated in country $i$ can be written:

$$\tilde{x}_h = x_h(n)\left(\mu_v^i\right)^\kappa$$

(7)

Firms invest resources to improve the quality. A successful firm responsible for each quality improvement in sector $h$ retains a monopoly right to produce the good $x_h(n)$ at the quality $\mu^\kappa$ and a competitive advantage in the international markets. We assume that to produce a quality $\mu^\kappa$, firms face a marginal cost $\tilde{a} = \left(\mu^\kappa\right)^e a$, where $e$ is the cost elasticity to quality. As a result, the prices in domestic and foreign markets are respectively:

$$\tilde{p} = \frac{\left(\mu_v^i\right)^ea}{a}$$

(8)

and

$$\tilde{p}^* = \frac{\tau^{ij}\left(\mu_v^i\right)^ea}{a}$$

(9)

Setting $\bar{A}^i = \left(\mu_v^i\right)^\kappa A^i$, profits in eq. (5) and eq. (6) become:

$$\tilde{\pi}_D^i = \tilde{a}^{1-\sigma} \bar{A}^i - f_D$$

(10)

and

$$\tilde{\pi}_X^i = \left(\tau^{ij}\tilde{a}\right)^{1-\sigma} \bar{A}^i - f_X$$

(11)

respectively.

Profits realized by a successful innovator are higher than profits realized by firms using old technologies if $\sigma < (e + 1)/e$. Since the purpose of innovation is to differentiate from

$^{4} \tilde{\pi}_D^i > \pi_D^i$ and $\tilde{\pi}_X^i > \pi_X^i$ if $\left(\mu^\kappa\right)^{e(1-\sigma)+1} > 1$.  

9
competitors, with quality improvement the elasticity of substitution among varieties tends to be close to 1, then this condition is quite convincing.

Innovation is the development of new values through solutions that meet new requirements imposed by the importing countries. The presence of NTMs can have a positive effect on the rate of innovation because firms will have a competitive advantage over their rivals once overcome the barrier. The slope of $\pi^i_D$ is $A^i$ while the slope of $\bar{\pi}^i_D$ is $\bar{A}^i$, more innovative firms are therefore more profitable (see Figure 2). Countries that innovate are likely able to face the complex rules linked to preferential schemes, gain a competitive advantage, and then get higher profits both in domestic and foreign markets.

4. Empirical strategy

4.1 Econometric approach

From a methodological point of view, this paper is related to the gravity model literature developed by Tinbergen (1962) and Pöyhönen (1963). Recent gravity models (Anderson and van Wincoop, 2004; Anderson and Yotov, 2011 and 2012) express bilateral trade flow at the sector level ($h$) between country $i$ and $j$ at time $t$ ($X^h_{ij,t}$) as:

$$X^h_{ij,t} = \frac{\gamma^h_{ij,t}}{\gamma^h_t} \left( \frac{\tau^h_{ij,t}}{\beta^h_{ij,t}} \right)^{1-\sigma_h}$$

(12)

where (excluding time index) $\gamma^h_t$ is the country $i$’s share of the world’s sales of goods class $h$; $E^h_t$ is the country $j$’s share of the world spending on $h$; $\sigma_h > 1$ is the elasticity of substitution across goods in $h$; $\beta^h_t \Pi^h_t$ are “multilateral resistance (MR) terms” (Anderson and van Wincoop, 2003) and $T^h_{ij,t}$ are the trade costs (distance, tariff, language, colony, etc). Specifically, the MR is an indicator of the barrier to trade that each country imposes to all trading partners.

Building on the gravity model, we estimate the following regression:

$$X^h_{ij,t} = \beta_0 + \beta_1 Y^h_{ij,t} + \beta_2 E^h_t + \beta_3 Distance_{ij} + \beta_4 Tariff_{ij} + \beta_5 N TM^h_{ij,t} + \beta_6 Patent^h_{ij,t} + \beta_7 N TM^h_{ij,t} * Patent^h_{ij,t} + \beta_8 Language_{ij} + \beta_9 Colony_{ij} + \epsilon^h_{ij,t}$$

(13)

where, $i$ indexes for exporter country, $j$ for importer country, $h$ for sector and $t$ for time. The dependent variable is the trade value between country $i$ and country $j$ in sector $h$ at time $t$.

---

5 The assumption $\sigma > 1$ implies that consumers in country $i$ have a preference to consume the largest possible number of varieties.

6 The inclusion of a MR index in empirical works has become the way to obtain a specification of gravity equation that could be interpreted as a reduced form of a model of trade with sound micro foundations.
Concerning explanatory variables, $Y_{i,t}^h$ and $E_{j,t}^h$ are economic sizes of countries proxied by nominal GDP; $\text{Tari}ff$ is the bilateral applied tariffs between two countries, in sector $h$ at time $t$; $\text{NTM}$ is the non-tariff measure indicating the frequency of restrictions on quality applied by country $j$ to country $i$ in a particular sector $h$ at time $t$. $\text{Patent}$ is the level of innovation of sector $h$ of exporter country expressed as the number of patents granted by the US patent office; $\text{NTM}^*\text{Patent}$ is the interaction term between the NTM and innovation. $\text{Distance}$ is the distance between country $i$ and $j$; $\text{Language}$ and $\text{Colony}$ are dummy variables taking the value of 1 for pair of countries showing, respectively, common language and current colonial ties, and zero otherwise. Finally, four sets of dummies at the level of exporter country $i$, importer country $j$, sector $h$ and time $t$ are added to account for MR indexes and all other unobserved variables, as country and product-specific characteristics. Country dummies are computed, respectively, on 73 exporters and 93 importers included in the analysis. Sector dummies are constructed on 13 ISIC codes (Revision 2) at the 3-digits level. Time dummies refer to 8 years included in the estimates.

Working at highly disaggregated data arises the issue of zero values in trade. The presence of zeros creates obvious problems in the log-linear form of the gravity equation. Zero flows do not reflect unobservable trade values but they are the result of economic decision making based on the potential profitability of engaging in bilateral trade at all. The treatment of zeroes is a matter both from a statistical point of view and form an economic perspective. Firstly, the omission of zeroes could lead to the sample selection bias, as defined by Heckman (1979), unless the zeros correspond to “missing at random”. Secondly, zeroes are important because they answer to the issue of whether and how trade polices improve market access, in particular from developing countries (DCs). Indeed, as specified by Shepherd (2010) reducing export costs (tariffs and transport costs), developing countries could export in different destinations.

There has been a long debate concerning what is the best econometric approach in order to avoid the bias that would be implied by eliminating the observations with zero flows. Several authors consider the Heckman two-step estimator (Heckman, 1979) as the best procedure (Linders and de Groot, 2006; Helpman et al., 2008; Martin and Pham, 2008). Others argue that gravity type models should be estimated in multiplicative form, and recommend maximum likelihood estimation.

\footnote{Helpman et al. (2008) extend Heckman’s estimation method to also take into account the bias associated with the heterogeneity of firms by developing a complete theoretical framework from which an empirical specification of the gravity equation is obtained. Their model accounts for firm heterogeneity, trade asymmetries and fixed trade costs, suggesting that the decision to export and the volume of exports are not independent variables. This model, firstly allows both positive and zero trade flows between countries to be predicted; secondly it allows exports to vary according to the destination country.}
techniques based on the Poisson specification of the model (Siliverstovs and Schumacher, 2007; Santos-Silva and Tenreyro, 2006, 2009).

However, since the bilateral trade flows are collected from multiple countries heteroskedasticity may be a challenge especially in the common practice of logarithmic transformation. As Santos Silva and Tenreyro (2006) showed, if the true gravity equation is in its multiplicative form and heteroskedasticity is present, estimates from the log-linearized gravity equation can be biased. They propose the use of the Pseudo Poisson Maximum Likelihood method (PPML). This specification of the gravity model solves three kind of problems. Indeed, thanks to its multiplicative form, the PPML specification provides a natural way dealing with zero trade flows. In addition, the estimation of the gravity model by PPML are consistent in the presence of heteroskedasticity and are reasonably efficient, especially in large samples. Finally, the objective function is log-linear instead of log-log, this imply that the dependent variable do not have to be transformed logarithmically.

Accordingly, we estimate the gravity model in multiplicative form, using Poisson pseudo-maximum-likelihood (PPML) estimator, commonly used in the recent empirical analyses (Anderson and Yotov, 2011 and 2012).

4.2 Data and descriptive statistics

The main source of data for the purpose of our empirical analysis is the *TradeProd* database, managed by the Cepii. *TradeProd* proposes bilateral trade, production and protection figures in a compatible industry classification for developed and developing countries. *TradeProd* covers 26 industrial sectors in the ISIC Revision 2 (International Standard Industrial Classification) at the 3-digits level, from 1980 to 2006.

To construct the dependent variable for our estimation model, we draw from *TradeProd* data on bilateral flows involving both developed and developing countries in several industrial sectors, over eight years. Data on exports are expressed in thousand dollars.

Concerning our explanatory variables, data issues are particularly problematic in the analysis of NTMs. In fact, in many cases this information is not available and sometimes it also not easily obtained. Usually, information on NTMs include either the number (or changes in their number) or the descriptions of measures, which are given for specific products. Even though several sources are available for these measures, our source is the *TradeProd* database. *TradeProd* provides information on bilateral trade policy: tariffs and NTMs. Specifically, the information is provided at

---

8 For more information, see http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=5.

9 Data on NTMs can also be obtained from United Nation’s Conference on Trade and Development (UNCTAD), from World Trade Organization (WTO) and from the Trade Analysis and Information System (TRAAINS) database.
the bilateral level over the period 1989-2001. The dataset provides two kind of NTMs: five frequency index and five coverage index, other than an index grouping all measures. In particular it contains: (i) frequency index related to price effect, (ii) those with a restriction on quantity, (iii) restriction on quality, (iv) threatening measures and (v) a frequency related to advanced payments and finally. The same classification applies for coverage measures. Among these NTMs we choose frequency index related to the quality.10

The second key explanatory variable is a measure of innovation. Patents have long been recognized as a very rich and potentially fruitful source of data for the study of innovation and technical change (Hall et al., 2001). Indeed, the main advantages in using patent data are: (i) each patent contains detailed information on the innovation itself, the technological area to which it belongs, the inventors (e.g. their geographical location), the assignee, etc., and (ii) patent data include citations to previous patents and to the scientific literature, allowing to study spillovers, and to create indicators of the “importance” of individual patents.

In this empirical study, we adopt the number of utility patents granted by the US Patent Office, provided by the national bureau of economic research (NBER), as a measure of technological intensity.11 The annual number of US granted utility patents are classified according to the US Patent Classification (USPC).12 However, the number of patents is a questionable measure of innovation because not all inventions are patented since they do not meet the patentable criteria set by the patent office. For this reason, a future development of this analysis is to include R&D expenditures by sectors alongside patents.

To limit the potential for omitted-variable bias, we add to the main variables of interest other controls that are based on the vast gravity literature focusing on trade. Tariff variable provided by TradeProd database takes into account the bilateral preferences across countries in the world in the ISIC Revision 2 at the three digits level. We also include distance that is expected to directly increase transaction costs because of the transportation costs of shipping products, the cost of acquiring information about other economies, and the cost of finding a partner and contracting at a distance. Concerning other bilateral characteristics, we include a dummy variable equal to 1 if importer and exporter countries share the same language and a dummy variable equal two 1 if

10 It is calculated based on number of HS commodity subject to measures. The number of product categories subject to NTMs is a percentage of the total number of product categories in the HS group in order to get the frequency ratio.
11 Data are available at http://www.nber.org/patents/. Broadly speaking, the dataset comprise detailed information on almost 3 million US patents granted between January 1963 and December 1999, all citations made to these patents between 1975 and 1999 (over 16 million), and a reasonably broad match of patents to Compustat (the data set of all firms traded in the US stock market) (Hall et al., 2001).
12 Since the original data on patents are classified according to the US Patent Classification, we combined them with other information adopting the correspondence scheme between the US Patent Classification and the International Patent Classification and between the latter and the ISIC Rev. 3 provided by Johnson (2002). Finally, concordances between ISIC Rev. 3 and ISIC Rev. 2 are applied.
countries are currently in colonial relationships. Bilateral characteristics are drawn from the dataset provided by the Cepii. Moreover, data on exporter’s and importer’s total GDP at current prices in US dollars are drawn from the World Economic Outlook provided by the International Monetary Fund.

Matching our different sources, we construct an original database that associates bilateral trade at the sector level and sector and country level variables, for a sample of developed as well as developing countries. Industries including finance and utilities are excluded, along with wholesale and retail trade, because of the non-tradable nature of these activities. We also exclude agriculture and primary sectors (i.e., mining and oil and gas extraction) due to the absence of data on NTM. As a result, we focus on manufacturing sectors (i.e., sectors with an ISIC code between 311 and 385). We end up with a large dataset including 73 exporters, 93 importers, 13 manufacturing sectors at the 3-digits ISIC, over the period 1994-2001.

Table 1 presents descriptive statistics of our variables of interest. Concerning the dependent variable, i.e. exports, it shows an average value of more than 251 million dollars and a high variability, with values ranging between 0 and 138,000 million dollars. Moreover, our first key explanatory variable, the frequency index of NTM (with a restriction on quality) is between 0 and 1 and shows and average value of 0.083. The number of patents, reflecting the technological development, is also highly variable in our sample, with values ranging between 0 (for manufacture of fabricated metal products in Turkey) and 1,188 (for manufacture of fabricated metal products in USA) and an average equal to 19.

Among bilateral characteristics, bilateral tariffs show a high variability, with values ranging between 0 and 268% and an average level of about 10%. Distance shows an average of more than 7,700 kilometres, with values ranging between 60 and more than 19,000 kilometres. Total GDP reflects the economic development of exporter and importer countries, with minimum values of 0.329 for Kenya (in 2000) and Jordan (in 1999), and the maximum value of more than 10,000 dollars for US (in 2001).

Table 2 reports simple correlations among the variables used in the empirical model. As expected, exports is positively correlated with innovation, GDP and common language. A negative correlation is reported between exports and tariff barriers, distance, colony and, surprisingly NTM. Moreover, a positive correlation is reported between tariff and non-tariff measures. This correlation

---

13 Data are available at http://www.cepii.fr/anglaisgraph/bdd/distances.htm
14 The CEPII follows the great circle formula and uses latitudes and longitudes of the most important cities (in terms of population) to calculate the average of distances between city pairs. Data on distances are available at: http://www.cepii.fr/anglaisgraph/bdd/distances.htm. We also adopted distances between capitals as an alternative measure and the results remain unchanged.
suggests a complementarity between these measures of protection. Even though summary statistics and bilateral correlations are suggestive, they do not control for potentially confounding factors. For this reason, in what follows we perform a more refined econometric analysis.

5. Results and major implications

5.1 Baseline results

This section provides the empirical analysis of the estimation technique. Results of the eq. (13) are reported in Table 3 and Table 4. In order to analyze the impact of our variables of interest (namely, the NTMs and the proxy for innovation), we first introduce these variables separately, and then we control contemporaneously for both. Finally we allow these measures to simultaneously interplay in order to estimate the accelerator effect. In all specifications, we control for exporter, importer, time and sector fixed effects, as specified in Section 4.1.

Model (1) of Table 3 shows results of the standard gravity equation augmented by our measure of interest for NTMs. As it can be inferred from the coefficients of explanatory variables, trade costs (i.e. bilateral tariff, distance, language and colony) show the expected impact on exports. Specifically, an increase in tariff factor of 10% implies a decrease of export equal to 1.63%. Moreover, the impact of distance is even larger since a 10% increase implies a trade reduction equal to 12.75%. However, language does not seem to exert a significant impact on trade, probably because we control for several fixed effects. Countries currently in colonial relationships are expected to show also trade relationships. The coefficient of this variable (0.813) is significant at the 1% level. The GDP of both importer and exporter show a positive and significant coefficient (0.296 and 0.368, respectively), meaning that market size of both origin and destination countries matters for trade.

Most notably, our measure of NTMs shows a positive (0.450) and highly significant coefficient at the 1% level. In economic terms, an increase of NTMs by a one standard deviation (0.176) implies an increase in exports which is equal to 0.079. This interesting results can be interpreted in the sense that a high frequency of quality standards imposed in different sectors by the importer induces the counterpart to export higher quality product and to register a high value of exporters. In other terms, high standard quality are an incentive, and not a constraint to trade, for exporting countries to produce and sell in the foreign markets high valued manufactured products.

Manufactured product may indeed be defined as products with high value added: once internalized the cost of complying with the importing requisite, there is no more obstacles to enter
that specific market. Furthermore, our results suggest that the absolute value of the effect of NTMs is higher than the impact of tariffs.

In model (2) of Table 3, we estimate the same baseline gravity model, augmented with our measure of innovation, namely the number of utility patents. The sign and significance of the gravity variables (i.e. bilateral tariff, distance, GDP, language and colony) are comparable to those reported in the previous estimate. Most interestingly, the coefficient of our proxy for innovation is positive (0.082) and highly significant at the 1% level. In terms of the economic impact, this coefficient implies that an increase of a one standard deviation (4.511) in the log of number of utility patents implies an increase of trade equal to 0.370. This result is consistent with most part of the literature on the relationship between innovation and export showing that more innovative manufacturing sectors are more likely to export in foreign countries. In other terms, innovation allows firms in a sector to improve the product quality and to export highly value added products.

In model (3) of Table 3 we aim to control for both NTMs and innovation measures. Reassuringly, results remain unchanged and the coefficients of our variables of interest (0.451 and 0.082) imply a similar impact as that discussed above.

Up to now, we have shown that NTMs and innovation have an independent effect on bilateral trade, consistent with some part of the literature. However, the two measures, other than showing an independent effect on trade, are expected to interact, according to our theoretical model presented in Section 3. The hypotheses of our model imply indeed that countries that innovate are more likely to face the complex rules linked to preferential schemes, gain a competitive advantage, and then get higher profits both in domestic and foreign markets.

For this reason, in the last model (4) of Table 3 we introduce the interaction term between the frequency index of quality and our proxy for innovation, alongside interacted variables. As it can be inferred from the table, the coefficient of the gravity variables remain almost unchanged, apart for colony that show a non-significant coefficient. The interacted variables, i.e. NTMs and patents, show a positive impact as in the previous estimates. However, their coefficients are quite lower (0.344 and 0.078) than that reported in model (3). Most notably, the interaction term exerts a positive (0.063) and significant impact on trade at the 10% level. It implies that innovation helps sectors in a country to export high quality products as required by the standards imposed by the importing partner. In other terms, not only NTMs imposed in a sector are not considered as trade barriers in our sample, but standards on quality are more likely to be reached the higher the level of innovation in that sector. This interesting result, recognize a different role to the innovation process in the sense that it amplify the positive effect of NTMs on exports.
5.2 Different groups of countries

Table 4 reports the results of the gravity equation by splitting the original sample by origin and destination country. Our purpose is determine whether an univocal interaction effect between standards and innovation exists and in which direction. Regarding NTMs, market access and competitiveness is the major issue from the perspective of exporters. Standards and regulations differ country by country and importing countries demand foreign products complying with their standards. The capacity of the exporters to comply with international standards is a matter in assessing the impact of NTMs on the competitiveness of the exporting countries. NTMs imposed by developed countries can affect both the exports of developing countries and LDCs and the exports of developed ones. However, confirming compliance with international standards poses difficulties and insurmountable troubles, particularly for developing countries, which are typically characterized by small and medium enterprises. All these considerations allow us to investigate the effect of our three variables of interest \((NTMs, Patents, NTMs^*Patents)\) by country groups.

Model (1) in Table 4 considers exports of developing countries toward the rest of the world. Model (2) analyzes the exports of developed countries toward the rest of the world. Model (3) studies developing country exports to developed areas and, finally, model (4) considers developed country exports to developed countries.

The impact of the importer’s size on exports is positive and statistically significant in models (1)-(3). Whereas, the economic size of the exporting countries is not significant in all estimated models implying that the size of the foreign country does not affect the trade flows. Probably, this can be associated to the presence of fixed effects in our estimations. As expected, distance and the bilateral tariff show the right sign and a strongly significant coefficient in all estimated models. The coefficient of the distance ranges between -1.282 and -1.465, while that of tariffs ranges between -0.095 and -0.293.

The coefficient of the NTMs is positive, even if not significant in models (2) and (4). On the contrary, it is negative and not significant in models 1 and 3. While the positive sign of NTMs means that, our proxy of quality standards, promotes trade, a negative sign implies that standards may hamper trade flows. Thus, we can think at the standards as an additional costs of compliance with the foreign measures.

Regarding the coefficient of the innovation proxy, estimates range between 0.067 and 0.087 which means that a higher number of utility patents increases bilateral trade flows. This impact is strongly significant in models (2) and (4).

Most interestingly, looking at the interaction term between NTMs and patents we find a negative and significant coefficient at the 5% level in models (1) and (3) (-0.249 and -0.357,
respectively). This negative and significant sign affects the exports of developing countries versus the rest of the word, and the exports of developing countries versus developed countries. How can we explain this result on the basis of our model? A negative sign implies that countries that innovate are not able to face the complex rules linked to quality requirements and lose competitiveness. In this case, standards act as barriers to trade and reduce exports from developing countries. This evidence is supported by the negative sign, even not significant, NTMs variable (-0.637). In fact, compliance costs can be greater in developing countries, such that the adaptation costs imposed by international standards may exceed the gains deriving from the adaptation of specific standards and, for this way exports from developing to developed or to rest of the world can be reduced by regulations or standards. Indeed, requirements of the importing countries can be particularly challenging for developing countries, which often lack the specialized technological, institutional infrastructure and financial resources to evaluate and conform their production to the requirements.

A positive and significant coefficient (0.225) of the interaction term is reported in model (4). The positive sign means that compliance with the international standards introduce into international market high quality products. This result is not surprising since the analysis covers developed countries: tight imports requirements of developed countries does not affect exports from developed ones and standards contribute to stimulate innovation. If we compare this result with that one of Table 3 model 4, here, we note that the effect of the interaction term is substantially higher.

6. Concluding remarks

This work is an assessment of the key role of the innovation to improve trade in presence of product standards imposed by the importing countries, in particular those concerning quality. Indeed, countries that export in markets protected by complex rules have more incentive to invest in innovation in order to enter international market, to be more competitive and then to gain a competitive advantage. This paper contributes to the literature by investigating both the role of standards on exports of manufactured products and whether innovation exerts an accelerator effect on those standards.

The first contribution of this paper is to provide an extension of the theoretical framework of Helpman, Melitz and Yeaple (2004). In presence of NTMs the firm-level decision of whether or not to export depends crucially on the decision to invest in innovation in order to improve the product quality. A successful firm responsible for quality improvement is likely to break through non-tariff barriers, enhance the quality of products, and then profitable exporting.
From a methodological point of view, the second contribution of the paper is to provide an analysis based on disaggregated data at 3-digit level, to account the heterogeneity of the policy across products, and the estimation of the impact of the simultaneous presence of NTMs and a positive degree of innovation, proxied by number of utility patents.

Our analysis show two important results. Firstly at sector level NTMs and patents have on average a positive impact on trade. Most notably, the coefficient of the interaction term between the measure of quality standards and the measure of innovation is even positive, implying that innovation helps sectors in a country to export high quality products as required by the standards imposed by the importing partner. This interesting result recognizes a different role to the innovation process in the sense that it not only impacts on trade, but it also amplifies the positive effect of NTMs on exports.

Secondly by splitting the original sample by destination country we show that how the spillover effect of the innovation on quality is strongly related to the level of development of exporting countries. On the one hand, adaptation costs imposed by international standards can be very high for developing countries. As a consequence, developing countries that innovate are not able to face the complex rules linked to quality requirements and lose competitiveness. On the other hand, this reasoning does not apply to developed countries.

From a policy perspective, our analysis highlights that complying with foreign standards or regulations is a crucial element across trading partners. These measures may act as an additional cost of entering to the foreign markets. However, if a country is able to overcome these kind of barriers, then standards do not constrain trade and can even foster trade through the support received from innovation and competitiveness across countries. In this context, we may think about the standards as a tool helping to improve quality of products through innovation and thus boost trade. This requires a major interaction between policy makers and industry needs. This might support innovation and promote the adoption of new technologies in order to increase consumers and environment protection.

We acknowledge that these findings present some limit especially dependent on the database used. This should be considered as the starting point of a deeper analysis in which other information on the innovation and regulation by sector should be included.
References


21

Appendix

Table 1. Descriptive statistics
This table reports descriptive statistics used in the empirical estimates.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Standard dev.</th>
<th>Min</th>
<th>Max</th>
<th>N. obs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td>250.971</td>
<td>4.928</td>
<td>2.425</td>
<td>0</td>
<td>138,000</td>
<td>56,529</td>
</tr>
<tr>
<td>Tariff(^a)</td>
<td>9.659</td>
<td>7.143</td>
<td>11.462</td>
<td>0</td>
<td>268.4052</td>
<td>56,529</td>
</tr>
<tr>
<td>NTMs(^b)</td>
<td>0.083</td>
<td>0.003</td>
<td>0.176</td>
<td>0</td>
<td>1</td>
<td>56,529</td>
</tr>
<tr>
<td>Patents(^b)</td>
<td>19.032</td>
<td>0.897</td>
<td>91.026</td>
<td>0</td>
<td>1,188</td>
<td>56,529</td>
</tr>
<tr>
<td>NTMs*Patents</td>
<td>-0.017</td>
<td>0.000</td>
<td>0.491</td>
<td>-6.823</td>
<td>6.061</td>
<td>56,529</td>
</tr>
<tr>
<td>Distance(^b)</td>
<td>7.757</td>
<td>8.181</td>
<td>4829</td>
<td>60</td>
<td>19,772</td>
<td>56,529</td>
</tr>
<tr>
<td>GDP exporter(^b)</td>
<td>1.021</td>
<td>276</td>
<td>1.944</td>
<td>0.329</td>
<td>10,128</td>
<td>56,529</td>
</tr>
<tr>
<td>GDP importer(^b)</td>
<td>0.501</td>
<td>116</td>
<td>1.354</td>
<td>0.425</td>
<td>10,128</td>
<td>56,529</td>
</tr>
<tr>
<td>Common language</td>
<td>0.109</td>
<td>0</td>
<td>0.312</td>
<td>0</td>
<td>1</td>
<td>56,529</td>
</tr>
<tr>
<td>Colony</td>
<td>0</td>
<td>0</td>
<td>0.015</td>
<td>0</td>
<td>1</td>
<td>56,529</td>
</tr>
</tbody>
</table>

\(^a\): this variable is included in the estimates as the ln(1+variable).
\(^b\): this variable is included in the estimates as the ln(variable).

Export is expressed in thousand dollars.

Table 2. Correlation matrix
This table reports correlations between variables used in the empirical estimates.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Export</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Tariff(^a)</td>
<td>-0.110</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) NTMs (^b)</td>
<td>-0.011</td>
<td>0.221</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Patents(^b)</td>
<td>0.084</td>
<td>0.020</td>
<td>0.010</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) NTMs*Patents</td>
<td>0.033</td>
<td>-0.039</td>
<td>0.013</td>
<td>0.427</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Distance(^b)</td>
<td>-0.178</td>
<td>0.449</td>
<td>0.176</td>
<td>-0.019</td>
<td>-0.009</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) GDP exporter(^b)</td>
<td>0.102</td>
<td>0.043</td>
<td>0.039</td>
<td>0.641</td>
<td>0.289</td>
<td>0.034</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) GDP importer(^b)</td>
<td>0.133</td>
<td>-0.348</td>
<td>0.091</td>
<td>-0.037</td>
<td>-0.012</td>
<td>-0.127</td>
<td>-0.030</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9) Common language</td>
<td>0.016</td>
<td>0.002</td>
<td>-0.011</td>
<td>-0.013</td>
<td>-0.033</td>
<td>-0.021</td>
<td>0.011</td>
<td>-0.007</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(10) Colony</td>
<td>-0.002</td>
<td>-0.013</td>
<td>-0.006</td>
<td>-0.019</td>
<td>-0.001</td>
<td>-0.030</td>
<td>-0.034</td>
<td>0.004</td>
<td>0.043</td>
<td>1</td>
</tr>
</tbody>
</table>

\(^a\): this variable is included in the estimates as the ln(1+variable).
\(^b\): this variable is included in the estimates as the ln(variable).
Table 3. Baseline results
This table reports the estimated coefficients of the gravity model.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.163***</td>
<td>-0.154***</td>
<td>-0.159***</td>
<td>-0.152***</td>
</tr>
<tr>
<td></td>
<td>(0.0309)</td>
<td>(0.0298)</td>
<td>(0.0300)</td>
<td>(0.0301)</td>
</tr>
<tr>
<td>NTMs</td>
<td>0.450***</td>
<td>0.451***</td>
<td>0.344**</td>
<td>0.078***</td>
</tr>
<tr>
<td></td>
<td>(0.1683)</td>
<td>(0.1653)</td>
<td>(0.1722)</td>
<td></td>
</tr>
<tr>
<td>Patents&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.082***</td>
<td>0.082***</td>
<td>0.078***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0173)</td>
<td>(0.0172)</td>
<td>(0.0173)</td>
<td></td>
</tr>
<tr>
<td>NTMs*Patents</td>
<td></td>
<td></td>
<td></td>
<td>0.063*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0346)</td>
</tr>
<tr>
<td>Distance&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-1.275***</td>
<td>-1.276***</td>
<td>-1.274***</td>
<td>-1.274***</td>
</tr>
<tr>
<td></td>
<td>(0.0240)</td>
<td>(0.0238)</td>
<td>(0.0239)</td>
<td>(0.0239)</td>
</tr>
<tr>
<td>GDP Exporter&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.296*</td>
<td>0.347**</td>
<td>0.323*</td>
<td>0.340**</td>
</tr>
<tr>
<td></td>
<td>(0.1716)</td>
<td>(0.1720)</td>
<td>(0.1714)</td>
<td>(0.1714)</td>
</tr>
<tr>
<td>GDP Importer&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.368**</td>
<td>0.497***</td>
<td>0.359*</td>
<td>0.346*</td>
</tr>
<tr>
<td></td>
<td>(0.1862)</td>
<td>(0.1921)</td>
<td>(0.1865)</td>
<td>(0.1860)</td>
</tr>
<tr>
<td>Language</td>
<td>-0.001</td>
<td>0.005</td>
<td>0.006</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>(0.0487)</td>
<td>(0.0483)</td>
<td>(0.0484)</td>
<td>(0.0484)</td>
</tr>
<tr>
<td>Colony</td>
<td>0.813*</td>
<td>0.824*</td>
<td>0.837*</td>
<td>0.818</td>
</tr>
<tr>
<td></td>
<td>(0.4807)</td>
<td>(0.4852)</td>
<td>(0.4818)</td>
<td>(0.4803)</td>
</tr>
<tr>
<td>Observations</td>
<td>56,529</td>
<td>56,529</td>
<td>56,529</td>
<td>56,529</td>
</tr>
</tbody>
</table>

<sup>a</sup>: this variable is included in the estimates as the ln(1+variable).
<sup>b</sup>: this variable is included in the estimates as the ln(variable).
Table 4. Different groups of countries
This table reports the estimated coefficients of the gravity model.

<table>
<thead>
<tr>
<th></th>
<th>(1) Developing vs rest of the World</th>
<th>(2) Developed vs rest of the World</th>
<th>(3) Developing vs developed</th>
<th>(4) Developed vs developed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tariff a</strong></td>
<td>-0.293 ***</td>
<td>-0.129 ***</td>
<td>-0.276 ***</td>
<td>-0.095 **</td>
</tr>
<tr>
<td></td>
<td>(0.0698)</td>
<td>(0.0334)</td>
<td>(0.0860)</td>
<td>(0.0421)</td>
</tr>
<tr>
<td><strong>NTMs</strong></td>
<td>-0.637</td>
<td>0.340</td>
<td>-0.732</td>
<td>0.251</td>
</tr>
<tr>
<td></td>
<td>(0.4164)</td>
<td>(0.2190)</td>
<td>(0.5940)</td>
<td>(0.2826)</td>
</tr>
<tr>
<td><strong>Patents b</strong></td>
<td>0.067 *</td>
<td>0.081 ***</td>
<td>0.087 **</td>
<td>0.077 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0350)</td>
<td>(0.0184)</td>
<td>(0.0395)</td>
<td>(0.0198)</td>
</tr>
<tr>
<td><strong>NTMs*Patents</strong></td>
<td>-0.249 **</td>
<td>0.076</td>
<td>-0.357 **</td>
<td>0.225 ***</td>
</tr>
<tr>
<td></td>
<td>(0.1098)</td>
<td>(0.0472)</td>
<td>(0.1704)</td>
<td>(0.0684)</td>
</tr>
<tr>
<td><strong>Distance b</strong></td>
<td>-1.465 ***</td>
<td>-1.282 ***</td>
<td>-1.430 ***</td>
<td>-1.347 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0545)</td>
<td>(0.0246)</td>
<td>(0.0667)</td>
<td>(0.0264)</td>
</tr>
<tr>
<td><strong>GDP Exporter b</strong></td>
<td>0.088</td>
<td>0.235</td>
<td>-0.044</td>
<td>0.330</td>
</tr>
<tr>
<td></td>
<td>(0.2068)</td>
<td>(0.2118)</td>
<td>(0.2482)</td>
<td>(0.2293)</td>
</tr>
<tr>
<td><strong>GDP Importer b</strong></td>
<td>1.095 ***</td>
<td>0.316 *</td>
<td>0.857 *</td>
<td>0.083</td>
</tr>
<tr>
<td></td>
<td>(0.3560)</td>
<td>(0.1895)</td>
<td>(0.4741)</td>
<td>(0.2540)</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>-0.082</td>
<td>0.041</td>
<td>0.090</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>(0.1115)</td>
<td>(0.0471)</td>
<td>(0.1664)</td>
<td>(0.0517)</td>
</tr>
<tr>
<td><strong>Colony</strong></td>
<td>0.743</td>
<td>0.817 *</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.4785)</td>
<td>(0.4523)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observations: 10,953 45,576 5,268 21,125

a: this variable is included in the estimates as the ln(1+variable).
b: this variable is included in the estimates as the ln(variable).
Figure 1. Profits from domestic sales, from exports and effect of preferential trade policies

Figure 2. Profits realized by successful innovator country