INTRODUCTION

China’s export growth rate increased rapidly from 6.8% in 2001 to 31.3% in 2010 after it joined the World Trade Organization (WTO). As a result, there is growing concern that the expansion of China’s exports may have negative effects on other countries’ exports. Studies in this area have focused mainly on the competition between China and other Asian countries (Eichengreen, Rhee, & Tong, 2007; Greenaway, Mahabir, & Milner, 2008; Ianchovichina & Walmsley, 2005; Lall & Albaladejo, 2004; Shafaeddin, 2004). Thus, the question of whether China’s export growth has a negative effect on the exports of Organisation for Economic Co-operation and Development (OECD) countries remains unanswered.

According to Greenaway et al. (2008), China’s export growth is expected to have a negative effect on high-income countries’ exports to third markets. Greenaway et al. (2008) stressed that because China’s comparative advantage comes from moving from the production of low-technology, low-skilled intensive goods to high value-added and less labour-intensive manufacturing, its export growth is having a strong displacement effect on high-income Asian exporters. However, this negative effect may not be applicable to intermediate goods. Therefore, a disaggregated, sectorial study is needed to reflect the increasing cross-country complementarity of production processes that accompany China’s rapid integration into the global production network. According to Eichengreen et al. (2007), China’s export growth has had a positive effect on the exports of other Asian countries in third markets for intermediate goods. In accordance with Athukorala (2009), this effect can be defined as a dampening effect, in that China’s exports grow faster than those of its
competitors and retard their growth.¹ Based on prior studies, the crowding-out or dampening effects of China’s export growth on the exports of OECD countries are expected.

However, the effects of China’s export growth on those of OECD countries may be weaker because importers are expected to select exports from OECD countries rather than from China when they have a strong preference for environmental quality. According to Copeland and Taylor (1994), higher income countries specialise in producing relatively clean goods. Thus, OECD countries are expected to export more environmentally friendly goods than China. According to Barboza’s (2007) report, China’s goods are vulnerable to contamination because of long supply chains with multiple contractors and subcontractors. This difference in the environmental quality of goods gives rise to the variation in the preferences for environmental quality across the importing countries. Consequently, the objective of this study is to analyse how importers’ preferences for environmentally friendly products influence the effect that China’s export growth has on the exports of OECD countries.

The gravity model has been used to investigate the effects of China’s exports in a number of prior studies (e.g., Athukorala, 2009; Eichengreen et al., 2007; Greenaway et al., 2008). However, these studies do not use a theoretical gravity model to analyse China’s exports; instead, they simply add exports as a factor into the gravity model. Thus, this study presents a new approach to examining the effect of China’s export growth on the exports of OECD countries by extending the theoretical gravity model developed by Anderson and van Wincoop (2003). Specifically, the effect of China’s exports is incorporated as a component of trade cost into the theoretical gravity equation, which is derived from general equilibrium analysis. In addition, the unobserved multilateral resistance factors, which are critical to the model of Anderson and van Wincoop (2003), are examined using the simple first-order log-linear Taylor-series expansion method proposed by Baier and Bergstrand (2009).

Another key innovation of this study is to ease the constraint of the assumption that importers’ preferences for environmentally friendly products are the same across countries and to propose a new measure that represents importers’ actual preferences for environmental quality across countries. The existing studies in this area implicitly assume that importers’ preferences are the same and do not consider them to be a significant factor.

The remainder of this paper is organised as follows. Section 2 provides an overview of the exports of China and selected OECD countries. Section 3 establishes a simple model that serves as the theoretical framework for the study. Section 4 provides empirical evidence on the influence that importers’ preferences for environmental quality have on the effect of China’s export growth on the exports of OECD countries based on the new indicator relating to importers’ preferences for environmentally friendly products. Section 5 concludes the paper.

2 | EXPORTS OF CHINA AND OECD COUNTRIES

Figure 1 presents the trends in export growth from 2000 to 2010 for China and OECD countries to the third markets by sector.² China’s exports increased rapidly across all sectors after it joined the WTO in 2001, whereas OECD countries’ exports grew slowly in this period. Thus, China’s

¹In other words, the dampening effect means that the exports of China’s competitors grow below unity due to the rapid growth of China’s exports. Lall and Albaladejo (2004) regarded this dampening effect as a partial threat.

²The three sectors are sorted in the HS 96 version according to the classification of Eichengreen et al. (2007) based on SITC revision 2 as follows: Capital goods fall under the 84, 85(−), 86, 87(−), 88 and 89 codes; consumption goods are defined as including the 01–24, 30, 61–66, 8527–8528, 8703, 8711–8713, 90–92 and 94–97 codes; and intermediate goods comprise the 25–29, 31–60, 67–83, 93 and 99 codes.
Export growth appears to have crowded out or dampened that of OECD countries, depending on the sector. Across the three sectors examined, the most significant gap between China and OECD countries during the period appears in relation to capital goods, of which China’s exports jumped sharply from $1,169 million in 2000 to $13,014 million in 2010, whereas those of OECD countries rose moderately from $1,003 million to $1,425 million on average over the same period. Hence, it is predicted that the crowding-out effect of China’s export growth on the exports of OECD countries, if it exists, is the most severe in this sector.

Table 1 shows the top five export destinations for China and a number of representative OECD countries based on the average export volumes from 2000 and 2010. China is included in the top five export markets of almost all of the selected OECD countries for intermediate goods and capital goods, whereas it is only in the top export market of Japan for consumption goods. OECD countries’ exports to China account for 10.7%, 7.2% and 4.1% of their total exports on average for intermediate goods, capital goods and consumption goods, respectively, while their average exports to each market account for 0.4% on average across all sectors, suggesting that China supports the export growth of OECD countries through its imports from them, especially of intermediate goods and capital goods.

China’s top five export destinations overlap with those of the selected OECD countries across all sectors, except for South Korea for consumption goods and Germany and the Netherlands for capital goods, although these three exceptions do belong within the other OECD countries’ top 10 export markets. China’s top five export markets account for 55.9%, 45.2% and 56.4% of its total exports of consumption goods, intermediate goods and capital goods, respectively. OECD

---

3South Korea and Germany are included in the top 10 export markets of Australia, Japan and the United States for consumption goods and capital goods, and the Netherlands is a top 10 export market of Germany and Japan for capital goods.
countries’ exports to the corresponding destinations account for 29.4%, 21.7% and 21.6%, on average, respectively. These figures indicate that there is intense export competition between China and OECD countries.

Figure 2 shows the trend in the Export Similarity Index (ESI) between China and OECD countries.\(^4\) First used by Finger and Kreinin (1979), this measure is a good proxy for the level of export competition between China and OECD countries in third markets. The value for each year

\(^4\)The Export Similarity Index is computed as follows:

\[ ESI(cj,i) = \left( \sum \min[X_r(ci), X_r(ji)] \right) \times 100, \]

where \(X_r(ci)\) is the share of product \(r\) in the exports of country \(c\) to country \(i\) and \(X_r(ji)\) is the share of product \(r\) in the exports of country \(j\) to country \(i\).
represents the average of the ESIs between China and the 30 OECD countries and is calculated based on the HS 96 version 6-digit codes. Among the three sectors, the level of export competition between China and OECD countries is the highest for capital goods and the lowest for consumption goods. In regard to the dynamic pattern of export competition, there is little change for consumption goods during the period of analysis. However, the export competition for capital goods and intermediate goods is becoming increasingly fierce. These figures are consistent with the observation that China’s exports are moving from low value-added to high value-added goods with China’s rapidly increasing participation in the global production networks.

3 | THE MODEL

This study extends the theoretical gravity model developed by Anderson and van Wincoop (2003) to investigate how importers’ preferences for environmentally friendly products influence the effect of China’s export growth on the exports of OECD countries. The traditional gravity model used in the literature lacks a theoretical foundation, mainly due to the absence of multilateral resistance factors, which represent the barriers to trade that each country faces with its trading partners. Accordingly, Anderson and van Wincoop (2003) develop a new theoretical gravity model to control for these factors under the assumption that each country specialises in the production of only one good, which is differentiated by place of origin, and that consumer preferences are identical and homothetic. The following demand equation is derived from Anderson and van Wincoop’s (2003) utility maximisation problem:
Although Baier and Bergstrand (2007) devise country-and-time effects as extended fixed effects to account for the time-varying multilateral resistance terms, this method leads to overly controlled time-varying country-specific variables, including those of interest in this study.

$$X_{ei} = \left( \frac{y_e y_i}{y_w} \right) \left[ \frac{t_{ei}}{\Pi_e P_i} \right]^{1-\sigma},$$  \hspace{1cm} (1)

where:

$$\Pi_e = \left\{ \sum_i \left[ \left( \frac{t_{ei}}{P_i} \right)^{1-\sigma} \theta_i \right] \right\}^{\frac{1}{1-\sigma}},$$  \hspace{1cm} (2)

$$P_i = \left\{ \sum_e \left[ \left( \frac{t_{ei}}{\Pi_e} \right)^{1-\sigma} \theta_e \right] \right\}^{\frac{1}{1-\sigma}},$$  \hspace{1cm} (3)

$X_{ei}$ is the bilateral trade flow from country $e$ to country $i$; $y_e$ ($y_i$) is the income of exporting country $e$ (importing country $i$); $y_w$ is the global income; $t_{ei}$ is the trade cost between $e$ and $i$; $\theta_e$ ($\theta_i$) = $y_e$/$y_w$ ($y_i$/$y_w$); and $\sigma = 1/(1-\rho)$ is the elasticity of substitution among different goods.

Under the assumption that trade costs are symmetric, $t_{ei} = t_{ie}$, a solution to Equations (2) and (3) is $\Pi_e = P_e$. Then, taking logarithms on both sides of Equation (1), the following equation is derived:

$$\ln X_{ei} = \alpha + \ln y_e + \ln y_i - (\sigma - 1) \ln t_{ei} + (\sigma - 1) \ln P_e + (\sigma - 1) \ln P_i,$$  \hspace{1cm} (4)

where $P_e$ ($P_i$) is the CES price index of exporting country $e$ (importing country $i$), which represents an unobserved multilateral resistance factor.

Although there are several methods for accounting for unobserved multilateral resistance terms, the simple first-order log-linear Taylor-series expansion approach proposed by Baier and Bergstrand (2009) is the most appropriate one for panel data estimation. The custom nonlinear least squares model introduced by Anderson and van Wincoop (2003) could be computationally challenging with panel data, and the fixed effect alternative cannot control for time-varying multilateral resistance factors (Awokuse & Yin, 2010). Thus, this study follows Baier and Bergstrand (2009) in representing the multilateral resistance terms as follows:

$$\ln P_e = \sum_{i=1}^{N} \theta_i \ln t_{ei} - \frac{1}{2} \sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m \ln t_{km},$$  \hspace{1cm} (5)

$$\ln P_i = \sum_{e=1}^{N} \theta_e \ln t_{ei} - \frac{1}{2} \sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m \ln t_{km}.\hspace{1cm} (6)$$

Substituting these derived equations into Equation (4) yields:

$$\ln X_{ei} = \alpha + \ln y_e + \ln y_i - (\sigma - 1) \ln t_{ei} + (\sigma - 1) \sum_{k=1}^{N} \theta_k \ln t_{ek} + (\sigma - 1) \sum_{k=1}^{N} \theta_k \ln t_{ki}$$

$$- (\sigma - 1) \sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m \ln t_{km}.\hspace{1cm} (7)$$

In this study, the unobservable trade cost is modelled as the following function of the observable variables:

$$t_{ei} = DIS_{ei} e^{-(\beta_2 CT_{ei} + \beta_3 CL_{ei} + \beta_4 CO_{ei}) C_i I_e},$$

where $DIS_{ei}$ is the bilateral distance between country $e$ and country $i$; $CT_{ei}$, $CL_{ei}$, and $CO_{ei}$ are dummy variables indicating whether the countries are contiguous, share a common official language and have ever had a colonial link, respectively. In addition, $C_i$ is the exports from China to country $i$.
i, I_e is an indicator function taking the value of one if exporting country e is an OECD country and zero otherwise, E_i is a measure of importing country i’s preference for environmentally friendly exported goods, and ̄E is the average global level of the preference for environmental quality.6 Except for C_i^f(\ln \bar{E} - \ln E_i), Equation (8) is a log-linear function of the observable variables derived from the literature (Anderson & van Wincoop, 2003; Baier & Bergstrand, 2009; Hallak, 2006). The novelty in specifying the unobservable trade cost relates to the influence of China’s exports to country i, the intensity of which is determined by the level of importing country i’s preference for environmental quality relative to the average global level. If exporting country e is not an OECD country, then the trade cost function follows that in the literature, which does not consider the variation in the preference for environmentally friendly goods across importing countries.

As China’s export growth to country i can impede or enhance the exports of OECD countries to the same markets, as explained, this factor is included in the trade cost function. The level of importing country i’s preference for environmental quality is also added to reflect the influence of the variation in preferences across importing countries on the export competition between China and OECD countries. The difference between China and OECD countries in the environmental quality of exports gives rise to the variation in the preferences for environmental quality across importing countries. Consequently, an importer with a strong preference for environmental quality is likely to exhibit a greater demand for exports from OECD countries than for those from China. Therefore, the effect of China’s export growth on the exports of OECD countries is assumed to be affected by the level of importing country i’s preference for environmental quality E_i relative to the world average level ̄E.

Provided that country e is an OECD country, inserting the trade cost from Equation (8) into Equation (7) generates the following gravity equation:

\[
\ln X_{ei} = \alpha + \ln y_e + \ln y_i - (\sigma - 1)(\ln ̄E - \ln E_i) \ln C_i - (\sigma - 1)\beta_1 \ln DIS_{ei} + (\sigma - 1)\beta_2 CT_{ei} + (\sigma - 1)\beta_3 CL_{ei} + (\sigma - 1)\beta_4 CO_{ei} + (\sigma - 1)\ln ̄MRC_i - (\sigma - 1)\beta_5 MREC_i - (\sigma - 1)\beta_6 MRDIS_{ei} - (\sigma - 1)\beta_7 MRCT_{ei} - (\sigma - 1)\beta_8 MRCO_{ei},
\]

(9)

where:

\[
MRC_i = \sum_{k=1}^{N} \theta_k \ln C_k + \sum_{m=1}^{N} \theta_m \ln C_i - \sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m \ln C_m,
\]

\[
MREC_i = \sum_{k=1}^{N} \theta_k \ln E_k \ln C_k + \sum_{m=1}^{N} \theta_m \ln E_i \ln C_i - \sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m \ln E_m \ln C_m,
\]

\[
MRDIS_{ei} = \left[ \sum_{k=1}^{N} \theta_k \ln DIS_{ek} + \sum_{m=1}^{N} \theta_m \ln DIS_{ei} - \sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m \ln DIS_{km} \right],
\]

\[
MRCT_{ei} = \left[ \sum_{k=1}^{N} \theta_k CT_{ek} + \sum_{m=1}^{N} \theta_m CT_{mi} - \sum_{k=1}^{N} \sum_{m=1}^{N} \theta_k \theta_m CT_{km} \right].
\]

The fourth term on the right-hand side of Equation (9), \(-(\sigma - 1)(\ln ̄E - \ln E_i) \ln C_i\), shows that the effect of China’s export growth on OECD countries’ exports to third markets is influenced by the importer’s preference for environmentally friendly products, given that \(\sigma\) and ̄E are constant. Where environmental preferences are the same across importers, or \(E_i = ̄E\), Equation (9) follows

---

6Environmental quality represents the cleanness of production as defined by Amacher, Koskela, and Ollikainen (2004). The cleanness of production implies environmentally friendly production and the use of less polluting inputs.

7MRCL_{ei} and MRCO_{ei} follow the pattern of MRCT_{ei}.
the gravity model of Anderson and van Wincoop (2003) and the variable for China’s exports $\ln C_i$ disappears. Thus, the practice of simply adding China’s exports to the gravity model as conducted in prior studies is implausible in this theoretical context.

The influence of importers’ preferences for environmental quality on the effect of China’s export growth on the exports of OECD countries is expected to be valid only in relation to consumption goods and intermediate goods and not capital goods. Consumers may demand more environmentally friendly goods to maximise their utility when purchasing consumption goods, given their increasing preference for environmental quality.\(^8\) Therefore, consumption goods can be included in the environmental demand sector. Although the users of intermediate goods are firms, these inputs are closely associated with consumption goods, as they are mostly used to produce consumption goods. Thus, intermediate goods can be included in the quasi-environmental demand sector. The buyers of capital goods take profit maximisation into account by reducing production costs rather than maximising consumer utility, as they are firms. Hence, capital goods can be treated as part of the non-environmental demand sector. Therefore, the argument regarding importers’ preferences for environmental quality is only applicable to the environmental demand and quasi-environmental demand sectors, as these sectors are closely related to consumer utility.

4 | EMPIRICAL ANALYSIS

In this section, a measure is first devised to gauge the level of importer preference for environmental quality across countries for the regression analysis. The econometric methods for estimating the specifications of the model established in Section 3 are then outlined, the data used described and the empirical results presented.

4.1 | Indicator of importer preference for environmental quality

The importer preference for environmental quality indicator (IPEQI) included in the model builds on an environmental quality indicator (EQI) that ranks export products according to the environmental protection efforts associated with their production. In constructing the EQI, reference is made to the PRODY index introduced by Hausmann, Hwang, and Rodrik (2007). The PRODY index measures the weighted average per capita GDP of countries exporting a given product and thus represents the income level associated with that product. This index has been used by a number of recent studies as a proxy for the level of export sophistication (e.g., Jarreau & Poncet, 2012; Minondo, 2010; Xu & Lu, 2009; Yao, 2009). The indicator is calculated as follows:

$$ PRODY_n = \sum_e \left( \frac{x_{en}}{X_e} \right) \frac{Y_e}{\sum_e \left( \frac{x_{en}}{X_e} \right)} $$

where $x_{en}$ denotes country $e$’s exports of product $n$ and $X_e$ is country $e$’s total exports. In addition, $\left( \frac{x_{en}}{X_e} \right) / \sum_e \left( \frac{x_{en}}{X_e} \right)$ is the revealed comparative advantage of country $e$ in relation to product $n$ and $Y_e$ is country $e$’s per capita GDP based on its purchasing power parity. Hence, $PRODY_n$ represents a weighted average of $Y_e$, where the weights correspond to the revealed comparative

---

\(^8\)Arora and Gangopadhyay (1995) reasoned that the growth in firms’ voluntary over-compliance with environmental regulations is due to consumers’ preferences for environmental quality. Hamilton and Zilberman (2006) also stressed that consumers’ preferences for market goods are as much determined by the environmental attributes of products as by any other quality attributes. Thus, the demand of consumers with new attitudes towards environmental values may be driving the market for green products (Chen, 2001).
advantage. According to Hausmann et al. (2007), the rationale for using revealed comparative advantage as a weight is to ensure that the size of a country does not distort the ranking of its goods. The fundamental assumption underlying the PRODY index is that countries with a higher per capita GDP export more sophisticated goods. The same logic can be applied in using the EQI to complement the environmental performance index (EPI), which is a direct and comprehensive measure of environmental preservation. That is, a country with a higher EPI exports more environmentally friendly goods. The EQI is constructed as follows:

$$EQL_n = \sum e \left[ \frac{(x_{en}/X_e)}{\sum e (x_{en}/X_e)} \right] EPI_e. \quad (11)$$

The EPI is a composite index of the effects of current national environmental protection efforts devised by the Yale Center for Environmental Law and Policy and the Center for International Earth Science Information Network at Columbia University, in collaboration with the World Economic Forum and the Joint Research Center of the European Commission. The EPI has been published biannually in a stylised form since 2006. The index builds on measures relevant to two core objectives: reducing the environmental stress to human health and protecting ecosystems and natural resources. The second objective is divided into five policy categories: air pollution, water resources, biodiversity and habitat, productive natural resources, and climate change. The EPI is aggregated through a weighted average of detailed indicators according to the aforementioned core objectives and policy categories (e.g., 16 indicators in 2006 and 25 indicators in 2008). The number of countries covered by the index also varies (e.g., 133 countries in 2006 and 149 countries in 2008). Table 2 reports the average EPI between 2006 and 2008. The value for Sweden, 90.5, is the highest among the 130 countries, whereas that of Niger, 32.4, is the lowest. The values for China and OECD countries of interest in this study are 60.6 and 82.6 (average), respectively, which provides further evidence supporting the argument made in Section 3 that OECD countries export more environmentally friendly goods than China.

The EQI is now used to construct the IPEQI. The extent of an importer’s preference for environmental quality is revealed by the level of imports of green goods. In other words, the IPEQI is the weighted average of the EQI, where the weights represent the share of each product in the country’s total imports. The IPEQI is given as follows:

$$IPEQI_i = \sum_n \left( \frac{m_{in}}{M_i} \right) EQL_n, \quad (12)$$

where $m_{in}$ denotes country $i$’s imports of product $n$ and $M_i$ denotes country $i$’s total imports. Table 3 shows the empirical results for the IPEQI as constructed by Equation (12). Note that because the average EQI between 2006 and 2008 is used to construct the IPEQI, the EQI values used in constructing the IPEQI do not vary over the years. Each statistic is obtained on the basis

---

9The EQI is a measure by-product and the EPI is a measure by country. The latter pays no regard to the sector, such as consumption or intermediate goods. The IPEQI is a measure by country with a component of the EQI. It is a target measure to gauge the level of importer preference for environmental quality across countries for the regression analysis. Jarreau and Poncet (2012) used a similar method to measure the sophistication level of imports by country.

10Current export values need to be transformed into constants for the average EQI, which requires the export price indices of each country and product. However, because these data are difficult to obtain, the US import price index used by Minondo (2010) is adopted as a good proxy of the average evolution of global export prices. The US import price indices are obtained from the U.S. Bureau of Labor Statistics. In addition, the weights in Equation (11) are calculated based on the HS 96 version 6-digit codes, which are the most disaggregated level in terms of international trade data.
of the average IPEQI from 2000 to 2010. The US export price index is used to transform current import values into constants. Table 3 reveals that Switzerland and Niger record the maximum (76.87) and minimum (67.01) values, respectively, among the 99 countries for consumption goods, and Switzerland and India have the respective maximum (76.14) and minimum (69.38) values for intermediate goods.11

As explained by Brecard, Hlaimi, Lucas, Perraudeau, and Salladarre (2009), environmentally friendly products are more expensive than less environmentally friendly goods, because the former incur additional costs required to develop environmentally friendly production technologies. Moreover, in this study, green goods are regarded as normal, rather than public goods. Thus, the IPEQI is expected to be constrained by the importer’s income (Arora & Gangopadhyay, 1995; Brecard et al., 2009; Franzen, 2003; Torgler & Garcia-Valinas, 2007). The relationship between income and the IPEQI is analysed in Table 3 through the correlation coefficient between the logarithm of the average IPEQI and the logarithm of the average income.12 The correlation coefficients between them are positively significant at the 1% level across all sectors. However, the value for intermediate goods is 0.62, which is unexpectedly low relative to the value of 0.79 for consumption goods. Trade conducted by multinational corporations provides a possible explanation for this low value for intermediate goods. According to the study by Helpman (1985), the share of intra-firm trade increases as the difference in relative factor endowments widens, provided that the difference is not too large. This finding supports the argument that subsidiaries in developing

---

11 India is unexpectedly ranked 99th for intermediate goods because it is highly dependent on environmentally poor natural resources. The items above 5% in terms of the average share of India’s total imports for intermediate goods from 2000 to 2010 are crude oil (30.3%), unwrought gold (9.2%) and unworked diamonds (7.8%).

12 The income is real GDP per capita measured at purchasing power parity in constant 2000 US dollars.
countries import eco-friendly intermediate inputs from their parent firms in developed countries to export finished goods. Therefore, the IPEQIs for developing countries are over-estimated, which leads to the low value of the correlation coefficient for intermediate goods.

4.2 Econometric method and data description

The specification for estimating Equation (9) using panel data is as follows:

\[
\ln X_{eit} = \alpha_0 + \alpha_1 \ln y_{eit} + \alpha_2 \ln y_{itin} + \alpha_3 \ln C_{itin} + \alpha_4 \ln E_{itin} \ln C_{itin} \\
+ \alpha_5 \ln DIS_{eit} + \alpha_6 CT_{eit} + \alpha_7 CL_{eit} + \alpha_8 CO_{eit} + MRC_{itin} \\
+ MREC_{itin} + MRDIS_{eit} + MRCT_{eit} + MRCL_{eit} + MRCO_{eit} \\
+ \phi_e + \phi_i + \phi_t + \epsilon_{eit},
\]

where \(\phi_e\) and \(\phi_i\) represent exporter and importer effects, respectively, which control for all time-invariant country characteristics, and \(\phi_t\) denotes time effects, which account for omitted variables that are common to all trade flows but vary over time.

As noted in the literature, the estimated parameters \(\alpha_1, \alpha_2\) and \(\alpha_6-\alpha_8\) are expected to have a positive sign such that the relevant variables act as trade-stimulating factors, whereas the parameter \(\alpha_5\) is likely to have a negative sign, as distance is a proxy for transportation cost. The estimated parameters \(\alpha_3\) and \(\alpha_4\) of interest in this study are expected to have negative and positive signs, respectively, in that the negative effect of China’s export growth on the exports of OECD countries is likely to be weaker in export destinations with a greater preference for environmental quality, where the demand for exports from OECD countries will be greater than that for goods from China. In accordance with Eichengreen et al. (2007), the effect of China’s export growth on the exports of OECD countries is expected to be manifested as a crowding-out effect in markets for consumption goods, whereas a dampening effect is observed in markets for intermediate goods.\(^{13}\) Thus, the slope of the curve representing China’s exports to country \(i\), \(\alpha_3 + \alpha_4 \ln E_{itin}\) is likely to have a negative value for consumption goods and a positive value between 0 and 1 for intermediate goods.

Various econometric methods, such as the ordinary least squares (OLS) method, fixed effects, random effects and Hausman–Taylor analyses, can be used to estimate Equation (13). However, OLS estimation may be biased, as it cannot control for the fixed effects of \(\phi_e, \phi_i\) and \(\phi_t\). Fixed and random effect analyses could provide suitable alternatives to control for such factors. However, fixed effect analysis is more appropriate than random effect analysis, as these factors are correlated with the explanatory variables in Equation (13). Nevertheless, fixed effect analysis cannot provide estimates for time-invariant variables. The Hausman–Taylor analysis can yield coefficients on time-invariant variables. The Chinese export variable \(\ln C_{itin}\) may be correlated with the error term, thus causing an endogeneity problem, unless Equation (13) controls for the effects of other countries’ export expansion on the export growth of OECD countries. In addition, the exporter and importer’s income variables and the multilateral resistance terms, which have income-related components, can cause simultaneous bias, as pointed out by Anderson (1979). The Hausman–Taylor estimation can alleviate endogeneity problems by adopting the appropriate instrumental variables from within the model. Moreover, the Hausman test of over-identification ensures the validity of the instrumental variables. Thus, the null hypothesis of the

---

\(^{13}\)Although capital goods are not associated with importers’ preferences for environmental quality, based on the study by Greenaway et al. (2008) and the observations presented in Section 2, China’s export growth is expected to have a crowding-out effect on the export growth of OECD countries in this sector.
Hausman test based on a comparison of the fixed effect and Hausman–Taylor estimators should not be rejected. Therefore, this study adopts the Hausman–Taylor analysis as an econometric method.

The data used for the regression analyses cover 30 OECD exporting countries and 60 OECD importing countries over the 2000–10 period. Importing countries that are not consistent across the variables are excluded from further analysis. In addition, the period in which the export pattern is investigated follows China’s accession to the WTO and an appropriate time span is considered for the EQI, which is used as a time-invariant indicator in constructing the IPEQI. Export data are obtained from the UNCOMTRADE data set and the data on real GDP (measured on a purchasing power parity basis), population and the strictness of environmental regulations from the World Development Indicator data set. Export values are deflated to 2000 constant US dollars using the US import price indices obtained from the U.S. Bureau of Labor Statistics. Moreover, the logarithm of one plus the export value is taken for the zero export value. As these values only occupy 0.27% for consumption goods, 0.29% for intermediate goods and 0.60% for capital goods in the sample, the manipulation does not need a censoring model for estimation.

The distance data, which are calculated using the latitudes and longitudes of the most important cities or agglomerations in terms of population, are sourced from the gravity data set of the CEPII, a French research centre. Table 4 summarises the variables used in the regression analyses.

4.3 Regression results

Table 5 shows the regression results for Equation (13) by sector obtained using the Hausman–Taylor estimation. The coefficients of lnCs are significantly negative at the 1% level for consumption goods and intermediate goods, whereas those of the interaction terms between lnC and lnIPEQI are significantly positive at the same level. For a specific explanation of these variables for consumption goods, the slope of the lnC curve is $-0.102$, $-0.092$, $-0.090$, $-0.089$ and $-0.086$ at the minimum (4.254), 1st quartile (4.312), 2nd quartile (4.323), 3rd quartile (4.329) and 4th quartile (4.348) of the lnIPEQI, respectively. With regard to the explanation for intermediate goods, the slope of the lnC curve is 0.209, 0.232, 0.237, 0.241 and 0.247 at the minimum (4.229), 1st quartile (4.294), 2nd quartile (4.309), 3rd quartile (4.320) and 4th quartile (4.337) of the lnIPEQI, respectively. These results suggest that the crowding-out effect of China’s export growth observed in markets for consumption goods and the dampening effect for intermediate goods on the export growth of OECD countries are weaker in export destinations with a greater preference for environmental quality. These results are consistent with this study’s predictions.

The coefficients on the distance variables are significantly negative at the 1% level across sectors and those on the dummy variables regarding common official language and colonial links are significantly positive at the 1%–5% levels, as expected. Concerning the dummy variable on contiguity, there is no robust evidence to support the prediction across sectors. The over-identification tests conducted for the Hausman–Taylor estimation do not reject the null hypothesis across sectors, thus validating the instrumental variables.

14See Appendix A for the list of countries used in the analysis. Chile, Estonia, Israel and Slovenia are excluded from the list of OECD countries, as they joined the group in 2010.

15See Appendix B for the regression results of capital goods.
| Variable | lnX_{et} | lnGDP_{et} | lnGDP_{it} | lnC_{g} | lnC* | lnIPEQI_{et} | lnDIS_{et} | lnPOP_{et} | lnPOP_{g} | lnSER_{et} | lnSER_{it} |
|----------|---------|-----------|-----------|-------|-----|------------|--------|--------|-------|--------|--------|
| Con. goods |         |           |           |       |     |            |        |        |       |        |        |
| No. of observations | 19,470 | 19,470 | 19,470 | 19,470 | 1,770 | 19,470 | 19,470 | 19,470 | 19,470 | 19,470 | 19,470 |
| Mean | 17.954 | 26.665 | 26.117 | 20.273 | 87.563 | 8.231 | 16.557 | 16.505 | −0.776 | −0.975 |
| SD | 2.845 | 1.426 | 1.512 | 1.925 | 8.37 | 1.11 | 1.521 | 1.664 | 0.766 | 0.9 |
| Min. | 0 | 22.816 | 22.69 | 13.714 | 58.805 | 4.088 | 12.547 | 12.547 | −4.094 | −4.094 |
| Max. | 25.042 | 30.087 | 30.087 | 25.292 | 109.471 | 9.883 | 19.55 | 20.926 | 0 | 0 |
| Inter. goods |         |           |           |       |     |            |        |        |       |        |        |
| No. of observations | 19,470 | 19,470 | 19,470 | 19,470 | 1,770 | 19,470 | 19,470 | 19,470 | 19,470 | 19,470 | 19,470 |
| Mean | 18.115 | 26.665 | 26.117 | 20.101 | 86.547 | 8.231 | 16.557 | 16.505 | −0.776 | −0.975 |
| SD | 2.857 | 1.426 | 1.512 | 1.946 | 8.306 | 1.11 | 1.521 | 1.664 | 0.766 | 0.9 |
| Min. | 0 | 22.816 | 22.69 | 14.745 | 63.195 | 4.088 | 12.547 | 12.547 | −4.094 | −4.094 |
| Max. | 25.535 | 30.087 | 30.087 | 24.466 | 105.083 | 9.883 | 19.55 | 20.926 | 0 | 0 |
4.4 Robustness tests

Table 6 presents the results of the robustness tests for the regression results reported in Table 5. The interaction terms between $\ln C$ and InpercapitaGDP of an importing country are included in the specification to ensure that the interaction terms between $\ln C$ and $\ln IPEQI$ are not driven by the income factor. The first column for each sector in Table 6 shows the regression result of Equation (13) extended by the interaction term between $\ln C$ and lnpercapitaGDP. The coefficients of these additional variables are significantly positive at the 1% level, but their magnitudes are relatively trivial. The regression results for the variables of interest are consistent with the benchmark model.

The population variables of the exporting and importing countries are incorporated into the specification to account for the factor endowment characteristics, in line with the Hecksher–Ohlin and non-homothetic taste factors addressed by Bergstrand (1989), given that the lnGDPs and lnpercapitaGDPs of exporting and importing countries are equivalent to their lnGDPs and lnPOPs in the specification. The second column for each sector in Table 6 shows the regression result of Equation (13) extended by population variables. The signs of the coefficients of these additional variables are consistent with those in the literature. More importantly, the signs of the coefficients

---

**Table 5** Regression results (Hausman–Taylor estimation)

|                      | (1) Consumption goods | (2) Intermediate goods |
|----------------------|-----------------------|------------------------|
|                      | Dependent variable: $\ln X_{eit}$ |                      |
| $\ln GDP_{et}$       | 3.342*** (22.73)     | 0.950*** (6.55)       |
| $\ln GDP_{it}$       | 1.940*** (20.12)     | 1.212*** (11.57)      |
| $\ln C_{it}$         | $-0.812^{***} (-2.99)$ | $-1.297^{***} (-4.45)$ |
| $\ln C \ast \ln IPEQI_{it}$ | 0.167*** (2.87)     | 0.356*** (5.77)       |
| $\ln DIS_{ei}$       | $-1.423^{***} (-31.12)$ | $-1.591^{***} (-37.86)$ |
| $\ln CT_{ei}$        | $-0.119 (-0.83)$     | $-0.152 (-1.15)$      |
| $\ln CL_{ei}$        | 0.419*** (3.62)     | 0.301*** (2.83)       |
| $\ln CO_{ei}$        | 0.355*** (2.40)     | 0.657*** (4.83)       |
| No. of observations  | 19,470               | 19,470                |
| $\chi^2(111)$        | 18,731.08***         | 17,034.05***          |
| Over-identification test: $\chi^2(19)$ | 0.00               | 0.00                  |

*Notes: The figures in parentheses are z-values. The values for the MRC, MRCE, MRDIS, MRCT, MRCL, MRCO, exporter dummy, importer dummy, year dummy and the constant do not appear in the table, although they are included in the analysis.

*Significance at the 10% level, **Significance at the 5% level, ***Significance at the 1% level.
### TABLE 6  Regression results (Hausman–Taylor estimation)

| Consumption goods | Intermediate goods |
|-------------------|-------------------|
| **Dependent variable: \( \ln X_{it} \)** | **(1)** | **(2)** | **(3)** | **(1)** | **(2)** | **(3)** |
| \( \ln GDP_{et} \) | 3.295*** | 3.474*** | 3.626*** | 0.945*** | 1.013*** | 1.327*** |
| | (22.42) | (23.62) | (23.56) | (6.53) | (6.96) | (8.73) |
| \( \ln GDP_{it} \) | 1.222*** | 2.011*** | 2.118*** | 0.884*** | 1.309*** | 1.473*** |
| | (8.94) | (20.86) | (21.27) | (5.75) | (12.26) | (13.43) |
| \( \ln C_{it} \) | −1.254*** | −0.769*** | −0.745*** | −1.462*** | −1.242*** | −1.309*** |
| | (−4.53) | (−2.85) | (−2.76) | (−4.92) | (−4.26) | (−4.50) |
| \( \ln C^* \ln IPEQI_{et} \) | 0.148** | 0.166*** | 0.155*** | 0.334*** | 0.342*** | 0.345*** |
| | (2.55) | (2.88) | (2.68) | (5.38) | (5.54) | (5.60) |
| \( \ln C^* \ln \text{per capita GDP}_{et} \) | 0.055*** | − – | − – | 0.025*** | − – | − – |
| | (7.41) | (2.90) | (5.38) | (5.54) | (5.60) | (5.60) |
| \( \ln DIS_{et} \) | −1.423*** | −1.423*** | −1.423*** | −1.591*** | −1.591*** | 1.591*** |
| | (−31.12) | (−31.12) | (−31.11) | (−37.86) | (−37.86) | (37.86) |
| \( \ln CT_{et} \) | −0.119 | −0.119 | −0.119 | −0.152 | −0.152 | −0.152 |
| | (−0.83) | (−0.83) | (−0.83) | (−1.15) | (−1.15) | (−1.15) |
| \( \ln CL_{et} \) | 0.419*** | 0.419*** | 0.419*** | 0.301*** | 0.301*** | 0.301*** |
| | (3.62) | (3.62) | (3.62) | (2.83) | (2.83) | (2.83) |
| \( \ln CO_{et} \) | 0.355** | 0.355** | 0.355** | 0.657*** | 0.657*** | 0.657*** |
| | (2.40) | (2.40) | (2.40) | (4.83) | (4.83) | (4.83) |
| \( \ln POP_{et} \) | − – | −3.508*** | −3.712*** | −1.723*** | −2.145*** | (Continues) |
| | (−11.30) | (−11.74) | (−5.61) | (−6.87) | (Continues) | (Continues) |
| \( \ln POP_{et} \) | − – | −1.767*** | −1.844*** | −1.027*** | −1.140*** |
| | (−9.19) | (−9.54) | (−5.23) | (−5.78) | (Continues) | (Continues) |
### Table 6 (Continued)

| Consumption goods | Intermediate goods |
|-------------------|---------------------|
| **Dependent variable: \( \ln X_{it} \)** | **\( \ln X_{it} \)** |
| (1) | (2) | (3) | (1) | (2) | (3) |
| \( \ln \) \( \text{SER}_{it} \) | – | – | –0.070*** | – | – | –0.143*** |
| | | | (−3.39) | | | (−7.08) |
| \( \ln \) \( \text{SER}_{it} \) | – | – | −0.072*** | – | – | −0.099*** |
| | | | (−3.90) | | | (−5.44) |
| No. of observations | 19,470 | 19,470 | 19,470 | 19,470 | 19,470 | 19,470 |
| \( \chi^2 \) (112, 113, 115) | 18,809.19*** | 19,022.26*** | 19,058.52*** | 17,043.20*** | 17,099.65*** | 17,191.16*** |
| Over-identification test: | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| \( \chi^2 \) (20, 21, 23) | | | | | | |

**Notes:** The figures in parentheses are \( z \)-values. The values for the MRC, MRCE, MRDIS, MRCT, MRCL, MRCO, exporter dummy, importer dummy, year dummy and the constant do not appear in the table, although they are included in the analysis.

*Significance at the 10% level, **Significance at the 5% level, ***Significance at the 1% level.
of the variables of interest are equal to those of the benchmark model and the magnitudes of the coefficients change only slightly.

To disentangle the pure effect of importers’ preferences for environmental quality on the export competition between China and OECD countries in third markets, an attempt has been made to control for the effect of environmental regulations on bilateral trade in the specification. To achieve this, the narrow measure regarding the strictness of environmental regulations adopted by Van Beers and van den Bergh (1997) is incorporated into Equation (13). Van Beers and van den Bergh (1997) found that the estimated coefficients of the measures for both exporters and importers were statistically significant and negative, although those for importers are theoretically positive. The third column for each sector in Table 6 presents the regression results of Equation (13) extended by the measures of the strictness of environmental regulations. Following the approach of Van Beers and van den Bergh (1997), the population variables of the exporting and importing countries are incorporated into the extended specification together. The coefficients on the measures of the strictness of environmental regulations are consistent with those of Van Beers and van den Bergh (1997). In addition, the regression results for the variables of interest almost follow those of the benchmark model. In sum, it can be concluded that the main regression results of this study are indeed robust across various specifications.

5 | CONCLUSION

This study makes several significant contributions to the literature. First, in examining the export competition between China and OECD countries, it assumes that importers’ preferences for environmentally friendly products are heterogeneous among countries. Second, a new measure is proposed to represent importers’ revealed preferences for environmental quality across countries. Third, the theoretical gravity model is used to systemically investigate the effect of China’s export growth on the exports of OECD countries in third markets.

OECD countries can regard China’s export growth as both a threat and an opportunity. As the results of this study indicate, the threat is manifested in direct crowding out in markets for consumption goods and partial dampening in markets for intermediate goods. The crowding-out and dampening effects of China’s export growth on the exports of OECD countries present significant obstacles to achieving export equality. However, a good way to reduce the export inequality arising from the threat posed by China is to deal with the variation in importers’ preferences for environmental quality, in that the crowding-out and dampening effects are weaker in export destinations where importers have greater preferences for environmental quality. This finding is confirmed by the panel data of observations for the 30 OECD exporting countries and the 60 importing countries over the 2000–10 period. Providing that China is slower in catching up with OECD exporters, the inequality of export growth is expected to narrow as the export markets in which consumers have strong preferences for environmental quality expand.

16As the country coverage of this study is broader than that of Van Beers and van den Bergh (1997), energy use (kg of oil equivalent) per US$1,000 GDP (constant 2005 PPP) obtained from the World Development Indicator data set is used to derive the measure of the strictness of environmental regulations. In addition, the base year for the change of energy intensity is 1995 instead of 1980 due to data limitations.
REFERENCES

Amacher, G. S., Koskela, E., & Ollikainen, M. (2004). Environmental quality competition and eco-labeling. Journal of Environmental Economics and Management, 47(2), 284–306. https://doi.org/10.1016/S0095-0696(03)00078-0

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. American Economic Review, 69(1), 106–116.

Anderson, J. E., & van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. American Economic Review, 93(1), 170–192. https://doi.org/10.1257/000282803321455214

Arora, S., & Gangopadhyay, S. (1995). Toward a theoretical model of voluntary overcompliance. Journal of Economic Behavior and Organization, 28(3), 289–309. https://doi.org/10.1016/0167-2681(95)00037-2

Athukorala, P.-C. (2009). The rise of China and East Asian export performance: Is the crowding-out fear warranted? World Economy, 32(2), 234–266. https://doi.org/10.1111/j.1467-9701.2008.01151.x

Awokuse, T. O., & Yin, H. (2010). ‘Does stronger intellectual property rights protection induce more bilateral trade? Evidence from China’s imports’ World Development, 38(8), 1094–1104. https://doi.org/10.1016/j.worlddev.2009.12.016

Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members’ international trade? Journal of International Economics, 71(1), 72–95. https://doi.org/10.1016/j.jinteco.2006.02.005

Baier, S. L., & Bergstrand, J. H. (2009). Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation. Journal of International Economics, 77(1), 77–85. https://doi.org/10.1016/j.jinteco.2008.10.004

Barboza, D. (2007). Scandal and suicide in China: A dark side of toys. New York Times, August 23. Retrieved from: https://www.nytimes.com/2007/08/23/business/worldbusiness/23suicide.html

Bergstrand, J. H. (1989). The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade. Review of Economics and Statistics, 71(1), 143–153. https://doi.org/10.2307/1928061

Brecard, D., Hlaimi, B., Lucas, S., Perraudeau, Y., & Salladarre, F. (2009). Determinants of demand for green products: An application to eco-label demand for fish in Europe. Ecological Economics, 69(1), 115–125. https://doi.org/10.1016/j.ecolecon.2009.07.017

Chen, C. (2001). Design for the environment: A quality-based model for green product development. Management Science, 47(2), 250–263. https://doi.org/10.1287/mnsc.47.2.250.9841

Copeland, B. R., & Taylor, M. S. (1994). North-South trade and the environment. Quarterly Journal of Economics, 109(3), 755–787. https://doi.org/10.2307/2118421

Eichengreen, B., Rhee, Y., & Tong, H. (2007). China and the exports of other Asian countries. Review of World Economics, 143(2), 201–226. https://doi.org/10.1007/s10290-007-0105-0

Finger, J. M., & Kreinin, M. E. (1979). A measure of export similarity and its possible uses. The Economic Journal, 89(356), 905–912. https://doi.org/10.2307/2231506

Franzen, A. (2003). Environmental attitudes in international comparison: An analysis of the ISSP surveys 1993 and 2000. Social Science Quarterly, 84(2), 297–308. https://doi.org/10.1111/1540-6237.8402005

Greenaway, D., Mahabir, A., & Milner, C. (2008). Has China displaced other Asian countries’ exports? China Economic Review, 19(2), 152–169. https://doi.org/10.1016/j.chieco.2007.11.002

Hallak, J. C. (2006). Product quality and the direction of trade. Journal of International Economics, 68(1), 238–265. https://doi.org/10.1016/j.jinteco.2005.04.001

Hamilton, S. F., & Zilberman, D. (2006). Green markets, eco-certification, and equilibrium fraud. Journal of Environmental Economics and Management, 52(3), 627–644. https://doi.org/10.1016/j.jeem.2006.05.002

Hausmann, R., Hwang, J., & Rodrik, D. (2007). What you export matters. Journal of Economic Growth, 12(1), 1–25. https://doi.org/10.1007/s10887-006-9009-4

Helpman, E. (1985). Multinational corporations and trade structure. Review of Economic Studies, 52(3), 443–457. https://doi.org/10.2307/2297663

Ianchovichina, E., & Walmsley, T. (2005). Impact of China’s WTO accession on East Asia. Contemporary Economic Policy, 23(2), 261–277. https://doi.org/10.1093/cepl/8i020
Jarreau, J., & Poncet, S. (2012). Export sophistication and economic growth: Evidence from China. *Journal of Development Economics, 97*(2), 281–292. https://doi.org/10.1016/j.jdeveco.2011.04.001

Lall, S., & Albaladejo, M. (2004). China’s competitive performance: A threat to East Asian manufactured exports? *World Development, 32*(9), 1441–1466. https://doi.org/10.1016/j.worlddev.2004.03.006

Minondo, A. (2010). Exports’ quality-adjusted productivity and economic growth. *The Journal of International Trade and Economic Development, 19*(2), 257–287. https://doi.org/10.1080/09638190802573071

Shafaeddin, S. M. (2004). Is China’s accession to WTO threatening exports of developing countries? *China Economic Review, 15*(2), 109–144. https://doi.org/10.1016/j.chieco.2003.09.003

Torgler, B., & Garcia-Valinas, M. A. (2007). The determinants of individuals’ attitudes towards preventing environmental damage. *Ecological Economics, 63*(2–3), 536–552. https://doi.org/10.1016/j.ecolecon.2006.12.013

Van Beers, C., & van den Bergh, J. C. J. M. (1997). An empirical multi-country analysis of the impact of environmental regulations on foreign trade flows. *Kyklos, 50*(1), 29–46. https://doi.org/10.1111/1467-6435.00002

Xu, B., & Lu, J. (2009). Foreign direct investment, processing trade, and the sophistication of China’s exports. *China Economic Review, 20*(3), 425–439. https://doi.org/10.1016/j.chieco.2009.01.004

Yao, S. (2009). Why are Chinese exports not so special? *China and World Economy, 17*(1), 47–65. https://doi.org/10.1111/j.1749-124X.2009.01130.x

---

**How to cite this article:** La, J. J. Effects of the preference for environmental quality on the export competition between China and OECD countries. *World Econ.* 2019;42:1180–1199. https://doi.org/10.1111/twec.12732

---

**APPENDIX A**

**TABLE A1** Country coverage

| Exporters (30) | Importers (60) |
|---------------|---------------|
| Australia     | Argentina     | Latvia       |
| Austria       | Austria       | Lebanon      |
| Belgium       | Austria       | Lithuania    |
| Canada        | Belarus       | Luxembourg   |
| Czech Rep.    | Belgium       | Malaysia     |
| Denmark       | Brazil        | Malta        |
| Finland       | Bulgaria      | Mexico       |
| France        | Canada        | Netherlands  |
| Germany       | Chile         | New Zealand  |
| Greece        | Hong Kong     | Norway       |
| Hungary       | Colombia      | Oman         |
| Iceland       | Croatia       | Philippines  |
| Ireland       | Cyprus        | Poland       |
| Italy         | Czech Rep.    | Portugal     |
| Japan         | Denmark       | South Korea  |
| Luxembourg    | Ecuador       | Romania      |

(Continues)
**APPENDIX B**

**REGRESSION RESULTS FOR CAPITAL GOODS**

For capital goods, the coefficient of $\ln C$ is significantly positive at the 5% level, whereas that of the interaction term between $\ln C$ and $\ln IPEQI$ is significantly negative at the 1% level. More specifically, the negative slope of the $\ln C$ curve becomes steeper as the value of $\ln IPEQI$ increases, with $-0.304$, $-0.315$, $-0.318$, $-0.320$ and $-0.330$ corresponding to the minimum (4.239), 1st quartile (4.289), 2nd quartile (4.302), 3rd quartile (4.311) and 4th quartile (4.355) of the $\ln IPEQI$, respectively. This result confirms the expectation in Section 2 that the crowding-out effect of China’s export growth on the exports of OECD countries is the most severe in this sector. However, as capital goods are included in the non-environmental demand sector, the variable for $\ln IPEQI$ cannot be regarded as reflecting an importer’s preference for environmental quality, as explained in Section 3. Rather, this value represents the level of the importing country’s income, given that the correlation coefficient between the logarithm of the average IPEQI for capital goods and the logarithm of the average income from 2000 to 2010 through 99 observations is 0.67 at the 1% significance level. Thus, it is expected that importing countries with higher incomes prefer exports from China to those from OECD countries because these countries are willing to obtain cheaper capital goods to cover their higher labour costs. Furthermore, it is predicted that richer countries are better able to use China’s capital goods as a result of their better production technology and infrastructure to produce high-quality consumption goods or intermediate goods. The positive relationship between income and production process sophistication supports this argument. The correlation coefficient between the average income and the average level of production process sophistication from 2007 to 2010 through 118 observations is 0.8035 at the 1% significance level.\(^\text{17}\)

---

\(^\text{17}\)The global competitiveness index published by World Economic Forum offers the production process sophistication index measuring to what extent firms in a country use the latest technologies for production.