Does ISO Adoption boost Export Performance? An Empirical Study using Industry-level Data

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ABSTRACT

This paper empirically explores whether the adoption of ISO 14001 boosts export performance, and whether the effect differs depending on the destination countries that have various levels of environmental governance and interests. To examine the effect of ISO 14001 on exports, we estimate the gravity model using a panel data of industry-level exports from South Korea to the various destination countries over the 1988-2015 period. We find that ISO 14001 has a positive impact on exports in the international trade market, and the size of the impact varies by the level of economic development of importing countries. Specifically, the impact is larger when the destinations are the OECD members than the non-OECD countries. We also find that ISO 14001 increases exports to the United States but has no significant impact on exports to China. As expected, GDP per capita has a positive impact and distance between countries has a negative impact on the volume of exports, however, tariffs and regional trade agreements show mixed results.

1. INTRODUCTION

ISO 14001 is one of the most widely adopted voluntary environmental program. Since its launch in 1996, it has provided generic guidelines to implement environmental management systems with the goal of improving environmental attributes of an organization's processes, products, and services. ISO 14001 adoption has grown fast in recent years with a six-fold increase in the number of certifications worldwide from 2002 to 2013. In 2016, the number of ISO 14001 certifications stood at 346,146. The cost of ISO adoption is not trivial, hence firms expect significant benefits when they voluntarily decide to adopt ISO 14001 (Lally, 1998; Bansal and Bogner, 2002; Darnall and Edwards, 2006). One of the main benefits expected by the ISO 14001 adopted firms is to signal their commitment to environmental friendliness (King et al., 2005; Potoski and Prakash, 2006; Berliner and Prakash, 2013).

Since the ISO 14001 certification has a high credibility through the third-party audit, the adoption of ISO 14001 can raise a firms' environmental reputation. According to Berliner and Prakash (2013), firms in a country that lacks proper environmental regulations are more likely to adopt ISO 14001 to signal their commitment to environmental quality to their foreign customers, illustrating the symbolic role of the ISO 14001 certification at an international level. Moreover, ISO 14001 certification is applicable to any type of firm, industry, or country, without restriction. It represents identifiable information about a firm's environmental aspects to its customers (e.g., environmental quality of the production process, future risk related to environmental performance). Thus, it may reduce the transaction costs related to the environmental quality of exporters in the international market. Since information asymmetry is more severe in the

international market than in the domestic market, ISO 14001 may significantly deliver information which is critical to enhance the profits of exporters (King et al.2005).

There have been many studies that examined whether export is a determinant of the ISO 14001 adoption. It is argued that exporters may be more likely to adopt ISO 14001 because they expect a positive impact on exports through a signaling effect (Corbett and Kirsch, 2001; King et al.2005; Potoski and Prakash, 2006; Nishitani, 2009; Tambunlertchai et al., 2013). King et al. (2005), using data of 7,899 US manufacturing facilities from the years of 1995–2001, find that firms that have foreign buyers are more likely to adopt the ISO 14001 program. Their results reveal that firms can signal the high quality of their environmental performance with an ISO 14001 certification. Hence, the firms may have more incentive to adopt ISO 14001 when there is higher information asymmetry between the exporter and the importer, measured by the distance between them. Potoski and Prakash (2006) provide evidence that the signaling effect exists in the international market by focusing on a country's ISO 14001 adoption rate. They investigate the relationship between the ISO 14001 adoption, measured by the country-level adoption rate, and export dependence, measured by the ratio of a country's total exports to their GDP. Using data for 108 countries, from 1996 to 2002, they find that the export-oriented countries are more likely to join ISO 14001 when the destination country widely adopts the ISO 14001 program. These results show that ISO 14001 adoption can reduce information asymmetry and signal about the exporters' environmental performance. It can lower export barriers and trade costs related with environmental aspects.

However, to our knowledge, no study has empirically investigated whether the adoption of ISO 14001 actually has an impact on exports. We could find only one anecdotal study that has

focused on the impact of ISO 14001 adoption on exports. Using a survey of 130 firms that import products from Israel, Bellesi et al. (2005) argue that importers are more likely decide to purchase products from the certified firms. Our paper differs from their study because their results are not an empirical analysis of causality, but a report of a survey that represents how importers perceive an impact of the ISO 14001 adoption.[1]

In this paper, we provide an empirical evidence whether ISO 14001 brings economic benefits in the form of higher volume of exports for adopters. In addition, we investigate if the beneficial impact depends on the destination countries' environmental governance and economic development. Specifically, developing countries have less strict environmental governance, since their economies rely more on high polluting industries than developed countries (Cole, 2000; Panayotou, 2000). On the other hand, consumers in developed countries might be more interested in environmental issues (e.g., eco-friendly products and production processes) to enhance their life quality and safety. Thus, ISO 14001 may be used by exporting countries with lax regulatory enforcements as a credible signal of environmental quality. For example, an ISO survey (2016) illustrates that the level of ISO 14001 adoption varies, depending on the economic development. More specifically, the number of certifications is significantly higher in countries with lower level of environmental performance and regulatory settings (e.g., 137,230 in China) than in countries with stricter environmental scrutiny (e.g., only 5,582 in the US). Moreover, the effect of the ISO 14001 adoption may be more critical when the destination countries require higher environmental assurance (e.g., OECD countries have stricter environmental stringency than non-OECD

[1] For example, to show whether the importers prefer to purchase goods from the certified firms, Bellesi et al. (2005) asked a following question to the survey respondents; "Does the fact that a potential supplier has a certified Environmental Management System affect your decision to buy their product?" Respondents answered for this question by choosing one of the four options, "definite effect", "has some effect", "has little effect", and "definitely no effect".

countries). Therefore, the impact of ISO 14001 on exports, if any, likely differs among importing countries.

We adopt the gravity model to investigate whether ISO 14001 enhances the volume of exports by focusing on South Korean industry-level data. The gravity model has been widely used in theoretical and empirical studies in international trade, and it has been performed well to examine whether specific factors such as trade policies influence on the volume of trade (Bergstrand, 1985; Anderson and Wincoop, 2003; Frankel and Rose, 2002; Carrère, 2006). We note, however, that the gravity model estimation may not generate a causal effect of ISO 14001 adoption on export performance for two reasons. First, unobservable variables (e.g., productivity) may exist that are correlated with both ISO adoption and the volume of export within industry. Second, reverse causality can be an issue, in the sense that large volume of export may lead more number of ISO 14001 adoption, as export has been found to be a determinant of ISO14001 adoption in previous studies (Prakash and Potoski, 2006; Nishitani, 2009; Berliner and Prakash, 2013). To account for the possibility of the endogeneity issue, we employ various fixed effects and lagged independent variables.

For the volume of exports, we collect data of the South Korean manufacturing industries, from 1988 to 2015. We employ each industry's ISO 14001 adoption ratio as our explanatory variable to explain its effect on exports. We analyze the data for South Korea because it is an appropriate case to study the impact of ISO 14001 adoption on exports; its economy relies largely upon exports and its trade partners include developed, emerging, and developing economies alike. In 2016, the export to GDP ratio was 42% which is far ahead of the OECD average (28%), and the

total amount of South Korea's exports is ranked at seventh in the world.[2] Based on the 6-digit the the Harmonized Commodity Description and Coding Systems (HS) code, we found that 4,313 products were exported to 221 countries.[3] Moreover, South Korea has the highest dependence on manufacturing industry among the OECD countries.[4]

This paper contributes to the literature that focuses on ISO 14001 in several ways. First, we provide empirical evidence about whether ISO 14001 actually increases exports. To our knowledge, this has yet to be examined empirically. Second, we assess the impact of the ISO 14001 adoption on exports using industry-level data that allows us to control for industry specific characteristics. When environmental impacts vary across industries, the related result in exports should differ. For instance, consumers in importing countries may be more sensitive to the ISO 14001 adoption of the exporter when the imported products are produced in high polluting industries, such as the chemical industry. Third, we consider the heterogeneity of the destination countries. The impact on the volume of exports may be more significant when the exporting destination is developed countries. For example, OECD countries requires exporting firms to meet a stricter level of environmental quality than non-OECD countries. Fourth, by investigating the data of South Korea, we provide more precise understanding about the role of ISO 14001 on exports for export-oriented countries.

[2] https://data.worldbank.org
[3] Summary statistics of the year 2016 are obtained from https://comtrade.un.org/. The HS code is international nomenclature for the classification of products. It allows participating countries to classify traded goods on a common basis for customs purposes. It is a six-digit code system.
[4] The fraction of exports due to the manufacturing sector in 2015: South Korea is 29.7% and the average OECD is 15.4%.

The remainder of this paper is organized as follows. Section 2 describes the model and the data. In Section 3, the estimation results are reported. Section 4 concludes with a discussion of major findings and future research.

2. METHODOLOGY

2.1. THE GRAVITY MODEL

Since the gravity model was introduced by Tinbergen (1962), it has been widely used in the literature on bilateral trade. By incorporating Newton's the law of gravitation, the gravity model describes bilateral trade as a function of the trading partners' economic mass and the distance between them. In general, economic mass is proxied by GDP, economic size of the trading countries. It captures the size of supply and demand and thus, a positive relationship between GDP and export is expected (Krugman, 1980). Distance represents the transaction costs, and it is expected that distance is negatively related with the volume of trades (Chaney, 2018). There are many studies that use the gravity model to analyze the impact of specific factors (e.g., free trade agreement, environmental regulations) on trade by including those factors as additional explanatory variables. In this paper, we employ the gravity model to examine the impact of ISO 14001 on the volume of exports. The model specification is as follows:

$$lnT_{ijt} = \alpha_0 + \alpha_1 lnY_{jt} + \alpha_2 lnD_j + \alpha_3 Tariff_{jt} + \alpha_5 RTA\_Bi_{jt} + \alpha_6 RTA\_Bloc_{jt} + \theta_i + \delta_j + \lambda_t + \varepsilon_{ijt} \quad (1)$$

where T_{ijt} denotes the sum of the total exports of industry i from South Korea to the country j in year t. D_j is a time invariant variable that presents the distance between South Korea and the

importing country j. Y_{jt} is per capita GDP of the importing country j in year t. $Tariff_{jt}$ is the weighted average tariff of the importing country j in year t. RTA_Bi_{jt} is a dummy variable for bilateral regional trade agreement between South Korea and the country j in year t. RTA_Bloc_{jt} is a dummy for the regional trade agreement at the economic bloc-level; it is 1 if South Korea and country j are the members of the same economic bloc for the preferential trade arrangement in year t. θ_i is an industry dummy, δ_j is a country dummy, and λ_t is a year dummy. Finally, the error term, ε_{ijt}, is assumed to be normally distributed with zero mean and constant variance. The variable definitions are listed in table 1.

[Table 1 about here]

Since this paper focuses on exports from a single country to various exporting partners, the model excludes the common terms such as the exporter's GDP per capita. In addition, other gravity variables addressed in previous studies such as border sharing, common language, and historical colonial relationship are excluded in our model because these may not be relevant to the data of South Korea; only few partners have relationship for those factors.[5]

We estimate the model in Equation (1) to examine the effect of ISO 14001 on the volume of exports. It includes several control variables that may influence exports. We include destination countries' per capita GDP to capture the impact of market size. Larger market size indicates higher demand that may lead higher volume of imports. Thus, a positive sign is expected for GDP per capita. In addition, distance between South Korea to the destination county is included to present trade costs. It proxies not only the physical cost such as transport cost, but also other costs related

[5] Based on CEPII data, North Korea is the only country that shares the border and uses the same language. Japan and Taiwan had a historical colonial tie before 1945, however our export data does not have Taiwan because UNCOMTRADE does not include Taiwanese data.

with distance such as cultural differences and delivery time. We expect that the distance between countries has a negative impact on exports as other studies on the gravity model have shown. Equation (1) also includes trade policy variables such as the weighted average tariff for the destination countries, the bilateral regional trade agreement between Korea and the destination country, and the preferential trade agreement at economic bloc-level. A higher tariff on products means that exporters will face higher costs of trade with the country, thus a negative relationship is expected with exports. On the other hand, the bilateral trade agreement and the preferential trade agreement among the economic bloc members are expected to increase exports. To test the heterogeneity in impacts on exports by the destination countries, we estimate Equation (1) using four different sub-groups; OECD, Non-OECD, Unites States, and China.

2.2 IDENTIFICATION

This paper empirically investigates whether the ISO 14001 adoption has a positive effect on exports using the log-linear equation (1). However, our model has a potential endogeneity issue between exports and the ISO 14001 adoption; firms with high volume of exports may be more likely to adopt ISO 14001. Moreover, there may exist omitted variables that are correlated with both exports and ISO 14001. For example, more profitable or more productive industries may have higher volume of exports, and at the same time, those industries may have higher ISO adoption ratios because they are capable to cover the adoption costs.

Thus, we use OLS with fixed effects and include the factors that may influence exports; GDP per capita, distance, and trade policies. These factors are important control variables to identify the impact of ISO 14001 on export performance because they capture the critical

determinants of exports; market size, transaction cost, and trade policies, respectively. In addition, the fixed effects are used to reduce the possible effect of the unobservables; year fixed effects account for the particular year impacts such as economic shocks, policy changes or time trends, industry fixed effects correct for the sector specific characteristics, and country fixed effects controls for the destination specific unobservables. The model also may have reverse causality issue because high export performance would lead the ISO 14001 adoption as previous studies have shown a positive relationship between trade and the ISO 14001 adoption. We use one year lagged independent variables to circumvent the reverse causality issue, based on the idea that the dependent variable in the future cannot influence on the independent variables in past due to the time separation.

2.3. DATA

This paper analyzes the manufacturing industry which is pollution-intensive and sensitive to environmental factors at the same time. The manufacturing industry contributes significantly to the exports of South Korea; 30% of South Korea's GDP comes from the manufacturing industry. This value is around 15%, on average, in other OECD countries (OECD, 2016). Moreover, the manufacturing industry in Korea is a high polluting industry; in 2013, 40% of total CO_2 was emitted from manufacturing the industry in Korea, while the OECD average was 24% (IEA, 2015). As a result, over 80% of the organizations in Korea's manufacturing industry have ISO 14001 certificates (ISO, 2015). According to UN-COMTRADE report in 2016, the top five exporting industries are manufacturing sectors; machines and electronics (39%), transportation (20%), metals (9%), chemicals (7%), and plastic or rubber (7%).

Dependent variable: The United Nations Commodity Trade Statistics Database (UN-COMTRADE) provides the data of total annual exports from South Korea to the destination countries for each exporting good, based on the product code, the Harmonized Commodity Description and Coding Systems (HS) code.[6] Since the original data from UN-COMTRADE is compiled at product-level, we convert the level of the data from product-level to the industry-level for our analysis. Using a concordance map offered by UN-COMTRADE, we convert HS to ISIC, and then match ISIC with KSIC using a concordance map from Statistics Korea (KOSTAT).[7] After setting up the export data based on 4-digit KSIC, we aggregate exports by the 3-digit KSIC.

Explanatory variable: We employ the ISO 14001 adoption ratio at industry-level as an explanatory variable. It is the ratio of the number of ISO 14001 certified firms to the total number of firms, within each industry (3-digit KSIC) in each year. To calculate the adoption ratio, we collect the ISO 14001 certification data from the Korean Accreditation Board from 1996 to 2015. Since the certificates are released at the plant-level, we use the earliest certified year as the adoption year of the firm.

Control variable: To capture the trade cost, we obtain the distance between South Korea and the destination countries from the CEPII database. Per capita GDP at current US dollars is available from the UN database and World Development Indicators (WDI). The average tariffs of each country are available from WDI, and the bilateral and bloc-wise regional trade agreements are derived from Trade Analysis Information System (TRAINS).

[6] The dataset is available at the UN Comtrade website: https://comtrade.un.org/data/. The HS code is international nomenclature for the classification of products. It allows participating countries to classify traded goods on a common basis for customs purposes. It is a six-digit code system.
[7] ISIC: International Standardization of Industry Classification. KSIC: Korean Standardization of Industry Classification.

In the end, our data set covers 70-subsectors of the manufacturing industry exporting to 192-destination countries in the period 1988-2015. Table 2 presents the descriptive statistics.

[Table 2 about here]

3. RESULTS

Table 3 shows the estimation results for the gravity equation (1). In the estimation, all dimensions of the fixed effects are included (industry, destination country, and year) and the coefficients are estimated with clustered standard errors to correct the possible serial correlations. Columns (1) to (5) present the results for the full sample, OECD countries, Non-OECD countries, the United States, and China.

Except the case of China, we find the significant positive impact of ISO 14001 on export performance in all samples. This fundamental result validates the theory tthat ISO adoption is partly driven by a desire to boosts exports; i.e., ISO 14001 adoption serves as a credible signal that generates economic benefits by expanding the market opportunity for adopters, reducing transaction costs, and mitigating export barriers. According to the survey of Bellesi et al. (2005), importers consider ISO 14001 as an important feature for their purchasing decision, and thus they are more likely to choose the goods from the ISO 14001 certified firms. In other words, ISO 14001 has the potential to attract more customers, which may increase the volume of exports. Second, the certification process of ISO adoption serves to reduce the information asymmetry and related costs such as search costs between importers and exporters (King et al., 2005). For example, importers may not have enough information about the exporter in the distant country, which requires time and labor costs to research. However, importers can save the related costs by choosing the ISO 14001 certified firms since the certification delivers credible information about the firms' environmental quality. As a result, the ISO 14001 certified exporters may become more

attractive to the importers and increase their volume of exports. Also, ISO 14001 would mitigate the export barrier by representing the adopter's environmental assurance to the importers (Berliner and Prakash, 2013). As the interests on the environmental safety increase, many developed countries tend to enforce strict environmental regulations to the importing goods. Although it aims to protect environment, it could act as a barrier in the international trade market. However, exporters may avoid the barrier by proving the certain level of environmental quality using ISO 14001. To summarize, we ascribe our empirical finding that ISO 14001 increases export performance to its signaling effect.

In addition to our main result, we find heterogeneity of the impact depending on where the destination countries are located in the economic development spectrum. Comparing the results in columns (2) and (3) shows that the impact of ISO adoption on exports is substantially larger when the destination countries are OECD members than non-OECD, which indicates that ISO 14001 is more effective at increasing exports when the destination countries have stricter environmental standards and higher environmental interests. Similarly, the impact is positive when the destination country is the United States. However, no significant effect is found in China even though China has the largest number of ISO 14001 certifications; this suggests that less-developed economies, with lax environmental regulations do not value ISO 14001.

The result shows that the gravity variables, GDP level and distance between countries, are significant determinants of the volume of exports in South Korean manufacturing industry. Both variables carry the expected signs, positive impact of GDP and negative impact of distance on exports. The positive sign of importing country's GDP indicates that the market size is critical to increase exports. The negative sign of distance implies that as the destination country is closer, the volume of exports increases because the related costs are declined. Tariff and bloc-level RTA are

not significant in our results.

[Table 3 about here]

4. CONCLUSION

Recently, many developed countries have strengthened their environmental regulation to enhance their environmental safety (OECD, 2002). Exporters in developing countries have expressed their concerns that this trend may act as a new non-tariff barrier to protect the importer's domestic industries (OECD, 2003). Our result shows the possible role of ISO 14001 in enhancing export performance, in addition to improving environmental quality. Interestingly, the impact level differs depending on whether the importing countries are developed or developing. This result implies that when the destination countries are developed, ISO 14001 would be an effective voluntary environmental program to circumvent stricter environmental requirements and mitigate the risk of export barrier. In other words, the significant effect of ISO 14001 on exports represents that developed countries actually use ISO 14001 to identify the proper environmental quality, and they value those environmentally qualified goods. Hence, ISO 14001 would be beneficial not only to improve the environmental performance, but also to enhance the economic benefits.

As next step, we will employ the Poisson Pseudo Maximum Likelihood (PPML) estimator suggested by Santos-Silva and Tenreyro (2006), and check whether the estimates are consistent across different functional form specifications. In addition, PPML is expected to correct heteroskedasticity which has been identified as a source of parameter inconsistency (Santos-Silva and Tenreyro 2006).

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Table 1. Variable Definitions

Variable	Definition
Export (Billion USD)	Total export from South Korea to the destination country j in industry i and year t (in Billion)
GDP	GDP per capita in country j in year t
ISO14001	The total number of ISO14001 certified firms to the total number of firms, within industry i and year t
Distance (km)	Distance from South Korea to country j (in kilometer)
Tariff (%)	Weighted average tariff in country j and year t
RTA(Bilateral)	1 if there is a bilateral trade agreement between South Korea and country j in year t, 0 otherwise
RTA(Bloc)	1 if South Korea and country j are the member of the same economic bloc for the preferential trade arrangement in year t, 0 otherwise

Table 2. Descriptive Statistics

Panel. A Descriptive Statistics by groups

	OECD		NON-OECD		POOLED	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Export (Billion USD)	0.03	0.18	0.02	0.23	0.02	0.22
GDP	27715.00	16487.30	8336.56	13920.73	11901.17	16263.82
ISO14001	0.09	0.15	0.09	0.15	0.09	0.15
Distance (km)	8497.13	2307.33	9254.64	4151.59	9116.96	3893.06
Tariff (%)	3.07	11.47	4.37	6.49	4.13	7.66
RTA(Bilateral)	0.02	0.15	0.01	0.11	0.01	0.12
RTA(Bloc)	0.25	0.43	0.36	0.48	0.34	0.47

Panel. B Descriptive Statistics (a single country)

	USA		CHINA	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Export (Billion USD)	0.34	1.18	0.39	1.35
GDP	38423.01	10574.76	2432.03	2440.30
ISO14001	0.08	0.14	0.08	0.14
Distance (km)	11065.70	0	955.65	0.00
Tariff (%)	2.10	1.02965	8.81	9.30
RTA(Bilateral)	0.14	0.34891	0.04	0.19
RTA(Bloc)	0	0	0.53	0.50

Table 3. Baseline estimates

VARIABLES	(1) Pooled Sample	(2) OECD	(3) NON-OECD	(4) USA	(5) China
L1_ISO14001	2.460***	3.453***	2.232***	5.278***	0.298
	(0.297)	(0.530)	(0.344)	(0.849)	(0.992)
L1_lnGDP	1.347***	1.859***	1.260***	-2.929	-0.0911
	(0.124)	(0.398)	(0.137)	(13.48)	(3.676)
lnDistance	-1.524***	-1.094**	-1.380***	4.509	1.876
	(0.132)	(0.471)	(0.147)	(14.45)	(3.077)
L1_Tariff	0.00203	-3.94e-05	0.000870	-15.69	0.0329
	(0.00192)	(0.00125)	(0.00340)	(67.79)	(0.181)
L1_RTA_Bi	-0.466***	-0.473	-0.496***	27.58	
	(0.112)	(0.318)	(0.130)	(99.26)	
L1_RTA_Bloc	-0.183	0.0820	-0.0903		4.436
	(0.124)	(0.244)	(0.189)		(11.29)
Industry FE	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	N	N
Year FE	Y	Y	Y	Y	Y
Observations	180,333	33,157	147,176	1,777	1,755
R-squared	0.864	0.921	0.849	0.986	0.982