Policy Research Working Paper 5677

International Harmonization of Product Standards and Firm Heterogeneity in International Trade

José-Daniel Reyes

The World Bank
Poverty Reduction and Economic Management Network
International Trade Department
June 2011

Abstract

As free trade areas have proliferated and statutory tariffs have been dramatically reduced in recent decades, non-tariff barriers (NTBs) to international trade have risen in importance. Destination-specific product standards are one of the major types of NTBs as they impose additional costs on exporters and increase the time required to bring a product to market. This paper examines the response of U.S. manufacturing firms to a reduction of this NTB by looking at the harmonization of European product standards to international norms in the electronics sector. Using a highly detailed dataset that links U.S. international trade transactions to U.S. firms and a new industry-level database of EU product standards, the author finds that harmonization increases U.S. exports to the EU and that this increase is due to more U.S. firms entering the EU market—the extensive margin of trade. New entrants to the EU region are drawn mainly from the most productive set of firms already exporting to developing markets before harmonization -the extensive margin of trade composition. These firms are characterized by being smaller and less productive than the firms that were already exporting to the EU before harmonization. Furthermore, harmonization decreases export sales at existing exporters -the intensive margin of trade. These findings are consistent with a model featuring the role of product standards heterogeneity across market destinations and productivity heterogeneity across firms. These results suggest that working toward a harmonization of product rules across markets could be a supportive policy to encourage small and medium size firms' ability to enter new export markets.

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José-Daniel Reyes*†

JEL Classification Numbers: F12, F13.

Keywords: Firm heterogeneity, Productivity, Standards, Microdata.

*International Trade Department (PRMTR), the World Bank, e-mail:*jreyes2@worldbank.org*

†I am deeply in debt with Rod Ludema and Brad Jensen for delightful discussions to previous versions of this work. I thank John Wilson for kindly sharing the World Bank EU electrotechnical product standards database with me. I also thank Andrew Bernard, Peter Schott, Francis Vella, Oliver Cadot, Justin Pierce, participants at the U.S. International Trade Commission Seminar and at the Latin American and Caribbean Economic Association 2010 meeting for helpful comments and discussions. The research in this paper was conducted while the author was a Special Sworn Status researcher of the U.S. Census Bureau at the Center of Economic Studies Research Data Center in Washington DC. Any opinions and conclusions expressed herein are those of the author and do not necessarily represent the views of the U.S. Census Bureau, the World Bank, its Board of Directors or the countries that they represent. All results have been reviewed to ensure that no confidential information is disclosed. All remaining errors are my responsibility.

``These days, it is differences in national regulations, far more than tariffs, that put sand in the wheels of trade between rich countries.'' The Economist, May 24^{th}, 1997.

1 Introduction

While numerous articles study the impact of trade liberalization in traditional trade policy instruments, few studies analyze the effect of liberalization in Non-Tariff Barriers (NTBs). This paper examines the response of U.S. manufacturing firms to a reduction of an NTB by looking at the harmonization of European product standards to international norms in the electronic sector. Heterogeneity of product standards across market destinations is an NTB because it imposes additional costs on exporters to comply with market-specific product requirements. It also increases the time required to bring a product to the market. In this paper, I provide the first firm-level evidence of the gains of liberalization in this NTB and decompose its impact into the different margins of trade.

The Agreement on Technical Barriers to Trade (TBT), signed by WTO member countries in 1995, defined product standards as *"a document approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory."* These characteristics are mainly safety rules but they can also include other attributes such as design, size, weight, and energy performance. Examples of standards are safety requirements for sewing machines, measures of electromagnetic emissions from integrated circuits, specific guards for lawn mowers, and mechanical safety of cathode ray tubes. Although the TBT agreement encourages countries to adopt international standards whenever possible, it also recognizes the rights of countries to adopt measures to the extent they consider appropriate — for example, for human, animal or plant life or health, for the protection of the environment, or to meet other consumer interests such as the prevention of deceptive practices.

While the use of standards remains voluntary, the European Union has, since the mid-1980s, made an increasing use of standards in support of its policies and legislation. The European Commission sets compulsory regulatory goals by means of "New Approach Directives", which outline "essential requirements" associated with the manufacturing of products. The system in place does not, however, specify how specific objectives should be achieved. For the electronic sector, this role is fulfilled by product standards issued by the European Committee for Electrotechnical Standardization (CENELEC).[1] EU member countries are obliged to adopt these standards and

[1]For example, the Low Voltage Directive (2006/95/EC) outlines "essential requirements" for electrical equipment with a voltage between 50 and 1000 V for alternating current and between 75 and 1500 V for direct current. Among other conditions, it establishes that "persons and animals are adequately protected against the danger of physical injury or other harm which might be caused by direct or indirect contact". Consequently, CENELEC issued a standard (EN 50371:2002) to demonstrate the compliance of low power electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields (10 MHz - 300 GHz).

withdraw any national standard that might conflict with them. If a manufacturer chooses to produce a product according to these standards, the product carries the CE mark, which implies compliance with the "essential requirements". On the other hand, manufacturers may use other technical specifications when manufacturing a product provided there is documentation certifying that the product meets the "essential requirements" formulated in the Directives. Nevertheless, anecdotal evidence suggests that the prohibitive costs of the latter option push exporting companies to favor compliance with CENELEC standards (see, for instance, Hanson (2005) and the 2010 U.S. Report on Technical Barriers to Trade). At the global level, the International Electrotechnical Commission (IEC) is the organization that prepares and publishes international standards for the electronic sector.

To examine the impact of the trade liberalization in this NTB, I use the CENELEC-IEC agreement to harmonize European product standards to international norms as a policy experiment. The Lugano Agreement, signed in 1991, and the Dresden Agreement, signed in 1996, sought to expedite the adoption of international standards in the EU as well as to facilitate the adoption of EU standards internationally. This synergy has taken the number of purely European standards as a share of all standards published by CENELEC from 50 percent in the early-1990s to 25 percent in 2008. In this context, the decrease in the share of idiosyncratic standards is a liberalization in an NTB to international trade.

Product standards are an important, albeit often overlooked, actor in the international trade arena. Swann (2010) and WTO (2005) present an excellent overview of product standards in the multilateral system and its impact on trade. The literature regarding the effect of harmonization of standards on international trade is relatively recent. Moenius(2004) provides the first valuable contribution by challenging the commonly held view that country-specific standards act as a barrier to trade whereas harmonized standards encourage trade.[2] In a gravity framework, the author uses a panel data set with data on country-specific and bilaterally standards for 471 industries in 12 OECD countries during the period 1980-1995. He finds that bilateral share standards are favorable to trade while country-specific standards tend to hinder trade in simple goods (including agricultural products, food, beverages, and mineral fuels) and promote trade in complex goods (like machinery and electronics). The author then offers an explanation for the divergent effect of country-specific standards based on the dual impact of standards in production and trade costs: While standards may impose additional costs on exporters as it maybe necessary to adapt products for specific markets (cost-effect), they also can reduce exporter's information cost if they convey relevant market information which would be costly to gather in the absence of the standard (informational-effect). Moenius (2004) results imply that the cost-effect outweighs the informational-effect for simple products while the opposite is true for complex products. In

[2]Moenius' work focuses mostly in bilateral harmonization of standards rather than in international harmonization of standards.

subsequent work, Moenius confirms these results for the agricultural sector (Moenius (2006a)) and for the electronics sector (Moenius (2006b)). In related studies, Baller (2007) and Chen and Mattoo (2008) study the impact of EU bilateral harmonization on third countries to conclude that such agreements increase trade between EU members but no necessarily for developing countries. Reyes (2011) extends this conclusion also for the case of international harmonization of EU standards in the Electronics sector.

Inspired by Johannes Moenius' work, and in light of the recommendations from the TBT agreement, researchers started working on the impacts of international harmonization of product standards in trade flows. Czubala et al. (2007) is the first study to consider the impact of international harmonization of standards in the textiles, clothing, and footwear sector on exports from 47 Sub-Saharan countries in Africa to the EU. They find that internationally harmonized standards are less trade restrictive than purely European standards. Building on this result, Shepherd (2007) examines the relationship between international harmonization and product variety in these sectors to find that harmonization is associated with higher export variety, mainly for low income countries's exports to the EU. Albeit limited by the lack of fim-level data, this paper is the first one to explore the impact of harmonization at the extensive margin of trade. Subsequently, Portugal-Perez et al. (2010) extend the analysis of international harmonization in more complex products. By focusing in the electronics sector, the authors not only confirm Moenius' finding about the benign role of standardization but also find that international harmonization enhances exports to the EU. My paper continues this analysis by providing, to the best of my knowledge, the first firm-level evidence of the gains from international harmonization and decomposes them into the extensive and the intensive margins of trade.

To study the impact of EU international harmonization of product standards on U.S. manufacturing firms, I develop and estimate a tractable general equilibrium model of international trade that includes productivity heterogeneity across firms and product standards diversity across market destinations. The model is a three-country version of the Cheney (2008) and Helpman et al. (2008) frameworks in which I assume that two countries have different but equally costly product standards (countries H and F) while the third country has less stringent product requirements (country R). After setting out the base case scenario without harmonization, I modify the model to allow harmonization between countries F and R and characterize the trade impact in country H. The theory provides three testable results: First, harmonization increases the number of $H's$ exporting firms to market F, the extensive margin of trade. Second, new entrants are mainly drawn from the most productive set of H's firms exporting to country R, the extensive margin of trade composition. These firms are characterized by being smaller and less productive than the incumbent exporters to country F. Third, harmonization decreases export sales of $H's$ existing exporters to country F, the intensive margin of trade.

To test these results empirically I merge two newly available datasets: the Linked/Longitudinal Firm Trade Transaction Database (LFTTD), which links individual trade transactions to firms in the US, and the World Bank EU Electrotechnical Standards Database (EUESDB), which provides an inventory of the stock of active standards published by CENELEC and their link with standards issued by the IEC. The LFTTD spans 13 years from 1992 to 2004 and allows the researcher to use information from the Censuses of Manufactures (CM) of the Longitudinal Research Database (LRD) of the U.S. Census Bureau to pin down additional firm characteristics on a quinquennial basis. The EUESDB covers the period 1990-2007 and classifies product standards according to the International Classification of Standards (ICS). See Bernard et al. (2009) and Portugal-Perez et al. (2010) for a complete description of each database, respectively. A key contribution of my analysis is the linking of firm level U.S. manufacturing data to industry level measures of EU product standards. Since there is currently no official concordance mapping from ICS codes to any product or industry classification system, I develop a concordance method between 5-digit ICS codes and 4-digit SIC industries for the Electronic sector.

Results are largerly consistent with theoretical implications. First, I confirm that U.S. industries with relatively high harmonization exhibit relatively high export value to the EU. Furthermore, I show that product standards harmonization increases the probability that higher-productivity firms enter the EU market —the extensive margin of trade. Second, I find that this impact is more relevant for U.S. firms that were already exporters serving developing countries than for firms entering the export activity —the extensive margin of trade composition. Third, I show that this impact is negative for the intensive margin of trade: the change in the value of U.S. goods that are already exported to the EU within surviving trade relationships, e.g., the same firm exporting the same product to Europe throughout the time span. Overall, the impact at the extensive margin outweighs the impact at the intensive margin. The empirical findings suggest that EU product standards harmonization to international norms contributes significantly to explain the export entry patterns observed in my sample of U.S. manufacturing firms.

These results have an important policy implication. The U.S. National Export Initiative laid down in 2010 seeks to double exports over the next five years by enhancing small and medium sized firms' ability to enter export markets and by actively reducing barriers to trade. The results obtained in this paper suggest that working towards a reduction in the differences of product requirements across markets could be a supportive policy to encourage firm entry into export markets.

The remainder of the paper is structured as follows. The next section develops the theoretical model. Section 3 describes the data set and presents summary statistics. Section 4 presents the empirical strategy and report results from testing the main theoretical results. Concluding remarks are offered in section 5. Finally, appendix 1 contains theoretical derivations and appendix 2 presents details of the data set.

2 A Model of Product Standards Harmonization

In this section, I present a model featuring the role of product standards heterogeneity across market destinations and productivity heterogeneity across firms. The model is a straightforward simplification of the Chaney (2008) and Helpman et al. (2008) frameworks in which I allow the fixed cost to export to vary bilaterally in a three-country version of the model. These costs arise from the adaptation of products and production processes to foreign standards and technical regulations. After setting out the base case scenario without harmonization, I modify the model to allow product standard harmonization covering two of the three countries. The impact of harmonization on the third country is then analyzed.[3]

2.1 Preferences

The three markets, indexed by $i \in \{H, F, R\}$, are symmetric. Labor is the only factor of production and each country is endowed with L units of labor, which is also the measure of each market. Consumers have no taste for leisure and inelastically supply their labor at the market prevailing wage rate. Consumers derive utility from the consumption of a continuum of differentiated varieties, indexed by ω, produced under increasing returns to scale and costly trade. The preferences of a representative consumer are given by the following CES utility function.

$$U_i = \left[\int_{\omega \in \Omega_i} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where Ω^i represents the mass of available goods in country i, $q(\omega)$ is the quantity of variety ω consumed, and σ is the elasticity of substitution between any two goods, $\sigma > 1$. This specification of utility gives rise to the following isoelastic demand functions.

$$q\left[p(\omega)\right] = \frac{E_i p(\omega)^{-\sigma}}{P_i^{1-\sigma}} = d_i p(\omega)^{-\sigma} \tag{2}$$

where $d_i = \frac{E_i}{P_i^{1-\sigma}}$ is a demand shifter parameter which is exogeneneous from the point of view of individual supplier, E_i is total expenditure by that country's consumer, and P_i is the ideal price index of market i given by:

$$P_i = \left[\int_{\omega \in \Omega^i} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} \tag{3}$$

2.2 Production

Country i has a measure N of single-plant, single-product firms, each choosing to produce a different variety ω. I assume that a producer bears only production costs when selling in the home

[3]This setting is similar to Shepherd (2008) but it is more flexible in the sense that I consider the equilibrium under different degrees of stringency of the harmonized standard. My framework also provides testable hypothesis on the impact of harmonization at the intensive margin of trade.

market. The cost function is represented by $l = \frac{q}{\varphi}$, where φ is a random unit labor productivity. If a producer seeks to export its product to country i, it has to bear a fixed cost f_i $(0 < f_i)$. To sharpen the role of heterogeneity in the fixed cost to export, variable trade costs are set equal to zero.[4] The fixed costs to export reflect the investment required to establish a production process that manufactures goods which accord with product standards in country i. Firms face productivity heterogeneity by assuming that φ is a random draw from a distribution $g(\varphi)$ with cumulative density function $G(\varphi)$ and support $[\varphi_L, \varphi_H]$.[5] Exporters confront product standards heterogeneity across market destinations by assuming that $f_R < f_F$ and $f_H = f_F$.[6] Profit maximization leads to the standard mark-up pricing rule:

$$p(\omega) = \frac{\sigma}{\sigma - 1}\frac{1}{\varphi}w \tag{4}$$

where w is the common wage rate hereafter normalized to one. The constant mark up pricing is equal across market destinations due to the assumption of no variable trade costs.

The conditional profit function from selling in country j can be expressed as:

$$\pi_{ij} = \varphi^{\sigma-1}\frac{d_j}{\sigma}\left[\frac{\sigma}{\sigma - 1}\right]^{1-\sigma} - f_j \tag{5}$$

where $\{i, j\} \in \{H, F, R\}$.

Due to my assumption that $f_{ii} = 0$ all N producers sell in country i. Following Chaney (2008) the ownership structure of the economy is as follows: each worker owns w_n shares of a global fund that collects all the profits from all firms in the world. The fund then redistributes all profits (Π) to its shareholders. The total revenue in country i is given by $R = \left(1 + \frac{\Pi}{3L}\right) L$.

2.3 Equilibrium

The equilibrium in each economy is given by the labor market clearing condition and the zero cutoff profits condition. The labor market clearing condition ensures that total expenditure equals the total revenue of consumers $E^i = R$. Equation 5 provides the minimum productivity level below which it is not possible to profitably export to country j, $\overline{\varphi}_{ij}$.

$$\overline{\varphi}_{ij}^{\sigma-1} = \frac{f_j \sigma}{d_j}\left(\frac{\sigma}{\sigma - 1}\right)^{\sigma-1} \tag{6}$$

for $i \neq j$.

The productivity threshold is decreasing in the demand level, d_j, and increasing in the cost

[4]The basic insights of the model does not change if I allow $\tau^i > 1$, and $\tau^R > \tau^F$.
[5]$0 < \varphi_L < \varphi_H$.
[6]Home country and Foreign country have different but equally costly product standards.

to comply with product standards, f_j. The partitioning of firms by export status within each country is ensured by $0 < f_j$. Under this assumption, firms drawing a productivity draw above the productivity cutoff, $\overline{\varphi}_{ij}$, will export to country j.

Figure 1 depicts the conditional profit fuctions to export and the productivity thresholds for the Home country. From H's standpoint, F's more restrictive trade policy makes that market tougher for a firm to export to it for two reasons: first, there is the direct effect of more costly product standards which reduces a firm's profits ($f_R < f_F$); second, there is an indirect effect via the demand level in the market $d_R < d_F$. To ensure that the productivity threshold to export is lower for the more protectionist stance, a fact borne out in a number of studies, I assume that the relative fixed cost to export to market F is large.[7] Productivity, thus, provides a natural hierarchy of firms, with less productive firms only serving market R (OR firms) whereas more productive firms being able to export also to market F (AF firms).

2.4 Product Standard Harmonization

Harmonization of product standards between country F and country R involves a single fixed cost, $\widehat{f}$, that home producers now must pay in order to access all foreign markets. The mutual recognition of standards involves a new fixed cost in between the pre-harmonization levels: $f_R \leq \widehat{f} \leq f_F$. Home country does not modify the stringency of domestic product standards, therefore the fix cost to export to H remains unchanged. Since home producers now are only required to pay a single fixed cost to export to F and R, H's conditional profits from export collapse into a single equation.

$$\widehat{\pi}_H = \varphi^{\sigma-1}\left[\frac{d_F + d_R}{\sigma}\right]\left[\frac{\sigma}{\sigma-1}\right]^{1-\sigma} - \widehat{f} \tag{7}$$

Consequently, H's productivity cutoff for exporting to both markets, $\widehat{\varphi}_H$, is given by.

$$\widehat{\varphi}_H^{\sigma-1} = \frac{\widehat{f}\sigma}{d_F + d_R}\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1} \tag{8}$$

The conditional profits of exporting from F and R to H, and the subsequent productivity cutoffs, are still given by equations 5 and 6, respectively. Profits to export within the harmonized zone, $\widehat{\pi}_{ij}$, and the new cutoffs, $\widehat{\varphi}_{ij}$, can now be written as follows.

$$\widehat{\pi_{ij}} = \varphi^{\sigma-1}\frac{d^j}{\sigma}\left[\frac{\sigma}{\sigma-1}\right]^{1-\sigma} - \widehat{f} \tag{9}$$

$$\widehat{\varphi}_{ij}^{\sigma-1} = \frac{\widehat{f}\sigma}{d_j}\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1} \tag{10}$$

[7] A large relative fixed cost to export to market F is one that meets the following condition: $\frac{f_F}{f_R} > \frac{\int_{\omega\in\Omega^R} p(\omega)^{1-\sigma}d\omega}{\int_{\omega\in\Omega^F} p(\omega)^{1-\sigma}d\omega}$.

where $\{i, j\} \in \{F, R\}$ and $i \neq j$.

Product standards harmonization between countries F and R involves two opposite effects in the Home country. On the one hand, it gives firms access to a bigger market upon the payment of a single fixed cost. On the other hand, it entails a fixed cost to export which is higher than the pre-harmonized fixed cost to export to R. The relationship between these impacts determines the consequences of harmonization.

Some OR firms, conditional on their productivity, are now able to enter the F market because the increase in the market size outweighs the increase in the fixed cost to export. The share of OR firms that enter the F market depends on the relative stringency of the harmonized standard. If $\widehat{f}$ is "close" to f_F, only the most productive firms within the OR firms find it profitable to remain as an exporter serving both markets (see appendix 1 for this condition). Figure 2 illustrates this situation. New entrants to the F market are characterized by the segment $[\widehat{\varphi}_H^{\sigma-1}, \overline{\varphi}_{HF}^{\sigma-1}]$. Conversely, low productivity OR firms drop export participation because the increase in the fixed cost to export offsets the increase in the market size; those firms are located in the segment $[\overline{\varphi}_{HR}^{\sigma-1}, \widehat{\varphi}_H^{\sigma-1}]$.

If the harmonized standards is undemanding, meaning $\widehat{f}$ is "near" f_R, then all OR firms enter the F market (see appendix 1 for this condition). Furthermore, the more productive non-exporter firms are now able to become exporters to F and R because the market size effect outweighs the modest increase in the fixed cost to export. Figure 3 describes this situation. New entrants to the F market are depicted in the interval $[\widehat{\varphi}_H^{\sigma-1}, \overline{\varphi}_{HF}^{\sigma-1}]$. New exporters are located in $[\widehat{\varphi}_H^{\sigma-1}, \overline{\varphi}_{HR}^{\sigma-1}]$ whereas OR firms entering the F markets are situated in $[\overline{\varphi}_{HR}^{\sigma-1}, \overline{\varphi}_{HF}^{\sigma-1}]$.

Firm entry into the foreign market has an impact on the average sale of AF firms —the intensive margin of trade. New entrants push the the aggregate price index of market F down and reduce the optimal quantity demanded of a given firm, see equation 2. Harmonization, then, involves a negative impact for AF firms because it increases the competition in the foreign market. Even though I model product standards as a fixed cost to export they may also affect the variable cost.[8] If this is the case, harmonization may increase exports from AF firms due to the reduction in the ongoing costs. As it turns out in the empirical application, the fixed cost aspect seems to be the key factor driving the trade impact of product standards harmonization.

This theoretical framework gives rise to three testable hypotheses on the impact of product standard harmonization on third countries:

1. Product standards harmonization increases the number of $H's$ exporting firms to market F. The extensive margin of trade.[9]

[8]Such as periodic testing or higher marginal costs that stem from a low scale of production. see Baldwin (2000), Chen and Mattoo (2004), and Baller (2007).

[9]This result, of course, is pretty sensitive to the CES assumption. The products I study in the empirical part are

2. New entrants are mainly drawn from the most productive set of OR firms. The extensive margin of trade composition.

3. Product standards harmonization decreases export sales at existing exporters. The intensive margin of trade.

The model presented above is fairly flexible in terms of the assumption on the level of stringency of international norms in country R. Note that hypotheses 1 and 3 remain unchanged if I assume that country F and country R have different but equally costly product standards to begin with. In this case, harmonization involves a different composition of the extensive margin of trade (hypothesis 2). It is represented now by entry from the most productive non-exporter firms because they can now access both markets upon the payment of a single fixed cost. Alternatively, I can relax the assumption that country R uses international norms and get the same theoretical results. In this scenario the only required assumption is that country R has lower fixed costs to export than country F and that harmonization entails some reduction on the cost to export to country F due to, for example, the elimination of standards aimed to protect domestic firms.

3 Data

This analysis uses the U.S. linked/Longitudinal Firm Trade Transaction Database (LFTTD), which links individual U.S. trade transactions to U.S. firms in the Longitudinal Business Database (LBD)[10], in conjunction with firm level information from the Censuses of Manufactures (CM) of the Longitudinal Research Database (LRD) of the U.S. Census Bureau. A key contribution of this study is the linking of firm level U.S. manufacturing data to industry level measures of EU product standards and their relationship with international norms. This section outlines the main features of the datasets.

3.1 U.S. Manufacturing firms Across Industries and Time

The CM is conducted every five years and the empirical part of this paper makes use of CM information from 1992, 1997, and 2002.[11] The unit of observation for the Census is a manufacturing establishment, or plant, and it contains detail information on inputs and output of all establishments.[12] For 1992 and 1997, plants are classified at the four-digit Standard Industrial Classification level (SIC4). In 2002, industry classification changed to the 6-digit North American Industry Clas-

ones for which differentiation and variety is important.

[10]See Bernard et al. (2009) for a complete description of the LFTTD and its construction. For an extensive discussion of the LBD see Jarmin and Miranda (2002).

[11]Though CM data are available for earlier periods, I cannot use them because export information on the LFTTD is not available.

[12]The CM imputes input usage data for small manufactures, referred to in the data as “administrative records”. As it is customary in the U.S. microdata research —see Bernard, Redding and Schott (2010)—, these observations are excluded from the analysis.

sification System (NAICS6). Details of the construction of the variables can be found in appendix 2.

The empirical analysis concentrates on the Electronic sector (SIC 36). This sector was chosen because of the availability of EU product standards data. This sector consists of 36 SIC4 Industries that ranges from vehicular lighting equipment and electric lamps to semiconductors and transformers. Table 1 provides a description of the relative level of detail between industries. U.S. exports to the EU in this sector represents roughly 15.0 percent of total exports to the EU between 1992 and 2002.

Table 2 shows firms' characteristics by exporting and non-exporting firms for 1992 and 1997.[13] Exporting firms are further divided into the set of firms that exports to the EU and those that export to other markets. As expected, exporters —nearly half of the firms— are bigger than non-exporters in terms of average value of shipments and average employment. Around half of exporting firms are multi-plant firms. Interestingly, and consistent with the theoretical model presented in section 2, exporters' characteristics differ in terms of the market destinations. Exporters to the EU are bigger and export more than exporters to other markets. Finally, there is firm entry into export markets across years, which —I argue— can be partially explained by the role of European product standards harmonization.

3.2 Trade Costs Across Industries and Time

Measuring the extent of product standardization across export market destinations is not an easy endeavor. I used The World Bank EU Electrotechnical Standards Database (EUESDB) to gauge this effect and to assess the degree of harmonization of EU standards with international norms. The EUESDB provides the first catalog of European standards in the electrotechnical sector[14] and their relationship with worldwide standards. The database provides an inventory of the "stock" of active standards[15] issued by the European Committee for Electrotechnical Standardization (CENELEC) and their link with standards issued by the International Electrotechnical Commission (IEC). Product standards are classified according to the International Classification of Standards (ICS) and the database covers the period 1990-2007.[16] See Portugal-Perez et al. (2010) for a full description of the EUESDB and its construction.

An important contribution of my analysis is the creation of a new set of industry level measures of EU product standards for the Electronic sector. There is currently no official concordance

[13] I do not present data for 2002 because the change in industry classification does not allow me to observe entry of new firms into sic4 industries for that year. This issue is not problematic for the empirical application since the model does not predict any role for product standard harmonization in domestic firm entry and exit.

[14] This sector refers to electrical, electronic and related technologies. More information can be found at www.iec.ch.

[15] The primary variable of interest is the total number of standards with which an exporter should comply during a particular year.

[16] A list of the ICS codes can be found at www.iso.org/iso/ics6-en.pdf

mapping from ICS codes to any product or industry classification system.[17] I deal with this issue by proposing a concordance between 5-digit ICS codes (ICS5) and SIC4 industries. The construction of this mapping involves a three-step procedure. First, I obtain the 10 digit HS codes (HS10) within each SIC4 industry from Pierce and Schott (2009). Second, I search the PERINORM database[18] —the source dataset for the EUESDB— and tabulate the ICS5 codes associate with the set of HS6 codes within each SIC4 industry. Third, I tabulate standards by those ICS5 codes in the PERINORM dataset and select the ICS5 codes whose standards are actually related to the industry into which they were classified in step two. "Terminology" or "vocabulary" standards are not taken into account. Table 3 presents this concordance and the description of the ICS codes within each industry.

The theoretical model suggests that the heterogeneity of product standards across market destinations is a barrier to trade. I define the non-harmonized share of standards for industry i in year t (NH_t^i) —a proxy for this NTB measure— as the number of CENELEC standards that are not "identical" to an existing IEC standard as a share of the total number of standards in each SIC4 industry. I also compute the tariff rate for industry i in year t (τ_t^i) as the weighted average rate across all 6-digit HS products within each SIC4 industry, using EU's import value from the U.S. as weights. For some products, tariffs were binding to zero by year 2000 due to the Information Technology Agreement (ITA), which is a tariff cutting mechanism enforced by the WTO between nations accounting for at least 90 percent of world IT trade. These zero-tariff bindings were on an MFN basis and thus available to exports from any other WTO member country.

Table 4 reports average tariff and non-tariff trade costs across SIC4 industries for five-year interval from 1992 to 2002. European tariff rates decline across a broad range of industries over time in the Electronic sector. Indeed, over the entire period, tariffs were halved for approximately 40 percent of industries. The rate of tariff declines, however, varies substantially across industries. According to the directives laid down by the Lugano and the Dresden agreements, European product standards have progressively been harmonized to international norms. The decline in the non-harmonized share of standards also differs across industries. The highest reduction is among industries producing household appliances, including cooking equipment, refrigerators, laundry equipment, and vacuum cleaners.

In addition to being a good match to the theory, the trade costs constructed here have several advantages. First, they are derived directly from a database used by firms to document the regulation requirements to export to the European Union. Second, they vary across industries and time. Even with these advantages, some caveats should be noted. First, the EUESDB does not

[17] Blind (2010) proposes a partial concordance from ICS codes to SITC codes. However, this bridge is too aggregate at the ICS level so individual SITC codes are mapped to a large number of ICS codes.

[18] PERINORM is a bibliographic database maintained by the British, French and German standard-setting bodies. It is designated to facilitate industry access to product standards and technical regulations.

provide information on which to base an assessment of the relative technical complexity of individual standards. Constructing such a measure requires highly specialized technical and commercial information that is currently not available. Second, product standards might vary across products within an industry. Mapping standards to products, however, is quite difficult and would have to be done manually.[19] Given the number of standards for electronic products this option is not currently feasible.

4 Empirical Analysis

In this section, I explore the firm-level relationship between changing trade costs, export growth and firm entry decisions. I confront the model's main predictions with the data. In particular, I estimate the impact of EU product standards harmonization on U.S. export value and I decompose the effect into the intensive and extensive margins. Overall, the empirical findings suggest that EU product standards harmonization contributes significantly to explain the export entry patterns observed among U.S. firms.

The theoretical results presented in section 2 are robust to different assumptions on the degree of stringency of international standards as well as to the level of adoption of international norms in region R. Accordingly, in the empirical analysis, I need to define a set of countries that use international standards if they use product standards at all. The empirical part makes use of the agreement on Technical Barriers to Trade where the World Trade Organization urges its members to use International Standards whenever possible. Given the institutional capacity required to create regional product standards, developing countries are assumed to mostly use international product standards if they use product standards at all.[20] In terms of the theoretical model, developing countries are embedded into the R region whereas Europe and the U.S. are represented by regions F and H, respectively.

4.1 Export Value

The existing literature has found robust evidence on the positive impact of product standards harmonization on export volume (Shepherd (2006), Czubala et. al (2009), and Portugal-Perez et al. (2010)). I test this result in my data by estimating a gravity-type equation where the role of firm heterogeneity is properly taken into account. Specifically, I regress U.S. export value of industry i to country j in year t (x^i_{jt}) on economic sizes (Y_{jt}), distances (D_j), and my measures of trade

[19] A manual mapping has been implemented for the textiles sector in Shepherd (2006) and used by Shepherd (2007) and by Czubala et al. (2009).

[20] I define the developing country group as including all countries in The World Bank's high middle income and low middle income groups. I use the classification for July 2009, which is in effect until July 2010. The list can be found at http://go.worldbank.org/K2CKM78CC0. China and India are excluded because they have prolific national institutes of standardization.

costs (τ_t^i and NH_t^i).[21] I also include the fraction of U.S. firms in industry i that export to country j in year t (W_{jt}^i) as a control for the self-selection of firms into export markets.[22] An industry is a SIC4 code and countries are the original EU-15 members.[23] D_j is the distance between the U.S. and country j whereas Y_{jt} is the GDP of country j in year t. Finally, γ_t and γ_i are sets of year and industry fixed effects and robust standards errors are adjusted for clustering at the country level.[24]

$$ln(x_{jt}^i) = \beta_0 + \beta_1 ln(D_j) + \beta_2 ln(Y_{jt}) + \beta_3 ln(\tau_t^i) + \beta_4 ln(NH_t^i) + \beta_5 ln(W_{jt}^i) + \gamma_t + \gamma_i + \epsilon_{jt}^i \quad (11)$$

Table 5 reports the results of estimating specification 11 from 1992 to 2004. The first and third column use the propensity to export[25] as the dependent variable, so the sample comprises all industry-country-year cells including those with zero trade. The second and fourth column focus on the U.S. export value, and the sample is all observations with positive exports. Columns three and four control for the non-random selection of observations with positive export value using the Heckman two-stages procedure. The two stages are separately identified by the functional form and the instrumental variable from the second-stage regression. An appropriate instrument is a variable that is correlated with the probability of export but largely uncorrelated with the export volume. At this high level of disaggregation, the only potential instrument is the lagged decision to export.[26]

I find an important role for European product standards harmonization on both the export value and the propensity to export: the negative coeffients on NH_t^i and τ_t^i indicate that falling trade costs are followed by an increase in the propensity to export as well as in the export value within industry-country-year bins. Interestingly, product standard harmonization seems to be more important than tariffs for the propensity to export. Henceforth, I make use of detail firm level data to show that the impact of harmonization on trade flows is due to the entry of new exporters —the extensive margin— rather than an increase in the export value of established exporters —the intensive margin.

An issue to be addressed is the possible endogeneity of my measure of product standards harmonization (NH_t^i) due to reverse causality: If higher U.S. export value to the EU triggers harmo-

[21] Note that an increase in harmonization of standards —a reduction in an NTB to international trade— implies a reduction in NH_t^i.

[22] Helpman et al. (2008) estimate W_{jt}^i as a predicted component from a probit regression on the propensity to export. I compute it from the underlying firm level data. Details of the construction of the variables are in appendix 2.

[23] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and United Kingdom.

[24] Year fixed effects control for observable and unobservable characteristics that change across years and are common to countries and industries; like exchange rates and other type of European trade policy tool. Industry fixed effects control for characteristics that vary across industries but not across years or across countries.

[25] The propensity to export is a dummy variable which is equal to one if there are positive export flows at the industry-country-year level.

[26] The lagged decision to export is represented by a dummy variable that is equal to one if there were U.S. exports in industry i to country j in the preceding period.

nization of European standards, for instance through a political economy process, the estimators are not longer unbiased or consistent. I argue that NH_t^i is exogenous to trade flows for two reasons: First, the decision making process to create or to harmonize an European standard does not involve any international consultation with trade partners.[27] Second, U.S. firms have raised concerns on their inability to participate in the formation of EU standards, these claims are documented in the 2010 Report on Technical Barriers to Trade.[28]

4.2 The Extensive Margin of Trade

While harmonization of product standards are important to increase U.S. export value to the EU, the theoretical model predicts that the extensive margin of trade (the number of exporting firms) accounts for this variation (hypothesis 1). I estimate the impact of falling trade costs on the probability that non-exporting firms to the EU become exporters to the EU via a logistic regression on my measure of changing trade costs, firm productivity and other firm characteristics. I use firms' information from the 1992, 1997, and 2002 U.S. Censuses of Manufactures. I define the change in trade costs for census year t as the log difference in tariffs over the preceding five years ($\triangle\tau_{t+5}^i$) and as the log difference on my measure of product standard heterogeneity over the preceding five years ($\triangle NH_{t+5}^i$). These regressions are given by:

$$\begin{array}{lll}
(\textit{Spec 1}) & Pr(E_{t+5}=1)= & \Phi(\beta_1\triangle\tau_{t+5}^i+\beta_2\triangle NH_{t+5}^i+\gamma_t+\gamma_i) \\
(\textit{Spec 2}) & Pr(E_{t+5}=1)= & \Phi(\beta_1\triangle\tau_{t+5}^i+\beta_2\triangle NH_{t+5}^i+\beta_3 PR_t+\gamma_t+\gamma_i) \\
(\textit{Spec 3}) & Pr(E_{t+5}=1)= & \Phi(\beta_1\triangle\tau_{t+5}^i+\beta_2\triangle NH_{t+5}^i+\beta_3 PR_t+\beta_4 Z_t+\gamma_t+\gamma_i) \\
(\textit{Spec 4}) & Pr(E_{t+5}=1)= & \Phi(\beta_1\triangle\tau_{t+5}^i+\beta_2\triangle NH_{t+5}^i+\beta_3 PR_t+\beta_4 Z_t+\beta_5 OR_Firm_t+ \\
 & & \beta_6 OR_Firm_t*\triangle NH_{t+5}^i+\gamma_t+\gamma_i)
\end{array} \tag{12}$$

where E_{t+5} is a dummy variable equal to one if a firm does not export to the EU in year t and becomes an exporter to the EU in year $t+5$; PR_t is the firm's revenue based labor productivity, and Z_t is a set of additional firm characteristics. Additional firm controls include size, capital intensity, wage level, and multi-plant dummies. In specification four, I include the dummy variable OR firm, which is equal to one if the firm is an exporter to a developing country and not to the EU in year t. I also include industry (γ_i) and time (γ_t) fixed effects and cluster the standard errors at the industry level.

Results are reported across four columns in Table 6, with the first column focusing on my trade costs measures and subsequent columns including additional firm characteristics. Across all specifications, I find a positive and statistically significant association between product standards harmonization and the probability that a non-exporting firm to the EU becomes an exporter to the EU across Census years. The probability of becoming an EU exporter is higher in industries with greater harmonization of product standards. Surprisingly, EU tariff changes do not affect the

[27] See Portugal-Perez et al. for the European institutional standard setting mechanism in Electronics.

[28] http://www.ustr.gov/about-us/press-office/reports-and-publications/2010-0

probability of becoming an exporter. In specification two and three, I find, as expected, a positive and significant association between firms' productivity and their entry into exporting. Larger and more capital-intensive firms are more likely to become exporters, as are multi-plant firms and firms that pay higher wages.

In line with the theoretical model, specification four shows that being an exporter to a developing market in year t increases the probability of becoming an exporter to the EU in year t+5. This relationship is significant at the 1% level. I also add an interaction of product standards harmonization with the OR firm variable to check whether responses to harmonization vary across types of exporting firms. The sign is, as expected, negative: the probability of entry into the EU market is relatively higher for firms that export to a developing country in the face of product standards harmonization. Hereafter, I further decompose the impact at the extensive margin of trade between OR firms and new exporters.

4.3 The Extensive Margin of Trade Composition

Product standards heterogeneity across market destinations in conjunction with productivity heterogeneity across firms provides a natural hierarchy of firms entering exporting markets. Less productive firms serve less stringent markets (OR firms) while more productive firms also serve most stringent markets (AF firms). The theoretical model predicts that harmonization of product standards triggers entry mainly from OR firms (hypothesis 2). To examine the potential impact of falling trade costs on the probability that OR firms become exporters to the EU, I start by estimating equations 12 for these two groups of firms separately. Table 7 reports the results, the first three columns present the specifications for OR firms whereas columns 4-6 show the estimations for non-exporting firms. Across all specifications, I confirm that harmonization increases the probability of observing a new exporter to the EU market. This effect is statistically significant across specification. As implied by the theory, this effect is more important for OR firms than for non-exporting firms. Remarkably, harmonization positively affects entry decisions for non-exporting firms. Again, tariffs do not significantly affect the probability of entering the EU market for either type of firms.

Harmonization of product standards can also influence firms' decision to star exporting a product to the EU. To check whether firms that export a product to a developing ocuntry are more likely to star exporting it to the EU in response to harmonization, I estimate a logistic regression at the firm-product level on my measure of changing trade costs, firm productivity, and other firm characteristics across Census years. I define $E_{p,t+5}$ as a dummy variable equal to one if a firm exports product p to a developing country but not to the EU in year t and in year $t+5$ that product is exported to the EU. These regressions are given by:

$$\begin{array}{lll} (\textit{Spec 1}) & Pr(E_{p,t+5}=1)= & \Phi(\beta_1\triangle\tau^i_{t+5}+\beta_2\triangle NH^i_{t+5}+\gamma_t+\gamma_i) \\ (\textit{Spec 2}) & Pr(E_{p,t+5}=1)= & \Phi(\beta_1\triangle\tau^i_{t+5}+\beta_2\triangle NH^i_{t+5}+\beta_3 PR_t+\gamma_t+\gamma_i) \\ (\textit{Spec 3}) & Pr(E_{p,t+5}=1)= & \Phi(\beta_1\triangle\tau^i_{t+5}+\beta_2\triangle NH^i_{t+5}+\beta_3 PR_t+\beta_4 Z_t+\gamma_t+\gamma_i) \end{array} \quad (13)$$

where the variables are defined as above. Z_t includes an additional dummy variable "Other EU product", which is equal to one if that firm exports another product to the EU in year t. As above, this regressions include year and industry fixed effects and standards errors are clustered at the industry level.

Results for three specifications with an increasing number of regressors are reported in Table 8. Changes in industry-level trade costs are negatively associated with the probability that an OR firm-product enters the EU market across census years. This relation is statistically significant at the 1 percent level in all specifications. Results in the second and third columns indicate that labor productivity is positively associated with the probability of entry only after controlling for other firm attributes. As expected, the fact that a firm exports another product to the EU increase the probability of entry.

4.4 The Intensive Margin of Trade

An important implication of the theoretical model presented in section 2 is that harmonization decreases export sales at existing exporters in market F (hypothesis 3). I test the impact of harmonization on the intensive margin of trade by estimating equations 11 on the export volume of U.S. goods that are already exported to the EU within surviving trade relationships (i.e. firm-product pairs that remain as exporters to the EU for the complete set of years of my sample). This sample is the equivalent to the export value from AF firms in the theoretical model.

Results for the Heckman model are reported across the first three columns in table 9. As a way to present further evidence on the different impact that harmonization exerts at the extensive margin of trade, columns fouth and five report the results of estimating equations 11 on the export volume constructed from the set of firm-product pairs that enter the EU market at some point after 1992 and that remain as exporters up to 2004. In order to make this group similar to the theoretical set of OR firms, I also require that the first time a pair is observed in the data is when it exports to a developing country and not to the EU region. I find, as expected, a positive and significant coefficient for the role of product standard harmonization in AF firms' export volume. This confirms the negative impact that European harmonization of product standards has at the intensive margin of trade of US exporters. Conversely, the coefficient for harmonization is negative and significant for OR firms's export value. Consistent with previous findings, harmonization increases the probability of observing trade within product-country-year bins.

5 Concluding Remarks

With the decline of traditional trade barriers, differences in product requirements across market destinations are increasingly viewed as impediments for trade. Yet despite the growing evidence of the negative impact of product standard heterogeneity, there is little understanding of the gains of harmonization at the micro level. This paper provides, to the best of my knowledge, the first firm-level evidence of the gains from product standards harmonization and decomposes them into the intensive and extensive margins of trade.

In this paper, I develop a heterogeneous firms model featuring the role of product standards differences across market destinations as country-specific fixed costs to export. The model is a three-country version of the Cheney (2008) and Helpman et al. (2008) frameworks in which I assume that two countries have different but equally costly product standards (countries H and F) while the third country has less stringent product requirements (country R). After setting out the base case scenario without harmonization, I modify the model to allow harmonization between countries F and R and characterize the trade impact in country H. The theory provides three testable results: First, harmonization increases the number of $H's$ exporting firms to market F, the extensive margin of trade. Second, new entrants are mainly drawn from the most productive set of H's firms exporting to country R, the extensive margin of trade composition. These firms are characterized by being smaller and less productive than the incumbent exporters to country F. Third, harmonization decreases export sales of $H's$ existing exporters to country F, the intensive margin of trade.

To examine the impact of product standards harmonization on the margins of trade, I use the European agreement to harmonize product standards to international norms as a natural experiment. This agreement was achieved thanks to the cooperation between CENELEC —the European Committee for Electrotechnical Standardization— and the IEC —the International Electrotechnical Commission— laid down in the Lugano and Dresden agreements in 1991 and 1996. I combine this information with U.S. linked/longitudinal firm trade data and the U.S. Censuses of Manufactures to empirically confront the results of my theoretical model for the Electronic sector.

An important contribution of my analysis is the creation of a new set of industry level measures of EU product standards for the Electronic sector. Since there is currently no official mapping between the classification of standards and any industry or product classification, I develop a method to obtain a concordance between five-digit ICS codes and the four-digit standard industrial classification.

The empirical findings largely confirm the theoretical results. First, I confirm that industries with relatively high harmonization and high reduction in tariff rates exhibit relatively high U.S. export value to the EU. Furthermore, I show that product standards harmonization increases the probability that higher-productivity firms enter the EU market whereas tariff rates do not affect entry decisions. Second, I find that this impact is more relevant for U.S. firms that were already exporters serving developing countries than for firms entering the export activity. Third, I show that this impact is negative for the intensive margin of trade: the change in the value of U.S. goods that are already exported to the EU within surviving trade relationships, e.g., the same firm exporting the same product to Europe throughout the time span. Overall, the empirical findings suggest that EU product standards harmonization contributes significantly to explain the export entry patterns observed in my sample of U.S. manufacturing firms.

These results have an important policy implication. The U.S. National Export Initiative laid down in 2010 seeks to double exports over the next five years by enhancing small and medium sized firms' ability to enter export markets and by actively reducing barriers to trade. The results obtained in this paper suggest that working towards a reduction in the differences of product requirements across markets could be a supportive policy to encourage the entry of small and medium size firms into export markets.

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Appendix 1

Proposition 1. *Under product standard harmonization, the number of H's exporting firms to market F increases, new exporters are drawn from the most productive set of OR firms* $\left(\widehat{\varphi_H}^{\sigma-1} < \overline{\varphi}_{HF}^{\sigma-1}\right)$.

Proof. Suppose $\widehat{\varphi_H}^{\sigma-1} \geq \overline{\varphi}_{HF}^{\sigma-1}$. Thus, by equations 6, 8, and 3, $\frac{\int_{\omega\in\Omega^F} p(\omega)^{1-\sigma} d\omega}{2\int_{\omega\in\Omega^{\widehat{F}}} p(\omega)^{1-\sigma} d\omega} \geq \frac{f_F}{\widehat{f}}$. Note that the the LHS expresion is increasing in $\widehat{f}$ and reaches an upper bound of $\frac{1}{2}$ when $\widehat{f} = f_F$, then $\frac{\int_{\omega\in\Omega^F} p(\omega)^{1-\sigma} d\omega}{2\int_{\omega\in\Omega^{\widehat{F}}} p(\omega)^{1-\sigma} d\omega} \leq \frac{1}{2}$. Since $\frac{f_F}{\widehat{f}} \geq 1$, this is a contradiction. Thus $\widehat{\varphi_H}^{\sigma-1} < \overline{\varphi}_{HF}^{\sigma-1}$. ■

Note that the relatively stringency of the harmonized standard determines the share of OR firms that enter the F market. I define $\widehat{f}$ to be "near" to f_R if it meets the following condition: $\frac{\int_{\omega\in\Omega^{\widehat{F}}} p(\omega)^{1-\sigma} d\omega}{2\int_{\omega\in\Omega^R} p(\omega)^{1-\sigma} d\omega} \leq \frac{f_R}{\widehat{f}}$. If this is the case, it is easy to show that $\widehat{\varphi}_H^{\sigma-1} \leq \overline{\varphi}_{HR}^{\sigma-1}$ and all OR firms enter market F as well as the most productive non exporting firms (figure 3). Otherwise, the harmonized standard is said to be too stringent ("close" to f_F) and only the most productive firms within the OR firm enter to market F (figure 2).

Appendix 2

The empirical analysis uses the U.S. linked/Longitudinal Firm Trade Transaction Database (LFTTD),which links individual U.S. trade transactions to U.S. firms in the Longitudinal Business Database (LBD), in conjunction with firm level information from the Censuses of Manufactures (CM) of the Longitudinal Research Database (LRD) of the U.S. Census Bureau. The impact of European product standards harmonization in Electronics is studied at two levels: the trade flows level (sections 4.1 and 4.4) and at the firm level (sections 4.2 and 4.3).

At the export flow level, I identify exports of electronic products to the E.U. from U.S. manufacturing firms in the following way: From the LFTTD, I aggregate export transaction up at the firm-product-country-year level from 1992 to 2004. Since a product is a 10-digit Harmonized System code (HS10) (schedule B), I merge the concordance between HS10 codes and 4-digit SIC industries (SIC4) from Pierce and Schott (2009) and retain HS10 codes within SIC 36. Next, I drop firms that are classified in industries outside SIC 36 in the LBD as well as exports to countries outside the EU-15 block. Finally, I collapse export value up at the sic4-country-year level. This is the sample used in section 4.1. In section 4.4, I use the same methodology but before collapsing out firms in the last step, I retain the set of exports of electronic products that are exported to the EU within surviving trade relationships (i.e. firm-product pairs that remain as exporters to the EU for the complete set of years of my sample); this sample is the equivalent to the export value from AF firms in the theoretical model. Section 4.2 also uses export flows from OR firms, which is constructed by keeping the set of firm-product pairs that begin export activity first in a developing country[29] and then enter into the EU market.

The firm level analysis have two components. The first component is the CM that contains input-output information at the manufacturing establishment level for years 1992, 1997, and 2002. For years 1992 and 1997, I collapse input-output information up at the firm level within each SIC4 industry. Since the 2002 CM classifies establishments in industries using the 6-digit North American Industry classification system (NAICS6), I assign each establishment into the SIC4 industry it was allocated in 1997 and, then, collapse input-output information up at the firm level within each SIC4 industry.[30] The second component is the LFTTD which contains information of the market destinations for exporting manufacturing firms.

Now, I describe the main variables and the data sources.

1. **Tariffs:** Tariffs are compiled through WITS from TRAINS under the HS nomenclature. SIC4 tariffs are weigthed averages of the underlying six-digit HS codes, using EU import value from the U.S. as weights.

2. **NH Share:** The non-harmonized share of products standards is computed as the number of CENELEC standards that are not "identical" to an existing IEC standard as a share of the total number of standards in each SIC4 industry. Product standards information is obtained from the World Bank EU Electrotechnical Standards Database.

3. **Distance:** Partner countries' great-circle distance from the United States. These data are from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

4. **GDP:** Partner countries' GDP from CEPII.

5. W^i_{jt}**:** Fraction of U.S. firms within SIC4 industry that export to country j in year t. The number of exporting firms comes from the LFTTD whereas the number of U.S. manufacturing firms comes from the LBD. Since the LBD changes to the NAICS industry classification from 2002, I use a NAICS-SIC correspondence provided by the U.S. Census Bureau to obtain a consistent measure throughout my time span.

6. **Labor productivity:** Ratio between total number of workers and total value of shipments at the firm level. These data come from the CM.

Other firm characteristics are from the information contained in the Censuses of Manufactures.

[29] China and India are excluded.

[30] The underlying assumption is that establishments do not change industries from 1997 to 2002. Note that I cannot allocate 2002 establishments births into SIC4 industries. This issue is not problematic for the empirical analysis since the theoretical model does not predict any role of harmonization on domestic firm dynamics. I cannot use the public available bridge NAICS-SIC bridge because single NACIS6 codes are mapped to more than one SIC4 code, which makes imposible to assign establishments into SIC4 industries.

Figures

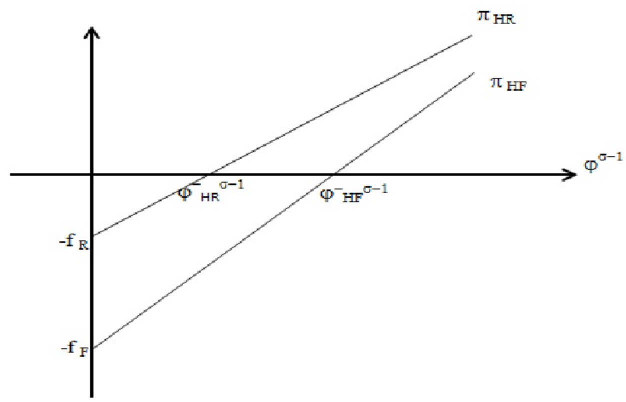

Figure 1 - Home profits and productivity cutoffs before harmonization.

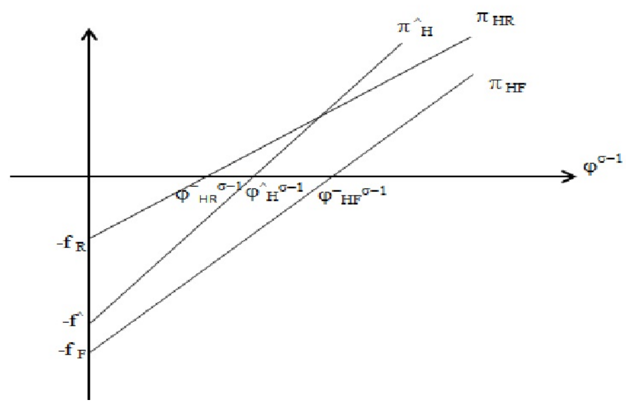

Figure 2 - Home Profits and productivity cutoffs after harmonization I.

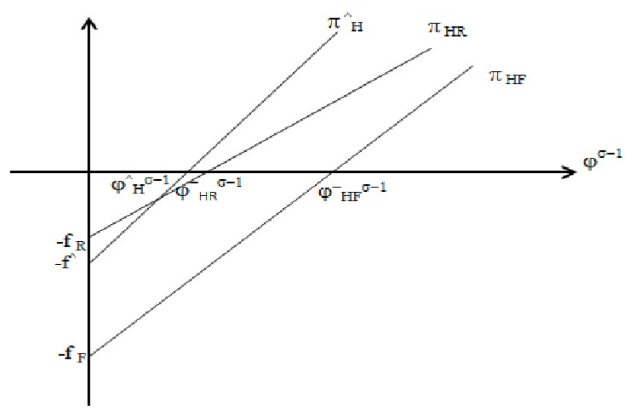

Figure 3 - Home Profits and productivity cutoffs after harmonization II.

Tables

Table 1: Four Digit SIC Codes and Descriptions

SIC4	Description
3612	Transformers
3613	Switchgear and switchboard apparatus
3621	Motors and generators
3624	Carbon or graphite products
3625	Relays and industrial controls
3629	Electrical industrial apparatus
3631	Household cooking equipment
3632	Refrigerators and refrigerating equipment
3633	Household laundry equipment
3634	Electric housewares and fans
3635	Household vacuum cleaners
3639	Household appliances, nec
3641	Electric lamps
3643	Current-carrying wiring devices
3644	Noncurrent-carrying devices
3645	Residential Electric Lighting fixtures
3647	Vehicular lighting equipment
3648	Lighting equipment, nec
3651	Radio and tv receiving sets, phonographs, record players record
3652	Phonograph records; pre-recorded magnetic tapes or wires master
3661	Telephone and telegraph apparatus
3663	Radio, broadcast, and television communications equipment
3669	Other communications equipment, nec
3671	Electron tubes
3672	Printed circuit boards
3674	Semiconductors and related devices
3675	Electronic capacitors
3676	Resistors for electronic applications
3677	Electronic coils and transformers
3678	Connectors, for electronic applications
3679	Electronic components, nec
3691	Storage batteries
3692	Primary batteries
3694	Electrical starting and ignition equipment for internal combustion engines
3695	Recording media
3699	Electrical equipment and supplies, nec

Notes: This table provides the codes and description of the 36 four digit SIC industries included in the sample. Some names are truncated to reduce clutter.

Table 2: Firm Characteristics by Type of Firm and Year

	Number		tvs		Exports		Employment		MU firms	
	1992	1997	1992	1997	1992	1997	1992	1997	1992	1997
Firms	7,985	8,443	26.1	39.9	–	–	170.4	177.6	31.6	30.0
No exporting firms	4,015	3,690	4.0	4.7	–	–	44.6	41.7	12.5	9.9
Exporting firms	3,970	4,753	48.5	67.2	30.2	45.7	297.6	283.1	50.8	45.7
EU	2,722	3,108	64,1	95.9	43.7	69.5	383.8	384.8	59.1	55.9
No EU	1,248	1,645	14.4	13.0	0.5	0.7	109.6	91.1	32.9	26.4

Notes: Table breaks out the number of firms, the average total value of shipments (tvs), the average value of exports, the average employment and the share of multi-plant firms (MU) according to the type of firm by year. EU exporters are firms that export to the EU whereas No EU exporters are firms that export to any other region but the EU. Total value of shipments and exports are in millions of nominal U.S. dollars.

Table 3: Concordances between ICS classification and SIC4 classification.

SIC4	ICS	ICS Description	SIC4	ICS	ICS Description
3612	13.140	Noise with respect to human beings	3644	29.035	Insulating materials
3612	29.180	Transformers. Reactors	3644	29.080	Insulation
3612	29.200	Rectifiers. Converters. Stabilized power supply	3645	29.140	Lamps and related equipment
3612	29.240	Power transmission and distribution networks	3647	29.140	Lamps and related equipment
3613	29.120	Electrical accessories	3648	29.140	Lamps and related equipment
3613	29.130	Switchgear and controlgear	3651	17.140	Acoustics and acoustic measurements
3621	27.100	Power stations in general	3651	33.100	Electromagnetic compatibility (EMC)
3621	29.160	Rotating machinery	3651	33.160	Audio, video and audiovisual engineering
3624	25.180	Industrial furnaces	3652	33.160	Audio, video and audiovisual engineering
3625	29.130	Switchgear and controlgear	3661	33.040	Telecommunication systems
3625	29.260	Electrical equipment for working in special conditions	3661	33.160	Audio, video and audiovisual engineering
3629	31.060	Capacitors	3663	33.160	Audio, video and audiovisual engineering
3631	13.120	Domestic safety	3663	33.180	Fibre optic communications
3631	97.030	Domestic electrical appliances in general	3669	33.160	Audio, video and audiovisual engineering
3631	97.040	Kitchen equipment	3671	31.100	Electronic tubes
3632	13.120	Domestic safety	3672	29.120	Electrical accessories
3632	97.030	Domestic electrical appliances in general	3672	31.180	Printed circuits and boards
3632	97.040	Kitchen equipment	3674	31.080	Semiconductor devices
3633	13.120	Domestic safety	3674	31.200	Integrated circuits. Microelectronics
3633	97.030	Domestic electrical appliances in general	3675	31.060	Capacitors
3633	97.060	Laundry appliances	3676	31.040	Resistors
3634	13.120	Domestic safety	3677	13.140	Noise with respect to human beings
3634	97.040	Kitchen equipment	3677	29.180	Transformers. Reactors
3634	97.060	Laundry appliances	3677	29.200	Rectifiers. Converters. Stabilized power supply
3634	97.170	Body care equipment	3677	29.240	Power transmission and distribution networks
3635	13.120	Domestic safety	3678	29.120	Electrical accessories
3635	97.030	Domestic electrical appliances in general	3678	29.240	Power transmission and distribution networks
3635	97.080	Cleaning appliances	3679	31.200	Integrated circuits. Microelectronics
3639	13.120	Domestic safety	3691	29.220	Galvanic cells and batteries
3639	61.080	Sewing machines and other equipment for the clothing industr	3692	29.220	Galvanic cells and batteries
3639	91.140	Installations in buildings	3694	43.060	Internal combustion engines for road vehicles
3639	97.030	Domestic electrical appliances in general	3695	33.160	Audio, video and audiovisual engineering
3641	29.140	Lamps and related equipment	3699	17.220	Electricity. Magnetism. Electrical measurements
3643	29.060	Electrical wires and cables	3699	31.040	Resistors
3643	29.140	Lamps and related equipment	3699	31.260	Optoelectronics. Laser equipment
3644	13.260	Protection against electric shock. Live working	3699	97.120	Automatic controls for household use

Notes: This table presents the concordance between four-digit SIC industries and five-digits ICS classification codes. The description of ICS codes are presented. Some names are truncated to reduce clutter.

Table 4: Trade Costs by Four-Digit SIC Industry and Year

	Tariff Rate (Percent)			Share Non-harmonized Stds (Percent)		
SIC4	1992	1997	2002	1992	1997	2002
3612	5.6	4.1	2.9	80.0	61.5	51.0
3613	4.5	3.6	2.5	65.0	54.8	47.7
3621	3.5	2.6	2.0	61.1	37.0	66.7
3624	4.8	3.8	3.1	25.0	6.7	4.5
3625	4.6	3.2	2.3	85.9	57.4	51.6
3629	4.9	3.8	0.0	27.3	67.3	68.1
3631	4.7	3.5	2.7	98.0	49.4	31.4
3632	3.0	2.3	1.8	98.0	49.4	31.4
3633	4.4	3.2	2.2	94.4	51.4	37.5
3634	5.2	3.7	2.7	95.2	40.2	29.8
3635	4.3	2.9	2.2	95.2	61.5	39.5
3639	4.8	3.4	2.4	94.0	60.2	46.2
3641	5.1	3.6	2.6	50.7	34.2	29.5
3643	4.5	3.5	2.0	53.3	41.4	40.0
3644	5.9	4.9	2.9	25.4	24.2	22.0
3645	0.0	4.9	3.7	50.7	34.2	29.5
3647	4.9	3.5	2.7	50.7	34.2	29.5
3648	5.8	4.4	3.5	50.7	34.2	29.5
3651	8.3	7.1	6.0	22.2	22.7	21.3
3652	3.2	4.1	2.7	10.5	6.5	9.0
3661	7.3	6.9	0.5	15.0	11.7	10.4
3663	3.8	5.3	3.3	14.8	19.0	14.0
3669	4.2	2.8	1.6	10.5	6.5	9.0
3671	7.8	5.0	4.0	75.0	69.2	69.2
3672	6.2	5.2	0.0	45.7	42.3	38.9
3674	10.9	6.6	0.0	100.0	96.9	53.3
3675	5.8	4.2	0.0	27.3	67.3	68.1
3676	5.5	3.7	0.4	54.5	82.1	70.0
3677	4.3	3.9	2.5	71.4	61.3	50.9
3678	5.0	3.8	2.4	50.9	53.9	51.8
3679	6.2	4.2	1.3	100.0	100.0	66.7
3691	4.0	3.1	2.3	9.1	31.3	27.7
3692	8.9	6.2	4.5	9.1	31.3	27.7
3695	4.9	3.8	0.6	10.5	6.5	9.0
3699	4.6	3.2	2.1	44.6	48.6	39.0
Average	5.2	4.1	2.2	53.5	44.5	37.8

Notes: This table summarizes tariffs and the number of no harmonized standards as a share of total standards across four-digit SIC industries. Tariffs are weighted averages of the underlying six-digit HS codes, using EU import value from the U.S. as weights. The final row is the unweighted average of all manufacturing industries included in the analysis.

Table 5: U.S. Export value to the EU, SIC4-Country-Year. 1992-2004

Regressor	Propensity to export dummy	ln (Export value)	Propensity to export dummy	ln (Export value)
Ln(Distance)	-0.693***	-3.007***	-0.422***	-2.655***
	(0.033)	(0.086)	(0.040)	(0.086)
Ln(GDP)	0.311***	0.500***	0.200***	0.380***
	(0.003)	(0.009)	(0.004)	(0.009)
Ln(Tariff rate)	-0.035***	-0.278***	-0.002	-0.227***
	(0.005)	(0.013)	(0.007)	(0.013)
Ln(NH share)	-0.097**	-0.059***	-0.034***	-0.026**
	(0.005)	(0.011)	(0.006)	(0.011)
Ln(W)		0.376***		0.360***
		(0.010)		(0.009)
Lag export decision			2.092***	
			(0.008)	
$\hat{\eta}$				-0.828***
				(0.017)
Sample	Full	positive export value	Full	positive export value
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	7020	4971	7020	4971
Estimation	Probit	OLS	Heckman First-stage	Heckman Second-stage

Notes: Robust standard errors adjusted for clustering at the country level are in parentheses. Industry fixed effects are for four-digit SIC codes. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Coefficients for the regressions constant and dummy variables are suppressed.

Table 6: Probability of Entering the EU Market, All firms.

Regressor	spec1	spec2	spec3	spec4
Change in tariff rate	0.122	0.127	0.199	0.204
	(0.198)	(0.209)	(0.209)	(0.218)
Change in NH share	-0.155***	-0.140**	-0.145**	-0.149***
	(0.053)	(0.057)	(0.059)	(0.460)
Ln(labor Productivity)		0.469***	0.256**	0.236**
		(0.112)	(0.103)	(0.111)
Ln(employment)			0.255**	0.223**
			(0.106)	(0.105)
Ln (K/L)			0.083**	0.074*
			(0.038)	(0.038)
Ln(Wage)			0.260**	0.255**
			(0.125)	(0.126)
Multiple-Plant Firm			0.409***	0.362***
			(0.080)	(0.081)
OR firm				0.769***
				(0.124)
x change in NH share				-0.037*
				(0.019)
Year fixed effects	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes
Observations	4294	4294	4294	4294
log likelihood	-1993.16	-1973.75	-1869.62	-1850.18

Notes: Firm-level logistic regression results. Robust standard errors adjusted for clustering at the four-digits SIC level are in parentheses. Industry fixed effects are for three-digit SICs. Dependent variable indicates whether a non-exporting firm to the EU becomes an exporter to the EU between year t and year t+5. Regressions cover two panels: 1992 to 1997 and 1997 to 2002. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Coefficients for the regressions constant and dummy variables are suppressed.

Table 7: Probability of Entering the EU Market, OR firms and non-exporting firms.

	OR firms			Non-exporting firms		
Regressor	spec1	spec2	spec3	spec1	spec2	spec3
Change in tariff rate	0.012	-0.006	0.053	0.075	0.115	0.193
	(0.253)	(0.256)	(0.249)	(0.260)	(0.255)	(0.255)
Change in NH share	-0.238**	-0.233**	-0.242**	-0.143***	-0.128**	-0.133**
	(0.102)	(0.103)	(0.107)	(0.052)	(0.051)	(0.054)
Ln(Labor Productivity)		0.118	-0.020		0.647***	0.452***
		(0.118)	(0.128)		(0.185)	(0.119)
Ln(employment)			0.382**			0.216
			(0.150)			(0.165)
Ln (K/L)			0.052			0.090
			(0.059)			(0.058)
Ln(wage)			-0.081			0.57**
			(0.163)			(0.185)
Multiple-Plant Firm			0.215			0.493***
			(0.141)			(0.168)
Year Fixed Effects	yes	yes	yes	yes	yes	yes
Industry Fixed Effects	yes	yes	yes	yes	yes	yes
Observations	1129	1129	1129	2153	2153	2153
Log likelihood	-882.296	-867.525	-811.514	-490.385	-488.763	-466.03

Notes: firm level logistic regression results. Robust standard errors adjusted for clustering at the four-digits SIC level are in parentheses. Industry fixed effects are for three-digit SICs. OR firms indicate whether an exporting firm to the a developing country but not to the EU becomes an exporter to the EU between year t and year t+5. Non-exporting firms indicate whether a non-exporting firm becomes an exporter to the EU between year t and year t+5. Regressions cover two panels: 1992 to 1997 and 1997 to 2002. *** Significant at the 1% level; **significant at the 5% level; * significant at the 10% level. Coefficients for the regressions constant and dummy variables are suppressed.

Table 8: Probability of Entering the EU Market, OR firm-product pairs.

Regressor	spec1	spec2	spec3
Change in tariff rate	-0.439***	-0.380***	-0.144***
	(0.000)	0.057)	(0.082)
Change in NH share	-1.631***	-1.530***	-0.687***
	(0.000)	(0.098)	(0.152)
Ln(labor Productivity)		-0.082	0.155**
		(0.081)	(0.073)
Ln(employment)			0.251**
			(0.114)
Ln (K/L)			-0.282***
			(0.060)
Ln(Wage)			-0.134
			(0.119)
Multiple-Plant Firm			-1.370***
			(0.120)
Other EU product			0.650**
			(0.135)
Year Fixed Effects	yes	yes	yes
Industry Fixed Effects	yes	yes	yes
Observations	4867	4867	4867
Log likelihood	-1874.07	-1873.11	-1751.01

Notes: Firm-product level logistic regression results. Robust standard errors adjusted for clustering at the four-digits SIC level are in parentheses. Industry fixed effects are for three-digit SICs. Dependent variable indicates whether a firm-hs10 pair is observed in a developing country but not in the EU in yeat t and it is observed in the EU in year t+5. Regressions cover two panels: 1992 to 1997 and 1997 to 2002. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Coefficients for the regressions constant and dummy variables are suppressed.

Table 9: U.S. Export value to the EU: AF firms and OR firms, SIC4-Country-Year. 1992-2004

	AF firms' export value		OR firms' export value	
Regressor	Propensity to export dummy	ln (Export value)	Propensity to export dummy	ln (Export value)
Ln(Distance)	-0.356***	-2.491***	-0.915***	-1.687***
	(0.054)	(0.130)	(0.064)	(0.202)
Ln(GDP)	0.166***	0.261***	0.285***	-0.012
	(0.005)	(0.013)	(0.005)	(0.020)
Ln(Tariff rate)	-0.014	-0.095***	-0.031***	-0.086***
	(0.009)	(0.016)	(0.009)	(0.024
Ln(NH share)	-0.046***	0.101**	-0.025***	-0.055**
	(0.007)	(0.023)	(0.008)	(0.024)
Ln(W)		0.262***		0.016
		(0.013)		(0.021)
Lag export decision	2.516***		1.654***	
	(0.011)		(0.013)	
$\hat{\eta}$		-1.026***		-0.828***
		(0.019)		(0.017)
Sample	Full	positive export value	Full	positive export value
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	7020	4971	7020	4971
Estimation	Heckman First-stage	Heckman Second-stage	Heckman First-stage	Heckman Second-stage

Notes: Robust standard errors adjusted for clustering at the country level are in parentheses. Industry fixed effects are for four-digit SIC codes. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. Coefficients for the regressions constant and dummy variables are suppressed.