WPS3809

Do Standards Matter for Export Success?[1]

Maggie Xiaoyang Chen[2], Tsunehiro Otsuki[3], and John S. Wilson[4]

Abstract

Standards and technical regulations are an increasingly prominent part of the international trade policy debate. In particular, there has been considerable discussion of whether standards and regulations affect trade costs and export prospects for developing countries. In this paper, we examine how meeting foreign standards affects firms' export performance, reflected in export propensity and market diversification. The analysis draws on the World Bank Technical Barriers to Trade Survey database of 619 firms in 17 developing countries. Our results indicate that standards and technical regulations in developed countries do affect firms' propensity to export in developing countries. In particular, testing procedures and lengthy inspection procedures by importers reduce exports by 9% and 3%, respectively. Furthermore, in our model, the difference in standards across foreign countries causes diseconomy of scale for firms and affects decisions about whether to enter export markets. The empirical analysis presented here implies that standards impede exporters' market entry, reducing the likelihood of exporting to more than three markets by 7%. In addition, we find that firms that outsource components are more challenged by compliance with multiple standards than those that do not outsource..

1. Introduction

Export success and the ability to enter international trade markets are increasingly critical to job creation and poverty alleviation in developing countries. Determining what factors drive export performance, as part of achieving these goals, is clearly important. While there has been a significant decline in explicit trade barriers such as tariffs and quotas over the past decades, standards and technical regulations are increasingly mentioned as a factor driving trade costs. This is particularly true for firms in developing countries. Studies conducted by the United Nations Conference on Trade and Development (UNCTAD), for example, have shown that some developing countries have suffered considerable export losses due to their inability to respond to restrictive and duplicative environmental standards and regulations imposed in developed countries.[5] Such environmental requirements cover a broad spectrum of instruments and include product-content standards, mandatory and voluntary labeling, testing and certification procedures. The rising challenge in meeting complex technical regulations by exporters has also led to a rise in trade disputes centering on these issues. As such, we are interested in examining based on empirical data, how standards and technical regulations affect developing country firms' export performance.

In this paper, we define a firm's export performance in two dimensions: export propensity (the overall export share), and market diversification (the total number of export markets entered by a firm). A number of previous studies have focused on total exports and the factors driving export success for firms. For example, Glejser et. al (1980) explore how export performance, i.e., export share of individual firms in export markets, is related to firm size, location, information, foreign subsidiaries, and market structures. The number of empirical studies explaining firms' decision on the number of export markets to enter is limited. Efforts to diversify export markets are clearly a crucial strategy, however, for firms to respond to international risk, such as export price uncertainty and other factors. In fact, Hirsch and Lev (1971) find that sales stability and market diversification are

---

[5]For example, the Study of the Effects of Environmental Measures on Market Access from India in its communication to the WTO noted that it has become a great concern to their exporting firms to meet the existing standards on industries such as textiles, leather products, and packaging that

positively correlated. Furthermore, as competition in popular export destinations intensifies it is critical for firms to consider entry into new export markets. As Eaton, Kortum, and Kramarz (2004) point out and we observe in this paper, the number of firms selling to three or more markets is negatively correlated with the number of export destinations.

Research that has examined firms' export decisions, including Dixit (1989a,b), Krugman (1989) and others, suggests that these decisions are driven in part by sunk costs in entering a particular export market. A number of studies have focused on firms in developing countries, including Roberts and Tybout (1997) and Bernard and Jensen (2004), and examine empirically factors affecting decision-making such as entry costs that influence a firm's export behavior. Roberts and Tybout (1997) test for the presence and magnitude of sunk costs using a sample of Colombian plants, while Bernard and Jensen (2004) test for the possible existence of entry costs by looking at the effects of exporting yesterday on exporting today. Both papers find entry cost significant in explaining firms' export decisions.

In this paper, we introduce the role of standards and technical regulations in explaining a firm's export performance. Standards and technical regulations affect both dimensions of export performance for a number of reasons. First, governments have the ability to set standards based on domestic firms' product characteristics or technology capacity. This can raise foreign exporters' costs to accommodate these requirements. Second, there often exists a great difference in standards across markets each of which requires an individual fixed compliance cost such as the redesign cost. Hence, the difference in regulations across markets can severely limit a firm's scale production capacity and affect a firm's decision in the number of export markets. Third, besides complying with standards and technical regulations, firms often experience time delays in procedures such as the inspection process and difficulty in accessing standards-related information. These inefficiencies may constitute significant implicit barriers to exporting firms.

---

differ significantly across markets.

4

Hence, we examine the above potential channels through which standards and technical regulations affect firms' export behavior and quantify, both analytically and empirically, their impact on firms' export propensity as well as market diversification. We first consider standards as the provision of public goods as in Fischer and Serra (2000), and model how the compliance with standards imposes additional costs on producers. Following Baldwin (2001) and Ganslandt and Markusen (2001), we also assume that meeting a standard in each export market requires an individual fixed cost to establish the capacity and subsequently variable production cost. The requirement of a single fixed cost in each market, arising from the differences in technical requirements across markets, endogenizes a firm's export decisions and the total number of markets to enter. Therefore, when the compliance with the standards and technical regulations in developed countries imposes significant additional costs on firms and impedes their ability to export, these firms' overall propensity to export and likelihood to diversify their markets will inevitably decrease considerably.

We then proceed to estimate the hypotheses established in the model using the World Bank Technical Barriers to Trade Survey (2002) as our data source. As far as we know, there are only two empirical studies that have investigated the role of standards in trade, Swann, et al (1996) and Moenius (1999). The former uses simple counts of standards to measure the effective stock of technical specifications and finds that British exports are raised by this measurement of British national standards. The latter paper concludes that bilaterally shared standards raise trade volume significantly. However, there is still relatively little known about how standards and technical regulations affect individual firms, in particular, their export decisions.

The World Bank Technical Barriers to Trade Survey (2002) enables such analysis by eliciting systematically firm-level information on their production and export activities, cost structures, impediments to domestic sales and exports, and compliance with standards and technical regulations. The surveys were administered to 619 firms in 17 developing countries from five regions, including Eastern Europe, Latin America, Middle East, South

Asia, and Sub-Saharan Africa.[6] The 619 firms in the survey vary significantly in characteristics such as the value of sales, the size of employment, age and ownership structure. This survey collects firms' responses to a series of questions on topics including mandatory standards, conformity assessment (testing, certification, labeling requirements and inspection), and their effect on their cost of production and ability to export. Maskus, Otsuki, and Wilson (2004) estimate a translog cost function based on the survey data and find that standards increase firms' short-run production cost by requiring additional labor and capital.

In this paper, we estimate the impact of standards and technical regulations in determining firms' export performance reflected in export propensity and market diversification. We begin with estimating whether the existence of these technical requirements deter firms' overall propensity to export. Our estimates suggest that testing procedures reduce export share by 9%. In particular, domestically owned firms tend to export 16% less of their total sales because of testing procedures. Both testing procedures and lengthy inspection processes cause a larger adverse impact on agricultural firms which produce highly perishable goods. Information barriers, on average, reduce firms' propensity to export by 18%. We then find that meeting standards also hinders firms' entry into foreign markets, reducing the likelihood for firms to export to more than three markets by 7%. Moreover, firms which import inputs from abroad are much less likely to diversify their export markets, because importing inputs from numerous locations (in which inputs are produced without the ultimate destination in mind) makes compliance with multiple standards more difficult.

The rest of the paper is organized as follows. In section 2, we set up a simple model of a firm's export decision taking into account both fixed and variable costs of meeting standards and technical regulations, and determine firms' share of export and number of markets. Next, following the description and discussion of data in section 3, we estimate the impact of standards and technical regulations on firms' export propensity in section 4. In section 5, we present our estimated impact of technical requirements on firms' export

---

[6]A detailed description of this survey can be found in Wilson and Otsuki (2003).

decisions and market diversification. We conclude with policy implications from the results in section 6.

2. The Model

With a simple model, we analyze a profit-maximizing firm's export behavior by modeling its decision to export to a set of differentiated markets. Suppose the world consists of N importing countries, labeled as $j=1, 2, ..., N$. Each importing country imposes varied standards and technical requirements on the good that is marketed in its market, such as emission standards and regulations, to reduce the negative externality arising from consumption, such as pollution. Because of the nature of the standards as the provision of a public good, a firm's compliance with the standards has no effect on consumers' demand for the regulated product.[7]

The compliance with each country's technical requirements implies a differentiated fixed cost to the firm, denoted by $F_{ij} \equiv F_j + D_i$. The first component of this fixed cost, F_j, is the common fixed cost to comply with the technical regulations imposed in country j, which is identical across exporters. The second component, D_i, represents the firm-wise deviation from F_j due to the varied impact each firm receives from standards and technical regulations.[8] D_i varies across exporters due to their difference in factors such as technology endowment and hence the ability to meet standards. Because standards across markets can simply differ in the content of the norm (referred as horizontal standards such as a standard on permissible electric plug) instead of the strictness of the norm (referred as vertical standards such as the nutrition standard) or just be duplicative (such as repetitive testing and certification procedures), we assume, as in Baldwin (2001), that a fixed

---

[7] We realize there also exist some product standards, such as safety standards, that are targeted at reducing market failures such as information asymmetry between producers and consumers, in which case firms' compliance, by contrast, would affect consumers' demand.
[8] An example of D_i is the remodeling cost, which depends on a firm's ability to accommodate foreign design requirement. Firms with established platforms that may be modified slightly to accommodate foreign markets will involve a very small amount of D_i .

compliance cost for each market is inevitable.[9] Furthermore, we assume that F_j is uniformly distributed as follows:

$$F_j \sim UNIF\left[0, \bar{F}\right]. \tag{1}$$

Subsequently, producing the product that complies with the standards and technical regulations also requires a variable cost $c(Z_i | q_i)$, where Z_i measures firm i's characteristics, such as size, productivity, and ownership structure, that may be correlated with its variable production cost and hence export behavior.

To prove its compliance with the standards imposed in a foreign market (such as inspection process) takes a certain amount of time, denoted by T. We assume that the firm produces at the profit-maximizing level of exports, q_i^*, at price p_i for each market once it enters a foreign market. Provided that standards considered in this model are imposed to reduce consumption externality, p_i is independent of the standards in country i. In a representative export market j, firm i receives its expected profit

$$E[\pi_{ij}] = \beta \cdot p_i \cdot q_i^* - c(Z_i | q_i^*) - F_{ij} \tag{2}$$

where $\beta \equiv \int_T^\infty \left[\rho e^{-\rho t}\right] dt = e^{-\rho T}$ reflects the probability that the revenue is realized between T and L.

If the profit from selling market j as defined in equation (2) is nonnegative, firm i will export to market j. The export status of firm i to market j is thus given by Y_{ij}, where

$$\begin{aligned} Y_{ij} &= 1 \text{ if } \pi_{ij} \geq 0 \\ Y_{ij} &= 0 \text{ if } \pi_{ij} < 0. \end{aligned} \tag{3}$$

Recall F_{ij} (j=1, 2, ..., N) is uniformly distributed in $[D_i, D_i + \bar{F}]$, so we can identify $\hat{F}_i$ at which level the firm makes zero profit:

---

[9] This assumption basically rules out the possibility that firms choose to meet the strictest standard when selling to multiple markets whose standards only vary with the stringency level and avoid the fixed costs of meeting a different standard in each market.

$$\hat{F}_i = \hat{\pi}_i = \left[\beta \cdot p_i \cdot q_i^* - c_i(Z_i \mid q_i^*) \right]. \tag{4}$$

Furthermore, $\hat{F}_i$ pins down the market set firms decide to export to, characterized as

$$A_i \equiv \left\{ k \mid F_{ik} \leq \hat{F}_i \right\} \tag{5}$$

and $Y_{ij} = 1 \ \forall j \in A_i$. The number of exporting destinations in the choice subset, denoted as $n_i^* \equiv \sum_{j \in A_i} Y_{ij}$, is therefore determined by

$$n_i^* = N \cdot \frac{\hat{F}_i - D_i}{\bar{F}} = \frac{N}{\bar{F}} \cdot \left[\beta \cdot p_i \cdot q_i^* - c(Z_i \mid q_i^*) - D_i \right] \tag{6}$$

From the above equation, a negative impact received by firm *i* on its ability to export, when complying with standards imposed in foreign markets, indicates $D_i > 0$ and leads to a smaller number of markets it exports to at equilibrium. A longer time delay before a firm accesses its markets, i.e., a larger T which decreases the value of β, also restrains firms from entering multiple markets.

The total export amount by the firm, defined as $Q_i^f \equiv \sum_{j \in A_i} q_{ij}$, is characterized as

$$Q_i^f = n_i^* q_i^* = \frac{N}{\bar{F}} \cdot \left[\beta \cdot p_i \cdot q_i^* - c(Z_i \mid q_i^*) - D_i \right] \cdot q_i^*. \tag{7}$$

In addition to exporting to the chosen set of foreign countries, the firm produces for its local market as well. We assume that the production for the local market is subject to minimum technical regulations, and thus ensures the entry decision by the firm without any uncertainty. Thus, the export share, ES_i^*, is obtained by scaling Q_i^f with total sales, i.e., $Q_i^f + q_i^*$. Factors, which determine a firm's export, including standards, technical regulations, and time delay, would have similar influence on a firm's export share, i.e., propensity to export.

The rest of the paper quantifies how the presence of standards and technical regulations affects the two indicators of export performance: export propensity and market diversification. We first briefly describe our data and variables employed for the empirical

investigation.

3. Data

The data used in this paper is supplied by the World Bank Technical Barriers to Trade Survey, the first attempt to investigate the impact of technical requirements at the firm level. The survey solicits input from 619 firms in 25 agricultural and manufacturing industries located in 17 developing countries regarding technical barriers encountered in developed export markets. The 17 developing countries from which the data were collected are Argentina, Bulgaria, Chile, Czech Republic, Honduras, India, Iran, Jordan, Kenya, Mozambique, Nigeria, Pakistan, Panama, Poland, Senegal, South Africa and Uganda. The five export markets include the EU, USA, Canada, Japan and Australia.

One of the central questions this survey seeks to explore is whether standards and technical regulations imposed in many developed countries pose barriers to trade for exporters in developing countries. The survey collects participating firms' responses to a series of questions, which are specifically designed to investigate whether technical requirements, ranging from quality standard, testing/certification procedure, labeling requirement, to conformity assessment, affect developing country firms' ability to export. The compliance with each of these requirements potentially requires firms to incur additional cost of production, such as product redesign cost and additional labor for testing and certification. Predictably, firms subject to significant compliance cost are more likely to be affected in their ability to export and subsequently their performance in their export markets. The purpose of this paper, therefore, is to identify the impact of existing standards and technical regulations imposed by developed countries on firms' export performance measured by export share and number of export markets.

3.1 Description

In order to explain these two indicators of export performance, we construct a vector of variables, denoted by $X_i \equiv [x_{mi}]$, based on a selection of interview questions, conducted in the World Bank Technical Barriers to Trade Survey, inquiring whether firms have

perceived effect of standards and technical regulations on their ability to export. x_{mi} consists of:

- *Standards*: a dummy variable that is equal to 1 when respondents answer *Yes* to the question "Have quality/performance standards impacted your ability to export product?", and 0 when they answer *No*.

- *Testing procedures*: a dummy variable that is equal to 1 when respondents answer *Yes* to the question "Have testing procedures impacted your ability to export product?", and 0 when they answer *No*.

- *Labeling requirements*: a dummy variable that is equal to 1 when respondents answer *Yes* to the question "Have labeling requirements impacted your ability to export product?", and 0 when they answer *No*.

- *Information inquiry difficulty*: an average across export markets of a firm's Yes/No answers to the question "Do you have difficulty obtaining information about applicable regulations in the countries listed below?"[10]

The construction of these binary variables based on the above set of questions enables us to identify the existence of the impact of foreign standards and technical regulations across firms. Moreover, the questions' uniform format allows us to compare the impact among the different types of standards and technical regulations.[11] By estimating the effect of these binary variables respectively on firms' export share and number of export markets, we directly quantify the significance and magnitude of such impact reflected on export performance. In addition, we include the variable "*inspection time*", denoted by T_i, to represent the delay from inspection process:

- *Inspection time*: an average across export markets of a firm's answers to the question

---

[10] When firms answered "*No*" to one or more of these questions, the additional cost arising from complying with those particular standards and technical regulations might not be significant relative to their production cost incurred to supply only their domestic market.

[11] There exists an alternative set of questions in the survey that solicits firms' response on "how important has each of these technical requirements been in your ability to increase exports to the countries?". However, first, the content of this set of questions seems less direct and thus suitable for our analysis. Furthermore, since firms answer the question by choosing among "not at all important", "somewhat important", "important", "very important", and "not applicable", we are

"How many days does the conformity assessment -- inspection usually take?" Firms answer the question by choosing from 6 categories, with 0 = "1 day or less", 1 = "2-4 days", 2 = "5-6 days", 3 = "7 days", 4 = "8-13 days", and 5 = "more than 14 days".[12]

Table 1: The summary of statistics for variables on standards and technical regulations					
Variable	No. of Observation	Mean	Std. Dev.	Min	Max
Standards	619	0.58	0.49	0	1
Testing procedures	619	0.34	0.47	0	1
Labeling requirements	619	0.32	0.46	0	1
Information inquiry difficulty	570	0.79	0.37	0	1
Inspection time	243	1.11	1.23	0	5

The statistics of the above variables are summarized in Table 1. Furthermore, we follow Robert and Tybout (1997), Bernard and Jensen (2004), and employ the relevant characteristics of firms as additional variables that may explain firms' export behavior:

- *Size*: we adopt both material expenditure and total employment to measure a firm's size. Pervious studies, such as Bernard and Jensen (2004), find that a larger firm tends to be more likely to succeed in export.

- *Wage*: we use the wage rate as the unit labor cost.

- *Ownership structure*: the share of foreign ownership is included to characterize a firm's ownership structure.

- *Age*: we also consider the number of years a firm has been established as a control variable, although the relation between age and exports is ambiguous. Older plants might be more experienced with international trade, while newer plants may use relatively modern technology to increase productivity and product quality.

---

concerned with the potential endogeneity of the control variables that are constructed based on this set of questions.

[12] Limited by the choice categories of this survey question, the variable, "inspection time", is positively but not linearly correlated with the actual number of days for conformity assessment.

3.2 An example

In this subsection, we provide a simple example of the correlation between technical regulations and market diversification. Figure 1 plots the distribution of firms with respect to the number of export markets, by comparing those whose abilities to export have been impacted by standards with the rest. The horizontal axis represents the number of export markets reflecting firms' market diversification, while the vertical axis represents the percentage of firms within one group ("standards"=1 or "standards"=0) exporting to a certain number of markets.

First, the percentage of firms that exports to multiple markets declines with the number of markets in general. Second, a larger percentage of firms whose abilities have been impacted by standards, exports to two or fewer markets than those whose abilities have not been impacted. Third, in great contrast, when we examine more than two export markets, the percentage of firms exporting to multiple markets is greater in the group that does not receive impact from standards, with only one exception (when the number of markets is five). This figure seems to suggest that foreign standards impede market entry, and firms that are not impacted by standards are more likely to export to multiple markets than the others.
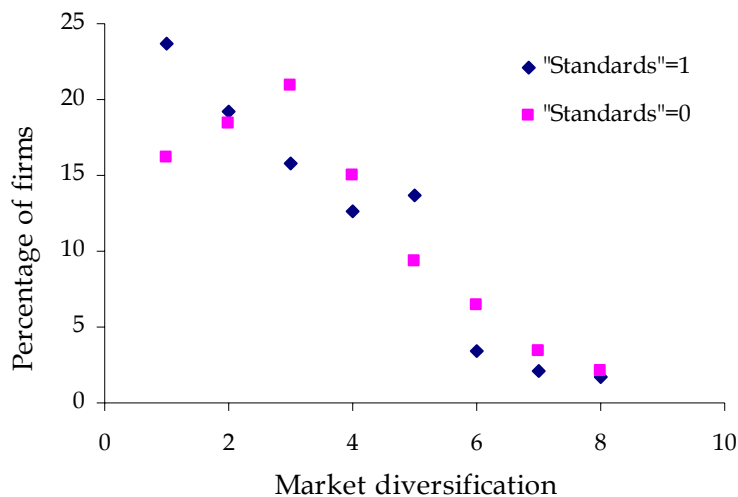

Figure 1: The distribution of firms in market diversification

4. Standards and Technical Regulations on Export Propensity

In this section, we first examine the effects of compliance with standards and technical regulations, along with firms' conventional characteristics, on firms' propensity to export. Then, we identify the types of firms that receive a larger impact by individually investigating groups of interest.

4.1 What matters to export propensity?

As established in section 2, the total export amount by the firm is characterized as

$$Q_i^f = \frac{N}{\overline{F}} \cdot \left[\beta \cdot p_i \cdot q_i^* - c(Z_i \mid q_i^*) - D_i \right] \cdot q_i^*. \tag{8}$$

Recall that D_i reflects firm-level deviation in compliance cost, led to by the impact of standards and technical regulations on an individual firm's ability to export. We estimate the share of export relative to total sales of the form, by scaling the total export amount with total sales to avoid the problem of endogeneity, in the form of:

$$ES_i = \lambda + D \cdot X_i + \gamma T_i + \delta Z_i + \varepsilon_i. \tag{9}$$

Recall that $X_i \equiv \left[x_{mi} \right]$ denotes a vector of variables representing the status (*Yes/No*) or the extent of respondents' received impact on the ability to export from "standards", "testing procedures", "labeling requirements", and "information inquiry difficulty". $D \equiv \left[d_m \right]$ denotes the vector of coefficients. $D \cdot X_i$ quantifies the effects vector of the above technical regulations on an individual firm's export share. For instance, when a firm's ability to export is affected by standards, i.e., x_{mi} ($\equiv$ "*standards*") = 1, $d_m x_{mi} = d_m$ measures the magnitude of reduction in its export share if d_m shows up negative.

Ordinary Least Squares is not suitable because it does not take into account that export share is bounded between zero and one. Instead, we proceed the estimation using the Generalized Linear Model proposed by Papke and Woolridge (1996), which is especially developed to deal with percentage variables. Throughout the analysis, we include the region fixed effect to capture the factors related to a firm's region of origin that may explain its export propensity (such as regional trade agreement), and the industry fixed

effect to control for the industry-specific factors (such as labor intensity).[13]

Table 2: The impact of standards and technical regulations on export propensity	
Dependent variable: export share	
Standards	0.03
	(0.05)
Testing procedures	-0.09**
	(0.04)
Labeling requirements	-0.05
	(0.05)
Information inquiry difficulty	-0.18***
	(0.06)
Inspection time	-0.03***
	(0.01)
Raw material inputs	-0.004
	(0.01)
Total employment	-0.02
	(0.02)
Wage	-0.03
	(0.02)
Age	-0.04***
	(0.02)
Foreign Ownership	0.03
	(0.03)
Number of observations	207
Log likelihood	-40.40
Standard errors are reported in parentheses.	
*** represents 5% significance level; ** represents 10%; * represents 15%.	

Estimation results are reported in Table 2. Firms whose abilities to export have been impacted by testing procedures have an export share nearly 9 percentage points lower than

---

[13] The region fixed effect considers the five regions in which firms of this survey are located, including East Europe, Latin America and Caribbean, Middle East, South Asia, and Sub-Sah. Africa. The industry fixed effect consider the industries defined at the SIC one-digit level.

the rest of the firms. This result is not surprising. According to the OECD Global Forum Workshop on Environmental Requirements and Market Access held in 2002, developing country participants expressed concerns that both voluntary and regulatory testing and certification programs may not be taking local market conditions and capacities into account, which they perceived as a barrier to export to developed country markets.

The variable "information inquiry difficulty" in major export destinations causes firms to export 18% less of their total sales. The length of inspection turns out to significantly reduce firms' incentives to export. The roles of standards and labeling requirements, however, seem ambiguous in determining the export share. A plausible explanation may be firms consider the compliance with some standards (such as nutrition or safety standards) and labeling requirements, even though raising production cost, also serves as a positive signal to consumers, whereas testing procedures, difficult information access, and lengthy inspection process only indicate additional cost without deriving any benefit.[14] Therefore, the overall impact of these types of standards and labeling requirements on firms' export propensity is ambiguous as suggested in Table 2, while the impact of testing procedures, information inquiry difficulty, and lengthy inspection process is unambiguously negative.

The firms' fundamental characteristics do not show up significantly except firms' age, indicating that younger firms have a stronger tendency to export relative to older firms. However, there is no clear correlation relating firms' other characteristics, such as size, wage rate, and foreign ownership, to export share.

4.2 How does the impact on export propensity vary?

After finding the negative effect technical regulations pose, both explicitly and implicitly, on firms' propensity to export, we investigate how such effect varies across different types of firms.

---

[14] For simplicity, the model of this paper considers technical requirements (such as emission standards or testing/certification procedures) that only raise costs to firms. However, it is intuitive to understand that, for many other technical requirements such as safety standards and labeling requirement, there exist both benefit and cost to complying firms, and therefore it is less clear which of these two effects dominates.

First of all, we explore whether the absence of foreign ownership would expose firms to a larger adverse effect or, equivalently, whether the existence of foreign ownership would stimulate firms' propensity to export. Since the majority of our sample is domestically owned firms and there is no sufficient data on firms with any foreign ownership, we only estimate equation (9) for the former and report the results in the second column of Table 3. By comparing the estimation results on domestically owned firms with those on pooled data described in Table 2, we notice that the coefficient on the variable "testing procedures" rises considerably, suggesting that testing regulations are a more critical concern to firms that are completely domestically owned. The increase in the magnitude of the coefficient on "information inquiry difficulty" seems to indicate that firms without any foreign ownership are more bothered with the access to technical requirements information. In the meantime, the effect of lengthy inspection becomes insignificant to this group of firms.

Second, we are also interested in how the impact of standards and technical regulations varies across industries and whether a certain industry is more sensitive to a particular type of technical requirements. Again, because most of the firms in our sample are manufacturing firms, we could only estimate equation (9) on these firms and summarize the results on the third column of Table 3. Similarly, when we compare the third column of Table 3 with the main results described in Table 2 with pooled data, we find that the estimated effect of "informational inquiry difficulty" on export propensity is greater for manufacturing firms. Younger firms are found to be even more eager to export in the manufacturing industry. However, the loss of significance of the coefficients on "testing procedures" and "inspection time", found in the last column of Table 3, seems to suggest that it is mainly the non-manufacturing (mostly agricultural) firms in the pooled sample whose export propensity is challenged by the testing procedures and lengthy inspection process. This finding is not surprising provided that agricultural firms produce perishable products whose value is more sensitive to any delay that occur in testing and inspection procedures.

5. Standards and Technical Regulations on Market Diversification

We now turn to the analysis of estimating the potential presence of scale diseconomy, arising from the difference in standards across export markets, by quantifying the impact of standards and technical regulations on the number of export markets firms choose to enter.

Dependent variable: export share	Domestically owned firms	Manufacturing firms
Table 3: The varied impact of standards and technical regulations on export propensity		
Standards	0.07 (0.06)	0.06 (0.07)
Testing procedures	-0.16*** (0.05)	-0.07 (0.06)
Labeling requirements	-0.07 (0.05)	-0.03 (0.06)
Information inquiry difficulty	-0.21*** (0.06)	-0.21*** (0.07)
Inspection time	-0.02 (0.02)	-0.03 (0.02)
Raw material inputs	-0.01 (0.01)	-0.02 (0.02)
Total employment	-0.02 (0.02)	-0.003 (0.02)
Wage	-0.03 (0.03)	-0.007 (0.03)
Age	-0.03* (0.02)	-0.08*** (0.03)
Foreign Ownership	--	-0.01 (0.04)
Number of observations	163	143
Log likelihood	-23.41	-30.42
Standard errors are reported in parentheses. *** represents 5% significance level; ** represents 10%; * represents 15%.		

5.1 What matters for market diversification?

From the one-country case analysis, we find that a firm exports if its expected revenue exceeds not only its variable cost but also the standards-related fixed cost

$$Y_{ij} = 1 \text{ if } \beta \cdot p_i \cdot q_i^* \geq c(Z_i \mid q_{ij}^*) + F_{ij}$$
$$Y_{ij} = 0 \text{ if } \beta \cdot p_i \cdot q_i^* < c(Z_i \mid q_{ij}^*) + F_{ij}. \tag{10}$$

With a choice set of N potential exporting destinations, a firm will export to any country in the subset A_i, where $A_i \equiv \{j \mid F_{ij} \leq \hat{F}_i \equiv \beta \cdot p_i \cdot q_i^* - c(Z_i \mid q_i^*)\}$. Thus, the number of countries chosen as export destinations is characterized as $n_i^* \equiv N / \bar{F} \cdot [\beta \cdot p_i \cdot q_i^* - c(Z_i \mid q_i^*) - D_i]$. Our goal is to identify the factors that affect the probability that a firm diversifies its export to multiple markets, in particular the factors embedded in standards and technical regulations.

We proceed with the estimation using an ordered discrete choice model of the form:

$$n_i^* = \lambda' + D' \cdot X_i + \gamma' T_i + \delta Z_i + \varepsilon_i'. \tag{11}$$

We adopt the ordered logit model for this ordinal discrete outcome framework with unobserved heterogeneity.[15] As shown in Table 4, the coefficient on "standards" shows up significant, indicating that standards are crucial in determining the number of markets firms export to. The negative coefficient implies that standards reduce exporters' likelihood of exporting to multiple markets. In contrast to section 4 in which standards are insignificant in explaining firms' export propensity, they are an important factor in explaining firms' market diversification. A possible explanation for this contrast, as considered in our model, may be that, to firms that export to more than one market, the compliance with each different standard across export markets requires a single fixed cost and thus leads to diseconomies of scale in their production. Taking this into account, firms become cautious when deciding which and how many markets to export to.

Because, in the ordered logit model, the marginal effects of the independent variables on

---

[15] When multinomial-choice variables are inherently ordered, such as voting outcomes, the multinomial logit or probit models would fail to account for the ordinal nature of the dependent variable. The ordered probit and logit models have come into fairly wide uses as a framework for analyzing such responses.

the probabilities associated with each outcome of the dependent variable (i.e., each value of n_i^*) are not equal to the coefficients, the interpretation of these coefficients has to be careful. Consider one of the independent variables, "standards". To understand how standards affect the probability of exporting to n_i^* number of markets, we plot the probability distribution of n_i^* in Figure 2, where the solid curve represents firms that are not impacted by standards ("standards"=0) and the dashed curve represents firms that are impacted ("standards"=1).

Table 4: The impact of standards and technical regulations on market diversification	
Dependent variable: the number of export markets	
Standards	-0.62** (0.36)
Testing procedures	-0.25 (0.31)
Labeling requirements	-0.11 (0.34)
Information inquiry difficulty	0.62 (0.43)
Inspection time	0.13 (0.12)
Raw material inputs	0.03 (0.06)
Total employment	0.34*** (0.10)
Wage	0.22 (0.17)
Age	0.26** (0.15)
Foreign Ownership	-0.04 (0.24)
Number of observations	161
Log likelihood	-292.74
Standard errors are reported in parentheses. *** represents 5% significance level; ** represents 10%; * represents 15%.	

As illustrated, the impact of standards is equivalent to shifting the distribution to the left. The effect of such shift is unambiguously moving some mass out of the rightmost cell, indicating a decline in the probabilities of exporting to more than five markets. In other words, firms who receive impact of standards tend to concentrate their export activities in a smaller number of markets.
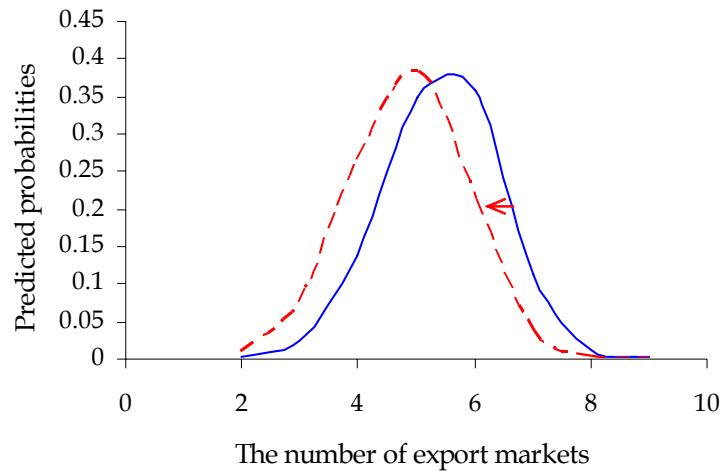

Figure 2: The effect of standards on market diversification

Table 5: The marginal effect of standards on market diversification	
Δ Prob [$n_i^* = 0$]	0.0003
Δ Prob [$n_i^* = 1$]	0.0057
Δ Prob [$n_i^* = 2$]	0.0820
Δ Prob [$n_i^* = 3$]	0.0538
Δ Prob [$n_i^* = 4$]	0.1278
Δ Prob [$n_i^* = 5$]	0.0322
Δ Prob [$n_i^* = 6$]	-0.1415
Δ Prob [$n_i^* = 7$]	-0.0770
Δ Prob [$n_i^* = 8$]	-0.0088
Δ Prob [$n_i^* = 9$]	-0.0021

To be more specific, the marginal effects of the binary variables "standards" on the firm's

decision to export are computed and presented in Table 5.[16] Notice that the sum of these marginal effects at every level of market diversification should be equal to zero. It is found that, because of the impact of standards, the likelihood for a firm to export to more than five markets is 23% smaller, and the probability to export to more than three markets is 7% smaller.

Furthermore, we find, in Table 4, that the coefficient of the variable "total employment" is statistically significant and equal to 0.34, implying that larger firms tend to export to more countries and have a more diversified structure of export markets. Contrast to our finding that young firms have a greater tendency of exporting, we find more mature firms are more likely to export to multiple markets. However, there is no clear evidence that wage rate, the amount of materials or the ownership structure is significant in determining the number of export markets.

5.2 How does the impact on market diversification vary?

The next question that naturally arises is: Are different types of firms equally affected in their export decisions by standards? For example, an informal interview with corporate executives, officers of trade associations and government officials, conducted by the United States International Trade Commission (1998), finds that standards constitute a particular trade restriction to firms which source inputs from numerous countries. The underlying reason is that, when the inputs are produced, their ultimate destination is unknown and thus they may not meet the technical requirements imposed in the market of the final product. Therefore, we separately look at the firms in our sample that import intermediate inputs from other countries (defined here as "outsourcing firms") and examine whether these firms are particularly concerned with the standards and technical regulations in their final product's markets when they decide on the number of export markets.

Table 6 reports the estimation results. It is interesting to find that the impact of standards on export market diversification is considerably larger to firms that import their inputs,

---

[16] Refer to Greene (1997) for a detailed description of the relevant computation methodology.

suggested by the marked rise in the magnitude of the coefficient in Table 6 compared to Table 4. In fact, relative to an average firm, these firms are much less likely to diversify their export markets under the impact of standards. We conclude that importing inputs from numerous locations, which are produced without the standards in the ultimate destinations in consideration, makes the compliance with standards that differ across markets increasingly difficult and can impede firms' entry into more markets.

Table 6: The impact of standards and technical regulations on market diversification for outsourcing firms	
Dependent variable: the number of export markets	Outsourcing firms
Standards	-1.40***
	(0.50)
Testing procedures	-0.43
	(0.28)
Labeling requirements	0.51
	(0.47)
Information inquiry difficulty	0.76
	(0.54)
Inspection time	0.30
	(0.17)
Raw material inputs	-0.07
	(0.09)
Total employment	0.52***
	(0.15)
Wage	0.75***
	(0.23)
Age	-0.01
	(0.19)
Foreign Ownership	-0.15
	(0.28)
Number of observations	102
Log likelihood	-174.51
Standard errors are reported in parentheses. *** represents 5% significance level; ** represents 10%; * represents 15%.	

6. Conclusion

In this paper, we quantify the impact of standards and technical regulations imposed in developed countries on the export performance of firms in developing countries. The different types of technical regulations examined adversely affect firms in both their overall propensity to export and diversification of markets.

First, we examine the impact of standards and technical regulations on firms' propensity to export. Firms that are impacted by testing procedures have a 9% smaller export share, and a 16% smaller export share if firms are domestically owned. On average, information access difficulty discourages exporters by 18% of their total sales. The length of inspection process significantly also reduces firms' export propensity. In particular, both testing procedures and lengthy inspection process constitute a greater concern to agricultural firms.

With the ordered logit model, we estimate the marginal effects of technical requirements on firms' decision in the number of export markets. The firms whose abilities are affected by standards are 7% less likely to export to more than three markets. Firms that import inputs from numerous locations are much less likely to export to multiple markets than an average firm in the presence of standards. The findings support the fact that outsourcing inputs from numerous locations, when production takes place without the ultimate destination in mind, makes compliance with multiple standards more challenging, and thus hinders these firms' diversification of their export markets.

Our findings suggest a number of considerations for exporting nations in efforts to address technical regulations imposed by importing countries. Negotiating on testing procedures towards mutual recognition with importing countries could stimulate exports. Building exporters' capacity in meeting standards, especially that of firms that outsource could help firms diversify their export markets and improve the stability of their sales given the uncertainty in international markets. Facilitating information exchange with importing countries on standards and technical regulations could also stimulate firms' propensity to export.

REFERENCES

Aitken, Brian, Gordon Hansen, and Ann Harrison (1997). "Spillovers, Foreign Investment, and Export Behavior." *Journal of International Economics* 43, No. 1-2: 103-132.

Baldwin, Richard (2001). Regulatory Protectionism, Developing Nations and A Two-Tier World Trade System. CEPR Discussion Paper No. 2574.

Bernard, Jensen and Bradford Jensen. (2004) "Why Some Firms Export". *The Review of Economics and* Statistics 86, No. 2: 561-569.

Dixit, Avinash (1989a). "Entry and Exit Decisions Under Uncertainty." *Journal of Political Economy* 97, No. 3: 620-638.

Dixit, Avinash (1989b). "Hysteresis, Import Penetration, and Exchange Rate Pass-Through." *Quarterly Journal of Economics* 104, No. 2: 205-228.

Eaton, Jonathan, Samuel Kortum, and Francis Kramarz (2004). "Dissecting Trade: Firms, Industries, and Export Destinations". NBER Working Paper No. 10344.

Fischer, Ronald, and Pablo Serra (2000). "Standards and Protection". *Journal of International Economics* 52: 377-400.

Ganslandt, Mattias and James Markusen (2001). "Standards and Related Regulations in Internatitonal Trade: A Modeling Approach". NBER Working Paper No. w8346.

Glejser, H., A. Jacquemin, and J. Petit (1980). "Exports in an Imperfect Competition Framework: An Analysis of 1,446 Exporters". *The Quarterly Journal of Economics* 94, No.3: 507-524.

Greene, William (1997). *Econometric Analysis*, Third edition. Prentice Hall, New York NJ.

Hirsch, Seev and Baruch Lev (1971). "Sales Stabilization Through Export Diversification". *The Review of Economics and Statistics* 53, No. 3: 270-277.

Krugman, Paul (1989). *Exchange Rate Instability*. MIT Press, Cambridge MA.

Maskus, Keith E., Tsunehiro Otsuki, and John S. Wilson (2005). "The Cost of Compliance with Product Standards for Firms in Developing Countries: An Econometric Study". World Bank Working Paper #3590, Washington, DC.

Maskus, Keith E. and John S. Wilson (2001). "A Review of Past Attempts and the New Policy Context", in *Quantifying the Impact of Technical Barriers to Trade: Can it*

be done? edited by Keith E. Maskus and John S. Wilson. University of Michigan Press, Ann Arbor, MI.

Moenius, Johannes (2000). Three Essays on Trade Barriers and Trade Volumes. Ph.D. Dissertation. University of California, San Diego.

Papke, L.E. and J. M. Woolridge (1996). "Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates" *Journal of Applied Econometrics* 11: 619-632.

Roberts, Mark and James Tybout (1997). "An Empirical Model of Sunk Costs and the Decision to Export." *American Economic Review* 87, No. 4: 545-564.

Swann, Peter, Paul Temple, and Mark Shurmer (1996). "Standards and Trade Performance: The UK Experience". *Economic Journal* 106: 1297-1313.

United States International Trade Commission (1998). *Global Assessment of Standards Barriers to Trade in the Information Technology Industry*. Publication 3141, Washington, DC: USITC.

Wagner, J. (2001). "A Note on Firm Size Export Relationship". *Small Business Economics* 17: 229-237.

Wilson, John S. and Tsunehiro Otsuki (2003). "Standards and Technical Regulations and Firm's Ability to Export: New Evidence from World Bank Technical Barriers to Trade Survey". Word Bank (mimeo), Washington, DC.

World Bank (2004). *World Bank Technical Barriers to Trade Survey*.