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Effect of ISO Standards on Exports of Firms in Eastern Europe and Central Asia: An Application of the Control Function Approach

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【Abstract】

Growing number of firms in developing countries have earned certifications such as International Standards Organization (ISO) as it enhances reputation of their company or brand and attract buyers particularly in export market. This study evaluates the effect of international standards certification on firm's export performance in Europe and Central Asia by applying the control function approach with endogenous treatment effect to firm-level data. Certification is found to increase export share in firm's sales by 44.9% on average. The results suggest that ignoring the effect of self-selection of certification leads to a substantial bias in the estimated treatment effect.

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1. Introduction

One of the recognized roles of international standards is to mitigate trade losses associated with the mandatory standards imposed by importing countries as those standards are set based on each country's safety or quality criteria which do not necessarily conform with the international norm (Maskus and Wilson, 2000). International standards certification may be particularly important for exporters in developing economies, who compete with firms in developed countries that have longer histories and better reputations in export markets. Firms that are certified as meeting international standards create favorable perceptions of their company or brand and attract buyers (Acharyya, 2005). For example, the number of firms in Central and Eastern Europe and Central Asia (Europe and Central Asia, hereafter) that earned ISO 9001 rose 6.6 times to 109,000 from 2002 to 2008, according to ISO surveys (ISO, 2006, 2008).

On the other hand, costs to attain international certification—application fees, monetary and human effort, and maintenance—may limit the ability of developing country firms to export. Thus, a firm's decision on acquisition of international standards depends on net benefit to firms. Benefits of certification may be difficult to predict because the benefits depend on many uncertain factors such as consumer's valuation of certification.

Several studies found a higher sales and export for firms certified with international standards (for example, Heras, Dick, and Casadesús (2002), Naveh and Marcus (2005), Ferro (2011)). But the previous studies do not consider the endogeneity of certification; firms that pursue certification are self-selecting with the expected returns in mind. This study applies a control function (CF) approach with endogenous treatment variable based on Heckman's selection model. The CF approach yields a consistent estimator of the effect of treatment (certification) by correcting for the sample selection bias as well as controlling for covariates that affect the outcome. In addition, the previous studies do not consider heterogeneity in effects across firms. This study also allows the treatment effect to vary across firms.

We estimate the benefit of international standards certification on exports of manufacturing and service sector firms in the developing economies of Europe and Central Asia in 2002, 2005, and 2008/2009. The countries in this region are integrating or seeking to be integrated into the EU, and it is important that firms meet international standards when accessing to and competing in the EU market. We use firm-level data of 25 countries from the Enterprise Survey of the World Bank for production, sales and export performance, certification and business environment.

The reminder of the paper is organized as follows. Section 2 develops the empirical model. Section 3 describes the data used for the estimation. Section 4 presents and discusses the estimation results. Section 5 concludes.

2. Model

This study uses firm-level data of 25 countries to evaluate the effect of earning international standards certification on a firm's export performance. This analysis faces a problem that is typical in nonexperimental data; the samples were not made comparable between treated (certified) and untreated (uncertified) firms with identical characteristics as in the experimental data. The literature regarding program evaluation has addressed problems associated with using nonexperimental data through randomization. The randomization makes individuals in a treatment group (the group participating in the program) and a comparison group (group not participating in the program) comparable. Matching methods introduced by Rosenbaum and Rubin (1983) have been widely used and they randomize the data through a propensity score (a probability of participation determined by individual characteristics).

In addition to randomization, the CF approach with endogenous treatment variable accommodates the self-selection of participating firms while the matching estimators suffer from bias due to the violation of mean conditional independence (see, for example, Cameron and Trivedi, 2005). Because seeking international certification is a

firm's decision, acquiring these standards is endogenous. The CF approach explicitly corrects for the potential bias in the fashion of Heckman's (1979) selection model. Further, randomization is conducted through the selection equation in the CF methods, which is equivalent to that in matching methods using a propensity score. Thus, in our study, it is appropriate to use the CF approach because of the need for randomization and the endogenous nature of participation.

Let y denote the outcome (export performance in our case) and d denote a dummy treatment variable (international standards certification in our case) with value of 1 if treated and 0 otherwise. The two outcomes y_1 and y_0 are associated with the treated state ($d=1$) and the untreated state ($d=0$), respectively.

Let $\mathbf{z}$ denote the variables that determine participation. The expected outcome is a function of $\mathbf{x}$ and d.

$$E[u_i \mid \mathbf{x}_i, d] = E[u_i \mid \mathbf{x}_i, d_i, \mathbf{z}_i] \quad (1)$$

Consider the following model:

$$y_{1i} = \mathbf{x}_i'\beta_1 + u_{1i} \quad (2a)$$

$$y_{0i} = \mathbf{x}_i'\beta_0 + u_{0i} \quad (2b)$$

$$d_i^* = \mathbf{w}_i'\gamma + \varepsilon_i \quad (2c)$$

where (2a) and (2b) are the outcome equation, and (2c) is the selection equation. The variable d_i^* is a latent variable such that

$$d_i = \begin{cases} 1 \text{ iff } d_i^* > 0 \\ 0 \text{ iff } d_i^* \le 0 \end{cases}$$

and $\mathbf{w} = \{\mathbf{x}, \mathbf{z}\}$. The vector $\mathbf{z}$ is a vector of the variables not contained in the outcome equations and is included in the selection equation. It is assumed that $E[u_1 \mid \mathbf{x}, \mathbf{z}] = E[u_0 \mid \mathbf{x}, \mathbf{z}] = 0$. It is also assumed that the error terms $(u_{1i}, u_{0i}, \varepsilon_i)$ follow a joint trivariate normal distribution with zero mean and covariance matrix

$$\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{10} & \sigma_{1\varepsilon} \\ \sigma_{10} & \sigma_{00} & \sigma_{0\varepsilon} \\ \sigma_{1\varepsilon} & \sigma_{0\varepsilon} & 1 \end{bmatrix}.$$

The variance of ε is normalized to 1 for identification. The nonzero covariance parameters $\sigma_{1\varepsilon}$ and $\sigma_{0\varepsilon}$ reflect the endogeneity of the treatment variable.

The benefit of treatment can be evaluated in two ways. The average treatment effect (ATE) measures the population average of the treatment effects. By definition, the ATE is given by

$$ATE = E[y_1 - y_0 \mid \mathbf{x}] = E[\mathbf{x}](\beta_1 - \beta_0). \quad (3)$$

The average treatment effect on treated (ATT) measures the effect of treatment on the treated samples, and hence, the benefit of participation. According to Maddala (1983), the treatment effect for the treated sample *i* is given by

$$\begin{aligned} TT_i = E[y_{1i} - y_{0i} \mid \mathbf{x}_i, d_i = 1] &= E[y_{1i} \mid \mathbf{x}_i, d_i = 1] - E[y_{0i} \mid \mathbf{x}_i, d_i = 1] \\ &= \mathbf{x}(\beta_1 - \beta_0) + (\sigma_{0\varepsilon} - \sigma_{1\varepsilon}) \frac{\phi(\mathbf{w}'\gamma)}{\Phi(\mathbf{w}'\gamma)}. \end{aligned} \quad (4)$$

The second term represents the effect of selection, and $\sigma_{0\varepsilon} - \sigma_{1\varepsilon} > 0$ if the program produces a greater benefit under self-selection than under random assignment. The average of TT over the treated individuals gives the ATT.

The treatment effects can be estimated by applying Heckman's (1979) two-step estimation separately to the subsample with $d = 1$ and $d = 0$ (Maddala, 1983) as it yields a consistent estimator by controlling for the effect of sample selection. The probit model is used to estimate the contribution of $\mathbf{x}$ and $\mathbf{z}$ in the self-selection of a firm to acquire certification.

3. Data

We use firm-level data for 25 countries in Europe and Central Asia in 2002, 2005, 2008/2009 from the Enterprise Survey of the World Bank. It includes data for establishments of all sizes in manufacturing and service industries and provides a

selection of information regarding production and marketing performance, and the business environment in all establishments. Some firms were interviewed more than once, but the data will not allow us to explore the nature of panel data since two-thirds of the firms were interviewed only once. The descriptive statistics are presented in Table 1. Out of the entire cleaned sample of 25,554 firms, we use 2164 observations after eliminating samples with missing data.

Share of export in total sales is used to measure export performance. Acquisition of international standards is a dummy variable with the value 1 if acquire, and 0 otherwise; thus, it represents the treatment status. The outcome-equation covariates ($\mathbf{x}$) and the variables in the selection equation that are excluded from the outcome-equation ($\mathbf{z}$) are also included in the table.

Table 1. Summary statistics for the variables used in the estimation (N = 2164)

Variable	Mean	Std. Dev.	Min	Max
Share of export in sales	0.163	0.284	0	1
Acquisition of internationally recognized standards such as ISO	0.326	0.468	0	1
Explanatory variables x				
Share of foreign ownership	0.138	0.315	0	1
Firm size as the number of workers	63.688	36.480	6	100
Firm age as the number of years since the firm is established	21.460	23.411	2	184
Explanatory variables z				
Ratio of expenditure on R&D to sales	0.035	0.066	0	0.8
Visit of external auditors to check financial statements	0.673	0.469	0	1
Percentage of production workers who received training program	24.537	31.505	0	100
Percentage of nonproduction workers who received training program	11.363	23.794	0	100
Degree of importance of pressures from foreign market in decisions to develop new products or services (1=Not at all important, 2 =Slightly important, 3=Fairly important, 4=Very important)	2.373	1.168	1	4
Degree of importance of pressures from domestic consumers in decisions to develop new products or services (the same as above)	2.982	0.984	1	4

Source: Author's calculation based on 2002, 2005 and 2008/2009 Enterprise Surveys.

4. Results

Table 2 presents the results of the estimation of the CF model with and without the restriction of homogeneous treatment effects across the samples. The results of ordinary least squares (OLS) are also presented for the comparison purpose.

The lower portion of the table shows the results of the selection equation which is common between the two CF models. It is found that the probability of acquiring international certification is greater for larger firms, possibly reflecting that the fixed cost of acquiring certification is a great obstacle for smaller firms. It is also found that firms inspected by external auditors tend to acquire international certification. In addition, the provision of training of production and nonproduction workers, and the presence of pressure in foreign markets and from domestic consumers will foster certification.

The upper portion of Table 2 presents the results of the outcome equation. Among the slope coefficients, that for the share of foreign ownership is positive and significant in the CF models as is expected. The model of homogenous treatment effects impose $\beta_0 = \beta_1$ and $\sigma_{0\varepsilon} = \sigma_{1\varepsilon}$ in the CF model, implying a constant ATE and ATT. The ATE is estimated to be 0.428 as shown in Table 3.[1] This implies that certification will raise the share of export in total sales of a firm by 42.8%. This ATE is much larger than the coefficient for international standards (0.084) in the OLS model, illustrating that the OLS tends to under-estimate the effect of certification both by not randomizing the samples and by ignoring the effect of self-selection. The same inference applies to the previous studies that ignore the self-selection nature of certification.

[1] The estimated ATE is statistically significant at the 1 percent level based on Wooldridge's (2010) estimation procedure using OLS with the pooled samples.

Table 2. Results of the Heckman two-step estimation (N = 2164)

Outcome equation (y=Share of export in total sales)	**Homogeneous treatment effect**		**Heterogeneous treatment effect**				**OLS**	
			Equation (2a)		Equation (2b)			
Foreign ownership	0.14365	***	0.12742	***	0.15333	***	0.1617	***
	(0.02174)		(0.03615)		(0.02441)		(0.0187)	
Firm size	0.00033		0.00082		0.00012		0.0014	***
	(0.00026)		(0.00056)		(0.00029)		(0,0002)	
Firm age	-0.00002		0.00018		-0.00017		0.0003	
	(0.00031)		(0.00050)		(0.00035)		(0.0003)	
International standards							0.0840	***
							(0.0128)	
Constant	-0.01696		0.33287	***	-0.01883		0.0137	***
	(0.01445)		(0.08591)		(0.01602)		(0.0119)	
Selection equation (d=acquisition of international standards)								
Foreign ownership	0.05072							
	(0.09407)							
Firm size	0.00855	***						
	(0.00096)							
Firm age	0.00238	*						
	(0.00129)							
R&D	0.16610							
	(0.44942)							
Auditors	0.22929	***						
	(0.06895)							
Training of production workers	0.00391	***						
	(0.00102)							
Training of non-production workers	0.00675	***						
	(0.00135)							
Pressures from foreign market	0.12948	***						
	(0.02713)							
Pressures from consumers	0.07813	**						
	(0.03243)							
Constant	-1.98551	***						
	(0.12716)							
$\sigma_{j\varepsilon}$, $j = 0,1$	-0.22104	***	-0.18204	***	0.25445	***		
	(0.03271)		(0.04917)		(0.04302)			
Model χ^2 (P-value)	248.47 (0)		14.84 (0)		42.44 (0)		adj R^2=0.117	

Note: Inside the parenthesis is standard error. “*”, “**”, and “***” denote 10, 5 and 1 percent significance.

In the model of heterogeneous treatment effects, the mean ATE is 0.449, which is close to that in the model of homogeneous treatment effects. Its low standard deviation (0.030) implies a low variation of the ATE that is caused by the observable factors. The ATE is higher for the manufacturing sector (0.456) than for the service sector (0.442) presumably because the former is more actively involved in export. Among the studied countries, Turkey holds the highest mean ATE (0.460), and Latvia holds the lowest mean ATE (0.436). The mean ATT is 0.833 with a moderate standard deviation (0.138). It is far larger than the mean ATE, and this difference is mainly accounted for by the selection effect.[2] The positive selection effect implies that firms that have unobservable advantage in export—for example, superior managerial skill and knowledge about consumer's preference regarding certification—tend to acquire international standards. Those firms acquire certification knowing that they can potentially expand their sales in foreign market with it.

Table 3. The estimated effect of international standards

	Mean	Std. Dev.	Min	Max
OLS				
	0.0840			
CF with homogeneous treatment effect				
ATE, ATT	0.4283			
CF with heterogeneous treatment effect				
ATE	0.4491	0.0297	0.3801	0.5343
ATT	0.8330	0.1377	0.5140	1.2667

Robustness of the results of the CF model regarding the treatment effect can be examined by comparing the current result with predicted results based on different subsample. We predict ATE and ATT for the 2005 and 2008/2009 subsamples using the model estimated using only the 2002 subsample. The mean predicted ATE is slightly higher—0.525 in 2005 and 0.531 in 2008/2009. In contrast, the mean predicted ATT is considerably high and beyond the upper limit—1.189 in 2005 and 1.126 in 2008/2009

[2] The maximum ATT exceeds 1 because the standard calculation of the ATT does not impose bounds.

although correlation between the current and predicted ATT is reasonably high (0.946 in 2005 and 0.883 in 2008/2009). Thus, the degree of the endogeneity of certification is not constant over time, and it is weaker in the recent years, possibly reflecting the declining brand effect certification over time.

5. Conclusions

This study evaluates the effect of international standards certification on firm's export performance in Europe and Central Asia by applying the control function approach with endogenous treatment effect to firm-level data. Certification is found to increase export share in firm's sales by 44.9% on average. The results demonstrate that ignoring the effect of self-selection of certification leads to a substantial bias in the estimated treatment effect.

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