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THE DRIVERS OF EXPORT PRODUCT DIVERSIFICATION IN CHINA: DOES NATURAL RESOURCE ENDOWMENTS MATTER?

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Abstract. Export product diversification (EPD) mitigates a country's vulnerability to global trade shocks, contributes to its high-quality economic progress, and increases its resilience. Natural resource endowment (NRE) is considered as one of the important determinants of EPD that is less explored by scholars. The contribution of NRE to EPD will remain a matter of debate in China. The paper aims to identify the drivers of the diversification of export products in China using the province level data from 2011 to 2019. It considers key determinants including foreign direct investment (FDI), human capital (HC), technological innovation (TI), and trade openness (TO). The results of the Fixed Effect-Driscoll-Kraay standard errors (FE-DKSE) indicate a positive and significant relationship between NRE and EPD. This suggests that a rise in NRE within a country promotes EPD. Furthermore, FDI, TO, TI, and HC have statistically significant positive links with EPD. Moreover, the findings of our research are consistent across all regions. The robustness analysis provides evidence that our findings are both significant and robust. The empirical findings indicate that the included variables are fundamental determinants of EPD, which provides policymakers with crucial policy implications. To encourage EPD, the government should implement policies that stimulate these determinants.

Keywords: export product diversification, natural resource endowments, technological innovations, trade openness, human capital, foreign direct investment, China.

JEL Classification: F13, J24, O13, O31.

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1. Introduction

China's economic structural transformation process started in 1978 with the reforms introduced under the leadership of Deng Xiaoping and continued with China's transition from a closed socialist economy to an open market economy (Brandt & Rawski, 2008). This economic structural transformation has been characterized by a transition from an agrarian-based economy to a manufacturing and services driven economy. This transformation has been propelled by various policies aimed at enhancing productivity and economic resilience, including investment in technology and innovation (Fahad et al., 2023; Zhu, 2012). In a bit to accelerate growth in manufacturing and services, and create new job opportunities and promote economic diversification the government focused on industrialization and urbanization

(Fahad et al., 2023). The transition toward innovative manufacturing activities resulted to a greater complexity in China's export structure. This diversification has been corroborated by the growth in exports of electronics, machinery, and high-tech products, as opposed to the previously dominant low-value commodities (Saenko, 2023). By diversifying its export basket, China has successfully mitigated its vulnerability to external shocks and unstable global demand, thus improving its resilience (Guliyev & Azizov, 2022). Recognizing factors that influence export diversification in China can contribute significantly to the advancement of its high-quality economic progress. Export diversification positively influences economic growth through various channels, including the enhancement of productivity through knowledge transfer (Can et al., 2024; Gözgör & Can, 2017), and improved productive and technological capabilities (Vergara, 2021). New economic growth models suggest that advanced innovations contributes to new export products (Feenstra & Kee, 2004). EPD occurs when there is a rise in the existing (traditional) exported products to existing markets (growth of intensive margin of the exports), or a rise in the quantity of exports to novel markets, or the introduction of a range of new products (extensive margin) (Shi et al., 2023). A more diversified export structure promotes the creation of new industries and expands existing ones due to more opportunities for advanced production. This phenomenon is particularly evident when an organization diversifies its export portfolio by incorporating new exports (Dou et al., 2023). EPD decreases the volatility of export revenue and the dependency on limited products (Li et al., 2021; Melitz, 2003). Thus, EPD would have a significant impact on China's development.

Regarding the drivers of EDP, natural resources (NR) form an important material base for a country's development and contribute significantly to national wealth and development. For instance, the UK's iron and coal resource endowment was the motivation behind the industrial revolution (Sun et al., 2019). NRE has also helped the United States, Germany, and Canada to achieve rapid, stable, and long-term economic growth. However, since the 1980s, many countries endowed with NR have faced more development challenges than those with fewer resources. Resources-poor countries like Japan, South Korea, Hong Kong, and Singapore have significantly higher per capita income than resource-rich (Sun et al., 2018). The effect of NRE on diversification is determined by the nature of the resource; however, properly managed resources can be beneficial in terms of capital formation and growth (Alemu, 2016). Therefore, governments must put in place policies that encourage the proper use of NR, and allocate additional NRE to EPD (Charles et al., 2018). As there are alternative uses for natural resources, China should use NRE to produce a variety of export products, which will increase export revenues, allowing it to achieve both the EPD and economic development goals more quickly.

FDI is not only a major driver of product diversification, but it also improves workers' skills (Fosu, 2021). It plays a significant role in a country's economic development, as it increases domestic saving, transfers advanced technologies, facilitates integration into global value chains, promotes growth and job creation, and creates more efficient local firms. FDI influences the EPD through (directly and indirectly) channels. FDI inflows stimulate domestic investment and technology diffusion, and bolster productivity in the host country (Golo, 2023). Whereas horizontal FDI which primarily focuses on local markets in host countries is the most prevalent, vertical FDI, which aims to reduce global costs through efficiency-oriented investments, is still on the rise. According to Gulguu (2022), the extent to which this type of

FDI impacts EPD depends on whether the foreign-owned plant produces a range of products that are similar to or distinct from those of other exporting firms in the host nation. FDI has the potential to diversify the host country's exports, either directly or indirectly. The direct influence requires expanding into the non-traditional export sectors. The indirect influence comes from increasing conventional exports, which have the smallest market share (spillover effects). Notwithstanding, the impact of FDI on EPD is uncertain (Khan et al., 2021).

Besides NRE and FDI, greater trade openness (TO) which contributes to market expansion is also an important driver of EPD (Dennis & Shepherd, 2011). More imports of products, technologies, and innovations are associated with TO; as a result, the technology and knowledge contained in these goods generate positive spillovers to the host economy (Baldwin et al., 2005). This can boost investment in new products, thereby promoting EPD. Imports of new products may encourage the export of goods and contribute to the growth of new domestic varieties (Bas & Strauss-Kahn, 2015). Amighini and Sanfilippo (2014) have also validated the influence of imports of products on export upgrading that affects EPD. According to Agosin et al. (2012), trade reforms increase export concentration or specialization through increasing the profitability of the traditional commodities sectors of countries that rely on the exports of primary products. Melitz (2003) opines that openness to trade can promote EPD by increasing exporters in sectors associated with greater export opportunities. Export diversification may be adversely affected in those economies where trade reforms increase the profitability of traditional sectors (Agosin et al., 2012). These ambiguous influence of openness to trade on EPD have led researchers to conclude that this matter remains an empirical question (Osakwe et al., 2018).

Human capital that has improved significantly in the last decade (Haini, 2021) is another determining factor of EPD. The level of HC in many countries in 2018 was up by more than 30% compared to 1990 (Zhang et al., 2023a). Onifade et al. (2021) defined HC (education returns and average year of schooling) as the knowledge and skills required to increase productivity. HC has a multifarious influence on production (Wang et al., 2023). The accumulation of HC positively contributes to the diversification of exports, which corroborates the idea that HC accumulation allows nations to shift focus from primary commodities to manufactured goods. A greater availability of HC and a lower relative cost of inputs allow industries to employ the HC for R&D and adapt to existing products and technologies, promoting EPD (Agosin et al., 2012). Moreover, high-level HC contributes to the production assorted products, broadens the products range, and accelerates the process of product diversification. EPD has the potential to reduce the country's exposure to global trade shocks, thereby diminishing macroeconomic instability and fostering growth. HC plays the most significant role in increasing EPD (Golo, 2023).

Another significant contributing factor to EPD is technological innovation (TI). Innovation in the manufacturing process increases the value-added of the final products, thereby contributing to greater GDP (Espoir, 2020). The acceleration of export diversification innovation facilitates the production of new products intended for the global market. An increasing number of exporting companies have prioritized the introduction of novel products for export purposes (Cirera et al., 2015). The development of an industry's capacity for innovation is the primary motivator for the industry to engage in export diversification activities. Moreover,

technological capabilities and productive matter (Vergara, 2021). The conventional strands of research have underlined them as key determinants of export and development. Economies with more productive capacities have more exporters, which tend to be large in size and set exorbitant prices for their goods. Vergara (2021) found that even after controlling for development level, size of economy, commodity-dependence, there is a positive association between diversification and technological potentials. Technological capabilities play a significant role in high-tech industries, like electrical machinery, pharmaceuticals and equipment, and electronics. In these sectors, country exporters with high R&D investments are more diversified in term of the destination markets. So, technological and more productive capabilities are significantly associated to the intensive and extensive margin of exports.

This study focuses on China, a country with a population of 1.4 billion that contributed about 30% to global economic growth in the eight years preceding 2019 (World Bank, n.d.). China has implemented market-based economic reforms since 1978, signaling a significant shift from a planned to a market economy. China has maintained an average annual growth rate of 10% between 1978 to 2007. However, since the global financial crisis of 2007–2008, China's growth rate has declined to 6.6% till 2018, and it is anticipated to decline to 5.5% by 2024 (Morrison, 2019). China's slowing growth rate is linked to a drop in investment, less technological innovation, and trade tensions with the US. In order to address these challenges, the Chinese government is upgrading the manufacturing sector through the "Made in China 2025" initiative (World Bank, n.d.), which places more emphasis on technological innovation. It is therefore crucial to determine the effect of NRE, HC, TI, FDI, and TO on EPD, as the primary EPD factors in China.

This paper contributes to the existing literature on China in several ways. Firstly, it examines the influence of NRE, FDI, TO, TI, and HC on EPD using provincial data spanning 2011–2019. NRE is important determinant of EPD (Akwasi et al., 2023; Giri et al., 2019), and existing research have ignored this impact especially in the case of China. Sun et al. (2018) explored the link between NRE, HC accumulation, and public education per capita investment in China. The study by Ur Rehman et al. (2021) investigated the impact of enhanced trade infrastructure on the sophistication and diversification of Chinese exports. As far we know no study has investigated the impact of these determinants on EPD at least in case of China. Second, our study uses a more comprehensive NRE metric by converting kerosene, fuel oil, diesel, petrol, coke, coal and natural gas into British thermal units (BTU). Third, our study measures EPD using the increase in export variety represented by exports sales income of new products[1], which is a better proxy (Agosin et al., 2012; Ferreira & Harrison, 2012). Two Studies by Shi et al. (2023) and Dou et al. (2023) on China explored the impact of EPD on environmental pollution rather than drivers of EPD. Further, our study used disaggregated level data (i.e., Chinese provinces) as compared to the existing studies explored the drivers of EPD on aggregated level (i.e., country level) data (Ali, 2017; Swathi & Sridharan, 2022; Vasilyeva et al., 2023; Zhang et al., 2023b) which do not depict the true picture. Fourth, we investigate

[1] "The industries' reference period sales incomes of novel product. Novel products are those designed and manufactured with advanced technologies and designs, or have been upgraded in terms of structure, material, process, or other features to enhance performance or upgrade their functions. Novel product s are those that have been approved by government establishments during their validity period and those that have been developed by enterprises without government approval within one year of their production", National Bureau of Statistics of China (n.d.).

the effects of NRE, FDI, TO, TI, and HC on EPD in the eastern, central, and western regions of China. Natural resource distribution in China is extremely unequal, with resource-rich regions clearly distinguishable from impoverished areas. The eastern region has fewer natural resources than the western and central regions. Nonetheless, the regional growth disparities are gradually widening (Wang & Li, 2019). Therefore, it is essential to investigate the regional effects of these determinants on EPD.

The subsequent sections of this study are organized as follows: Section 2 provides an overview of empirical literature. The data and empirical model are illustrated in Section 3. Section 4 provides a description of the results, and the concluded is presented in Section 5.

2. Literature review and theoretical framework

Numerous researches that have explored the impact of EPD on CO_2 emissions, SO_2 emission, energy consumption and economic growth (Can et al., 2024; Dou et al., 2023; Shi et al., 2023). However, none has explored the drivers of EPD particularly in China. Hence, this paper closes this gap in the literature.

2.1. Export product diversification

The EPD process normally commence after the agricultural phase during which countries tend to produce different products. The export product diversification process persists until income levels reached $ 22,500 (Cadot et al., 2011). After this, countries enters the re-concentration phase, during which they concentrate in the manufacturing of sophisticated products on the basis of their technological know-how (Can & Doğan, 2020). As emphasized by researchers, most emerging economies have embraced the export-led growth strategies, specializing in specific product cluster (De Piñeres & Ferrantino, 1997). This has resulted in the reduction of the export baskets of these developing countries. Additional, the specialization was challenging for the developing economies as economic variations in the global economy disrupted the global chain (Can & Kösekahyaoğlu, 2016). These obstacles significantly impacted developing economies, resulting in significant revenue losses from exports. Additionally, these economies were unable to abandon energy-intensive commodities in their baskets, as their export baskets already had limited amount of commodities. Consequently, this exerted a substantial negative impact on the growth of these economies. This perspective posits that increasing the variety of export products can result in a more consistent flow of export revenues which can substantially contribute to the expansion of an economy (Gozgor & Can, 2016b).

EPD can be achieved through two ways: augmenting the number of products in the export basket and increasing the actual quantity of products in the basket (Wilhelms, 1967). EPD is very important, particularly for the less-developed countries as it promotes economic growth (Klinger & Lederman, 2004). By transitioning from low-quality to high-quality goods, EPD protects less-developed nations from some remote trade-risks and offers valuable advantages. For instance, EPD protects economies from adverse events, such as international currency crises, and epidemics (Samen, 2010). Additionally, EPD reduces reliance on a limited number of product types and facilitates the acquisition of knowledge through diversification, which is then used to advance other economic industries (Can et al., 2024; Gozgor & Can, 2016a).

2.2. Natural resource endowment and export product diversification

Exploring the impact of natural resources, FDI, value added, and TO on export diversification in the CEMAC region, Dobdinga (2015) demonstrated that natural resources have a negative influence on export diversification, while TO, FDI, and value added of the manufacturing sector contributed to export diversification. Additionally, Sachs and Warner (2001) found an inverse relationship between NRE and economic growth. Investigates the relationship between urban development and the natural resource utilisation efficiency index (NRUEI) in 165 cities across China, Liu et al. (2023) found that NRE is associated with higher urban development. Investigating the relationship between NRE and economic development in Azerbaijan, Hamidova (2021) concluded that NRE has little impact on economic growth. Qiang and Jian (2020) used data from Chinese provinces from 2005 to 2018, to investigate relationship between NRE, institutional quality, and economic growth. The findings supported the hypothesis of resource curse at provincial level. Investigating the influence of NRE on ecological efficiency (EE) in China from 2006 to 2018, Wang and Chen (2020) found that NRE decreases EE and increases volatility. Su and Tan (2023) investigated the influence of NRE on energy transition in China from 2007 to 2020 and found that NRE dominated the country's energy transition.

H_1: *NRE has a positive relationship with EPD.*

2.3. Foreign direct investment and export product diversification

Policymakers and organizations in many economies have endeavored to increase foreign capital inflows in order to capitalize on FDI and expand their export sectors. Previous studies by Klinger and Lederman (2006), and Rodrik (2006) have emphasized the crucial role of FDI in the development of innovative manufacturing processes and the exportation of technological content associated with the products. According to the study's findings, countries that attract more FDI have faster economic growth and higher export volumes. Crespo and Fontoura (2007) provided evidence that FDI has a spillover effect that improves a country's export performance. FDI promotes export diversification by accelerating technology transfer and increasing production capacity (Iwamoto & Nabeshima, 2012). Tadesse and Shukralla (2013) used the data on FDI stocks and country products exported for 131 economies for the period 1984–2004 to explore the FDI impact on export diversification (horizontal). The findings support the hypothesis that FDI increases export diversification. However, Vakataki'Ofa et al. (2016) demonstrated that FDI has a lesser effect on EPD due to its limited penetration into specific industries and its restricted connections to other sectors of the economy. In their study of the determinants of EPD, Giri et al. (2019) concurred that human capital and FDI were the most important factors. They commended that in order to enhance export diversification, policymakers should prioritize the development of human capital and trade barriers reduction.

H_2: *FDI has a positive relationship with EPD.*

2.4. Technological innovation and export product diversification

TI that influence export diversification enables exporters to gain competitive advantage. Exporters can enhance innovation and knowledge domain via investment in the R&D (Vergara,

2021). Innovation helps exporters to enter new markets as new products are produced. Producing new products allows exporters to gain differentiation advantages as the new products enter the export basket (Lian et al., 2021). Employing the GMM approach, Madonna and Handoyo (2023) explored the impact of TI, HC, and logistic performance on the export diversification in manufacturing sectors of Indonesia. The study found the factors to be positively relation with EPD. Shi et al. (2023) and Dou et al. (2023) examined EPD, TI, economic growth, energy consumption, and urbanization impact on CO_2 and SO_2 emissions in China. Sharma et al. (2021) explored the relationship between EPD and TI in BRICS.

H_3: *TI has a positive relationship with EPD.*

2.5. Trade openness and export product diversification

Greater specialization has been associated with trade openness. In addition, Dennis and Shepherd (2011) demonstrated that trade promotes export diversification in less developed economies. According to existing research, tax reform involving a lower proportion of trade tax revenue and a higher proportion of domestic tax revenue in the public revenue structure (more TO) would reduce production distortions and promote efficient resource allocation in production sectors. This may foster the specialization in sectors where a country has a comparative advantage, thus stimulating EPD (Singer, 1950). The impact of TO on EPD is, in fact, ambiguous from a theoretical standpoint (Cadot et al., 2013). Whereas, modern international trade models have showed that TO stimulates EPD, traditional models have recommended that TO stimulate export product specialization or concentration through the factors reallocation efficiency (Dessy et al., 2010). However, the theoretical impacts of TO on EPD is ambiguous, which has led researchers to conclude that this problem requires empirical investigation. Gnangnon (2019) examined the effect of multilateral trade openness on EPD for 97 countries using data from 1996 to 2016. The study revealed a positive link between TO and EPD.

H_4: *TO has a positive relationship with EPD.*

2.6. Human capital and export product diversification

Extensive studies have been conducted on the relationship between human capital (HC) and economic development; however, its scope has been confined to the association between HC and export diversification. It is widely acknowledged that human capital impacts a country's comparative advantage as it facilitates the implementation of new technologies and narrows the technology gap. The human capital of East Asian economies has been identified as a defining factor in closing the technology gap (Lall, 1992). Larger human capital stock favors investment in new products (Nelson & Phelps, 1966). Similarly, the endogenous growth theory has proven that variations in a country's human capital lead to disparities in its capacity to innovate, adopt and integrate cutting-edge technologies, which contribute to economic growth and development. Elhiraika and Mbate (2014) investigated the determinants of EPD using data from 53 African nations spanning 1995 to 2011. The results showed that human capital, institutional framework, public investment, and income per capita were the most significant long-term determinants of EPD.

H_5: *HC has a positive relationship with EPD.*

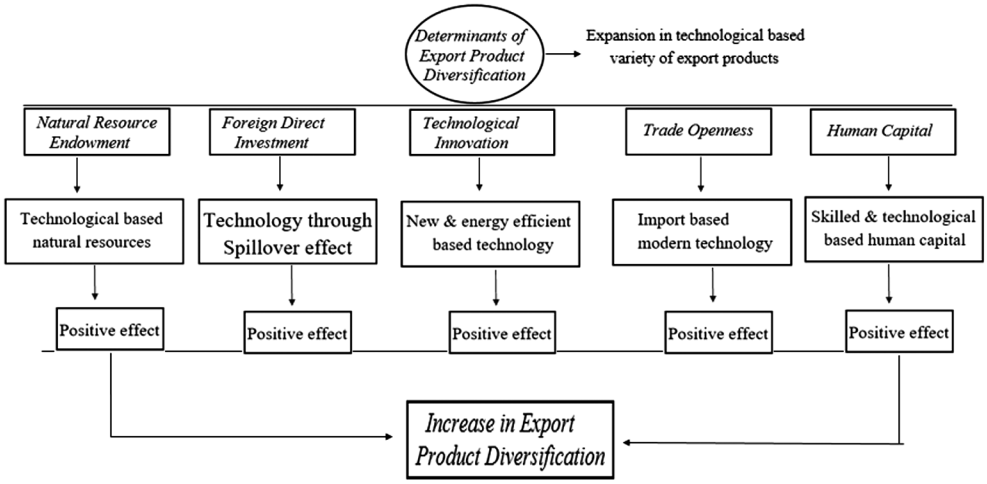

Figure 1. Flow chart of the model

The schema of the hypothesis and mechanism of the major influencing factors of EPD, based on the above literature review, is shown in Figure 1 above.

3. Data and model

This paper uses province-level data of China from 2011 to 2019, to empirically examine the impact of NRE, FDI, TO, HC, TI on EPD. This research on the basis of National Bureau of Statistics of China (n.d.), divides China into three regions namely: Eastern, Central, and Western (National Bureau of Statistics of China, n.d.). The existing works have employed panel data of 31 provinces of China, dividing China into the eastern, central and western regions (Kang et al., 2016; Sun et al., 2018, 2019; Zhang & Crooks, 2012; Zhong et al., 2021). As suggested by Shi et al. (2023) and Dou et al. (2023), the logarithm of sales revenue in tens of thousands of yuan from the export of new products by industrial enterprises is used as a proxy for EPD. The independent variable is natural resource endowment (NRE) which is the aggregation of natural gas consumption (100 million cubic meters), kerosene, gasoline, fuel oil, diesel, crude oil, coke, coal consumption in 10,000 tons, converted into BTU as suggested by Wang and Chen (2020), Visas et al. (2021).

$$\mathrm{NRE} = \frac{\omega_1 * coal + \omega_2 oil + \omega_3 naturegas}{coal + oil + naturegas},$$

ω_1, ω_2, and ω_3 represent standard conversion references for raw coal, crude oil, and natural gas, respectively (the reserves of coal, oil, and natural gas are denoted by the standard coal conversion values of 0.7143, 1.4286, and 1.33, as reported in China Energy Statistical Yearbook 2013 (National Bureau of Statistics Division of Energy, 2013). Following Ul-Haq et al. (2023), the logarithm of FDI inflows (USD 100 million) by province is utilized as a proxy for FDI. Following Hye and Lau (2015) trade openness (TO) is calculated as the ratio of regional trade to regional GDP. Following Shi et al. (2022) technological innovation (TI) is calculated

as the log of the total patent applications filed by domestic people. Following Golo (2023) human capital (HC) is taken as the log of the number of undergraduate students enrolled in general institutions of higher learning (10,000 people). The data utilized in this study is taken from National Bureau of Statistics of China (n.d.). The sample period is selected based on data availability[2]. The descriptive statistics for the study variables are given in Table 1.

Table 1. Descriptive statistics

	N	Average	S.D	Max.	Min.
EPD	270	14.399	2.3503	3.4	18.5901
NRE	270	4.4878	3.0734	0.5424	15.8026
FDI	270	3.5939	1.6721	–1.8131	5.8794
TI	270	9.6625	1.4989	5.3181	13.6019
TO	270	0.2791	0.2968	0.0128	1.4638
HC	270	6.0953	0.7713	4.1041	7.6327

Region-specific market disparities are conceivable due to the size of China's economy. As a result, we expect to observe the impact of these critical determinants on regional *EPD*; the panel model for this is as follows:

$$EPD_{jt} = \alpha_0 + \beta_1 NRE_{jt} + \beta_2 FDI_{jt} + \beta_3 TO_{jt} + \beta_4 HC_{jt} + \beta_5 TI_{jt} + \varepsilon_{jt}. \quad (1)$$

EPD represents export product diversification in province *j* (i.e., 31 provinces) at time *t* (i.e., 2011–2019) in the above model. *FDI*, *TO*, *HC*, and *TI* are all abbreviations. α_0 represents the intercept, while β_1–β_5 denote the respective coefficients of *NRE*, *FDI*, *TO*, *HC*, and *TI*. ε is the noise which meets the normality assumptions. We use the cross-section dependence (CD) test to identify instances of cross-sectional dependence, which renders estimates unreliable (Zhao et al., 2020). The provincial panel model is as follows:

$$y_{it} = \alpha_i + \beta' X_{it} + \mu_{it,}\ i = 1,\ldots,N \text{ and } t = 1,\ldots T. \quad (2)$$

X_{it} and β are (K*1) vector of independent variables and coefficients to be calculated. Time invariant disturbance parameters is shown as α_i at individual level. U_{it} is identically distributed (i.i.d.) and independent across time and the cross-sectional units is assumed by null hypothesis. Considering the alternative hypothesis, U_{it} may be linked to cross-sections, but there is no serial correlation in the assumption. The hypothesis:

$H_0 : \rho_{ij} = \rho_{ji} = cor\left(\mu_{it,}\mu_{jt}\right) = 0$ for $i \neq j$ against $H_1 : \rho_{ij} = \rho_{ji} = cor\left(\mu_{it,}\mu_{jt}\right) \neq 0$ for $i \neq j$ is tested, $\rho_{ij} = \rho_{ji}$ is disturbances correlation coefficient calculated as:

$$\rho_{ij} = \rho_{ji} = \frac{\sum_{t=1}^{T} \mu_{it}\mu_{jt}}{\sqrt{\sum_{t=1}^{T} \mu_{it}^2} \sqrt{\sum_{t=1}^{T} \mu_{jt}^2}}. \quad (3)$$

[2] Data is for core variables of NRE & EPD is only available till 2019 on the National Bureau of Statistics of China (n.d.).

The Breusch and Pagan (1980) (BPLM) test and Pesaran (2004) test are employed to investigate CD among the residual. Considering OLS approach, the BPLM test is conducted, which is appropriate when N and T are fixed and greater. Specifications for the LM test are as follows:

$$LM_{BP} = T\sum_{i=1}^{N}\sum_{j=i+1}^{N}\hat{\rho}_{it}^{2}, \tag{4}$$

$\hat{\rho}_{it}$ denotes the model estimates of the cross sectional pairwise correlation of residuals, *T* is time, and *i* is the entity. *N* revealed provinces. $\hat{\rho}_{it}$ is computed as:

$$\hat{\rho}_{ij} = \frac{\sum_{t=1}^{T}\hat{\mu}_{it}\hat{\mu}_{jt}}{\sqrt{\sum_{t=1}^{T}\widehat{\mu_{it}^{2}}}\sqrt{\sum_{t=1}^{T}\widehat{\mu_{jt}^{2}}}}, \tag{5}$$

$\hat{\mu}_{it}$ is assessment of u_{it} and *LM* is more likely distributed as χ^2 by degree of freedom *N* (*N*–1) under null hypothesis. Though, significant size distortions are considered where the case of *N* large and *T* finite for this assessment (Hye et al., 2023). Pesaran (2004) suggested the alternative as follow:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right), \tag{6}$$

no cross-sectional dependence $CD \rightarrow N(0,1)$ under a null hypothesis, as *N* goes toward infinity and sufficiently large *T*. This study uses both the BPLM and Pesaran tests to capture the pure estimates. On the other side, the occurrence of serial correlation also possible which may cause to yield inconsistent results. Thus, Wooldridge (2010) test is apply to verify the existence of serial correlation. It is demonstrated as:

$$y_{it} = \alpha + X_{it}\beta_1 + Z_i\beta_2 + \mu_i + \varepsilon_{it} i \in, t \in \left\{1,2,\ldots,T_i\right\}. \tag{7}$$

In this Equation, *y*, *x*, and *z* are the regress and, regressor, and controls variables. While, *t* and *i* for time and province respectively. The model parameters α, β and μ and ε represent error terms of the distinct variables and as a whole model. In addition, if μ_i is in link of related variable it will gives parametric inefficient estimates. However, to control this issue the better is the Wooldridge test as compared to others and presented in the following equation. It consider the model first difference to control this issue (Drukker, 2003).

$$\begin{aligned} y_{it} - y_{it-1} &= \left(X_{it} - X_{it-1}\right)\beta_1 + \varepsilon_{it} - \varepsilon_{it-1}, \\ \Delta y_{it} &= \Delta X_{it}\beta_1 + \Delta\varepsilon_{it}. \end{aligned} \tag{8}$$

Additional, considering the problematic issue of heteroscedasticity, the assumption about this is that linear regression must have the variance constant as demonstrate in mathematical term (ε_i)= 6^2 whereas ε_i and 6^2 are error term and constant. If the assumption is not fulfilled become the cause of heteroscedasticity. Thus, modified Wald test is used to check heteroscedasticity and written as:

$$V_i = T_i^{-1}\left(T_i - 1\right)^{-1}\sum_{t=1}^{T_i}\left(e_{it}^{2} - \hat{\sigma}_i^{2}\right)^{2}. \tag{9}$$

Where variance indicate with 6i, cross-sectional units with *N*, and time represent with *t*.

$$W = \sum_{i=1}^{N_g} \frac{\left(\hat{\sigma}_i^2 - \hat{\sigma}^2\right)^2}{V_i}. \quad (10)$$

Considering the problem of CD, heteroscedasticity, and serial correlation this paper uses the heterogeneous coefficient estimator of DKSE to present trustworthy estimates. This method not only generates the consistently predicted values for the sample averages but also consider significant amount of the variability. Additional, DKSE method is to the common errors as well as resilient to the CD (Asane-Otoo, 2015). The DKSE technique gives standard errors that are robust to cross-sectional and temporal dependence as opposed to the fixed effect method, which overlook the presence of CD even when grouping the standard errors (Jochmans & Verardi, 2020).

4. Results and discussion

4.1. Overall analysis

Table 2 contains the diagnostic results, including Wooldridge, Modified Wald, BPLM, and Pesaran. The findings of the Wooldridge test are presented in column (1), while the estimates from the BPLM and Pesaran tests are listed in column (3). The findings indicate the presence of serial correlation, heteroscedasticity, and CD.

Table 2. Diagnostics tests

Wooldridge test	Modified Wald test	Breusch-Pagan LM test
154.952***	8195.83***	673.650***
Pesaran (2004) test		
EPD	17.64***	
NRE	11.56***	
FDI	2.76***	
TO	21.62***	
HC	34.88***	
TI	57.16***	

The relationship between NRE and EPD is presented in column (1) of Table 3. The standard error associated with the coefficient of NRE is in parentheses. The coefficient on NRE shows that NRE favors EPD and this association is significant at the 1% level. A 1% increase in NRE increases EPD by 0.31%. In contrast to Niass (2022), the findings of this research are consistent with those of Gamariel et al. (2022) and Alemu (2016). Moreover, the studies of Jiang and Gao (2023); Alaya (2012) specified that NRE positively influences export diversification. Gamariel et al. (2022) found that NRE increases export concentration in NRE countries, which is a positive indicator for export diversification in NRE countries. According to Osakwe et al. (2018), export diversification is hindered in countries with high reliance on natural resources.

Conversely, Lederman and Maloney (2006) argued that countries endowed with abundant natural resources tend to exhibit greater exports concentrations. The study suggests that, if the NRE is efficiently managed in diversifying export products, China will achieve its target of EPD while also stimulating economic development. Thus, the government should emphasis on the use of NRE to improve EPD.

Table 3. Impact of NRE, FDI, TI, TO, HC on EPD in China

	(1)	(2)	(3)	(4)	(5)
NRE	0.313*** (0.0303)				
FDI		1.075*** (0.0412)			
TI			1.203*** (0.0818)		
TO				3.974*** (0.396)	
HC					2.419*** (0.0425)
Constant	13.03*** (0.214)	10.56*** (0.290)	2.806*** (0.708)	13.33*** (0.108)	–0.322 (0.252)
N	269	269	269	269	269

Note: EPD is regressand. Robust standard errors (S.E) are given in the parentheses. ***show significance at 1%, **reveal at 5%, and *** denote 10%.

The estimate of FDI in column (2) illustrate a positive relationship with EPD. Thus, FDI and EPD have a significant and direct relationship. For every 1% increase in FDI, the diversification of exported products increases by 1.075%. Our empirical findings are consistent with that of Fosu (2021), which suggested that FDI has a significant positive effect on EPD, and in contrast to that of Arawomo et al. (2014). The study by Gamariel et al. (2022) found that FDI positively affects export diversification, indicating that FDI has a significant impact on the composition of export baskets in the host economies. Moreover, credible institutions, production sector diversification, and macroeconomic stability are all essential for EPD. Enhancing infrastructure accessibility and providing fiscal incentives to foreign investors strengthen the impact of FDI on export diversification. Therefore, FDI is fundamental in accelerating the process of diversification (Gulguu, 2022). The FDI inflows also matters for EPD as foreign firms fill technological and investment gaps by providing the recipient economy with technology. Local firms also have the opportunity to learn from foreign enterprises, either by doing or watching. Thus, efficient FDI inflow methods should be top priority for policymakers in order to boost the EPD.

The impact of TI on EPD is positive and statistically significant, as indicated in column (3). A 1% increase in TI leads to a 1.203% increase in EPD. Consistent with the recommendation of Bayraktutan and Bıdırdı (2018), our findings support the notion that the exportation of high-technology products requires advanced technology or innovation. Furthermore, the findings of our research are in line with Lian et al. (2021); Bottega and Romero (2021), who found a positive effect of TI on EPD. Moreover, the manufacturing industry with innovation have expe-

rienced a direct influence on EPD (Emodi et al., 2017). TI has a robust correlation with success on the global market (Duspara et al., 2017); an assertion that supports this study's results. In a bid to pursue growth in foreign markets and competitive advantage, the government should adopt policies that highlight the significance of investing in a technological innovation strategy. Thus, this study has significant implications for the effective development of public policy instruments that are intended to encourage firm innovation in developing countries.

The coefficient of TO presented in column (4) is positive and significant. This finding indicates that TO significantly promote EPD. The results indicate that when a country is more receptive to international trade, it becomes more feasible to expand its product portfolio. Our findings align with those of Agosin et al. (2012), which indicated that trade openness positively impacts EPD. Makhlouf et al. (2015) also found that trade openness has a positive impact on export diversification. TO favors the import of cutting-edge technology, allowing for the production of technologically advanced and energy-efficient products, thereby improving EPD. It is therefore recommended that China prioritize the above determinants for its EPD process.

There is a positive and significant relationship between HC and EPD. Thus, an improvement in HC favors EPD. Our study finds that a 1% increase in HC increases EPD by 2.419%. Our findings are consistent with those of Lian et al. (2021); Gnangnon (2021), who concluded that HC is the most important factor influencing EPD. More trained and educated workers will be able to produce a wider range of products, promoting EPD. Blanchard and Olney (2017) showed that the variety of manufacturing products exported is directly related to higher education, and Lian et al. (2021) demonstrated that a labour force with a higher level of education and trained workforce can promote diversification. Furthermore, the long-term use of resources to produce products is impossible without the use of HC (Zafar et al., 2019). HC plays an important role in promoting EPD. As a result, countries seeking diversification must have a sufficient level of HC while also ensuring strong institutions that support EPD. Our findings support all of the hypothesis (i.e., H_1 *to* H_5).

4.2. Regional analysis

As data availability, culture, similarity in geography and close proximity permits, we break China into regions (i.e., eastern, central, and western). As indicated in Table 4 below, the eastern, central, and western region are comprised by the provinces of China.

Table 5 shows the key findings of regional analysis regarding the influence of NRE, FDI, trade openness, human capital, and technological innovation on EPD in the different regions.

Table 4. Chinese regions

Eastern	Central	Western
Sichuan, Yunnan, Gansu, Qinghai, Tibet'*', Xinjiang, Guangxi, Shaanxi, Guizhou, Inner Mongolia, and Ningxia	Jilin, Heilongjiang, Jiangxi, Henan, Anhui, Shanxi, Hubei, and Hunan	Jiangsu, Tianjin, Hebei, Beijing, Liaoning, Shanghai, Shandong, Zhejiang, Hainan, Guangdong, and Fujian

Note: *We dropped Tibet due to the unavailability of data.

Table 5. Impact of NRE, FDI, TI, TO, HC on EPD in China and across its regions

	China	Eastern	Central	Western
NRE	0.0669*** (0.0110)	0.0711*** (0.0149)	0.133*** (0.0357)	0.159*** (0.0350)
FDI	0.389*** (0.0419)	0.0244 (0.0486)	0.658*** (0.112)	0.140 (0.0952)
TI	0.451*** (0.0314)	0.145** (0.0615)	0.237* (0.112)	0.743*** (0.0989)
TO	1.135*** (0.0375)	0.951*** (0.152)	–0.940 (2.543)	7.597*** (1.377)
HC	0.743*** (0.121)	0.993* (0.502)	0.934 (0.567)	0.233 (0.184)
Constant	3.528*** (0.449)	7.014** (2.728)	3.295 (3.479)	3.103** (1.105)
N	269	99	72	98

Note: EPD is regressand. Robust S.E are given in the parentheses. ***show significance at 1%, **reveal at 5%, and *** denote 10%.

Column (1) shows the overall case and columns 2–4 indicate the eastern, central, and western regions respectively. The coefficient of NRE is positive and statistically significant in all regions and in overall China, suggesting that NRE promotes EPD in China. FDI, TI, TO, and HC are all key factors of EPD in the regions. EPD is perceived as the process of expanding the range of country's export basket (Dennis & Shepherd, 2011) or extending production for domestic consumption and exports to multiple sectors (Samen, 2010). FDI has a positive and statistical significant influence on EPD in overall China and the center region, but insignificant effect in the eastern and western regions. TI is directly related to EPD and its coefficient is significant in all regions, suggesting that an increase in TI promotes EPD. The coefficient of openness to trade is positive and significant in overall China, the eastern and western regions, but insignificant in the central region. The link between HC and EPD is positive and significant, showing that HC is important for the process of EPD in China.

4.3. Robustness checks

Table 6 shows the robustness checks results. As per our estimates, the coefficient of NRE is positive and statistically significant in column (1). Moreover, in column (2) after including FDI, the coefficient of NRE remains positive and significant. Furthermore, the inclusion of TI, TO, and HC yields the same results. The robustness checks therefore validate the core findings of all models. Thus China can promote it EPD by concentrating on these crucial factors. Table 7 present the empirical estimates of robustness for China.

In Table 7, columns 1–3 show robustness estimates of overall China, using the DKSE, FGLS, and PCSE respectively. NRE has a significant positive influence on EPD as indicated by its coefficient in each of the columns in 7. The robustness check results show the same signs and significance for FDI, TI, TO, and HC. Thus, our results are robust and significant in all cases. IMF and World banks have suggested EPD policies for poor economies' sustainable development and for countries that have not diversified their products (Shahzad et al., 2020).

Table 6. Impact of NRE, FDI, TI, TO, HC on EPD in China (robustness checks)

	DKSE	DKSE	DKSE	DKSE	DKSE
NRE	0.313*** (0.0303)	0.121*** (0.00947)	0.0842*** (0.0115)	0.110*** (0.00609)	0.0669*** (0.0110)
FDI		0.995*** (0.0363)	0.598*** (0.0352)	0.527*** (0.0330)	0.389*** (0.0419)
TI			0.685*** (0.0543)	0.615*** (0.0403)	0.451*** (0.0314)
TO				1.147*** (0.0897)	1.135*** (0.0375)
HC					0.743*** (0.121)
Constant	13.03*** (0.214)	10.31*** (0.230)	5.270*** (0.380)	5.768*** (0.282)	3.528*** (0.449)
N	269	269	269	269	269

Note: EPD is regressand. Robust S.E are given in the parentheses. ***show significance at 1%, **reveal at 5%, and *** denote 10%.

Table 7. Impact of NRE, FDI, TI, TO, HC on EPD in China (robustness checks)

	DKSE	FGLS	PCSE
NRE	0.0669*** (0.0110)	0.0525*** (0.0126)	0.0669*** (0.0194)
FDI	0.389*** (0.0419)	0.373*** (0.0436)	0.389*** (0.0771)
TI	0.451*** (0.0314)	0.365*** (0.0367)	0.451*** (0.0713)
TO	1.135*** (0.0375)	1.136*** (0.124)	1.135*** (0.224)
HC	0.743*** (0.121)	1.003*** (0.108)	0.743*** (0.206)
Constant	3.528*** (0.449)	2.919*** (0.458)	3.528*** (0.960)
N	269	269	269

Note: EPD is regressand. Robust S.E are given in the parentheses. ***show significance at 1%, **reveal at 5%, and *** denote 10%.

NRE is a necessary precondition for take-off for countries to achieve sustainable economic development. FDI also plays a key role in improving EPD through the transfer of technology. Technologies and new ideas utilized by international firms are diffused to local firms via either horizontal or vertical spillovers. Additional, local firms tend to expand to new markets as they become knowledgeable about the opportunities that occur in the new markets via their liaison with the international firms. Consequently, local firms become efficient to export to the broader markets, therefore stimulating diversification. Also, FDI promotes innovation, development, and research in domestic markets hence facilitating the technology transfer which increases the labor productivity and therefore technological efficient production of new products (Agosin et al., 2012).

5. Conclusions

Export product diversification can play a significant role in promoting the growth of developing countries. Therefore, growing competitive market conditions have compelled many countries to develop export strategies. EPD is one strategy that can help countries improve their competitiveness in global trade. Thus, in this study, we examined the impact of NRE, FDI, TO, TI, and HC on EPD using the province level data of China from 2011 to 2019. For this purpose, we form a model and used a consistent technique such as DKSE. The empirical result shows that the relationship between NRE and EPD is both positive and significant. FDI, TO, FDI, HC, and TI are all positively associated with EPD. In sum, NRE, HC, FDI, TI, and TO have an essential positive contribution to EPD. The findings of the regional analysis show that NRE, FDI, TO, HC, and TI positively impact EPD, implying that these are important for promoting EPD across Chinese. The robustness analysis for overall China demonstrates that our estimates are reliable. The findings of our study is beneficial for Chines government as it offers the policy implication about crucial drivers of EPD on disaggregated level.

Based on our results, government in China should adopt strategic and long-term plans to enhance export product diversification. In this perspective, policies are recommended to enhance the export products variety. Achieving the ability to produce a diverse range of goods should be the main goal of emerging economies. This capability can be achieved through improvements in institutional quality, infrastructure, and the availability of skilled labor. More complex and sophisticated products are possible once an economy develops certain skills. Exports based on the economy's expertise will be possible thanks to the sophisticated products basket. Developing economies can diversify their revenue streams and reduce their dependence on commodities through this process. Consequently, countries can move forward toward economic growth with the option to diversify.

Moreover, governments should offer a variety of export incentives, such as financing services and tax reliefs, to businesses that can afford to export new products. This policy will encourage businesses to add more commodities to the economy's export basket. Trade agreements can also be effective in enhancing EPD as they facilitating trade between and among nations and increase the opportunities to diversify products. It is also wise to implement more export-oriented industrial strategies with the goal of exporting products to multiple trading partners. In this context, incentive-based export strategies can be implemented to encourage the export of products to various countries. Additionally, governments can offer benefits and offer international investors to enhance the product diversity in local markets.

Despite the value added by this study, the investigation is restricted to data from 2011 to 2019, which is considered a limitation that may influence the empirical estimates. To overcome this limitation, the current study paves the way for future research into whether NRE, HC, FDI, TO, and TI influence export product diversification by employing the world data and dividing economies on the basis of income-levels.

References

Agosin, M. R., Alvarez, R., & Bravo-Ortega, C. (2012). Determinants of export diversification around the world: 1962–2000. *The World Economy*, *35*(3), 295–315. https://doi.org/10.1111/j.1467-9701.2011.01395.x

Alaya, M. (2012). *The determinants of MENA export diversification*: *An empirical analysis* (Working paper No. 709). The Economic Research Forum. https://erf.org.eg/app/uploads/2014/08/709.pdf

Alemu, A. M. (2016). The impacts of natural resource abundance on export diversification and structural change in African economies. *Journal of Economic Development*, *Management*, *IT*, *Finance*, *and Marketing*, *8*(2), 1–15.

Ali, M. (2017). Determinants of related and unrelated export diversification. *Economies*, *5*(4), Article 50. https://doi.org/10.3390/economies5040050

Amighini, A., & Sanfilippo, M. (2014). Impact of South–South FDI and trade on the export upgrading of African economies. *World Development*, *64*, 1–17. https://doi.org/10.1016/j.worlddev.2014.05.021

Arawomo, D. F., Oyelade, A. O., & Tella, A. T. (2014). Determinants of export diversification in Nigeria: Any special role for foreign direct investment (FDI)? *Journal of Economics and Business Research*, *20*(2), 21–33.

Asane-Otoo, E. (2015). Carbon footprint and emission determinants in Africa. *Energy*, *82*, 426–435. https://doi.org/10.1016/j.energy.2015.01.053

Baldwin, R., Braconier, H., & Forslid, R. (2005). Multinationals, endogenous growth, and technological spillovers: Theory and evidence. *Review of International Economics*, *13*(5), 945–963. https://doi.org/10.1111/j.1467-9396.2005.00546.x

Bas, M., & Strauss-Kahn, V. (2015). Input-trade liberalization, export prices and quality upgrading. *Journal of International Economics*, *95*(2), 250–262. https://doi.org/10.1016/j.jinteco.2014.12.005

Bayraktutan, Y., & Bıdırdı, H. (2018). Innovation and high-tech exports in developed and developing countries. *Journal of International Commerce*, *Economics and Policy*, *9*(3), Article 1850011. https://doi.org/10.1142/S1793993318500114

Blanchard, E. J., & Olney, W. W. (2017). Globalization and human capital investment: Export composition drives educational attainment. *Journal of International Economics*, *106*, 165–183. https://doi.org/10.1016/j.jinteco.2017.03.004

Bottega, A., & Romero, J. P. (2021). Innovation, export performance and trade elasticities across different sectors. *Structural Change and Economic Dynamics*, *58*, 174–184. https://doi.org/10.1016/j.strueco.2021.05.008

Brandt, L., & Rawski, T. G. (2008). *China's great economic transformation*. Cambridge University Press.

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies*, *47*(1), 239–253. https://doi.org/10.2307/2297111

Cadot, O., Carrère, C., & Strauss-Kahn, V. (2011). Export diversification: What's behind the hump? *Review of Economics and Statistics*, *93*(2), 590–605. https://doi.org/10.1162/REST_a_00078

Cadot, O., Carrère, C., & Strauss-Kahn, V. (2013). Trade diversification, income, and growth: What do we know? *Journal of Economic Surveys*, *27*(4), 790–812. https://doi.org/10.1111/j.1467-6419.2011.00719.x

Can, M., & Kösekahyaoğlu, L. (2016). Doğrudan Yabancı yatırımların ihracat ürün çeşitliliğine etkisi: Gelişmekte olan ülkeler üzerine bir uygulama [The effect of foreign direct investments on export product diversity: An application on developing countires]. *Akdeniz İİBF Dergisi*, *16*(*33*), 122–152.

Can, M., & Doğan, B. (2020). The effect of knowledge and skill-based production on agricultural employment: An empirical analysis in the sample of South Korea. In S. Sikdar, R. C. Das, & R. Bhattacharyya (Eds.), *Role of IT-ITES in Economic Development of Asia*: *Issues of Growth*, *Sustainability and Governance* (pp. 223–234). Springer. https://doi.org/10.1007/978-981-15-4206-0_17

Can, M., Ahmed, Z., Ahmad, M., & Oluc, I. (2024). Economic progress in emerging countries: The roles of diversification of import and export products and energy consumption. *Environment, Development and Sustainability*, *26*(7), 18207–18229. https://doi.org/10.1007/s10668-023-03386-8

Charles, A., Mesagan, E., & Saibu, M. (2018). Resource endowment and export diversification: Implications for growth in Nigeria. *Studies in Business and Economics*, *13*(1), 29–40. https://doi.org/10.2478/sbe-2018-0003

Cirera, X., Marin, A., & Markwald, R. (2015). Explaining export diversification through firm innovation decisions: The case of Brazil. *Research Policy*, *44*(10), 1962–1973. https://doi.org/10.1016/j.respol.2015.06.004

Crespo, N., & Fontoura, M. P. (2007). Determinant factors of FDI spillovers – What do we really know? *World Development*, *35*(3), 410–425. https://doi.org/10.1016/j.worlddev.2006.04.001

De Piñeres, S. A. G., & Ferrantino, M. (1997). Export diversification and structural dynamics in the growth process: The case of Chile. *Journal of development Economics*, *52*(2), 375–391. https://doi.org/10.1016/S0304-3878(96)00446-4

Dennis, A., & Shepherd, B. (2011). Trade facilitation and export diversification. *The World Economy*, *34*(1), 101–122. https://doi.org/10.1111/j.1467-9701.2010.01303.x

Dessy, S., Mbiékop, F., & Pallage, S. (2010). On the mechanics of trade-induced structural transformation. *Journal of Macroeconomics*, *32*(1), 251–264. https://doi.org/10.1016/j.jmacro.2009.10.003

Dou, S., Ul-Haq, J., Visas, H., Aslam, B., & Khanum, S. (2023). Does export product diversification reduce sulfur dioxide emissions in China? A regional analysis. *International Journal of Environmental Science and Technology*, *20*(6), 6247–6258. https://doi.org/10.1007/s13762-022-04353-y

Drukker, D. M. (2003). Testing for serial correlation in linear panel-data models. *The Stata Journal*, *3*(2), 168–177. https://doi.org/10.1177/1536867X0300300206

Duspara, L., Knežević, S., & Turuk, M. (2017). Competitiveness and innovation challenge in Croatia. *Business Excellence*, *11*(2), 41–58. https://doi.org/10.22598/pi-be/2017.11.2.41

Elhiraika, A., & Mbate, M. (2014). Assessing the determinants of export diversification in Africa. *Applied Econometrics and International Development*, *14*(1), 147–160.

Emodi, N. V., Murthy, G. P., Emodi, C. C., & Emodi, A. S. A. (2017). Factors influencing innovation and industrial performance in Chinese manufacturing industry. *International Journal of Innovation and Technology Management*, *14*(6), Article 1750040. https://doi.org/10.1142/S0219877017500407

Espoir, L. M. (2020). Determinant of export diversification: An empirical analysis in the case of SADC countries. *International Journal of Research in Business and Social Science* (*2147–4478*), *9*(7), 130–144. https://doi.org/10.20525/ijrbs.v9i7.942

Fahad, S., Ullah, M., & Aftab, M. (2023). Export diversification potential and structural transformation in Pakistan: A product space perspective. *Journal of Applied Economics and Business Studies*, *7*, 81–96. https://doi.org/10.34260/jaebs.715

Feenstra, R. C., & Kee, H. L. (2004). *Export variety and country productivity* (Working Paper No. 10830). National Bureau of Economic Research. https://doi.org/10.3386/w10830

Ferreira, G. F., & Harrison, R. W. (2012). From coffee beans to microchips: Export diversification and economic growth in Costa Rica. *Journal of Agricultural and Applied Economics*, *44*(4), 517–531. https://doi.org/10.1017/S1074070800024081

Fosu, A. K. (2021). Infrastructure and the impact of foreign direct investment (FDI) on export diversification: Evidence from Africa. *Journal of African Development*, *22*(1), 102–123. https://doi.org/10.5325/jafrideve.22.1.0102

Gamariel, G., Bomani, M., Musikavanhu, L., & Juana, J. (2022). Foreign direct investment and export diversification in developing countries. *Risk Governance & Control: Financial Markets & Institutions*, *12*(1), 74–89. https://doi.org/10.22495/rgcv12i1p6

Giri, R., Quayyum, M. S. N., & Yin, R. (2019). *Understanding export diversification: Key drivers and policy implications* (IMF Working Papers, 2019(105)). SSRN. https://doi.org/10.2139/ssrn.3404061

Gnangnon, S. K. (2019). Export product diversification, trade openness and foreign direct investment inflows: An empirical analysis. *Asian Development Perspectives* (*ADP*), *10*(2), 114–134.

Gnangnon, S. K. (2021). Manufacturing exports and services export diversification. *The International Trade Journal*, *35*(3), 221–242.

Golo, Y. N. (2023). Foreign direct investment, human capital and export diversification in Africa: A panel smooth transition regression (PSTR) model analysis. *The Journal of International Trade & Economic Development*, *33*(7), 1371–1396. https://doi.org/10.1080/09638199.2023.2265496

Gozgor, G., & Can, M. (2016a). Effects of the product diversification of exports on income at different stages of economic development. *Eurasian Business Review*, *6*, 215–235. https://doi.org/10.1007/s40821-016-0045-5

Gozgor, G., & Can, M. (2016b). Export product diversification and the environmental Kuznets curve: Evidence from Turkey. *Environmental Science and Pollution Research*, *23*, 21594–21603. https://doi.org/10.1007/s11356-016-7403-9

Gözgör, G., & Can, M. (2017). Causal linkages among the product diversification of exports, economic globalization and economic growth. *Review of Development Economics*, *21*(3), 888–908. https://doi.org/10.1111/rode.12301

Guliyev, M., & Azizov, T. (2022). Diversification through promotion of export-oriented production and "Green transformation" in Azerbaijan. *Scientific Horizons*, *25*(10), 62–70. https://doi.org/10.48077/scihor.25(10).2022.62-70

Gulguu, A., (2022) Landlockedness, foreign direct investment, and export diversification. *Tomsk State University Journal of Economics*, *58*, 224–237.

Gyamfi, B. A., Onifade, S. T., Haouas, I., & Adedoyin, F. F. (2023). The impacts of resource abundance and export diversity on financial development in the South Asian economic bloc. *Heliyon*, *9*(4), Article e15105. https://doi.org/10.1016/j.heliyon.2023.e15105

Haini, H. (2021). Examining the impact of ICT, human capital and carbon emissions: Evidence from the ASEAN economies. *International Economics*, *166*, 116–125. https://doi.org/10.1016/j.inteco.2021.03.003

Hamidova, L. (2021, June 25–26). Impact of natural resource endowment on the economic development of Azerbaijan. In *Proceedings of the 70th International Scientific Conference on Economic and Social Development* (pp. 178–185). Baku, Azerbajain.

Hye, Q. M. A., & Lau, W.-Y. (2015). Trade openness and economic growth: Empirical evidence from India. *Journal of Business Economics and Management*, *16*(1), 188–205. https://doi.org/10.3846/16111699.2012.720587

Hye, Q. M. A., Ul-Haq, J., Visas, H., & Rehan, R. (2023). The role of eco-innovation, renewable energy consumption, economic risks, globalization, and economic growth in achieving sustainable environment in emerging market economies. *Environmental Science and Pollution Research*, *30*, 92469–92481. https://doi.org/10.1007/s11356-023-28945-4

Iwamoto, M., & Nabeshima, K. (2012). *Can FDI promote export diversification and sophistication of host countries?: Dynamic panel system GMM analysis* (Discussion Paper No. 347). Institute of Developing Economies, Japan External Trade Organization (JETRO).

Jiang, W., & Gao, H. (2023). The nexus between natural resources and exports of goods and services in the OECD countries. *Resources Policy*, *85*, Article 103950. https://doi.org/10.1016/j.resourpol.2023.103950

Jochmans, K., & Verardi, V. (2020). Fitting exponential regression models with two-way fixed effects. *The Stata Journal*, *20*(2), 468–480. https://doi.org/10.1177/1536867X20931006

Kang, Y.-Q., Zhao, T., & Yang, Y.-Y. (2016). Environmental Kuznets curve for CO_2 emissions in China: A spatial panel data approach. *Ecological Indicators*, *63*, 231–239. https://doi.org/10.1016/j.ecolind.2015.12.011

Khan, H., Khan, M. A., Ahmed, M., Popp, J., & Oláh, J. (2021). The nexus between export diversification and foreign direct investment: Empirical evidence from China. *Montenegrin Journal of Economics*, *17*(2), 105–117. https://doi.org/10.14254/1800-5845/2021.17-2.9

Klinger, B., & Lederman, D. (2004). *Discovery and development*: *An empirical exploration of" new" products* (Policy Research Working Paper No. 3450). World Bank. https://doi.org/10.1596/1813-9450-3450

Klinger, B., & Lederman, D. (2006). *Diversification*, *innovation*, *and imitation inside the global technological frontier* (Policy Research Working Paper No. 3872). World Bank. https://doi.org/10.1596/1813-9450-3872

Lall, S. (1992). Structural problems of African industry. In F. Stewart, S. Lall, & S.Wangwe (Eds.), *Alternative development strategies in Subsaharan Africa* (pp. 103–144). Springer. https://doi.org/10.1007/978-1-349-12255-4_4

Lederman, D., & Maloney, W. F. (2006). *Natural resources*, *neither curse nor destiny* (Report No. 37893). World Bank. https://doi.org/10.1596/978-0-8213-6545-8

Li, M., Ahmad, M., Fareed, Z., Hassan, T., & Kirikkaleli, D. (2021). Role of trade openness, export diversification, and renewable electricity output in realizing carbon neutrality dream of China. *Journal of Environmental Management*, *297*, Article 113419. https://doi.org/10.1016/j.jenvman.2021.113419

Lian, W., Liu, F., Svirydzenka, K., & Zhu, B. (2021). A diversification strategy for South Asia. *IMF Working Papers*, *2021*(202). https://doi.org/10.2139/ssrn.4026401

Liu, Y., Lu, F., Xian, C., & Ouyang, Z. (2023). Urban development and resource endowments shape natural resource utilization efficiency in Chinese cities. *Journal of Environmental Sciences*, *126*, 806–816. https://doi.org/10.1016/j.jes.2022.03.025

Madonna, M., & Handoyo, R. D. (2023). The effect of innovation, logistic performance, and human capital on export diversification of manufacturing industry. *Kinerja*, *27*(1), 129–147. https://doi.org/10.24002/kinerja.v27i1.6459

Makhlouf, Y., Kellard, N. M., & Vinogradov, D. (2015). Trade openness, export diversification, and political regimes. *Economics Letters*, *136*, 25–27. https://doi.org/10.1016/j.econlet.2015.08.031

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695–1725. https://doi.org/10.1111/1468-0262.00467

Morrison, W. M. (2019). China's economic rise: History, trends, challenges, and implications for the United States. *Current Politics and Economics of Northern and Western Asia*, *28*(2/3), 189–242.

National Bureau of Statistics of China. (n.d.). Retrieved on February 25, 2022, from https://www.stats.gov.cn/english/

National Bureau of Statistics Division of Energy. (2013). *China Energy Statistical Yearbook 2013*. China Statistics Press.

Nelson, R. R., & Phelps, E. S. (1966). Investment in humans, technological diffusion, and economic growth. *The American Economic Review*, *56*(1/2), 69–75.

Niass, D. (2022, June 8–10). *Does natural resources endowment affect export diversification in Africa? A CROSS-country analysis* [Conference presentation]. The 25th Annual Conference on Global Economic Analysis. Purdue University, Indiana, United States.

Onifade, S. T., Gyamfi, B. A., Haouas, I., & Bekun, F. V. (2021). Re-examining the roles of economic globalization and natural resources consequences on environmental degradation in E7 economies: Are human capital and urbanization essential components? *Resources Policy*, *74*, Article 102435. https://doi.org/10.1016/j.resourpol.2021.102435

Osakwe, P. N., Santos-Paulino, A. U., & Dogan, B. (2018). Trade dependence, liberalization, and exports diversification in developing countries. *Journal of African Trade*, *5*(1–2), 19–34. https://doi.org/10.1016/j.joat.2018.09.001

Pesaran, M. H. (2004). *General diagnostic tests for cross section dependence in panels* (Cambridge Working Paper in Economics No. 435). University of Cambridge.

Qiang, Q., & Jian, C. (2020). Natural resource endowment, institutional quality and China's regional economic growth. *Resources Policy*, *66*, Article 101644. https://doi.org/10.1016/j.resourpol.2020.101644

Rodrik, D. (2006). What's so special about China's exports? *China & World Economy*, *14*(5), 1–19. https://doi.org/10.1111/j.1749-124X.2006.00038.x

Sachs, J. D., & Warner, A. M. (2001). The curse of natural resources. *European Economic Review*, *45*(4–6), 827–838. https://doi.org/10.1016/S0014-2921(01)00125-8

Saenko, A. (2023). The state of services and trade in Africa and their impact on export diversification. *International Economics*, 6, 365–374. https://doi.org/10.33920/vne-04-2306-02

Samen, S. (2010). *A primer on export diversification*: *Key concepts*, *theoretical underpinnings and empirical evidence*, *growth and crisis unit*. World Bank.

Shahzad, U., Ferraz, D., Doğan, B., & Rebelatto, D. A. do N. (2020). Export product diversification and CO2 emissions: Contextual evidences from developing and developed economies. *Journal of Cleaner Production*, *276*, Article 124146. https://doi.org/10.1016/j.jclepro.2020.124146

Sharma, R., Shahbaz, M., Kautish, P., & Vo, X. V. (2021). Analyzing the impact of export diversification and technological innovation on renewable energy consumption: Evidences from BRICS nations. *Renewable Energy*, *178*, 1034–1045. https://doi.org/10.1016/j.renene.2021.06.125

Shi, J., Visas, H., Ul-Haq, J., Abbas, S., & Khanum, S. (2023). Investigating the impact of export product diversification on environmental degradation: Evidence from Chinese Provinces. *Environment*, *Development and Sustainability*, 25, 11455–11486. https://doi.org/10.1007/s10668-022-02536-8

Singer, H. W. (1950). The distribution of gains between investing and borrowing countries. In R. Jolly (Ed.), *Milestones and turning points in development thinking* (pp. 265–277). Springer. https://doi.org/10.1057/9781137271631_19

Su, X., & Tan, J. (2023). Regional energy transition path and the role of government support and resource endowment in China. *Renewable and Sustainable Energy Reviews*, *174*, Article 113150. https://doi.org/10.1016/j.rser.2023.113150

Sun, H.-P., Sun, W.-F., Geng, Y., & Kong, Y.-S. (2018). Natural resource dependence, public education investment, and human capital accumulation. *Petroleum Science*, *15*(3), 657–665. https://doi.org/10.1007/s12182-018-0235-0

Sun, H.-p., Sun, W.-f., Geng, Y., Yang, X., & Edziah, B. K. (2019). How does natural resource dependence affect public education spending? *Environmental Science and Pollution Research*, *26*, 3666–3674. https://doi.org/10.1007/s11356-018-3853-6

Swathi, M., & Sridharan, P. (2022). Determinants of export diversification: Evidence from fractional logit estimation model. *Foreign Trade Review*, *57*(2), 160–177. https://doi.org/10.1177/00157325211072922

Tadesse, B., & Shukralla, E. K. (2013). The impact of foreign direct investment on horizontal export diversification: Empirical evidence. *Applied Economics*, *45*(2), 141–159. https://doi.org/10.1080/00036846.2011.595692

Ul-Haq, J., Visas, H., Umair, M., Hussain, Z., & Khanum, S. (2023). Does economic fitness matter in carbon emissions mitigation in BRICS countries? *Environmental Science and Pollution Research*, *30*(19), 55112–55131. https://doi.org/10.1007/s11356-023-26162-7

Ur Rehman, F., Ahmad, E., Khan, M. A., Popp, J., & Oláh, J. (2021). Does trade related sectoral infrastructure make Chinese exports more sophisticated and diversified? *Sustainability*, *13*(10), Article 5408. https://doi.org/10.3390/su13105408

Vakataki'Ofa, S., Spence, M., Mevel, S., & Karingi, S. (2016). Export diversification and intra-industry trade in Africa. In K.-M. Steve, S. Abebe, L. Angela, & M. Ahmed (Eds.), *Inclusive growth in Africa*: *Policies*, *practice*, *and lessons learnt* (1st ed., pp. 142–175). Routledge.

Vasilyeva, R., Urazbaeva, A., & Voytenkov, V. (2023). Determinants of export diversification: The case of Russian regions. *Eastern European Economics*, 1–37. https://doi.org/10.1080/00128775.2023.2265919

Vergara, S. (2021). The role of productive and technological capabilities in export dynamics in developing countries. *CEPAL Review*, *2021*(133), 7–30. https://doi.org/10.18356/16840348-2021-133-1

Visas, H., Ul-Haq, J., & Khanum, S. (2021). Natural resource dependence and life expectancy nexus: The role of education. *Journal of Economics and Finance*, *2*(2), 76–96.

Wang, B., & Li, J. (2019). An empirical study on the "resource curse" effect of China's coal cities". *Statistics and Decision*, *10*, 121–125.

Wang, Y., & Chen, X. (2020). Natural resource endowment and ecological efficiency in China: Revisiting resource curse in the context of ecological efficiency. *Resources Policy*, *66*, Article 101610. https://doi.org/10.1016/j.resourpol.2020.101610

Wang, Q., Zhang, F., & Li, R. (2023). Revisiting the environmental kuznets curve hypothesis in 208 counties: The roles of trade openness, human capital, renewable energy and natural resource rent. *Environmental Research*, *216*, Article 114637. https://doi.org/10.1016/j.envres.2022.114637

World Bank. (n.d.). *The World Bank in China*. *Overview context*. Retrieved September 11, 2019, from https://www.worldbank.org/en/country/china/overview

Wilhelms, C. (1967). Export diversification in Latin America. *Intereconomics*, *2*(2), 46–48. https://doi.org/10.1007/BF02930583

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT Press.

Zafar, M. W., Zaidi, S. A. H., Khan, N. R., Mirza, F. M., Hou, F., & Kirmani, S. A. A. (2019). The impact of natural resources, human capital, and foreign direct investment on the ecological footprint: The case of the United States. *Resources Policy*, *63*, Article 101428. https://doi.org/10.1016/j.resourpol.2019.101428

Zhang, Q., & Crooks, R. (2012). *Toward an environmentally sustainable future*: *Country environmental analysis of the People's Republic of China*. Asian Development Bank. https://www.adb.org/sites/default/files/publication/29943/toward-environmentally-sustainable-future-prc.pdf

Zhang, L.-X., Lai, M.-T., Chang, T., Ranjbar, O., & Saboori, B. (2023a). Measuring the export diversification of creative products' basket and identifying its drivers: Cross-country evidence. *Applied Economics Letters*, *31*(21), 2261–2265. https://doi.org/10.1080/13504851.2023.2219883

Zhang, Y., Kumar, S., Huang, X., & Yuan, Y. (2023b). Human capital quality and the regional economic growth: Evidence from China. *Journal of Asian Economics*, *86*, Article 101593. https://doi.org/10.1016/j.asieco.2023.101593

Zhao, J., Jiang, Q., Dong, X., & Dong, K. (2020). Would environmental regulation improve the greenhouse gas benefits of natural gas use? A Chinese case study. *Energy Economics*, *87*, Article 104712. https://doi.org/10.1016/j.eneco.2020.104712

Zhong, S., Li, J., & Zhao, R. (2021). Does environmental information disclosure promote sulfur dioxide (SO2) remove? New evidence from 113 cities in China. *Journal of Cleaner Production*, *299*, Article 126906. https://doi.org/10.1016/j.jclepro.2021.126906

Zhu, X. (2012). Understanding China's growth: Past, present, and future. *Journal of Economic Perspectives*, *26*(4), 103–124. https://doi.org/10.1257/jep.26.4.103