Product Standards, Harmonization, and Trade: Evidence from the Extensive Margin

Ben Shepherd*

Princeton University

GEM, Sciences Po

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Abstract

I use a new database of EU product standards in the textiles, clothing, and footwear sectors to present the first empirical evidence that international standards harmonization is associated with increased partner country export variety. For an average low income country, the elasticity of export variety with respect to EU standards is -0.8 and the harmonization elasticity is 0.2, while for an average high income country the corresponding figures are 0.4 and approximately zero. Standards and harmonization thus have the potential to exert an important impact on export variety growth in the developing world. These results are robust to the use of alternative samples, and instrumental variables estimation. Simulations show that they are consistent with a heterogeneous firms model of trade in which harmonization is beneficial at the extensive margin provided that any increases in compliance costs are not too large.

JEL codes: F13; F15.

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*Postdoctoral Research Associate, Niehaus Center for Globalization and Governance, Princeton University; and Research Associate, GEM, Sciences Po. Comments to bshepher@princeton.edu; bashepherd@gmail.com. I am grateful to the following for helpful discussions and suggestions: Silja Baller, Chad Bown, Joe Francois, Bernard Hoekman, Patrick Messerlin, John S. Wilson, and participants at the Spring 2008 Midwest International Economics Meetings. This work arose out of a World Bank project on trade facilitation and development supported through a Trust Fund of the U.K. Department for International Development (http://econ.worldbank.org/projects/trade_costs). The findings, interpretations, and conclusions expressed in this paper are entirely those of the author. They do not necessarily represent the view of the World Bank, its Executive Directors, or the countries they represent.

1 Introduction

By increasing the fixed product adaptation costs that firms must pay in order to access foreign markets, "regulatory protectionism" (Baldwin, 2000) has the potential to impact trade at the extensive, or new products, margin: higher fixed costs discourage export market entry, and reduce the range of product varieties exported. This effect could be particularly strong in poor countries, where lack of access to information, technology, managerial capacity and finance can impede the ability of firms to adapt production processes quickly and adequately to meet product standards in rich country markets, or to obtain testing and certification services required to demonstrate conformity.

It has been suggested in the literature (Collier and Venables, 2007) that trade preferences might be one way of promoting export diversification in developing countries, i.e. an expansion in the range of product varieties exported. But such schemes focus almost exclusively on tariffs, and neglect the costs imposed by non-tariff measures (including product standards), not to mention the important role played by supply side constraints (see Hoekman, 2007, for a review). The costs imposed by NTMs are significant, however: Kee et al. (2006) estimate that they add 70% to the level of restrictiveness imposed by tariffs alone. Complementary policies to address these costs would therefore be an important part of any renewed focus on preferences as a possible means of promoting an increase in developing country export variety.

One complementary policy that deserves further attention is international harmonization of product standards. This paper provides empirical support for two important propositions: the negative impact of standards on foreign exporters is stronger for exporting countries with lower levels of per capita income; and those negative impacts can be attenuated somewhat through international harmonization of standards. The main novelty of this paper is its focus on the extensive margin of trade. The intuition behind this positive impact of harmonization on the extensive margin is simple: by providing access to all harmonizing markets upon compliance with a single standard–and payment of a single fixed market entry cost–harmonization not only reduces compliance costs for harmonizing countries, but also eliminates the multiple costs that would otherwise face exporters in non-harmonizing countries. Numerical simulations using a three-country heterogeneous firms model show that the extensive margin impacts of harmonization should be positive for harmonizing and non-harmonizing countries alike, even if the harmonized standard results in a moderate increase in compliance costs.

I find strong support for these predictions using a new World Bank database of EU product standards in the textiles, clothing, and footwear sectors (Czubala et al., 2007). These standards are issued by the European Normalization Committee (CEN). Although compliance is voluntary as a matter of law (as is the case for the standards considered by Swann et al., 1996, and Moenius, 2004), there is potential for these standards to have significant economic impacts: as at the end of 2006, CEN had issued 12,357 standards and approved documents and had another 3,510 in preparation. Results in this paper should therefore be seen as complementing previous work (see below) that focuses on EU-wide harmonization of mandatory standards, through EC Directives.

Standards data are related to export variety of developing countries using measures built up from highly detailed, 8-digit mirror data. Results show that the total count of standards in a given sector is negatively associated with the range of varieties exported by partner countries, with an average elasticity of around -0.7. By contrast, the total count of internationally harmonized EU standards–proxied by the number of standards which are identical or equivalent to ISO standards–is positively associated with partner country export variety. The elasticity of export variety with respect to the number of harmonized standards is nearly 0.3 on average. Both results are robust to broadening and narrowing the sample, and to estimation using instrumental variables. This paper finds convincing evidence of theory-consistent causal links from standards and harmonization to export variety, and those links appear to be economically significant from a developing country standpoint.

These results make two main contributions to the literature. First, they expand the scope of recent empirical work on trade growth at the extensive margin by examining the effects of standards and harmonization. Although the need to adapt products and production processes to meet foreign standards is often used as a motivation for including fixed market entry costs in models of international trade, this appears to be the first paper to make an empirical link between standards harmonization and extensive margin growth. Hummels and Klenow (2005) show that bigger, richer countries tend to export a wider range of products, as do those which face lower international transport costs. The positive extensive margin impacts of tariff liberalization and preferences are examined by Kehoe and Ruhl (2003), and Feenstra and Kee (2007).

This paper also expands the existing literature on the trade impacts of product standards both through a focus on extensive margin growth, and by an explicit examination of the partner country impacts of international harmonization. In an important early contribution on which this paper builds, Moenius (2004) uses a gravity model to show that bilaterally shared standards–and in some cases specific national standards–can promote trade. However, his data do not differentiate between standards which are internationally (not just bilaterally) harmonized and those which are not. Swann et al. (1996) do make such a distinction, finding evidence that UK national standards are associated with higher levels of both exports and imports, but that the corresponding effects are much weaker in the case of internationally harmonized standards. Their results are difficult to interpret, however, since their empirical model does not include factors such as market size (GDP) and trade barriers (tariffs).

Two recent empirical papers have carefully examined the third-country impacts of harmonization, focusing on the intensive margin of trade. Chen and Mattoo (2008) use a sample selection gravity model (cf. Helpman et al., 2008) to examine the impacts of EU Harmonization Directives and Mutual Recognition Agreements on intra- and extra-European trade. Baller (2007) adopts the same approach using data on both EU and ASEAN harmonization and mutual recognition agreements. Empirical results generally suggest that harmonization boosts trade among harmonizing countries, as well as imports from third countries. The present paper builds on and extends these results by focusing on product variety, which is not the object of analysis in either of these two previous papers, and looking at CEN European standards rather than EC Harmonization Directives.

The plan of the paper is as follows. The next section provides some theoretical motivation for the empirical hypotheses to be tested later on, using a heterogeneous firms model of trade. I provide an explicit definition of harmonization within this framework, and use simulations to examine its impacts on export product variety in harmonizing and non-harmonizing countries. Section 3 describes the dataset, a new World Bank database of EU product standards, as well as measures of export variety covering up to 200 countries for the period 1995-2003. The empirical model is presented in section 4, along with estimation results, robustness checks, and details of instrumental variables estimates. Section 5 concludes, and offers some suggestions for further research in this area.

2 Theoretical Motivation

This section develops a simple theoretical framework that is used to make predictions which the remainder of the paper tests empirically. Since the model is essentially a three-country version of Melitz (2003), it is presented in outline only.[1] The key feature of this model is the inclusion of fixed market entry costs that are allowed to vary bilaterally. I motivate the existence of such costs by relating them to the need to modify products and production processes in order to meet foreign standards.[2] The available firm-level evidence suggests that foreign standards can indeed impose substantial fixed costs of compliance: Maskus et al. (2005) report an average of $425,000 per firm, or 4.7% of value added, based on a survey of over 600 firms in 16 developing countries. For firms in the textiles and clothing sectors, the mean investment cost required to comply with technical requirements is 2.7% of firm sales. The range is very wide, however, running from 0.01% to 44.1%. This suggests that the firm-level impacts of standards can vary drastically, thereby making a heterogeneous firms approach particularly attractive.[3]

[1] The presentation here is closest to the version of Melitz (2003) that appears in Helpman et al. (2004) or Baldwin and Harrigan (2007). Baller (2007) and Felbermayr and Jung (2008) also apply heterogeneous firms frameworks to the analysis of product standards.

[2] The model does not directly address the distinction drawn in the policy literature between mandatory and voluntary standards. The fixed costs modeled here can be seen as related to standards that are either a commercial or legal necessity for export sales. Note that I do not consider the role that standards can play on the consumption side (Fischer and Serra, 2000; Ganslandt and Markusen, 2001), nor reductions in information costs for exporters (Moenius, 2004).

[3] There is also an emerging body of case study evidence on this point. World Bank (2005) shows that management capacity and strategic decisions are an important determinant of how developing country firms react to changes in foreign product standards. The logic of the Melitz (2003) model presented here suggests that the cost increases associated with such changes will be felt most acutely by relatively unproductive firms, which may drop out of markets as a result.

After setting out a baseline scenario without harmonization, I modify the model to take account of product standard harmonization covering two of the three countries only. Harmonization lowers the fixed costs of exporting from one harmonizing country to another such that they are at the same level as the costs of domestic market entry. This reflects the fact that under harmonization, domestic producers in both harmonizing countries produce goods satisfying the same standard, and they can therefore export them inside the harmonization zone without paying any further adaptation costs. From the perspective of the third (non-harmonizing) country, harmonization means that it is only necessary to pay one fixed cost (not two) in order to access both foreign markets.

Using numerical simulations, I show that harmonization thus defined raises the export marginal cost cutoff in the two harmonizing countries vis-à-vis each other, and also in the non-harmonizing country. Foreign harmonization therefore makes it easier for producers in the third country to overcome the cost hurdles associated with exporting, which in turn results in increased export variety due to the association of each firm with a distinct product variety. Although the level of compliance costs imposed by the harmonized standard as compared with pre-existing national standards has the potential to limit or even reverse this outcome, simulations show that the third-country impact is positive even when compliance with the harmonized standard is moderately more burdensome.

2.1 Consumption Block

The world consists of three regions: Home (H), Foreign (F), and the Rest of the World (R). Labor is the only factor of production, and the regions are endowed with L units each. Each region has two productive sectors. One produces a freely traded homogeneous good under constant returns to scale with one unit of labor required for one unit of output. Wages are therefore equal to unity in equilibrium. The other sector produces a continuum of differentiated goods under increasing returns to scale and costly trade. Absolute specialization in any sector is excluded.

Identical consumers in all markets maximize the two-tier utility function (1). Their expenditure shares are β for the differentiated sector and $(1-\beta)$ for the homogeneous sector. The elasticity of substitution in the differentiated sector is σ, across the set of varieties V.

$$U = q^{(1-\beta)} \left(\int\limits_{v \in V} x(v)^{1-\frac{1}{\sigma}} dv \right)^{\beta\left(\frac{\sigma}{\sigma-1}\right)} \tag{1}$$

As is well known, a typical demand function x is:

$$x[p(v)] = \frac{\beta E [p(v)]^{-\sigma}}{\int\limits_{v \in V^i} p(v)^{1-\sigma} dv} \equiv d^i [p(v)]^{-\sigma} \tag{2}$$

where V^i is the set of varieties available in country $i \in \{H, F, R\}$, $E = L$ is total expenditure by that country's consumers, and the summary parameter d^i is a demand shifter.

2.2 Production Block

As usual in Dixit-Stiglitz models, producers in the differentiated goods sector engage in constant markup pricing such that $p(v) = \frac{\sigma}{\sigma-1} c$. Firms in each country face a fixed startup cost f_d^i that must be paid in order to enter the domestic market. This cost reflects the investment required to establish a production process that manufactures goods which accord with local product standards. A typical firm's domestic market profit function is therefore:

$$\pi_d^i = \underbrace{d^i \left(\frac{\sigma}{\sigma-1} c \right)^{1-\sigma}}_{\text{revenue}} - \underbrace{d^i \left(\frac{\sigma}{\sigma-1} c \right)^{-\sigma} c}_{\text{variable costs}} - \underbrace{f_d^i}_{\text{fixed costs}} \equiv \frac{d^i}{\sigma} \left(\frac{\sigma}{\sigma-1} c \right)^{1-\sigma} - f_d^i \tag{3}$$

Setting this expression equal to zero and solving for c establishes three maximum marginal costs c_d^i above which it is not possible to profitably supply the domestic market in each country.

$$c_d^i = \left(\frac{\sigma f_d^i}{d^i} \right)^{\frac{1}{1-\sigma}} \left(\frac{\sigma - 1}{\sigma} \right), \ (i \in \{H, F, R\}) \tag{4}$$

Firms wishing to export face an additional layer of costs over and above the cost of domestic market entry: they must pay a fixed cost to adapt their production process so as to produce goods that comply with foreign product standards.[4] Product standards are unique to each country, so fixed product adaptation costs must be paid cumulatively (i.e. one fixed cost per market entered). I use f_x^{ij} to indicate the fixed market entry costs that must be paid when exporting from i to j, and assume that compliance with foreign standards is in all cases more costly than compliance with domestic ones (i.e., $f_x^{ij} > f_d^i, f_d^j$). Thus, the additional profits from exporting are:

$$\pi_x^{ij} = \underbrace{d^j \left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}}_{\text{revenue}} - \underbrace{d^j \left(\frac{\sigma}{\sigma-1}c\right)^{-\sigma} c}_{\text{variable costs}} - \underbrace{f_x^{ij}}_{\text{fixed costs}} \equiv \frac{d^j}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma} - f_x^{ij} \tag{5}$$

and the maximum marginal cost c_x^{ij} above which it is not possible to profitably export is:

$$c_x^{ij} = \left(\frac{\sigma f_x^{ij}}{d^j}\right)^{\frac{1}{1-\sigma}} \left(\frac{\sigma-1}{\sigma}\right), \ (i \in \{H,F,R\}, i \neq j) \tag{6}$$

I introduce marginal cost heterogeneity by assuming that c follows an identical Pareto distribution with support $[0,\bar{c}]$ in all three countries. This setup implies a cumulative distribution function $G(c) = \left(\frac{c}{\bar{c}}\right)^k$ and probability density function $g(c) \equiv \frac{dG(c)}{dc} = \frac{kc^{k-1}}{\bar{c}^k}$, where $k > \sigma - 1$ is a "shape" parameter that indexes firm heterogeneity.[5]

A free entry condition closes the production block of the model. The expected profits from domestic and export market sales are equated with the fixed cost of entering the marginal cost "lottery" f_e

[4] To sharpen the focus on the role of fixed adaptation or retooling costs, variable (iceberg) trade costs are set equal to unity. This assumption could be relaxed, for instance to study the impact of per unit conformity assessment and certification costs. However, the basic insights of the model would not change.

[5] Assuming $k > \sigma - 1$ ensures convergence of the integrals in the free entry conditions below.

(identical in all countries):

$$\underbrace{\int_0^{c_d^i}\left(\frac{d^i}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}-f_d^i\right)dG(c)}_{\text{Expected profits from domestic sales}}+\underbrace{\int_0^{c_x^{ij}}\left(\frac{d^j}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}-f_x^{ij}\right)dG(c)}_{\text{Expected profits from export sales to } j}+$$
$$\underbrace{\int_0^{c_x^{ik}}\left(\frac{d^k}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}-f_x^{ik}\right)dG(c)}_{\text{Expected profits from export sales to } k}=f_e,\ \ (i\in\{H,F,R\};i\neq j\neq k) \quad (7)$$

The above framework gives three free entry conditions (7), three cutoff expressions for domestic market entry (4), and six additional cutoff expressions for export market entry (6). The model has the same number of unknowns, namely three demand shifters d^i, three domestic market cost cutoffs c_d^i, and six export cost cutoffs c_x^{ij}. Equilibrium will see firms in each country self-selecting into four groups based on their marginal cost draws: high cost firms will exit immediately without producing for any of the three markets, those with slightly lower costs will produce for the domestic market only, and those with relatively low costs will in addition export to one or both other markets. The higher the export marginal cost cutoff for each bilateral trading relationship, the greater the proportion of active domestic firms that will be able to enter that export market. So for a given mass of firms, a higher threshold is associated with greater export variety since each firm produces a distinct variety of the differentiated good.

2.3 Modeling Product Standard Harmonization

International harmonization of F's product standards–i.e., bringing them into line with those prevailing in the rest of the world (R)–means that all firms now have access to two markets upon payment of a single fixed cost.[6] With the same standard in place in both markets, goods manufactured in F or R can be sold freely in the other country without any need for further adaptation. The fixed costs of exporting are eliminated between these two markets, leaving only the fixed costs

[6]The model treats harmonization as a discrete, exogenous policy shock. For an examination of harmonization in a political economy setting, see Gandal and Shy (2001).

of domestic market entry (identical in the two countries). The profit function for sales within the harmonization zone is therefore

$$\pi^i = \underbrace{\frac{d^i}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}}_{\text{net domestic sales}} + \underbrace{\frac{d^j}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}}_{\text{net foreign (within zone) sales}} - \underbrace{f_d^i}_{\text{fixed costs}}, \; (i,j \in \{F,R\}, i \neq j) \tag{8}$$

which gives a combined domestic and export market cutoff for each harmonizing country:

$$c_d^i = \left[\frac{f_d^i}{\frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}[d^i + d^j]}\right]^{\frac{1}{1-\sigma}}, \; (i,j \in \{F,R\}, i \neq j) \tag{9}$$

The export conditions from F and R to H remain unchanged from the pre-harmonization model, but those in the opposite direction require modification. After harmonization, producers in H still face a fixed cost of exporting to F or R due to the need to adapt their product to the harmonized standard (originally R's standard). However, there is now only one additional standard they need meet in order to sell in both F and R, as opposed to the two separate standards that initially prevailed. H's two export market profit expressions therefore collapse into a single one:

$$\pi_x^H = \underbrace{\frac{d^F}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}}_{\text{net sales in } F} + \underbrace{\frac{d^R}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}}_{\text{net sales in } R} - \underbrace{f_x^H}_{\text{fixed costs}} \tag{10}$$

which leads to a new cutoff for H covering exports to both F and R:

$$c_x^H = \left[\frac{f_x^H}{\frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}[d^F + d^R]}\right]^{\frac{1}{1-\sigma}} \tag{11}$$

These changes to the profit conditions require corresponding changes to the free entry conditions for all countries. For H, the condition is now

$$\underbrace{\int_0^{c_d^H}\left(\frac{d^H}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}-f_d^H\right)dG(c)+}_{\text{Expected profits from domestic sales}}$$
$$\underbrace{\int_0^{c_x^H}\left(\frac{d^F}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}+\frac{d^R}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}-f_x^H\right)dG(c)}_{\text{Expected profits from export sales in } F \text{ and } R}=f_e \quad (12)$$

while for F and R the condition takes the following form:

$$\underbrace{\int_0^{c_d^i}\left(\frac{d^i}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}+\frac{d^j}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}-f_d^i\right)dG(c)+}_{\text{Expected profits from sales within the harmonization zone}}$$
$$\underbrace{\int_0^{c_x^{iH}}\left(\frac{d^H}{\sigma}\left(\frac{\sigma}{\sigma-1}c\right)^{1-\sigma}-f_x^{iH}\right)dG(c)}_{\text{Expected profits from export sales to } H}=f_e,\ \ (i,j\in\{F,R\};i\neq j) \quad (13)$$

The system to be solved now has nine equations: the three modified free entry conditions (12) and (13) together with the unchanged domestic cutoff for H (4), the two unchanged export cutoffs for F and R to H (6), and the three modified cutoffs (9) and (11). The number of unknowns is also equal to nine: three demand shifters d^i, three domestic market cutoffs f_d^i, and three export market cutoffs c_x^H, c_x^{FH}, and c_x^{RH}.

2.4 Simulation Results

To gauge the impact of product standard harmonization in F and R on the extensive margin of trade, I compare numerical simulations of the pre- and post-harmonization models over a range of reasonable parameter values. This requires making some assumptions as to the relative and absolute values of the various fixed cost parameters.[7] To fix ideas, I focus on the case of "harmonizing up":

[7] See Baldwin (2000) for examples of the many ways in which these parameters can be varied to capture aspects of different types of harmonization.

i.e., the initial standard in R is more costly to comply with than the initial standards in H and F, so bringing F's standards into line with R's entails an increase in restrictiveness. Intuitively, harmonizing up should be less favorable to product variety growth in third countries than "harmonizing down" to a less costly standard in R. These results can therefore be interpreted as putting a lower bound on harmonization's impact.

Prior to harmonization, $f_x^{iH} = f_x^{iF} = 0.15$ (export costs into H and F) and $f_d^H = f_d^F = 0.1$ (costs of domestic market entry in H and F). To consider different levels of compliance costs in R, f_x^{iR} (export costs into R) varies over the range 0.15 to 0.2, while f_d^R varies over the range 0.1 to 0.15. It is important to allow both of these parameters to vary, in order to reflect the fact that more costly standards in R impact foreign and domestic producers alike. Post harmonization, f_x^{iH} remains unchanged but f_x^H (the new export threshold for firms in H) varies over the range 0.15 to 0.2, while $f_d^R = f_d^F$ varies over the range 0.1 to 0.15. For the values of invariant parameters, I follow Bernard et al. (2007).[8]

Figure 1 shows simulated equilibrium export cutoffs for all three countries. Simulation results are expressed as percentage changes following harmonization. The first simulation point represents the limiting case in which F and R impose different but equally costly standards prior to harmonization. Moving from left to right across the figure shows changes in the impact of harmonization as the additional cost burden associated with R's initial standard becomes larger.

At all points in the parameter space used here, harmonization raises the export cutoffs in all countries. This is the case even though the harmonized standard is moderately more costly to comply with than the unharmonized one in F (the difference is around 33% at the upper boundary). The intuition behind this is that reduction in the multiplicity of fixed market entry costs dominates a moderate increase in compliance costs. However, a very burdensome standard in R could entail a rise in compliance costs for F that would dominate the reduction in multiplicity and produce a negative impact on H.

The largest harmonization effects are felt in the two harmonizing countries F (dotted and dashed

[8]Like those authors, I assume: $\sigma = 3.8$, $k = 3.4$, $L = 1000$, $\beta = 0.5$, $\bar{c} = 0.2$, and $f^e = 2$.

line) and R (crossed line). The percentage jump in F's effective export threshold to R declines only slowly with increasing compliance costs under harmonization, but for R this effect is much more rapid. This difference reflects the fact that from R's point of view, harmonization leads to the imposition of a more burdensome standard in F; however, from F's point of view, the standard prevailing in R does not change.

Although the impact of harmonization on H's export cutoff is positive vis-à-vis both foreign markets, the effect varies substantially by destination. The effective rise in the export threshold to R remains approximately constant over the full range of compliance costs considered here. This again reflects the fact that R's standard does not change due to harmonization. On the other hand, F's standard does change, and this results in an export cutoff increase that declines sharply in the costs of compliance under harmonization: with equally burdensome standards in F and R, harmonization lifts H's export threshold by just under 13%, but when R's compliance costs are 33% higher than F's, the rise is limited to 4.6%.

3 Data and Stylized Facts

The remainder of the paper tests two hypotheses that flow from the above model. The first is that more burdensome standards in an importing country should be associated with reduced partner country export variety. The second is that international harmonization should be associated with an increase in partner country export variety. This section presents two new data sources that play an important role in the empirical work: the World Bank's EU Standards Database, and measures of export variety covering up to 200 countries based on highly-detailed, 8-digit mirror (import) data from Eurostat.

3.1 The EU Standards Database

Measuring the extent of standardization in EU product markets is not an easy business.[9] Each member state sets both voluntary and mandatory standards on a national level, while centralized EU bodies also have the power to set standards with transnational application. Swann et al. (1996) and Moenius (2004) examine the trade impacts of voluntary national standards, while Chen and Mattoo (2008) and Baller (2007) focus on transnational mandatory standards (EC Directives). Only Czubala et al. (2007) look at the role played by transnational voluntary standards, such as those issued by the European Committee for Standardization (CEN).

CEN is a transnational association established in 1961 by national standards bodies from across Europe. Its standards must be adopted by all EU countries, and override any conflicting or inconsistent national standards. In addition to its work complementing EU Harmonization Directives, CEN is also active in independently developing standards in consultation with industry and national bodies. As noted above, CEN's output to date is substantial: 12,357 standards and approved documents, with 3,510 more in preparation. By contrast, the European Commission has issued less than two dozen Harmonization Directives under its "New Approach". (See Pelkmans, 1987, for a review of the New Approach.)

The World Bank's EU Standards Database (EUSDB) provides the first catalogue of CEN European standards in the agriculture, textiles, clothing, and footwear sectors, with mapping to a standard trade classification (HS 2000). This paper focuses exclusively on the three manufactured goods sectors.[10] From a development point of view, these sectors are particularly important since they are associated with the early stages of industrialization in many countries.

For a full overview of EUSDB's methodology, see Czubala et al. (2007). The general approach is similar to that of Swann et al. (1996) and Moenius (2000, 2004), although those authors both

[9] For a general review of these mechanisms, see EC (2000).

[10] I exclude agriculture because the measure of international harmonization recorded by EUSDB (equivalence with an ISO standard) is arguably less relevant to that sector. Standards promulgated by organizations such as the Codex Alimentarius are likely to be of greater importance.

consider national standards in EU member states rather than CEN's EU-wide standards.[11] The primary information source for EUSDB is Perinorm (www.perinorm.com), a bibliographic database maintained jointly by the British, French, and German national standards bodies. It contains over 1.1 million records from 22 (mostly OECD) countries. Each record corresponds to a single national, regional, or international standard. For each standard, EUSDB contains data including the dates of entry into force and withdrawal, and a 1-0 dummy variable indicating whether or not it is identical or equivalent to an ISO standard. This variable is used as a proxy for de facto international harmonization. All information is cross-checked against CEN's own on-line standards catalogue, before being manually mapped to the Harmonized System product classification (http://www.cen.eu/catweb/cwsen.htm).

For each 2- and 4-digit HS code, EUSDB provides a count of the number of CEN standards in force in a given year over the sample period (1995-2003).[12] It also counts the number of those standards that are treated as internationally harmonized using the above definition. Simple counts are used as proxies for the standards burden because Perinorm does not provide information on which to base an assessment of the relative restrictiveness of individual standards. Constructing such measures would require highly specialized technical and commercial information that is not currently available, and in any event would pose substantial problems of comparability across countries and sectors. Counts are therefore used as the best available proxy at the current time.

Table 1 presents basic descriptive statistics, which disclose a number of notable features (see Czubala et al., 2007, for a complete discussion). All three sectors have undergone rapid growth in terms of the total number of standards in force. However, the bulk of standards remain concentrated in the textiles sector (84%). Although the proportion of internationally harmonized standards has generally risen, the pattern across sectors is by no means uniform. In the context of instrumen-

[11] An alternative approach is taken in recent papers by Fontagné et al. (2005) and Disdier et al. (2008). They use WTO notifications under the SPS and TBT Agreements to build databases of mandatory national standards. This is a promising approach, but one which currently suffers from the inconsistent reporting behavior of WTO Members.

[12] Counts include standards that entered into force prior to 1995 provided they were still in force at some point during the sample period. A standard is considered to be in force for a given year if it came into force before or during that year. If it is withdrawn at some point during the year, it is still assumed to be in force for the entire year. Amendments to existing standards are counted as additional standards.

tal variables estimates below, some of the possible reasons for this non-uniformity will become apparent.

3.2 Measuring Export Variety

To examine the impact of standards and international harmonization on the extensive margin of trade, I construct new measures of export variety covering up to 200 countries. I follow the recent empirical literature on product variety in trade (e.g., Hummels and Klenow, 2005; and Broda and Weinstein, 2006), in building on the theory-consistent measure of variety developed by Feenstra (1994). I use the version of his measure set out by Feenstra and Kee (2008):

$$\Lambda_{xst} = \frac{\sum\limits_{l \in V_{s,t}^{x}} \overline{p_l^w q_l^w}}{\sum\limits_{l \in V_s^w} \overline{p_l^w q_l^w}} \tag{14}$$

The denominator is the total value of world exports in a particular sector, summing across all product varieties within that sector. Thus, V_s^w is the full set of varieties exported in sector s, taking account of all exporting countries and all time periods. Average world trade values by product variety across all years ($\overline{p_l^w q_l^w}$) are used to create the sum. While the denominator is invariant by exporter and time, the numerator is not. It consists of the sum of world average trade values in product varieties shipped by exporter x at time t. The use of world average trade values ensures that variation in the numerator–and in Λ_{xst} itself–is due only to changes in x's variety set. This measure therefore has the important advantage of allowing consistent comparisons of product variety to be made across years and countries.

To implement this approach empirically, I use 8-digit import data from the European Union for the years 1995-2003.[13] In line with availability of standards data, I calculate Λ for three sectors: textiles (HS chapters 50-60), clothing (chapters 61-63), and footwear (chapter 64). Prior to calculation, I exclude from the dataset all observations relating to internal trade amongst EU-15 members, as

[13] These data are freely available through the Eurostat website (http://fd.comext.eurostat.cec.eu.int/xtweb/).

well as product codes without verbal description which correspond to residual categories covering confidential or otherwise unclassified flows. For the world average trade value $\overline{p_l^w q_l^w}$, I take the average over the sample period of import values for the EU-15 (treated as a single entity).

Table 2 provides some basic descriptive statistics for this variety measure, broken down by sector and year. The median variety measure in the clothing and footwear sectors ($\Lambda_{med} = 0.2$ to 0.3) is noticeably higher than in textiles ($\Lambda_{med} \leq 0.1$). However, the range in each case is very wide, running from just a little above zero to 0.8 or 0.9. The fact that the median is so low within this range suggests that most countries export a relatively modest range of varieties in these three sectors, but that a few countries export a very wide range.

In terms of the rank ordering of countries by variety, results are broadly sensible: China, Turkey, India, and a number of countries in Central and Eastern Europe appear at the top of the list for clothing and footwear, while highly industrialized countries like Switzerland and the United States arrive in the lead for the more capital intensive textiles sector. The presence of the United States and Switzerland amongst the leading countries in clothing and footwear suggests that the trade data from Eurostat may be picking up some amount of re-exports or processing trade. This is not problematic for the paper's results, however, since they are robust to the inclusion or exclusion of developed countries in the estimation sample (see below).

3.3 Standards and Extensive Margin Growth

Before moving to a formal empirical model in the next section, it is useful to first investigate the data graphically (see also the correlation matrix in Table 4). Figure 2 uses non-parametric Lowess regressions to provide some preliminary evidence as to the relationships between standardization, harmonization, and partner country export variety.[14] As expected, the total number of standards (a proxy for total compliance costs) in the EU is associated with a decline in partner country export

[14]To obtain the graphs, I average export variety across all partner countries for each sector-year. I then express the data in sector mean deviations, and run a multivariate version of the Lowess smoother (Royston and Cox, 2005). The dependent variable is export variety, and the independent variables are the total number of EU standards and the number of EU standards that are ISO-harmonized.

variety, while the reverse is true for internationally harmonized EU standards. The remainder of the paper investigates these associations more rigorously, including from the point of view of causation.

4 Empirical Model and Estimation Results

The theoretical model suggests that international harmonization of EU standards in the textiles, clothing, and footwear sectors should be positively associated with partner country export variety, provided that any additional compliance costs imposed by harmonized standards are not too high.[15] To test this hypothesis empirically, I use EUSDB to calculate the number of internationally harmonized standards (iso_{st}) and the total number of EU standards ($stds_{st}$) for each sector-year. I use the former as a proxy for the degree of international harmonization, and the latter as a proxy for the overall compliance burden associated with EU standards. (See Table 3 for data sources, and descriptive statistics.)

An important assumption of the theoretical model that will be relaxed in the empirical part of the paper is that the costs of compliance with a given standard do not vary across countries. As an empirical matter, there is emerging evidence that this is not the case. Firm level data (e.g., Maskus et al., 2005) suggest that compliance costs can in fact differ substantially across countries. In developing countries, a lack of availability of appropriate production technologies, testing laboratories, and certification agencies could increase the cost of compliance with standards, and conversely increase the benefits of harmonization. By interacting $stds_{st}$ and iso_{st} with the exporting country's per capita income level ($gdppc_{xt}$ in constant 2000 dollars from the World Development Indicators) it will be possible to gauge the extent to which the impacts of standards and harmonization differ according to development level.

Identification of a causal effect running from standards and harmonization to export variety poses two main challenges. First, I need to control for the impact of other possibly relevant factors. EU

[15] Due to lack of data, I do not consider intersectoral linkages or the possibility of cumulation of standards as goods pass from one processing stage to another.

trade policy is one such factor, and I control for it using WITS-TRAINS data on applied bilateral tariffs (τ_{xst}). Market size is also important, and to this end I include the total value of EU imports in each sector (imp_{st}) as a proxy for sectoral expenditures. Two dummies ($atc2$ and $atc3$) are equal to unity for years 1998 onwards and 2002 onwards, in order to capture the effects of quota liberalization under phases 2 and 3 of ATC implementation.[16]

The panel structure of the data–146 developing countries, three sectors, and nine years–makes it possible to rely to a large extent on fixed effects to control for additional factors.[17] Exporter-sector fixed effects take care of factors that are largely invariant over the time horizon considered here. Examples include comparative advantage in each of the three sectors, and long term connections with EU importers through contractual arrangements or FDI. Exporter-year fixed effects control for changes in the level of industrial or institutional development, country-specific macroeconomic or policy shocks, as well as technological change affecting all three sectors but specific to each exporting country (such changes being highly likely due to the interlinkages that exist among the sectors).

$$\ln(\Lambda_{xst}) = \beta_1 \ln(stds_{st}) + \beta_2 \ln(iso_{st}) + \beta_3 \ln(stds_{st}) * \ln(gdppc_{xt}) + \beta_4 \ln(iso_{st}) * \ln(gdppc_{xt}) + \ldots$$
$$\ldots + \beta_5 \ln(1+\tau_{xst}) + \beta_6 \ln\left(imp_{st}^{EU}\right) + \beta_7 atc2_{st} + \beta_8 atc3_{st} + \delta_{xs} + \delta_{xt} + \varepsilon_{xst} \quad (15)$$

Baseline OLS results for the estimating model in (15) are given in Table 5, with and without the per capita income interaction terms. Columns 1 and 3 show that in both cases, results are in line with expectations. The total standards count has a negative and statistically significant coefficient, while the count of ISO standards has a positive and, once the income interaction is included, statistically significant coefficient. The magnitude of those coefficients, in particular in the specification with per capita GDP interaction terms, suggests that the effects being captured are of real eco-

[16] I assume that ATC quotas apply only to the textiles and clothing sectors as defined here, and not to footwear. This is basically consistent with the product list in the Annex to the ATC, which has extensive coverage in HS chapters 50-63, but lists only three 6-digit product lines in Chapter 64.

[17] I define the developing country group as including all countries not in the World Bank's high income group. This definition is relaxed below in the context of robustness checks.

nomic significance: a 1% increase in the overall number of standards is associated with a nearly 0.6% decrease in partner country export variety, while a 1% increase in the number of harmonized standards is associated with a 0.1% increase in variety (column 1).

The interaction terms between standards and per capita GDP also display the expected signs. A higher level of national income is consistent with a weaker negative impact of standards, and this effect is statistically significant at the 10% level. The positive impact of harmonization appears to be marginally weaker as income increases, but the effect is not statistically significant. The coefficients on $stds_{st}$ and iso_{st} are noticeably stronger once the interaction with per capita income is taken into account.

In terms of the model's overall performance, it does a reasonable job of explaining the observed variation in partner country export variety with an overall R^2 of 0.07. Although the main variables of interest have precisely estimated coefficients, as does the total value of EU sectoral imports as a proxy for sectoral expenditures, the same is not true of tariffs: they have an unexpected positive sign, but are statistically insignificant. The most likely reason for this result is that many developing countries benefit from tariff preferences that, at least for the early years of the sample, may not be fully captured in the data available from WITS-TRAINS. The prevalence of non-tariff measures in the textiles, clothing, and footwear sectors is also likely to be an important factor, which the model controls for by including dummies to take account of WTO-induced liberalization of the quota system. Rules of origin are also an important determinant of trade patterns in these sectors (e.g., Cadot and de Melo, 2007). But since only one importing market (the EU) is concerned, there is no sample variation that can be exploited in order to gauge precisely the effect of rules of origin on export variety in partner countries.

4.1 Instrumental Variables Results

It is important to be sure that these results are not biased due to the possible endogeneity of product standards (and tariffs) with respect to export variety.[18] It is commonplace to view endogenous tariffs as the outcome of a lobbying process in which a government balances support from lobbies seeking protection against the national welfare costs of imposing that protection (e.g., Grossman and Helpman, 1994). Since harmonization can, like tariff liberalization, lower the cost barriers facing foreign firms, local incumbents have an interest in lobbying against it. For the moment, the political economy of this process remains to be examined in detail in the literature.[19] I draw on the general framework that has emerged from the endogenous tariffs literature to identify some likely determinants of endogenous standards, which I then use as instruments in combination with one-period lags of the suspected endogenous variables.

In the EU context, the type of firm-to-government lobbying envisaged by Grossman and Helpman (1994) is accompanied by an additional layer of government-to-government lobbying within centralized EU bodies.[20] This is due to the fact that trade policy and the EU standards under consideration here are not decided unilaterally by national governments, but by European bodies (the Commission and CEN). To capture the lobbying potential of industries on an EU-wide basis, I use total sector value added and employment. The first of these measures proxies a sector's political "muscle", i.e. the potential lobbying resources at its disposal. The second measure proxies a different dimension of sectoral politics, namely the direct voting power of an industry's workers. In addition, I capture the lobbying potential of national governments using Herfindahl indices of value added and employment across EU member states. These measures proxy the extent to which each sector is geographically concentrated in particular countries, and thus the extent to which governments have a perceived economic or political interest in protecting "their" industry.[21]

[18] Moenius (2004) addresses endogeneity by using five year lags of his standards variables as instruments for their current levels. Chen and Mattoo (2008) use harmonization of closely related sectors as an instrument for harmonization of a given sector. In both cases, instrumental variables estimation does not substantially change the results.

[19] Essaji (2005) is the only empirical study dealing with the political economy of standards in a trade setting.

[20] Balaoing and Francois (2006) report that after controlling for the size of an industry, its "nationality" remains an important determinant of the level of protection it receives through the EU common external tariff.

[21] These data come from Eurostat annual enterprise statistics on industry and construction, freely downloadable from

Treating all independent variables in (15) except standards and tariffs as exogenous, I re-estimate the equation using two-step GMM.[22] Results are in columns the columns 2 and 4 of Table 5. Point estimates are quite close to those obtained using OLS. The coefficient on the total number of standards is larger in absolute value, and 1% significant. Its income interaction is also slightly stronger, and is 5% significant. The ISO standards coefficient is 10% significant if the income interaction is excluded, but loses significance if it is included. The coefficient on EU sectoral imports remains positive but slightly smaller than under OLS, and it is only marginally significant (prob. = 0.109) in the column 4 specification, which includes the per capita income interaction terms. Based on the GMM results without interaction terms (column 2), a 1% increase the number of standards is associated with a nearly 0.7% decrease in partner country export variety, while a similar increase in the number of harmonized standards is associated with a nearly 0.3% increase in variety. Both effects are statistically significant, and moreover are of real economic significance in light of the rapid growth in the number of EU standards during the sample period (see Table 1).

How valid is the instrumental variables specification? Endogeneity does not seem to be a major problem in these data, based on a Hausman test (column 4, prob. = 0.169). Nonetheless, the standard IV diagnostics suggest that the choice of instruments is appropriate. A Hansen over-identification test does not reject the null (prob. = 0.117), thereby supporting the exogeneity of the set of instruments used. In terms of relevance, the maximal bias suggested by the Stock-Yogo test is of the order of 5% (critical value = 13.856) based on the model without interaction terms. The test statistic for the model with interaction terms is of similar magnitude, but no critical values exist against which it can be compared.

First stage estimates in Table 6 show that the instruments are indeed strongly correlated with the potentially endogenous variables. F-tests of the excluded instruments uniformly reject the null hypothesis at the 1% level, and in all but one case are substantially larger than 10. The tariff regres-

http://epp.eurostat.ec.europa.eu. Series codes are V12150 (value added at factor cost) and V16110 (number of persons employed). I construct the Herfindahl indices as the sum of the squared country shares for each indicator. For the textiles, clothing, and footwear sectors, I use NACE industry codes DB17, DB18, and DC193 respectively.

[22] Two-stage least squares results (available on request) are very similar, but GMM is preferred in this case due to improved efficiency.

sion performs less well than the others, and none of the instruments are individually significant. They are jointly significant, however, and the diagnostic tests reported above–such as Stock-Yogo–suggest that taken together, the instruments do a satisfactory job of accounting for variation in the potentially endogenous variables.

The signs and magnitudes of the political economy instruments are partially consistent with the lobbying story set out above. The total number of standards has a strong positive association with industry size (number of employees) and geographical concentration. The opposite is true for the number of internationally harmonized standards. Results for the value added instruments, and in the tariffs regression, do not fit the pattern so easily, however. Higher value added is associated with lower standards counts, both harmonized and non-harmonized. One reason for this might be that more productive industries–higher value added for a given use of labor–have less incentive to lobby for the imposition of standards based on protectionist motivations, hence the negative signs in Table 6. In the tariffs regression, there is some limited support for a link between geographical concentration of employment and higher tariffs, but it is not statistically significant. Otherwise, the estimated coefficients are much smaller in magnitude than in the other first stage regressions, and carry unexpected signs.

The overall conclusion to be drawn from these IV estimates is that endogeneity with respect to partner country export variety does not appear to be a serious problem in these data, but even once it is corrected for the basic conclusions of the paper do not change.

Before moving to robustness checks in the following section, it is useful to put the above results in their economic context. Using the interaction terms in Table 5 column 4, it is possible to derive elasticity estimates for standards and harmonization based on average per capita income levels in the three main World Bank groups. The contrast is striking. For the average high income country, the standards elasticity is in fact positive (0.414) in line with some the results found by Moenius (2004), and the harmonization elasticity is very close to zero (-0.058). The corresponding elasticities for an average middle income country are -0.383 and 0.123 respectively, while for the average low income country they are -0.825 and 0.224. Standards and harmonization thus have the potential to exert an important impact on export variety growth in the poorer countries, even if their impacts in richer and more developed economies seem much more muted.

4.2 Robustness Checks: Country Sample, Quotas, and Regional or Preferential Agreements

Thus far, the estimation sample has covered all developing country exporters for which data are available. In this section, I adjust the sample to take account of factors external to the model that might be influencing results. Columns 1-2 of Table 7 present results using the full developing and developed country sample, i.e. all exporters except the EU-15. Point estimates are very similar to the baseline OLS and GMM estimates in Table 5, but the inclusion of a wider range of countries produces considerably more precise estimates: all four standards variables and interaction terms are significant at the 5% level or better in the full sample specification. Inclusion of a wider range of countries therefore tends to strengthen this paper's conclusions.

The remaining columns of Table 7 estimate the model using progressively smaller samples. Columns 3-4 exclude developed countries and, in addition, those developing countries subject to ATC quotas. Results in terms of magnitude, sign, and significance are very close to the baseline in columns 1-2 of Table 5, suggesting that the conclusions are robust to any complications that might arise from the progressive liberalization of quotas in the textiles and clothing sectors during the sample period.

Columns 5-6 exclude, in addition, all countries having a regional trade agreement with the EU, since these countries might benefit from preferential treatment in relation to standards as part of their agreements.[23] Results in this case are close in magnitude to the baseline, but all coefficients except the total standards count lose statistical significance; in the GMM specification, EU imports and tariffs are significant at the 15% level, but the latter has an unexpected sign. One likely reason

[23] Data on regional agreements come from http://www.worldtradelaw.net/fta/ftadatabase/ftas.asp, supplemented by information from http://trade.ec.europa.eu/doclib/docs/2006/december/tradoc_111588.pdf.

for the unexpected sign on tariffs is again the imperfect recording of preferential rates in WITS-TRAINS. More generally, the considerably smaller country sample also makes it difficult to obtain precise coefficient estimates. Similar problems arise when the African, Caribbean and Pacific group of countries (ACP) is excluded in addition: all coefficients lose statistical significance, and the total standards count now carries an unexpected positive sign.[24] The per capita interaction terms both have appropriate signs. Due to the lack of precision in these estimates, however, the most that can be said is that even an extreme reduction in the breadth of the country sample leads to results that are broadly consistent with the paper's main findings, even though it would be unwise to draw any strong statistical conclusions based on the narrow sample estimates.

5 Conclusions, Policy Implications, and Future Research

This paper has provided the first direct empirical evidence that while product standards overall impact negatively on partner country export variety, international harmonization can act as an important mitigating factor. Based on GMM estimates using lagged policy variables and political economy data as instruments, I conclude that (on average) a 1% increase in the total number of standards leads to a 0.7% decrease in partner country export variety, but that a 1% increase in the number of internationally harmonized standards leads to a 0.3% increase in export variety. I also find convincing evidence that both effects are larger in absolute value terms for low income countries than for high income countries, thus highlighting the importance of the standardization and international harmonization from a development point of view. These effects emerge even more strongly when the sample is expanded to include developed countries. They are generally robust to the exclusion of particular developing country groups such as those countries subject to ATC quotas, RTA beneficiaries, and the ACP countries.

These are significant findings given the importance of the textiles, clothing, and footwear sectors to economies in the early stages of industrialization. Based on a heterogeneous firms framework,

[24] The list of ACP countries comes from http://ec.europa.eu/development/Geographical/RegionsCountries_en.cfm.

these results would tend to suggest that harmonization can be an effective way of promoting foreign market access for firms with lower productivity than incumbent exporters, since it induces an upwards shift in the export marginal cost cutoff. International harmonization could therefore be expected to encourage exports by small and medium enterprises in developing countries–a prediction that future work using firm level data could test. Importing countries looking to provide an impulsion to non-traditional exports from developing countries could perhaps use international standards harmonization as a complement to more generous tariff preferences and more open rules of origin.

An alternative way of interpreting the results presented here is in terms of export diversification, an important policy issue for many developing countries. By equating variety growth and diversification, a case can be made that international standards harmonization could be one way in which the large, rich country import markets could help support export diversification in developing countries. These results therefore complement recent work on diversification, which has highlighted the importance of policies such as trade facilitation and the rationalization of barriers to domestic market entry within developing countries (Dennis and Shepherd, 2007).

The main obstacle to future empirical work in the area of product standards and their trade effects remains limited data availability. While the World Bank's EU Standards Database provides information on the textiles, clothing, and footwear sectors, there is clearly a need to expand on this. One direction for possible expansion would be the addition of further countries, including data on national standards in EU-15 member states. At the current time, the data do not permit an assessment of the impact of product standard harmonization on geographical export diversification; however, the relatively weak (but statistically significant) elasticity found here suggests that geographical diversification, rather than product variety, might be the more important channel for trade growth in this case. It is to be hoped that future work will investigate this possibility.

It would of course also be desirable to increase the sectoral reach of standards data. In particular, it would be useful to include products of interest to middle income developing countries, such as electronic goods. Building on previous efforts to exploit the Perinorm bibliographic database (e.g., Swann et al., 1996; Moenius, 2004) would likely prove very beneficial to empirical work in this area.

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Tables

Table 1: Standardization in the EU, 1995-2003.

	Clothing		Footwear		Textiles	
	Total	% ISO	Total	% ISO	Total	% ISO
1995	15	6.67	5	0.00	102	50.98
1996	18	5.56	10	40.00	125	55.20
1997	20	5.00	15	33.33	164	57.93
1998	28	17.86	18	27.78	187	60.96
1999	32	18.75	31	54.84	223	62.33
2000	28	21.43	39	56.41	249	59.84
2001	32	21.88	57	64.91	268	56.34
2002	35	22.86	60	61.67	281	56.94
2003	41	19.51	67	58.21	303	56.11

1. Clothing = HS chapters 61-63. Footwear = HS chapter 64. Textiles = HS chapters 50-60.

2. Total refers to the total number of CEN European standards in force for each sector-year. % ISO is the proportion of the total number of standards that are internationally harmonized (i.e., identical or equivalent to an ISO standard).

Table 2: Partner export variety (Λ_{xst}) by sector and year.

	Clothing			Footwear			Textiles		
	Median	Max.	Countries	Median	Max.	Countries	Median	Max.	Countries
1995	0.22	0.94	185	0.26	0.96	134	0.08	0.81	180
1996	0.21	0.95	193	0.27	0.99	135	0.08	0.82	179
1997	0.28	0.95	185	0.34	0.99	131	0.10	0.82	168
1998	0.24	0.95	187	0.34	0.99	129	0.09	0.83	166
1999	0.26	0.96	186	0.32	0.99	135	0.08	0.83	178
2000	0.26	0.96	191	0.26	0.99	137	0.10	0.83	171
2001	0.28	0.96	203	0.27	0.99	145	0.08	0.83	179
2002	0.28	0.96	200	0.36	0.99	136	0.09	0.83	179
2003	0.27	0.96	204	0.33	0.99	141	0.07	0.82	187

1. Λ_{xst} is calculated as described in the text, using 8-digit Eurostat import data.
2. The sample for this table includes all countries (developed and developing) for which data are available, except the EU-15.

Table 3: Data, descriptive statistics, and sources.

Variable	Definition	Obs.	Mean	Std. Dev.	Min.	Max.	Source
Λ_{xst}	Export variety; see formula in text.	4544	0.333	0.340	0	0.987	Eurostat; own calculations.
$stds_{st}$	Total number of EU standards.	5652	91.799	95.037	5	303	EUSDB.
$stds_{st} * gdppc_{xt}$	Total number of EU standards interacted with per capita income (constant 2000 dollars).	4319	4.012E+05	1.055E+06	282.601	1.16E+07	EUSDB, WDI.
iso_{st}	Number of ISO-harmonized EU standards.	5652	48.839	58.241	0	170	EUSDB.
$iso_{st} * gdppc_{xt}$	Number of ISO-harmonized EU standards interacted with per capita income (constant 2000 dollars).	4319	2.142E+05	6.132E+05	0	6.529E+06	EUSDB, WDI.
τ_{xst}	Simple average EU tariffs (applied).	4158	4.268	4.564	0	17	WITS-TRAINS.
emp_{st}^{EU}	Total EU employment.	5652	7.357E+05	2.981E+05	275792	1.082E+06	Eurostat.
va_{st}^{EU}	Total EU value added.	5652	19576.460	10174.710	4612.2	35802.6	Eurostat.
$hemp_{st}^{EU}$	Herfindahl index of EU employment.	5652	0.231	0.060	0.159	0.402	Eurostat.
hva_{st}^{EU}	Herfindahl index of EU value added.	5652	0.260	0.095	0.164	0.588	Eurostat.

1. Subscripts are used as follows: x = exporter; s = sector; t = year.

Table 4: Correlation matrix.

	Λ_{xst}	$stds_{st}$	$stds_{st} * gdppc_{xt}$	iso_{st}	$iso_{st} * gdppc_{xt}$	τ_{xst}	emp_{st}^{EU}	va_{st}^{EU}	$hemp_{st}^{EU}$	hva_{st}^{EU}
Λ_{xst}	1									
$stds_{st}$	-0.3183	1								
$stds_{st} * gdppc_{xt}$	0.0745	0.3795	1							
iso_{st}	-0.317	0.9955	0.3783	1						
$iso_{st} * gdppc_{xt}$	0.0486	0.3997	0.9949	0.402	1					
τ_{xst}	0.4627	-0.2041	0.1044	-0.2017	0.0806	1				
emp_{st}^{EU}	-0.1912	0.4538	0.1603	0.4063	0.1521	-0.0602	1			
va_{st}^{EU}	-0.2813	0.7761	0.2861	0.7447	0.291	-0.141	0.8934	1		
$hemp_{st}^{EU}$	0.1868	-0.5779	-0.215	-0.541	-0.2133	0.1312	-0.8113	-0.8665	1	
hva_{st}^{EU}	0.1508	-0.5072	-0.1911	-0.4762	-0.1901	0.1422	-0.6748	-0.7528	0.9687	1

Table 5: Regression results.

	OLS	GMM	OLS	GMM
$\ln(stds_{st})$	-0.590***	-0.686***	-1.962**	-2.638***
	[0.175]	[0.170]	[0.765]	[0.875]
$\ln(iso_{st})$	0.143	0.274*	0.673*	0.638
	[0.099]	[0.142]	[0.379]	[0.538]
$\ln(stds_{st}) * \ln(gdppc_{xt})$			0.206*	0.298**
			[0.106]	[0.123]
$\ln(iso_{st}) * \ln(gdppc_{xt})$			-0.081	-0.068
			[0.053]	[0.080]
$\ln(1+\tau_{xst})$	0.075	0.309	0.071	0.667
	[0.139]	[0.502]	[0.141]	[0.471]
$\ln\left(imp_{st}^{EU}\right)$	0.703**	0.311	0.929**	0.812
	[0.352]	[0.509]	[0.365]	[0.507]
Cons.	-16.867**		-22.175***	
	[8.393]		[8.524]	
Obs.	3023	2396	2864	2272
R^2	0.093	0.027	0.070	0.027
Endog.		2.912		7.770
Over-id.		7.327		7.383
Under-id.		94.415***		100.843***
Weak-id.		13.856*		11.537(NA)

1. All models include fixed effects by exporter-sector, and exporter-year. All models include dummy variables for the second and third phases of ATC liberalization (not reported). Robust standard errors appear in square brackets under the coefficient estimates. Statistical significance is indicated using * (10%), ** (5%), and *** (1%).

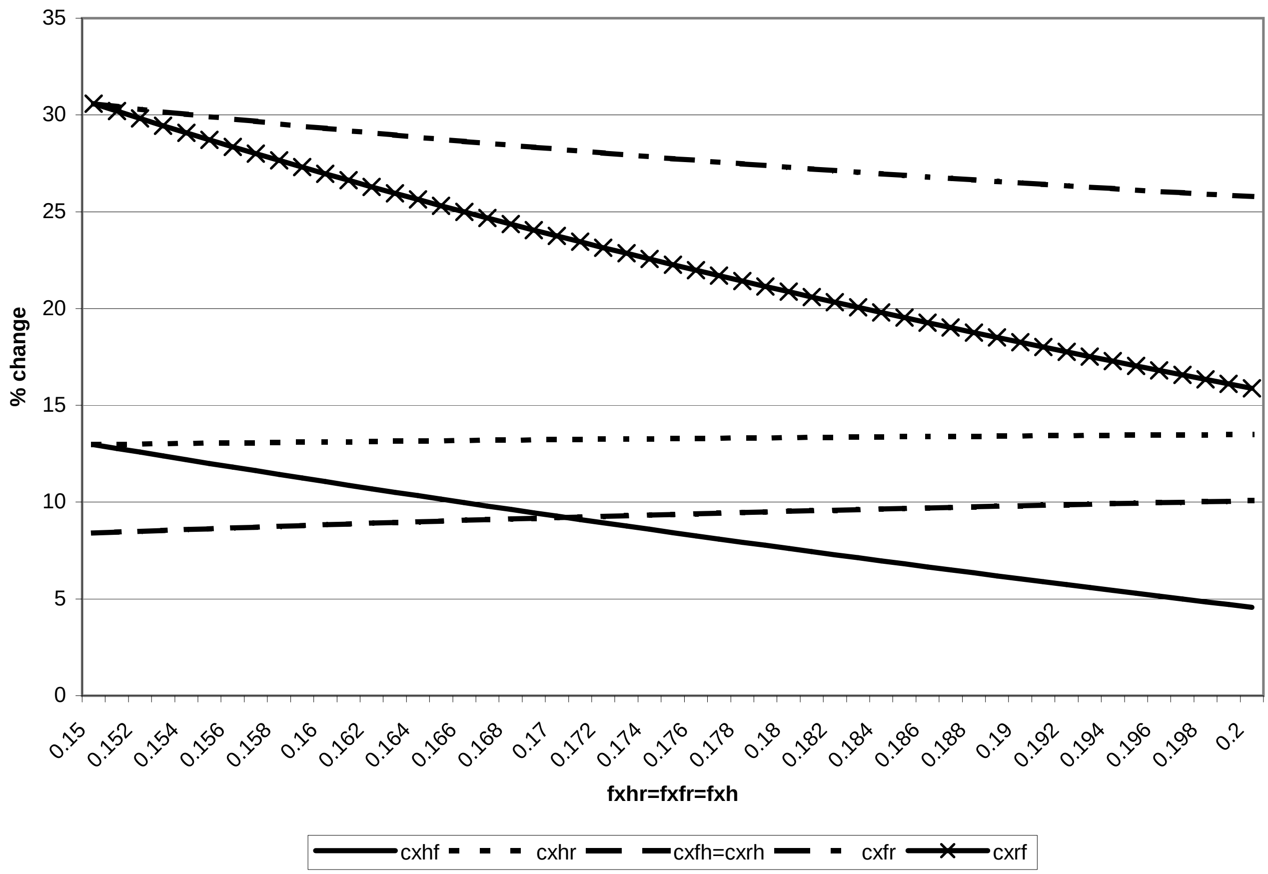
2. Endogeneity and overidentification tests are Durbin-Hausman-Wu and Hansen's J respectively. Under-identification is tested via Anderson's likelihood ratio. Weak-identification is tested using the Stock-Yogo procedure, with stars indicating the maximal relative bias (NA = no critical values available).

3. Instruments in columns 2 and 4 are the first lags of the standards variables (including interactions where appropriate), sector value added, sector employment, and the Herfindahl indices of value added and employment (EU).

4. The estimation sample for this table is limited to developing countries only, i.e. it excludes all high income countries.

Figures

Figure 1: Simulated change in export marginal cost cutoffs (%) following harmonization.



1. Following Bernard et al. (2007), I use the following invariant parameters: $\sigma = 3.8$, $k = 3.4$, $L = 1000$, $\beta = 0.5$, $\bar{c} = 0.2$, and $f^e = 2$.

2. Prior to harmonization, $f_x^{iH} = f_x^{iF} = 0.15$ and $f_d^H = f_d^F = 0.1$. $f_x^{HR} = f_x^{FR}$ varies over the range 0.15 to 0.2, while f_d^R varies over the range 0.1 to 0.15.

3. Post harmonization, f_x^{iH} remains unchanged but f_x^H varies over the range 0.15 to 0.2, while $f_d^R = f_d^F$ varies over the range 0.1 to 0.15.

4. The solid line shows the percentage change in the export cutoff for H to F following harmonization. The dotted line is for H to R, the dashed line is for F and R to H, the dotted and dashed line is for F to R, and the crossed line is for R to F.

Table 6: First-stage IV regressions.

	$\ln(stds_{st})$	$\ln(stds_{st}) * \ln(gdppc_{xt})$	$\ln(iso_{st})$	$\ln(iso_{st}) * \ln(gdppc_{xt})$	$\ln(1+\tau_{xst})$
$L.\ln(stds_{st})$	1.033***	1.597***	1.433***	8.811***	0.098
	[0.040]	[0.324]	[0.245]	[1.669]	[0.159]
$L.\ln(iso_{st})$	-0.364***	-2.107***	-0.450**	-6.701***	-0.003
	[0.033]	[0.229]	[0.201]	[1.347]	[0.060]
$L.\ln(stds_{st}) * \ln(gdppc_{xt})$	0.001	0.826***	0.007	0.254	-0.018
	[0.005]	[0.049]	[0.034]	[0.261]	[0.022]
$L.\ln(iso_{st}) * \ln(gdppc_{xt})$	0	-0.066*	-0.006	0.466**	0
	[0.005]	[0.037]	[0.029]	[0.213]	[0.009]
$L.\ln(1+\tau_{xst})$	0.018**	0.138**	0.105**	0.751**	-0.157
	[0.008]	[0.064]	[0.047]	[0.346]	[0.109]
$\ln\left(emp_{st}^{EU}\right)$	1.076***	7.248***	2.437***	16.482***	-0.759***
	[0.040]	[0.294]	[0.224]	[1.551]	[0.154]
$\ln\left(va_{st}^{EU}\right)$	2.233***	15.084***	-10.195***	-70.192***	-1.046
	[0.135]	[1.137]	[0.789]	[5.723]	[0.666]
$\ln\left(hemp_{st}^{EU}\right)$	-0.470***	-3.167***	-2.477***	-16.727***	-0.218
	[0.065]	[0.490]	[0.372]	[2.612]	[0.257]
$\ln\left(hva_{st}^{EU}\right)$	3.932***	27.127***	-6.227***	-41.566***	0.48
	[0.132]	[1.102]	[0.820]	[5.941]	[0.516]
$\ln\left(imp_{st}^{EU}\right)$	-2.638***	-18.161***	0.216	1.297	-0.023
	[0.064]	[0.592]	[0.420]	[2.988]	[0.321]
Cons.	-46.895***	-316.386***	91.315***	633.359***	35.621***
	[2.153]	[17.571]	[11.790]	[84.110]	[10.934]
Obs.	2394	2394	2394	2394	2394
R^2	0.332	0.297	0.152	0.214	0.022
Instr. F	4224.04***	1587.94***	151.64***	115.08***	4.88***

1. All models include fixed effects by exporter-sector, and exporter-year. All models include dummy variables for the second and third phases of ATC liberalization (not reported). Robust standard errors appear in square brackets under the coefficient estimates. Statistical significance is indicated using * (10%), ** (5%), and *** (1%).

2. The instrument F test is a test of the null hypothesis that the coefficients on the excluded instruments are jointly equal to zero.

3. The estimation sample for this table is limited to developing countries only, i.e. it excludes all high income countries.

Table 7: Robustness checks.

	Full Sample		No Quota		No RTA		No ACP	
	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
$\ln(stds_{st})$	-1.778***	-2.753***	-1.948**	-2.628***	-1.504	-1.775*	0.308	1.118
	[0.470]	[0.524]	[0.885]	[0.996]	[0.975]	[1.078]	[1.256]	[1.308]
$\ln(iso_{st})$	0.581**	1.052***	0.742*	0.681	0.584	0.386	0.518	0.504
	[0.245]	[0.352]	[0.433]	[0.607]	[0.476]	[0.681]	[0.589]	[0.895]
$\ln(stds_{st}) * \ln(gdppc_{xt})$	0.178***	0.312***	0.189	0.279**	0.109	0.135	-0.056	-0.211
	[0.056]	[0.068]	[0.123]	[0.140]	[0.139]	[0.153]	[0.176]	[0.180]
$\ln(iso_{st}) * \ln(gdppc_{xt})$	-0.062**	-0.118**	-0.089	-0.069	-0.063	-0.021	-0.083	-0.065
	[0.029]	[0.049]	[0.060]	[0.090]	[0.067]	[0.102]	[0.080]	[0.126]
$\ln(1+\tau_{xst})$	0.036	0.954**	0.059	0.635	0.078	0.853	0.302*	0.351
	[0.122]	[0.446]	[0.157]	[0.449]	[0.176]	[0.530]	[0.166]	[0.503]
$\ln\left(imp_{st}^{EU}\right)$	0.776**	0.563	1.037**	0.872	1.138**	0.968	1.676***	1.184*
	[0.311]	[0.424]	[0.431]	[0.572]	[0.493]	[0.646]	[0.551]	[0.714]
Cons.	-18.808**		-24.523**		-26.927**		-40.836***	
	[7.360]		[10.267]		[11.779]		[13.012]	
Obs.	3472	2786	2612	1950	2355	1713	1097	828
R^2	0.125	0.004	0.094	0.033	0.096	0.038	0.026	0.073
Over-id.		5.659		7.262		7.809*		5.156
Under-id.		125.780***		118.219***		98.352***		51.352***
Weak-id.		14.415(NA)		13.698(NA)		11.357(NA)		5.884(NA)

1. All models include fixed effects by exporter-sector, and exporter-year. All models include dummy variables for the second and third phases of ATC liberalization (not reported). Robust standard errors appear in square brackets under the coefficient estimates. Statistical significance is indicated using * (10%), ** (5%), and *** (1%).

2. Endogeneity and overidentification tests are Durbin-Hausman-Wu and Hansen's J respectively. Under-identification is tested via Anderson's likelihood ratio. Weak-identification is tested using the Stock-Yogo procedure, with stars indicating the maximal relative bias (NA = no critical values available).

3. Instruments in columns 2, 4, 6, and 8 are the first lags of the standards variables (including interactions where appropriate), sector value added, sector employment, and the Herfindahl indices of value added and employment (EU).

Figure 2: Non-parametric (Lowess) regression of Λ_{xst} on $stds_{st}$ and iso_{st}.