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Beyond the Information Technology Agreement

Harmonization of Standards and Trade in Electronics

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Abstract

Product standards can have a dual impact on production and trade costs. Standards may impose additional costs on exporters as it may be necessary to adapt products for specific markets (cost-effect). In contrast, standards can reduce exporters' information costs if they convey information on industrial requirements or consumer tastes that would be costly to collect in the absence of standards (informational-effect). Using a new World Bank database of European standards for electronic products, the authors examine the impact of internationally-harmonized European standards on European Union imports. They find that European Union standards for electronic products that are harmonized to international standards have a positive and significant effect on trade. The results suggest that efforts to promote trade in electronic products could be complemented by steps to promote standards harmonization. This might include, for example, re-starting talks to extend the Information Technology Agreement to non-tariff measures and commitments to harmonize national standards in electronic products.

This paper—a product of the Trade Team, Development Research Group—is part of a larger effort in the department to explore the linkages between trade costs, facilitation, and economic development. This work is aligned with the project "Trade Facilitation and Economic Growth: The Development Dimension" in the Development Economics Research Group with support from the governments of Norway, Sweden and the United Kingdom through the Multidonor Trust Fund for Trade and Development. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at jswilson@worldbank.org and aportugalperez@worldbank.org.

Beyond the Information Technology Agreement: Harmonization of Standards and Trade in Electronics

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"…it is important to keep in mind the contribution that an ambitious initiative to cut barriers to trade in industrial products, such as the ITA, can make to development throughout the entire spectrum of the WTO membership."

Pascal Lamy
Director-General
World Trade Organization
March 28, 2007

1. Introduction

The expansion of trade in electronics and information technology goods has contributed in a major way to productivity growth, human welfare, and societal change. Increasingly powerful electronic and digital equipment enables lower cost accounting and management systems that increase productivity in offices around the world, for example. Access to radio and television programs in schools allow people in remote villages the opportunity to access to a world of information and knowledge. Handheld computers provide real time data and monitoring of costs for goods in transit, access to medical records to speed diagnosis of patients in hospitals, and allow farmers in developing countries minute to minute information on crop prices. In addition, investing in expanding this sector in developing countries generates positive spillovers in terms of technology transfer and innovation. These are some of the benefits that electronic products provide – driven by innovation, lower costs of production, and trade.

Global trade in the information technology and electronic products doubled over the period 1997 to 2005, totaling over $1.4 trillion (WTO 2007). Developing countries have a particularly large stake in benefiting from expanding access to electronic products. They have also increasingly participated in the production and assembly of these products, in part as a function of the continued global dispersion of steps in the manufacturing process that has taken place over the past several decades.

Ways to promote trade and lower the cost for producers and consumers is at the forefront of policy debate and discussion in the electronics sector. Removing non-tariff barriers to trade and building on models of success, such as the Information Technology Agreement (ITA)[1], which cut tariffs to zero on 97% of world trade of a list of information technology products defined during negotiations, is one option for consideration. Discussions on

[1] The Information Technology Agreement (ITA), negotiated in 1996, is a remarkable example of an agreement that successfully achieved sectoral liberalization under WTO's auspices. At the origin, IT-producing nations agreed to bind their MFN tariffs at zero for a specific list of IT goods that included computers, semiconductor manufacturing equipment, and electronic instruments. The agreement stated that zero tariffs were to be reached by 2000, although some developing nations had a longer phase-in period (2005 being the latest possible date). In addition, zero-tariff bindings achieved under ITA were on an MFN basis and thus available to exports from any other WTO member. A key provision in the 1996 agreement stipulated that it would come into effect only if nations accounting for at least 90 per cent of world IT trade had signed. The original negotiators did not meet this threshold in 1996, but nine more nations signed up by the March 1997 deadline and the agreement came into force. Legal texts and more references can be found in the WTO page on ITA: http://www.wto.org/english/tratop_e/inftec_e/inftec_e.htm

extension of the ITA, which includes coverage of more electronic products, to non-tariff measures —including standards— began shortly after the ITA was signed in 1996[2].

Facilitating trade by harmonizing product standards to international ones is one possible way, among others in building on the ITA to address non-tariff measures. Moreover, the WTO Technical Barriers to Trade Agreement encourages harmonization of standards and includes the Code of Good Practice to promote this objective. Concrete options to achieve wider use of international standards in support of the Agreement have specifically been discussed in the electronics sector[3], and a number of initiatives are underway in regional organizations to harmonize standards.[4]

Does harmonization of regional standards to international ones affect trade? Is the impact of international standard harmonization in electronics different respect to other sectors, say textiles and apparel? Using a new World Bank database of European standards for electronic products, this study examines the net impact of internationally-harmonized European standards on EU imports. To our knowledge, this is the first study to directly evaluate the impact of international harmonization of standards on trade flows for the electronics sector. In the closest article related to this research, Moenius (2006b) studies the role of international harmonization of standards on trade flows of product that depend on electricity. He defines international harmonization as bilaterally shared standards among an importing-exporting country pair. We take advantage of the features of our dataset to widen this definition as we consider internationally harmonized standards as those standards that are aligned with worldwide practices defined by global institutions. We consider this a more accurate framework to analyze the role of international synchronization in standards on trade flows.

This paper leverages a new data set of European and international standards collected by the World Bank. The data set includes European standards for electrical, electronic and related products over the period 1990-2006. We quantify the differentiated effect on trade of European standards that are internationally harmonized against those that are not. Our main finding is that internationally-harmonized EU standards expand EU imports of electronic products. Conversely, European standards that are not aligned with international norms have a lower effect on EU imports, or even a negative one. This is the first paper to find robust evidence on the positive trade effects of international harmonization in electronic products. The results contrast with Czubala et al. (2008), who

[2] On 2000, the Committee of Participants on the Expansion of Trade in Information Technology Products (ITA Committee) agreed on its "Non-Tariff Measures Work Programme" (contained in WTO document G/IT/19). This document aimed to identify NTM which were impediments for trade and to examine the economic and developmental impact of such measures on trade in ITA products.

[3] As a matter of fact, in September 2008 the EU submitted a proposal (G/IT/W/28) to review and initiate negotiations to update the ITA. On non-tariff barriers it proposed, "... agreement on substantive provisions concerning the recognition of internationally agreed standards and of methods of conformity assessment, in order to avoid multiple testing and enable greater economies of scale without compromising on product safety".

[4] There are a number of initiatives underway in regional trade and industry groups to harmonize standards in electronic and electrical products. These include; the Association of Southeast Asian Nations (ASEAN), Asia Pacific Economic Cooperation (APEC), Pan American Standards Commission (COPANT), among others.

found that international harmonization of EU standards has a negative effect on imports, although milder than the effect exerted by the EU standards that are not internationally harmonized. A possible explanation for this differentiated effect resides on the benefits of the information that standards convey, regarding industrial requirements, interoperability, or consumer tastes in the importing country (informational effect), which are likely to be higher the more complex a good is. In the case of standards for electronic products, the informational benefits seem to outpace the costs of complying with standards.

The paper is structured as follows. Next section briefly explains the standards development system in Europe as it relates to electronics products. It also provides an overview of the literature on standards harmonization and trade. The third section describes the new World Bank database on electronic standards. We present our empirical model and estimates in section four. Finally, we conclude by providing a summary of questions for further research and policy implications for consideration based on our results.

2. Product Standards, Harmonization and the Electronic Sector

Product standards and technical regulations set out product characteristics, related processes and production methods. The World Trade Organization (WTO) differentiates them by its compliance degree: a technical regulation is mandatory, while a product standard is voluntary. In practice, this distinction is blurred, as public agencies often use standards to achieve regulatory goals (Hanson 2005). Standards affecting electronic products cover a wide range of product specifications. They include for example, safety requirements for sewing machines (EN 60204-31) and measures of electromagnetic emissions from integrated circuits (EN 61967)[5]. This paper aims at evaluating whether harmonization of electronic standards with international norms has an impact on trade flows. To our knowledge, this question has not yet been empirically explored.

The following section describes the institutional setting of product standardization in Europe, including reference to the international system for standardizing electronic products. We also summarize the literature on the effects of internationally harmonized standards on trade flows.

2.1. Institutional Standard-Setting Processes

Product standards have been part of trade policy forums for several decades. Since its creation in 1947, the General Agreement on Tariffs and Trade (GATT) contained general provisions relevant to technical regulations and standards. At the conclusion of the Tokyo Round in 1979 thirty-two GATT contracting parties signed the Agreement on Technical Barriers to Trade (TBT Agreement). In the Uruguay Round members elaborated on these rules in 1995 to create a revised TBT Agreement which is binding on all WTO members.

[5] Even though standards pursue an important number of benefits, such as facilitating exchange of information between producers and consumers, interoperability of products, and promotion of environmental protection and safety, they can also be means of hidden protection. Matutes and Regibeau (1996), Blind (2004), and Swan (2000) provide a discussion on the positive and negative effects of product standardization.

Concurrently with the TBT Agreement, the European Union adopted a "New Approach to technical harmonization and standardization" in 1985, was aiming at simplifying the movement of goods throughout the European Union (EU) and the European Free Trade Area (EFTA). New Approach Directives are confined to outlining "essential requirements" or regulatory objectives associated with the manufacturing of products, mainly related to safety. The regulatory framework applies either directly to final electronic goods or indirectly to electronic components used in other goods. Table 1 lists the Directive areas for which CENELEC has issued harmonized standards.

Table 1 here

Compliance with the New Approach Directives' is compulsory for the free movement of certain or covered products within the EU. The system in place does not, however, specify how specific objectives, such as consumer protection through product safety, should be achieved. This role is fulfilled by European standards published by supranational standardization bodies, such as the European Committee for Standardization (CEN) or the European Committee for Electrotechnical Standardization (CENELEC). The latter institution prepares and publishes standards relevant to the electronic sector. These standards are "harmonized" EU standards and member countries are obliged to adopt them and withdraw any national standard that might conflict with them.

If a manufacturer chooses to produce a product according to these harmonized standards, the product carries the "CE" marking, which implies compliance with the "essential requirements" mandated by law in Europe. 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 European Directives. By 2006, the number of harmonized standards linked to compliance with New Approach Directives account for 27.3 percent of the total stock of standard published by CENELEC[6]. The remaining standards are market driven and are not referenced in relation to compliance with the New Approach Directives.

The decision making process to create a standard in CENELEC consists of three stages elapsed in general over a three year period. The first stage involves producing a draft standard prepared by a CENELEC technical committee. This step requires a project proposal emanating from one of four possible bodies: CENELEC's own technical bodies, CENELEC's Cooperating partners[7], the International Electrotechnical Commision (IEC), or the national committees themselves. The second stage involves an enquiry procedure

[6] CENELEC facts & figures as of January 2008.
http://www.cenelec.eu/Cenelec/CENELEC+in+action/News+Centre/CENELEC+in+figures/Default.htm

[7] A cooperating partner is an independent European or international organization representing, with a sufficient degree of representativity within its defined area of competence, a sector or subsector of the electrotechnical field. Examples of such bodies are: The European Committee for Cooperation of the Machine Tool Industries (CECIMO); The European Coordination Committee of the Radiological, Electromedical and Medical IT Industries (COCIR); and The European Electronic Component Manufacturers Association (EECA), among others.

among CENELEC members[8] to comment on the draft. After the comments are incorporated into the document, a final draft is sent for vote. At this third stage members' votes are weighted according to the size of the country they represent. The approval of a standard requires that a majority of the national committees voted in favor of the document and that at least 71 percent of the "weighted" votes cast are positive.

At the global level, the International Electrotechnical Commission (IEC) is the organization that prepares and publishes international standards for electrical, electronic and related technologies. Table 2 reports the procedures to formulate IEC standards. It follows a similar procedure to standards formulated under CENELEC, however, the voting procedure occurs not only at the approval stage but also at the enquiry stage between qualified members. In some instances there is a join effort between IEC and the International Organization for Standardization (ISO) to publish standards related to this sector.

Table 2 here

CENELEC standards can be divided into three groups according to their relationship to international principles (IEC standards): i) standards identical to international norms, ii) standards based on international norms but modified with some specifications added for the European market, and iii) purely European standards. For this study, we only differentiate between CENELEC standards identical to IEC standards (internationally harmonized) from those that are not (non-internationally harmonized). By 2007, 70.1 percent of CENELEC standards (3,704) were internationally harmonized[9] whereas the remaining 22.7 percent were not (1,200).

For example, EU standard EN 61300 is an internationally harmonized standard in electronics that is identical to IEC 61300, which outlines the general requirements for optical fiber interconnecting devices and passive components. By opposition, standard EN 50049-1/A2, which delineates the interconnection requirements for domestic or similar electronic equipment, is a purely European standard since there is not an international norm equivalent to it.

2.2. Internationally Harmonized Standards and Global Trade

The literature about the effect of harmonization standards on international trade is limited[10]. Until recently, the literature was concentrated on examining the commonly held view that block-harmonized standards encourage international trade and that

[8] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Spain, Slovakia, Slovenia, Sweden, Switzerland and United Kingdom.

[9] CENELEC facts & figures, as of January 2008.

[10] The role of product standards –or more generally, technical barriers to trade (TBT)–, on international trade is also recent. At the theoretical level, Baldwin (2000) and Ganslandt and Markusen (2001) propose an analytical framework to understand the role of TBT on international flows. At the empirical level, Wilson and Otsuki (2004), Blind and Jungmittag (2005), and Chen et al. (2006) have estimated the impact of product standards or the effect of their liberalization. WTO (2005) provides a complete overview on the relation of product standards and international trade.

country-specific standards are barriers to trade. In this regard, Moenius (2004) finds that bilateral share standards are favorable to trade while country-specific standards reduce imports for non-manufactured goods and increase imports for manufactured goods in Europe.

In a similar study focusing on agricultural products, Moenius (2006a) refutes that country-specific standards always block trade since they provide essential information about markets and that European harmonized standards always expand trade as they also reduce the variety of goods being traded. In conclusion, Moenius work suggests that "importer standards tend to hinder trade in simple goods (including agricultural products) and promote trade in complex goods (like machinery)"[11].

The first article to consider the differentiated trade impact of "idiosyncratic" national standards versus international standards is Swann et al. (1996). Using data from 1985 to 1991, the authors regress British net exports on count data of country-specific standards and international standards in United Kingdom and Germany for 88 manufacturing industries. The results indicate that UK-specific standards have a stronger positive effect on British net exports than international standards.

Otsuki et al. (2001) is the first case study to directly address the role of internationally harmonized standards as opposed to purely European standards on trade flows. They employ a gravity model to estimate the impact of European aflatoxin standards on imports of groundnut products from Africa during 1988-1998. Results suggested that European standards set at the most restrictive level would involve trade flows significantly lower than when international standards are adopted.

Regarding the role of EU directives in trade, Chen and Matoo (2008) find that such agreements increase trade among EU members but not necessarily with non-members. The authors used a detailed panel dataset that identifies the industries influenced by each Directive to concluded that developing countries may be the worst affected since their firms are likely to be less prepared to comply with stricter standards. Although this article does not directly address the role on international harmonization in standards, it sheds light on the differentiated impact of EU standardization on third countries. In a closely related article, Baller (2007) also finds evidence that the effect of harmonization on third countries is positive for industrialized countries and mixed for developing countries.

Using a new World Bank database of EU product standards in the textiles, clothing, and footwear sector (EUSDB database), Czubala et al. (2007) consider the impact of international harmonization as opposed to purely European standardization at the intensive margin. The authors use a gravity model to examine the role of EU standards on African exports during the period 1995-2003. They find robust evidence on the negative impact of standards on trade, however, they find that internationally harmonized standards are less trade restrictive than purely European standards. The policy implications of this result suggest that it is indeed appropriated for the TBT Agreement to champion the use of international standards whenever possible and that it is no just technical regulations that can have a significant impact on trade.

[11] Moenius (2006a), page 3.

Building on Czubala et al, Shepherd (2007) examines the impact of internationally harmonized standards on the extensive margin of trade at the sectoral level. He suggests that although product standards have a negative impact on partner country export variety, international harmonization acts as a mitigating factor. The result is consistent with numerical simulations on a three-country version of Melitz (2003) model in which harmonization is beneficial at the extensive margin. The empirical results indicate that a 10% increase in the total number of standards reduces export variety by 6% meanwhile a 10% increase in the proportion of internationally harmonized standards leads to a 0.2% increase in export variety.

Finally, Moenius (2006b) is the only paper having focused on products that depend on electricity. He studies the different impacts of country-specific standards and standards shared by the exporting and the importing country. The author defines the latter as international harmonized standards and, in a gravity framework, concludes that both types of standards promote trade flows. He also finds that national standardization dominates bilateral standardization and that electricity-dependent products benefit more from international standardization than manufacturing products. At the empirical level, the fact that the base specification entails a regression of import flows on only dummy variables is worrisome.

3. The World Bank EU Electrotechnical Standards Database (EUESDB)

The European Union Electrotechnical Standards Database (EUESDB) compiles European Standards for electrotechnical products[12] over the period 1990-2007, and maps them to the Standard International Trade Classification (SITC). The database provides counts of the number of standards and their relation with international principles. This section presents the methodology as well as some description of the standardization activity in electronic goods.

In an effort to increase the availability of empirical data on standards, the new EUESDB is based upon the methodology proposed in Czubala's (2007) in assembling the European Union Standards Database in textiles, clothing, and agricultural products. Accordingly, the Perinorm database (www.perinorm.com) is used to extract the standards published by CENELEC. This approach has been employed previously in studies by Swann et al. (1996) and Moenius (2000, 2004, and 2006).

Perinorm is a subscription-only database of national, European and International product standards developed by the British Standard Institute (BSI), the *Association Française de Normalisation (*AFNOR) and the *Deutsches Institut für Normung* (DIN). It contains more than 1.1 million records from 23 countries, in addition to international bodies such as ISO and IEC and supranational organizations such as CEN and CENELEC. At this stage, EUESDB does not include data on national standards from individual EU member states[13].

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[12] According to the IEC (http://www.iec.ch), the term electrotechnical refers to electrical, electronic and related technologies.

[13] There are three reasons for this omission: First, a considerable number of national standards are in fact supranational standards implemented at the national level. Second, data availability varies considerably

Each record in the Perinorm dataset corresponds to a single national, regional, or international standard. Each observation has information on its title, the history of versions, its international relationship, its classification, the original language, the issuing body, the publication date, the withdraw date (if applies) and a brief description of it. Only those documents classified as European standards (coded as "EN") in Perinorm are included in the count database.

We use that information to build an inventory of the "stock" of active standards[14] for a given product-year in the electrotechnical sector. As Perinorm classifies standards according to the International Classification of Standards (ICS), standards are matched to products using Blind's (2004) concordance between ICS classification and SITC revision 2 classification[15]. A standard is considered to be in force for a given year if it was published before or during the year in question and (if applicable) if it was withdrawn after the same year. Amendments to existing standards are counted as additional standards. A standard is considered internationally harmonized if it is "identical" to an existing IEC standard. For instance, European standard EN 61965 delineates the mechanical safety of cathode ray tubes[16]. It was introduced in 2002 and modified in 2003, so it appears as active standard from 2002 on. It is considered as internationally harmonized since it implements IEC standard IEC 61965. This standard applies to SITC 776 which included thermionic, cold and photo–cathode valves, tubes and parts.

The extent of international harmonization varies mainly due to the introduction on new harmonized standards. From the total stock of internationally harmonized standards active in 2007 (1,447), 86% were new standards. The rest are either internationally harmonized standards that were active over the full sample (11 %) or some pre-existing non-harmonized standards that were replaced by harmonized standards (3%).

It is worth noting the limitations of the data set. Even though the count variable is a proxy of the number of standards an exporter should comply with, it is not possible to identify the level of technical complexity among those standards affecting a given product. Previous attempts to include the number of pages of each standard as a proxy for its technical complexity proved unworkable, we believe, as Perinorm records the number of pages of each standard in its original language, which may differ among standards.

Table 3 here

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across EU member countries. Third, as supranational standards are relatively recent, it is more feasible to obtain accurate stock data for them than for national standards.

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

[15] An advantage of this automatically mapping over the manual mapping used in Czubala et al. (2007) is its transparency and automation. On the other hand, the manual mapping has the benefit of allowing a finer level of product-detail. This advantage might be partly offset by the considerable room for the exercise of the analyst's judgment.

[16] Cathode ray tubes are electronic vacuum tubes that use focused electron beams to display images. They are most famous for their use in such things as televisions, computer and radar displays, and automated teller machines.

From the complete stock of electrotechnical standards, we extracted those standards directly related to electronic goods from 1990 to 2006. In an attempt to consider groups of homogenous goods where standards entail similar technical requirements among products, we distinguish between three groups of electronics: i) Electronic components; ii) consumer electronics and telecom; and iii) Information technology products. Lall et. al (2004) use a similar categorization to study industry fragmentation in electronic products. Table 3 reports the SITC categories within each group.

Table 4 here

Figure 1 here

Table 4 and figure 1 show the evolution of total number of product standards in each category. In average, IT products accounts for 11 percent of the overall number of standards. The main standardization activity has taken place in categories 1 and 2, in average they account for 36 percent and 53 percent of the total number of standards, respectively.

Table 5 here

Figure 2 here

The share of internationally harmonized standards (IEC standard) has increased in the sample period for electronic products as shown in table 5 and figure 2. This pattern differs among subsectors. In 1990, categories 1 and 2 began with a high share of international harmonization (almost 90 percent), partly due to the small number of standards in those categories. While the EU standardization process increased over time, the share of internationally harmonized standards temporarily decreased reaching its lowest level in 1993 for category 1 (36 percent) and in 1996 for category 2 (69.2 percent). From that point on, the share of international harmonization has remained constant for category 2 whereas it has increased in category 1 to reach 70 percent in 2006. Category 3 has a lower initial value (30 percent) in 1990, it reached it lowest point in 1992 (20 percent) to begin increasing until reach a level of 23 percent in 2006 (figure 3).

Figure 3 here

It is worth mentioning that the percentage of international harmonization tends to converge on the 70% to 80% range for the stock of standards of each sub-sector. This pattern may be the result of the implementation of the Dresden Agreement in 1996, which lays down a set of parameters to expedite the collaboration between IEC and CENELEC in the preparation and publication of international standards.

4. Model and Estimation Results

In this section, we provide the basic intuition for the empirical question we examine in this research. Next, we present an empirical model and discuss the econometric strategy as well as our estimates. Since we attempt to make the basic mechanisms underlying the model as clear as possible, we keep the theoretical presentation highly stylized.

Product standards can have a dual impact on costs, and therefore on trade. On the one hand, they may impose additional fixed costs (or even variable costs) on exporters as it may be necessary to alter production processes to adapt products to such standards in the importing country. Moreover, a producer willing to export to several markets may be confronted to idiosyncratic standards specific to each markets, and compliance with them may further inflate production costs.[17] Moreover, certification aiming to certify compliance with this set of rules can generate additional costs for the exporter.

On the other hand, product standards can potentially reduce exporter's information costs if they convey information as to industrial requirements, or consumer tastes in the importing country, that would be costly to collect in the absence of standards. Compared to other sectors where the complexity of goods is lower, such as textiles and clothing, the information conveyed by standards in the electronic sector may be relatively more valuable,—as it would facilitate the performance and interoperability of devices and components— and the benefits of standardization seem to outpace its compliance costs.

4.1. Empirical Model

To examine the differentiated impact of internationally harmonized and non-harmonized standards on EU imports of electronic goods, we use a standard gravity model of international trade applied to data on EU-15 imports from the rest of the world[18]. Individual EU standards in electronics often tend to be applied across numerous product lines, which make it convenient to aggregate the trade data to a higher level of generality.

As starting point, we take the micro-founded gravity model formulation of Anderson and Van Wincoop (2003, 2004) and adapt it to the electronics sector:

$$\ln\left(M_{ijt}^{k}\right)=\log\left(E_{jt}^{k}\right)+\log\left(Y_{it}^{k}\right)-\log\left(Y_{t}^{k}\right)+\left(1-\sigma_{k}\right)\log\left(t_{ijt}^{k}\right)-\left(1-\sigma_{k}\right)\log\left(P_{jt}^{k}\right)-\left(1-\sigma_{k}\right)\log\left(\Pi_{it}^{k}\right)+\varepsilon_{ijt}^{k} \qquad (1)$$

where: M_{ijt}^{k} = Country j imports from country i in category k for year t; Y_{it}^{k} = Production of country i in sector k for year t; E_{jt}^{k} = Expenditure of country j in category k for year t; Y_{t}^{k} = Aggregate (world) output in category k for year t; σ_{k} = Elasticity of substitution in category k; t_{ijt}^{k} = Trade costs facing exports from country i to country j in category k for year t; ; ω_{it}^{k} = Country i's output share in category k for year t; ω_{jt}^{k} = Country j's expenditure share in category k for year t; and ε_{ijt}^{k} = Random error term, satisfying the usual assumptions. The inward resistance term, $\left(P_{jt}^{k}\right)^{1-\sigma_{k}}=\sum_{i=1}^{N}\Pi_{it}^{\sigma_{k}-1}\omega_{it}^{k}\left(t_{ijt}^{k}\right)^{1-\sigma_{k}}$, captures the dependence of country j imports on trade costs across all suppliers. By contrast, the

[17] This assumption could be tested if a database similar to the one in the EU would exist for other markets.
[18] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, ,Sweden, and United Kingdom.

outward resistance term, $\left(\Pi_{it}^{k}\right)^{1-\sigma_k} = \sum_{j=1}^{N} P_{jt}^{\sigma_k - 1}\omega_{jt}^{k}\left(t_{ijt}^{k}\right)^{1-\sigma_k}$, describes the dependence of exports from country i on trade costs across all importers.

We modify the bilateral trade costs component, t_{ijt}^{k}, in the standard model (1) as to explicitly include our standards count variables. Ideally, the model would require data on the direct costs of compliance with standards for the categories we use. Unfortunately, such data is not available at the categories level, let alone at the firm level, and we are forced to resort to count-variables as proxies that capture the effects of standards. Indeed, other empirical papers resort to standards count, see for instance Czubala et al (2007) for EU standards on apparel and textiles, as well as by Swann (1996) and Moenius (2000, 2004, and 2006).

Our standards count variables make a distinction between the number of EU standards internationally harmonized with IEC standards ($IH\_std_t^k$) in product category k and the number of EU standards not internationally harmonized ($NIH\_std_t^k$). By defining the standards count variable at the product category, we allow for uneven effects of standards on trade across categories, as the number of standards per product-category k diverges. We also include in the trade cost function $Tappl_{ijt}^{k}$, an import-weighted average of applied tariffs to category k levied by EU importers to exports from country i, as explained below. Finally, the trade cost function also includes, as is usual in this literature, the distance between pairs of trading countries (*dist*) as proxy for transport costs, as well as dummy variables to take into account important geographical and cultural links such as colonial links (*Dcolony*), and a common official language (*Dcomlang*). We also control for the differentiated impact of exports from the ten European countries that formally acceded to the EU in 2004, by including a dummy (*DEU_memb*) that equals one when exporter i is one of the ten countries in 2004 or a subsequent year, and zero elsewhere. Furthermore, as part of EU-accession, the ten countries had also benefited from zero-tariff preferences in the EU for several sectors – including manufacturing- since 1998, prior becoming full EU-members. Therefore, zero-tariffs were applied by EU-15 countries on the export of electronic products of these countries from 1998 onwards[19], as captured by the applied tariff variable in the estimates.

Assuming linearity, we therefore specify:

$$\ln\left(t_{ijt}^{k}\right) = \sum_{k=1}^{3}\theta_k \ln(IH\_std_t^k) + \sum_{k=1}^{3}\varphi_k \ln(NIH\_std_t^k) + \varsigma_1 Tappl_{ijt}^{k} + \varsigma_2 \ln\left(dist_{ij}\right) + \varsigma_3 Dcolony_{ij} + ...$$
$$..... + \varsigma_4 Dcomlang_{ij} + \varsigma_5 DEU\_memb_{ij} \quad (2)$$

As to implement the estimation procedure, Anderson and Van Wincoop (2003, 2004) suggest that the model can be simplified by replacing the “multilateral resistance” terms with appropriate fixed effects. In this case, a strict interpretation of their structural model in a panel context would require fixed effects in the importer-sector-time, exporter-sector-time, and sector-time dimensions. However, this approach is difficult to implement

[19] For an account of EU enlargement issues, see for instance Breuss (2002)

as it requires estimation of a large number of parameters, a problem accentuated in our case by the large number of countries. For our baseline model (3), we therefore prefer a simpler formulation using fixed effects only in the exporter (θ_j), importer (δ_i) and product-year $(\psi_k \times \tau_t)$ dimensions. The last term has the advantage of controlling for unobserved effects time-varying effects specific to each category of electronics that are likely to influence trade, such as technological innovation. The importer and exporter fixed effects control for country-specific unobserved factors.

Plugging (2) into (1) and replacing the "multilateral resistance" terms with appropriate fixed effects, we obtain:

$$\ln\left(M_{ijt}^{k}\right)=\delta_i+\theta_j+\left(\psi_k\right)\times\left(\tau_t\right)+\sum_{k=1}^{3}\alpha_1\ln(IH\_std_t^k)+\sum_{k=1}^{3}\beta_1\ln(NIH\_std_t^k)+\gamma_1\ln\left(\tau_{jt}\right)+\ldots$$
$$\ldots+\gamma_2\ln\left(dist_{ij}\right)+\gamma_3 Dcolony_{ij}+\gamma_4 Dcomlang_{ij}+\gamma_5 DEU\_memb_{ij}+\varepsilon_{ijt}^{k} \quad (3)$$

Data

Our panel covers three categories of electronic products described in Table 3 imported by the EU-15 countries from 131 countries exporting countries[20] over the period 1990-2006. Export and tariff data were compiled through WITS from COMTRADE and TRAINS, respectively under the SITC revision-2 nomenclature. Core gravity variables, such as bilateral distances, colonial and common language dummies, were obtained from the CEPII web-site[21]. Data on standards was explained in section 3.

Exports to the EU in electronics have increased over time. In average, information technology products represent 50 percent of electronic exports to the EU meanwhile consumer electronics and electronic components represent 32 percent and 18 percent, respectively (figure 4). Table 6 shows EU import composition by exporter regions. East Asian & Pacific countries are clearly the major source of EU imports, with exports accounting for more than 80 percent in each category.

Figure 4 here

Table 6 here

As shown in figure 5, EU tariffs for electronic products decreased continuously as the electronics sector experienced a period of sustained liberalization. This pattern coincides with the implementation of the Information Technology Agreement (ITA), a sectoral tariff-cutting multilateral agreement negotiated by an important number of WTO member countries in 1996 for several IT products.[22]

[20] The sample size for 131 exporting countries, 15 importing countries, 3 electronic categories, and 17 years is 100,215.
[21] http://www.cepii.fr/anglaisgraph/bdd/distances.htm
[22] ITA set tariffs for all products listed in its Declaration at a zero-level after an implementation period. As to the three categories we consider, almost half (47%) of their number of tariff lines were affected by ITA, accounting for 25 % of total EU imports volume in these categories

Figure 5 here

Econometric Strategy

The econometric strategy was guided by the trade-offs resulting from the presence of a large number of observations with zero-exports in the data: about 57 percent of observations. To deal with zero-exports, estimations were carried out with several econometric methods, using a logarithmic transformation in the dependent variable to avoid giving too much weight to observations with a high-volume of exports. However, the use of logarithms brings in a truncation problem for observations with zero-exports. The standard solution in the literature (see for instance Frankel et al. (1997)) consisted of shifting all export values by one dollar before applying the logarithmic transformation, so that the dependent variable in (3) $\ln\left(1+M_{ijt}^{k}\right)$. This increases the mean of exports by one unit without affecting its variance. In addition, with this correction, product categories with zero exports are linked to zero values of the dependent variable. Then, Tobit estimation may appropriately account for the censorship of the dependent variable. However, as shown by de Melo and Portugal-Perez (2008), coefficient estimates can be very sensitive to this (arbitrary) choice of adding one dollar. Therefore, it is prudent to explore alternatives.

Eaton and Tamura (ET 1995) proposed to estimate a variation of the Tobit model in which the independent variable is $\ln\left(a_v + M_{ijt}^{k}\right)$ and the maximum likelihood (ML) function is modified to endogenize the choice of the a_v parameter. Then, the ML estimator includes an estimate of the value of a_v among the set of estimates which means that the dependent variable will be censored at the value $\ln\left(a_v\right)$ (see Appendix A for details on the Eaton Tamura (ET) tobit Model).

Along the same lines, Santos Silva and Tenreyro (SS-T) (2006) propose a Poisson Pseudo Maximum Likelihood (PPML) model to deal with heteroskedasticity in constant-elasticity models, such as log-linear gravity models. Using Monte-Carlo simulations, they show that that the PPML produce estimates with the lowest bias for different patterns of heteroskedasticity. However, Martin and Pham (2008) noticed that the data-generating process used by SS-T did not produce zero-values properly. When correcting the data-generating process to obtain a sample with an important amount of zero-value observations –a situation closer to ours – Martin and Pham find that the ET-Tobit estimates have a lower bias than those obtained with the PPML estimator.

The above formulation captures the impact of trade costs on bilateral trade volumes. However, the impact that we are capturing is conditional on trade taking place between the two countries, i.e. on $M_{ijt}^{k} > 0$. Zero or missing trade flows are excluded from the effective sample in (3), which has been shown to bias the resulting coefficient estimates (e.g., Helpman et al., 2008). Moreover, equation (3) on its own does not allow us to say anything about the second part of our working hypothesis, which has to do with export propensity. Ideally, one would want to implement a two-stage procedure in which a decision to export a specific product is taken in a first stage (selection equation), then in a second stage a decision is taken on volume (outcome equation) as in Helpman, Melitz and Rubinstein (2008) [23]. Indeed, we also estimate a Heckman (1979) sample selection model. Such an approach requires an appropriate exogenous instrument that would influence only the decision to export in the first-stage and not the volume of exports in the second stage in order to comply with the exclusion restrictions of the two-stage method. At this high level of disaggregation with panel data, the only potential instrument in this data set would be the lagged decision to export (represented by a dummy that is equal to one if the product was exported from country i to country j in the preceding period).[24] However, since there is not much heterogeneity in this indicator, we are also inclined to retain ET-Tobit estimates.

Another issue to be addressed is the possible endogeneity of the standards count variables, $H\_std_t^k$ and $NH\_std_t^k$ in all three types of electronics, to trade flows. The number of standards in a particular sector could, in a general sense, be endogenous to imports through a political economy process. Moreover, we take into consideration exports to the EU from a large group of countries. It is therefore unlikely that sector-wide standards in electronics —which apply to both domestic production and imports from all sources— are set in response to unexpectedly large imports from a single country in a single year. As robustness checks we include alternately in our regressions lagged count variables for standards, see below in table 8. Although we do not expect major problems with endogeneity in this case, we leave for future research alternative ways of dealing with it.

4.2. Econometric Results

We first report the results for the baseline equation using the different estimation techniques discussed above in the empirical strategy. Then, we carry out robustness checks using the ET-Tobit and Heckman selection estimators, our preferred ones.

Baseline Results

Table 7 reports the estimates from equation (3) obtained under several estimation methods. Column 1 reports the OLS method with the logarithm of exports, ln(M), as

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[23] The first stage consists of a probit regression that explains the probability that country i exports to country j (selection equation), where the dependent variable is a dummy that is equal to one if country i exports to country j. The second stage consists of a gravity equation estimated in logarithmic form that explains the volume of exports from i to j (outcome equation) and incorporates a term based on estimates of the first-stage, known as the inverse Mills-ratio, to correct for the non-random prevalence of zero trade flows and intra-sector firm heterogeneity. The two-stage procedure aims at correcting for two potential drawbacks prevalent in the estimation of gravity models. First, a standard selection bias can result from the necessity to drop observations with zero trade. Second, there is a potential bias due to unobserved firm level heterogeneity resulting from an omitted variable that measures the impact of the number of exporting firms, an aspect related to the extensive margin in the model.

[24] Helpman, Melitz, and Rubinstein (2008) employ a two-stage Heckman estimation procedure in cross-section estimates. In order to comply with the exclusion restriction condition, they use separately two instrumental variables in the first-stage probit excluding them from the second-stage: a common religion variable and a variable on the regulation costs of firm entry in a country.

dependent variable. Columns 2 and 3 report Tobit-type of estimates for (3). The "standard" Tobit estimates in column 2 account more appropriately for the censorship of the dependent variable. Now the dependent variable is the log of imports plus one dollar, implying that av=1. However, as discussed before, all coefficient values, are very sensitive to the choice of av used to avoid truncation. Column 3 goes one step further and reports the ET-Tobit estimates that also estimates the value of av that fits best the data. Column 4 and 5 report estimates for the outcome and the selection equations of the Heckman selection model. Finally, column 5 reports estimates when applying the Poisson Pseudo Maximum Likelihood (PPML) model recommended by Santos Silva and Tenreyro (SS-T) (2006) to deal with heteroskedastic errors in log-linear gravity models.

Table 7 here

Most coefficients are significant with reasonable magnitudes and expected sign across estimation methods. Among the standard gravity variables, distance is negative and statistically significant, while a colonial relationship (statistically significant) and common official language (statistically significant) are both positive. The coefficient of the applied tariff is negative and significant except in the last column for the PPML, confirming the negative impact tariffs have on imports. A possible explanation for the sign reversal when using the PPML method lies on the fact that the dependent variable is in level rather than logarithmic form, giving more weight to extreme observations and, the loss in precision being attributable to giving probably too much weight to very noisy data at the level at which product categories are defined.

We find that all estimated coefficients for the count of internationally harmonized standards in each category of electronics goods are positive and significant across all columns. The results are less homogenous for non-harmonized variables. Although coefficients for non-harmonized standards in category 3 are all positive, the non-harmonized standards coefficients in categories 1 and 2 have different signs across estimation methods. However, when non-harmonized standard coefficients are positive, their magnitude is always smaller than corresponding coefficients for harmonized standards[25], as confirmed more formally when carrying out hypothesis tests (not reported here)[26].

[25] The single exception is the coefficient for category 1 in column 5, but it is the selection equation of the Heckman selection model.

[26] As standards harmonization seems to reduce the informational asymmetries between producers and buyers, the effect should be larger for products that suffer the most from these asymmetries. A possible avenue for future extension of this research is to test this hypothesis using variables of technical complexity for our defined categories as proxies of the scope for informational asymmetry, as suggested by an anonymous referee. A similar identification challenge was faced by Kugler and Verhoogen (2008), who use the ratio of total industry advertising and R&D to total industry sales for the US firms from the 1975 U.S. Federal Trade Commission (FTC) Line of Business Survey as a measure of the scope for quality differentiation.

Robustness Checks

For next results, we only report estimates of the ET-Tobit and the Heckman selection methods, our preferred ones. We report results for robustness checks in table 8. Column 1 to 3 report estimates on a sample that excludes the 10 countries having joined the EU in 2004, whereas columns 4 to 6 report estimates on a sample that reduces the time horizon to the period 1996-2006. Estimates in both sets of specifications are very similar. There are two main contrasts with our preferred results in table 7. First, standards count coefficients are slightly higher when the samples are reduced. Second, coefficients for non-harmonized standards in category 3 are no longer negative, but they are lower in absolute value than coefficients for internationally-harmonized standards.

Table 8 here

Omitted variable bias and measurement error leading to our large estimated values could have resulted from omitting the exchange rate differential between exporter and importer currency as it could also have an impact on exports. Nevertheless, when adding the ratio of importer/exporter exchange rates (with respect to the dollar), its effect was not significant (not reported here).

As noted previously, another potential difficulty with our results is the possible endogeneity of our standards measures. To deal with this issue, we re-run estimates in columns 3-5 of table 8 using two and five period lags of our standards count variables. Table 9 presents the results. Qualitatively, they are identical to our baseline results: harmonized standards exert a positive impact on trade values and export propensity, where as non-harmonized standards have a mixed result; although in cases where the impact is positive it is smaller than for harmonized standards. With five lags, coefficients of standards tend to be significant at least at the 10% in fewer cases. If anything, attempting to account for endogeneity by using lag-variables tends to strengthen our initial results.

Table 9 here

5. Concluding Remarks

This analysis centers on evaluating the impact of international harmonization of voluntary standards on trade in electronic goods. We estimated a micro-founded gravity-type model of trade to find robust empirical evidence on the positive impact of EU standards aligned with international norms on both EU import volumes of electronic products and the propensity to import. This result remains robust to alternative specifications, samples, and estimation methods.

We have also shown the differentiated impact of harmonization on three categories of electronics: electronic components, consumer electronics and telecoms, and information technology. Although a positive and robust relationship between international harmonization and trade seems to appear in all of the three categories, we found that EU-specific standards not aligned to international norms have a mixed impact on trade across sectors and estimation methods used. Yet, even when the impact of non-harmonized standards is found, at best, to be positive, the trade-effect is smaller than with internationally harmonized standards.

Compared with previous empirical work on EU standards harmonization in textiles undertaken by Czubala et al. (2007) —where internationally harmonized standards were shown to have a negative effect on imports from Africa, although a more mitigated adverse effect compared to non-harmonized standards— the evidence in this paper confirms the importance of international harmonization of standards on the commercialization of more complex goods, such as electronics, as well as on their production and consumption.

From the empirical point of view, our paper builds on previous empirical work and improves it in three fundamental ways. First, we consider the differentiated impact of international harmonization across three categories of electronics as opposed to considering the average impact on the whole sector. Second, this paper considers the full set of exporters to the EU in a sector, so that selection bias does not become an issue. Third, among our estimation techniques explored, we obtain ET-tobit estimates that adequately control for the important proportion of observations with zero-exports at the disaggregated level.

The policy implications of these results are of significant interest. There may be a good case for deepening efforts on international harmonization in electronics with a positive and significant impact on trade. Building on the Information Technology Agreement, for example, could include talks to undertake commitments to harmonize standards in electronics products to international norms.

In regard to future research work, we view two areas of particular interest. First, there may be significant gains from collecting data through firm-surveys in major exporters in order to explore the effect of standards at the firm-level. Second, as the new database of EU standards in electronics reveals cross-sectoral variation in the number and type (harmonized vs. non-harmonized) of standards, further research on the political economy forces that play a role in standard setting behavior may also prove useful.

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Appendix A. The Eaton-Tamura (ET) Tobit model.

This appendix draws on de Melo and Portugal-Perez (2008) and spells out the ET model estimated in the main text and derives expressions for the marginal effects drawing a distinction between continuous variables (lumped in vector x_{it}^{jk}) and dummy variables (lumped in vector R_{it}^{jk})

A1.The Eaton-Tamura (ET) tobit model

Consider the following 'Tobit-like' :model:

$$\ln\left(a_v + M_{it}^{jk}\right) = \begin{cases} y_{it}^{jk*} = \beta_0 + \beta_1 x_{it}^{jk} + \beta_2 R_{it}^{jk} + \varepsilon_{it}^{jk} \equiv \mathrm{Z}_{it}^{jk}\theta_M + \varepsilon_{it}^{jk}, \text{ if } y_{it}^{jk*} \geq \ln\left(a_v\right) \\ \ln\left(a_v\right) \qquad \text{if } y_{it}^{jk*} < \ln\left(a_v\right) \end{cases} \quad (0.1)$$

where M_{it}^{jk} is country k's imports of apparel variety j from country j at year t, x_{it}^{jk} is a continuous regressor, R_{it}^{jk} is a dummy variable, and a_v is endogenously determined in the maximum-likelihood procedure. Notice that $M_{it}^{jk} \geq 0$, and that $\varepsilon_{it}^{jk} \sim Normal\left(0,\sigma^2\right)$. Notice also that for simplicity, we defined: $\beta_0 + \beta_1 x_{it}^{jk} + \beta_2 R_{it}^{jk} \left(\equiv \mathrm{Z}_{it}^{jk}\theta_M\right)$, and $\ln\left(a_v + M_{it}^{jk}\right)\left(\equiv \mathrm{y}_{it}^{jk}\right)$

Model (0.1) is equivalent to the constant elasticity model:

$$M_{it}^{jk} = \begin{cases} M_{it}^{jk*} = -a_v + \exp\left(\beta_0 + \beta_1 x_{it}^{jk} + \beta_2 R_{it}^{jk}\right)\exp\left(\varepsilon_{it}^{jk}\right) \text{ if } M_{it}^{jk*} \geq 0 \\ 0 \qquad \text{if } M_{it}^{jk*} < 0 \end{cases} \quad (0.2)$$

As $\varepsilon_{it}^{jk} \sim Normal\left(0,\sigma^2\right)$, then $\exp\left(\varepsilon_{it}^{jk}\right)$ is a log-normal random variable.

From model (0.1), the maximum likelihood estimates of a_v and $\theta_M \left(=(\beta_0,\beta_1,\beta_2)\right)$ maximize the log-likelihood function:

$$\ln L\left(a_v,\theta_M\right) = \sum_{M=0} \ln\left(F_{it}\right)$$
$$+\sum_{M>0}\left\{-\ln\left(a_v + M_{it}^{jk}\right) - 0.5\left(\ln\left(2\pi\right) + \ln\left(\ln\left(2\pi\right)\right)\right) - \left(1/2\sigma^2\right)\left[\ln\left(a_v + M_{it}^{jk}\right) - \mathrm{Z}_{it}^{jk}\theta_M\right]^2\right\}$$

where F_{it} =Prob$\left(M_{it}^{jk}=0\right)$ = Prob$\left(\varepsilon_{it}^{jk} \geq \ln\left(a_v\right)\text{-}\mathrm{Z}_{it}^{jk}\theta_M\right)$[27], as determined from (0.1)

A2. Evaluating the marginal effects in an ET tobit model

We are interested in calculating the two marginal effects:

[27] We correct for the typographical errors in the log-likelihood function Eaton and Tamura (1994), page 491.

1) $$\frac{\partial E\left[M_{it}^{jk} \middle| M_{it}^{jk*} > 0\right]}{\partial x_{it}^{jk}}$$ for the continuous variable x_{it}^{jk}

2) $$\frac{\Delta E\left[M_{it}^{jk} \middle| M_{it}^{jk*} > 0\right]}{\Delta \partial R_{it}^{jk}}$$ for the dummy variable R_{it}^{jk}

1) $$\frac{\partial E\left[M_{it}^{jk} \middle| M_{it}^{jk*} > 0\right]}{\partial x_{it}^{jk}}$$

We deduce from model (0.2):

$$E\left[M_{it}^{jk} \middle| M_{it}^{jk*} > 0\right] = -a_v + \exp(\beta_0 + \beta_1 x_{it}^{jk} + \beta_2 R_{it}^{jk}) E\left[\exp\left(\varepsilon_{it}^{jk}\right) \middle| M_{it}^{jk} > 0\right] \quad (0.3)$$

Deriving (0.3), with respect to x_{it}^{jk}:

$$\begin{aligned}\frac{\partial E\left[M_{it}^{jk} \middle| M_{it}^{jk*} > 0\right]}{\partial x_{it}^{jk}} &= \beta_1 \left(\exp\left(\beta_0 + \beta_1 x_{it}^{jk} + \beta_2 R_{it}^{jk}\right) E\left[\exp\left(\varepsilon_{it}^{jk}\right) \middle| M_{it}^{jk} > 0\right]\right) \\ &= \beta_1 \left(-a_V + \exp\left(\beta_0 + \beta_1 x_{it}^{jk} + \beta_2 R_{it}^{jk}\right) E\left[\exp\left(\varepsilon_{it}^{jk}\right) \middle| M_{it}^{jk} > 0\right] + a_V\right) \\ &= \beta_1 \left(a_V + E\left[M_{it}^{jk} \middle| M_{it}^{jk} > 0\right]\right)\end{aligned} \quad (0.4)$$

Furthermore, if x_{ij} is a variable expressed in percent terms (such as a tariff) or a logarithmic variable (such as log(GDP) , we will be interested in estimating the semi–elasticity:

$$\begin{aligned}\frac{\partial E\left[M_{it}^{jk} \middle| M_{it}^{jk} > 0\right]}{\partial x_{it}^{jk}} \frac{1}{E\left[M_{it}^{jk} \middle| M_{it}^{jk} > 0\right]} &= \beta_1 \left(a_V + E\left[M_{it}^{jk} \middle| M_{it}^{jk} > 0\right]\right) \frac{1}{E\left[M_{it}^{jk} \middle| M_{it}^{jk} > 0\right]} \\ &= \beta_1 \left(1 + \frac{a_v}{E\left[M_{it}^{jk} \middle| M_{it}^{jk} > 0\right]}\right)\end{aligned} \quad (0.5)$$

This semi elasticity can be interpreted as the percent change in imports following a 1% increase in the value of the continuous variable x_{ij}

2) Using the definition of model (0.2), we develop:

$$
\begin{aligned}
\frac{\Delta E\left[M_{it}^{jk}\middle|M_{it}^{jk*}>0\right]}{\Delta\partial R_{it}^{jk}} &= E\left[M_{it}^{jk}\middle|M_{it}^{jk*}>0,R=1\right]-E\left[M_{it}^{jk}\middle|M_{it}^{jk*}>0,R=0\right] \\
&= -a_V+\exp\left(\beta_0+\beta_1 x_{it}^{jk}+\beta_2\right)E\left[\exp\left(\varepsilon_{it}^{jk}\right)\middle|M_{it}^{jk}>0\right] \\
&\quad +a_V-\exp\left(\beta_0+\beta_1 x_{it}^{jk}\right)E\left[\exp\left(\varepsilon_{it}^{jk}\right)\middle|M_{it}^{jk}>0\right] \\
&= \left[\exp\left(\beta_2\right)-1\right]\exp\left(\beta_0+\beta_1 x_{it}^{jk}\right)E\left[\exp\left(\varepsilon_{it}^{jk}\right)\middle|M_{it}^{jk}>0\right] \\
&= \left[\exp\left(\beta_2\right)-1\right]\times E\left[M_{it}^{jk}\middle|M_{it}^{jk*}>0,R=0\right]
\end{aligned}
\tag{0.6}
$$

We are interested in evaluating the percent change of the expected value of positive values of the dependent variable (here imports) following a unit-change in the dummy R_{it}^{jk} (in our case shifting from a double to a single transformation RoO for apparel).

The expression is equal to:

$$
\frac{\Delta E\left[M_{it}^{jk}\middle|M_{it}^{jk*}>0\right]}{\Delta\partial R_{it}^{jk}}\frac{1}{E\left[M_{it}^{jk}\middle|M_{it}^{jk*}>0,R=0\right]}=\left[\exp\left(\beta_2\right)-1\right] \tag{0.7}
$$

Tables and Figures

Table 1. New Approach Directives for which CENELEC has issued harmonized standards.

Directive Area	Directive reference
Electromagnetic Compatibility	2004/108/EC
Explosive Atmospheres	94/9/EC
Gas Appliances	90/396/EEC
Interoperability of European High-speed Railway	96/48/EC
Interoperability of trans-European conventional rail	2001/16/EC
Low-Voltage Equipment	2006/95/EC
Machinery	98/37/EC + 2006/42/EC
Measuring Instruments	2004/22/EC
Medical Devices	93/42/EEC
Medical Devices: Active Implantable	90/385/EEC
Medical Devices: In Vitro Diagnostic	98/79/EC
Non-automatic Weighing Instruments	90/384/EEC
Personal Protective Equipment	89/686/EEC
Pressure Equipment	97/23/EC
Radio & Telecom Terminal Equipment	99/5/EC
Recreational Craft	94/25/EC
Safety of Toys	88/378/EEC

Source: CENELEC, facts and figures (as a January 20008)

Table 2. Preparation Stages for IEC Standards.

Project stage	Associated Document
Preliminary stage	Preliminary work item
Proposal stage	New work item proposal
Preparatory stage	Working draft(s)
Committee stage	Committee draft(s)
Enquiry stage	Enquiry draft *
Approval stage	Final draft International Standard*
Publication stage	International IEC Standard

* A draft is approved if a two-thirds majority of the votes cast by P-members of the technical committee are in favour and no more than one-quarter ot the total number of votes cast are negative.

Source: ISO/IEC Directives, Part 1
http://www.iec.ch/tiss/iec/Directives-Part1-Ed6.pdf

Table 3. Finished Products and Parts and Components in Trade in Electronics

Group (k)	SITC	Product
1. Electronic components	7761	Television picture tubes,cathode ray
	7762	Other electr.valves and tubes
	7763	Diodes,transistors and sim.semi-conductor devices
	7764	Electronic microcircuits
	7768	Piezo-electric crystals,mounted,parts of 776-
2. Consumer electronics and Telecoms	7611	Television receivers,colour
	7612	Television receivers,monochrome
	7621	Radio-broadcast receivers for motor vehicles
	7622	Radio-broadcast receivers portable,incl.sound rec.
	7628	Other radio-broadcast receivers
	7631	Gramophones & record players,electric
	7638	Other sound recorders and reproducers
	7641	Elect.line telephonic & telegraphic apparatus
	7642	Microphones,loudspeakers,amplifiers
	7643	Radiotelegraphic & radiotelephonic transmitters
	7648	Telecommunications equipment
	7649	Parts of apparatus of division 76-
3. Information Technology	7511	Typewritters;cheque-writting machines
	7512	Calculating machines,cash registers.ticket & sim.
	7518	Office machines, n.e.s.
	7521	Analogue & hybrid data processing machines
	7522	Complete digital data processing machines
	7523	Complete digital central processing units
	7524	Digital central storage units,separately consigned
	7525	Peripheral units,incl.control & adapting units
	7528	Off-line data processing equipment. n.e.s.
	7591	Parts of and accessories suitable for 751.1-,751.8
	7599	Parts of and accessories suitable for 751.2-,752-

Table 4. Count by Category of EU Standards in Electronics

Category (k)	1	2	3	Total
1990	42	121	40	203
1991	77	134	55	266
1992	111	153	83	347
1993	144	219	89	452
1994	199	272	83	554
1995	260	336	84	680
1996	307	399	75	781
1997	354	531	79	964
1998	405	592	85	1082
1999	445	631	57	1133
2000	480	661	58	1199
2001	524	771	67	1362
2002	604	831	78	1513
2003	657	910	84	1651
2004	679	977	89	1745
2005	644	1026	99	1769
2006	685	1057	107	1849

Source: EUESDB (2008)

Table 5. Count by Type of EU Standards in Each Category

Category	1		2		3		Total	
(k)	IEC Standard	Non-IEC standard	IEC Standard	Non-IEC standard	IEC Standard	Non-IEC standard	IEC Standard	Non-IEC standard
1990	35	7	107	14	12	28	154	49
1991	40	37	112	22	14	41	166	100
1992	43	68	124	29	15	68	182	165
1993	52	92	165	54	20	69	237	215
1994	83	116	199	73	20	63	302	252
1995	111	149	235	101	23	61	369	311
1996	131	176	276	123	29	46	436	345
1997	161	193	386	145	30	49	577	387
1998	195	210	439	153	34	51	668	414
1999	230	215	473	158	35	22	738	395
2000	267	213	502	159	40	18	809	390
2001	306	218	560	211	46	21	912	450
2002	379	225	617	214	54	24	1050	463
2003	430	227	670	240	57	27	1157	494
2004	462	217	704	273	65	24	1231	514
2005	435	209	735	291	75	24	1245	524
2006	477	208	778	279	86	21	1341	508

Source: EUESDB (2008)

Table 6 EU-15 import Composition by Region

Region	Electronic Components	Consumer Electronics and Telecom	Information Technology
East Asian & Pacific	83.9%	81.2%	93.2%
Europe and Central Asia	3.3%	14.4%	0.9%
Latin America and Caribbean	7.4%	2.8%	5.1%
Middle East & North Africa	4.3%	0.6%	0.2%
South Asia	0.7%	0.4%	0.3%
Sub-Sahara Africa	0.5%	0.6%	0.3%
	100%	100%	100%

Table 7
Base line results with different estimation methods

	1	2	3	4	5	6
	OLS(m>0)	tobit(1+m)	ET-tobit	Heckman (outcome)	Heckman (selection)	ppml
$H\_std_t^1$	0.611	1.118	0.972	0.504	0.065	0.631
	[0.058]***	[0.069]***	[0.059]***	[0.090]***	[0.049]	[0.101]***
$H\_std_t^2$	0.747	0.848	0.747	0.996	0.807	0.732
	[0.081]***	[0.089]***	[0.075]***	[0.117]***	[0.075]***	[0.149]***
$H\_std_t^3$	0.73	1.663	1.411	0.865	0.733	1.033
	[0.054]***	[0.045]***	[0.038]***	[0.042]***	[0.029]***	[0.144]***
$NH\_std_t^1$	-0.137	-0.158	-0.14	0.19	0.595	0.188
	[0.051]***	[0.061]***	[0.052]***	[0.121]	[0.071]***	[0.041]***
$NH\_std_t^2$	-0.051	0.517	0.425	-0.144	-0.178	0.144
	[0.058]	[0.080]***	[0.068]***	[0.097]	[0.062]***	[0.122]
$NH\_std_t^3$	0.266	0.203	0.191	0.435	0.342	0.475
	[0.051]***	[0.053]***	[0.044]***	[0.052]***	[0.034]***	[0.087]***
Tappl	-0.023	-0.072	-0.061	-0.023	-0.041	0.07
	[0.009]**	[0.005]***	[0.004]***	[0.005]***	[0.003]***	[0.018]***
ldistw	-1.252	-1.377	-1.233	-1.277	-0.36	-0.781
	[0.145]***	[0.046]***	[0.039]***	[0.045]***	[0.028]***	[0.265]***
DEU_memb	1.105	1.36	1.271	1.089	0.214	0.949
	[0.130]***	[0.086]***	[0.071]***	[0.079]***	[0.072]***	[0.159]***
Dcolony	0.835	1.408	1.148	0.844	0.464	0.08
	[0.122]***	[0.054]***	[0.046]***	[0.045]***	[0.036]***	[0.094]
Dcomm_lang	0.254	0.841	0.683	0.282	0.344	0.392
	[0.110]**	[0.053]***	[0.044]***	[0.045]***	[0.032]***	[0.110]***
D_posexp_t-1					1.075	
					[0.015]***	
Constant	4.375	10.029	9.99	-0.107	1.361	7.861
	[1.482]***	[0.523]***	[0.440]***	[1.168]	[0.332]***	[2.785]***
Observations	43524	100215	100215	94320	94320	100215
R-squared	0.75					

Standard errors in brackets
*** significant at 10%; ** significant at 5%; *** significant at 1%**
SAMPLE: 90-06, Importer fixed effects: yes, exporter fixed effects: yes, product-year fixed effects: yes

Table 8
Robustness checks

	1	2	3	4	5	6
	ET-tobit	Heckman (outcom)	Heckman (select.)	ET-tobit	Heckman (outcome)	Heckman (select.)
$H\_std_t^1$	1.973	0.66	0.094	1.294	0.711	0.467
	[0.088]***	[0.091]***	[0.052]*	[0.055]***	[0.068]***	[0.038]***
$H\_std_t^2$	1.98	0.727	0.901	1.517	0.573	0.755
	[0.093]***	[0.120]***	[0.078]***	[0.197]***	[0.205]***	[0.142]***
$H\_std_t^3$	1.685	0.726	0.73	2.214	0.938	1.059
	[0.040]***	[0.043]***	[0.030]***	[0.065]***	[0.069]***	[0.048]***
$NH\_std_t^1$	-0.321	-0.139	0.578	0.506	-0.096	0.42
	[0.056]***	[0.123]	[0.074]***	[0.095]***	[0.107]	[0.067]***
$NH\_std_t^2$	-0.487	0.004	-0.271	0.51	0.338	0.178
	[0.071]***	[0.100]	[0.064]***	[0.201]**	[0.208]	[0.147]
$NH\_std_t^3$	0.832	0.354	0.383	0.839	0.303	0.394
	[0.050]***	[0.053]***	[0.036]***	[0.076]***	[0.079]***	[0.054]***
tap1_dif	-0.042	-0.007	-0.044	-0.03	-0.013	-0.028
	[0.005]***	[0.005]	[0.003]***	[0.009]***	[0.010]	[0.007]***
ldistw	-1.011	-0.988	-0.365	-1.367	-1.375	-0.426
	[0.048]***	[0.054]***	[0.034]***	[0.044]***	[0.052]***	[0.035]***
D_EU membership				0.664	0.829	0.072
				[0.070]***	[0.080]***	[0.073]
D_colonial relationship	1.163	0.881	0.474	0.978	0.772	0.417
	[0.046]***	[0.047]***	[0.036]***	[0.052]***	[0.052]***	[0.043]***
D_common language	0.67	0.294	0.341	0.736	0.373	0.374
	[0.044]***	[0.046]***	[0.032]***	[0.049]***	[0.051]***	[0.037]***
D_posexp_t-1			1.037			0.957
			[0.016]***			[0.018]***
Constant	7.005	-1.33	-1.652	8.704	0.453	0.578
	[0.414]***	[1.183]	[0.305]***	[0.611]***	[1.232]	[0.460]
Observations	92565	87120	87120	64845	64845	64845
Comments	**no new EU10**	**no new EU10**	**no new EU10**	**period 96-06**	**period 96-06**	**period 96-06**

Standard errors in brackets
*** significant at 10%; ** significant at 5%; *** significant at 1%**

Table 9
Regressions using lagged standards measure

	-1	-2	-3	-1	-2	-3
	ET-tobit	Heckman (outcome)	Heckman (select.)	ET-tobit	Heckman (outcome)	Heckman (select.)
$H\_std^1_{t-2}$	1.28	0.297	0.669			
	[0.087]***	[0.098]***	[0.057]***			
$H\_std^2_{t-2}$	1.461	0.466	0.702			
	[0.092]***	[0.094]***	[0.061]***			
$H\_std^3_{t-2}$	1.73	0.756	0.767			
	[0.045]***	[0.046]***	[0.032]***			
$NH\_std^1_{t-2}$	0.114	0.14	-0.006			
	[0.050]**	[0.066]**	[0.031]			
$NH\_std^2_{t-2}$	-0.059	0.206	-0.11			
	[0.068]	[0.069]***	[0.044]**			
$NH\_std^3_{t-2}$	0.464	0.123	0.217			
	[0.052]***	[0.052]**	[0.036]***			
$H\_std^1_{t-5}$				0.625	-0.012	0.413
				[0.093]***	[0.104]	[0.066]***
$H\_std^2_{t-5}$				0.671	0.179	0.353
				[0.094]***	[0.097]*	[0.068]***
$H\_std^3_{t-5}$				1.456	0.565	0.706
				[0.055]***	[0.057]***	[0.041]***
$NH\_std^1_{t-5}$				0.002	0.023	-0.05
				[0.054]	[0.068]	[0.035]
$NH\_std^2_{t-5}$				0.358	0.267	0.118
				[0.066]***	[0.069]***	[0.047]**
$NH\_std^3_{t-5}$				0.004	-0.076	0.014
				[0.051]	[0.051]	[0.037]
tap1_dif	-0.049	-0.026	-0.034	-0.024	-0.013	-0.027
	[0.005]***	[0.006]***	[0.003]***	[0.008]***	[0.009]	[0.005]***
ldistw	-1.335	-1.308	-0.405	-1.382	-1.377	-0.43
	[0.040]***	[0.046]***	[0.029]***	[0.043]***	[0.050]***	[0.033]***
D_EU membership	1.001	1.048	0.141	0.719	0.891	0.071
	[0.070]***	[0.079]***	[0.073]*	[0.071]***	[0.080]***	[0.073]
D_colonial relationship	1.091	0.843	0.439	1.006	0.785	0.431
	[0.047]***	[0.046]***	[0.037]***	[0.050]***	[0.050]***	[0.041]***
D_common language	0.71	0.3	0.358	0.726	0.347	0.371
	[0.046]***	[0.046]***	[0.033]***	[0.048]***	[0.049]***	[0.035]***
D_posexp_t-1			1.029			0.975
			[0.016]***			[0.018]***
Constant	9.148	5.022	2.277	12.647	7.42	1.373
	[0.472]***	[0.693]***	[0.343]***	[0.511]***	[0.739]***	[0.388]***
Observations	88425	88425	88425	70740	70740	70740

Standard errors in brackets
*** significant at 10%; ** significant at 5%; *** significant**

Figure 1. Breakdown by sub-sector of EU Standards in Electronics

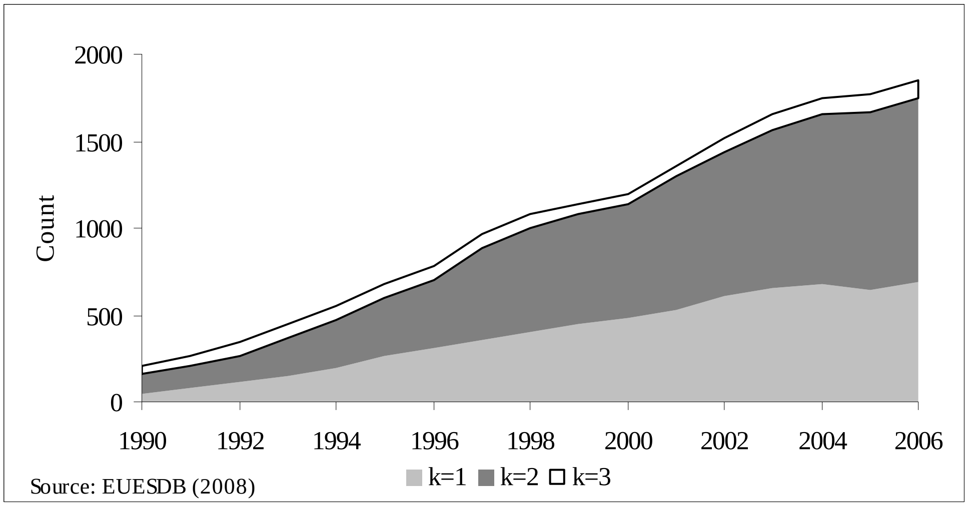

Figure 2. Breakdown by type of EU Standard in Electronics

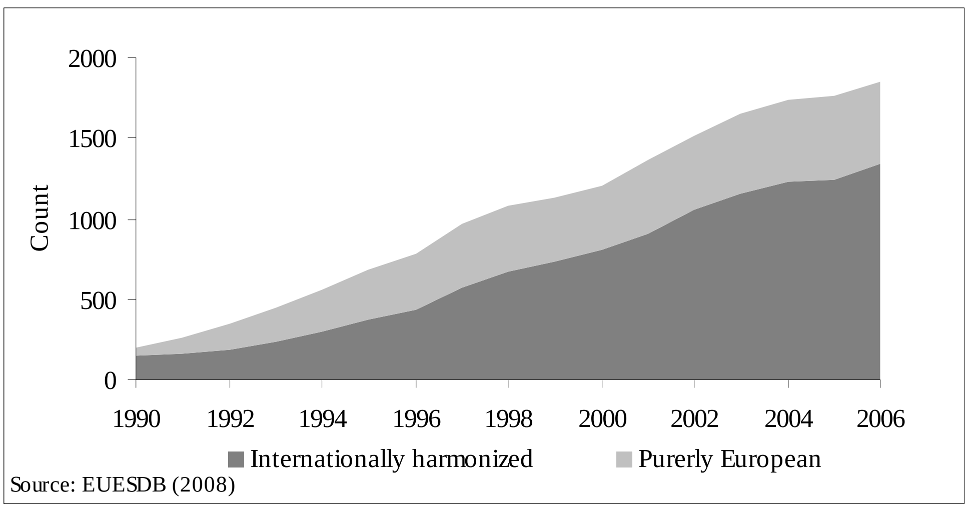

Figure 3. Internationally Harmonized Standards as a Share of Total Standards in each Subsector

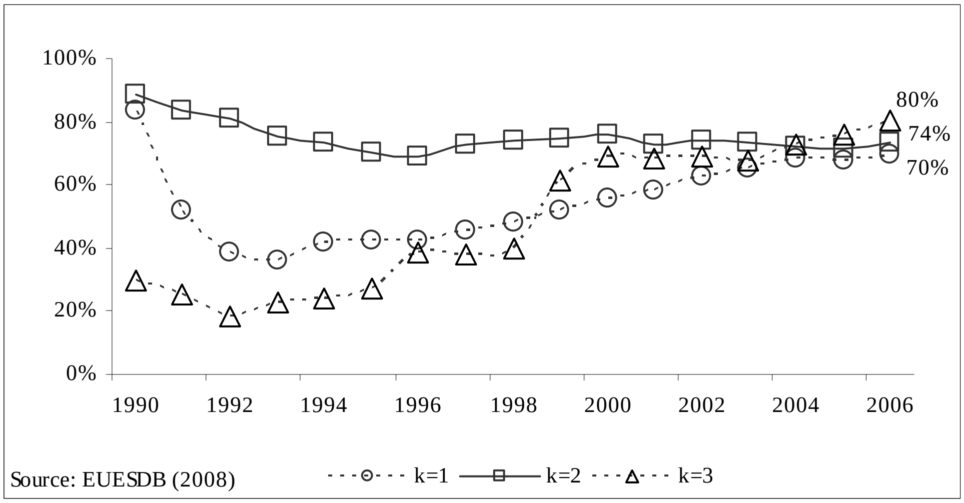

Figure 4. EU-15 Import Composition by type of Electronic

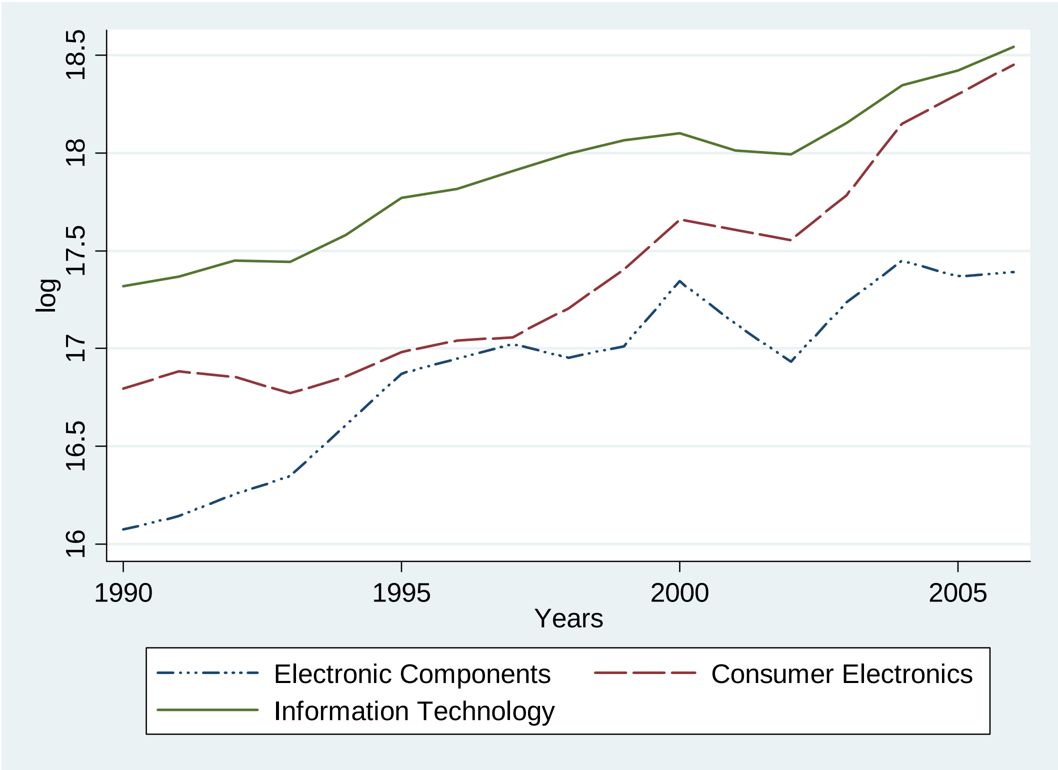

Figure 5. Applied EU tariffs in electronic goods