Technological and Economic Development of Economy
ISSN: 2029-4913 / eISSN: 2029-4921
2023 Volume 29 Issue 3: 1041–1079
https://doi.org/10.3846/tede.2023.17061

NONLINEAR EFFECTS OF DIGITALIZATION ON EXPORT ACTIVITIES: AN EMPIRICAL INVESTIGATION IN EUROPEAN COUNTRIES

Nguyen Thi Hong NHAM[1], Nguyen Khac Quoc BAO[2*], Le Thanh HA[3]

[1,2]*School of Finance, University of Economics Ho Chi Minh City (UEH), Ho Chi Minh, Vietnam*
[3]*Faculty of Economics, National Economics University, Ha Noi, Vietnam*

Received 17 November 2021; accepted 15 April 2022

Abstract. Our study is the first to empirically analyze the nonlinear relationship between digitalization and export value and diversification. This paper measures the digital transformation process in terms of digital connectivity, uses of the internet, e-business, e-commerce, and e-government. The various econometrics techniques are applied for the database of 23 European countries during the period 2015–2020. The vital findings should be conveyed here. *First*, the bottlenecks of export values could be resolved by promoting digital transformation. However, the non-linear reverted U-shaped relationship between digitalization and export diversification suggests that positive effects only appear when the digital activities, especially in digital connectivity, humans with digital skills, use of internet services, or digital public services reaches a certain threshold. *Second*, the positive influence of digitalization on exports stems from a reduction in export cost and export time to deal with documentary and border compliance as well as improvements in competence and quality of logistic services and quality of trade and transport-related infrastructure, thus enhancing exports. *Third*, the role of digital connectivity and the integration of digital technology into business and commerce become especially important for export diversification.

Keywords: digital transformation, export value and diversification, European countries.

JEL Classification: F21, G21, O16, C33.

Introduction

The global economy is going through a dark period when the novel coronavirus was declared by the World Health Organization (WHO) in March 2020 (Jebril, 2020; Sohrabi et al., 2020), which cause the world to have been experiencing a series of devastating losses (Gopinath, 2020). The COVID-19 epidemic's devastation has dealt a catastrophic blow to the global economy. Under this context, the governments have continued to take extraordinary measures, such as lockdowns and social distancing measures to save lives. As a consequence, the

*Corresponding author. E-mail: *Nguyenbao@ueh.edu.vn*

global economy has experienced an unprecedented sharp decrease when economic activities and economic sectors were essentially shut down (Guerrieri et al., 2020). Prior experts, such as Daszak (2012), Ford et al. (2009), and Webster (1997) had anticipated that the worldwide pandemic would create serious stresses on the elements of global supply chains, which lead to a global economic disaster. With the increasingly serious situation of the pandemic, more and more stringent measures have been implemented, which strain the elements of the global supply chain and international trade more remarkably.

Furthermore, globalization makes interdependent countries more vulnerable to disruptions. According to the U.S. Institute for Supply Chain, the proportion of companies that have reported disruption in supply chains is 75 percent (Fernandes, 2020). COVID-19 health crisis also has led to a reduction in flexibility of the several layers of their global supply chains and a reduction in diversification in sourcing strategies and exporting activities (Baker McKenzie, 2020). These disruptions then adversely influence the exporting countries, such as unavailability of output for their local business and importing countries, such as lack of raw materials for their production (Fernandes, 2020). Europe's exports are much lower in value. Non-essential items have gotten less attention than food and medical care, resulting in a loss of diversity in exports due to transportation difficulties. Medical instrument exports have been given increased priority by countries (Ibn-Mohammed et al., 2021; Ranney et al., 2020). Medical consumables are the biggest exported product group among the 23 EU Member States, with Cyprus accounting for 95% and Greece for 90%. Lithuania has the largest proportion of diagnostic equipment (41 percent). Finland (46%) and Estonia (41%), on the other hand, have the largest share of medical equipment (European Commission, 2021a). During the worst of the pandemic, the structure of export commodities was simplified. Exports are put at risk due to the pandemic and extraordinary measures would be taken to combat it (Ibn-Mohammed et al., 2021).

Under the serious consequences caused by the COVID-19 pandemic on the global economy, the digital transformation is entrenched (Bayram et al., 2020). Extraordinary measures like the lockdown and social distancing have emphasized the importance of remote working (Dingel & Neiman, 2020). The digital transformation under the COVID-19 pandemic circumstance can be considered as a tool to help countries overcome difficulties. Digitalization significantly affects the way that businesses operate globally (Dethine et al., 2020) and provides the business with a competitive advantage in the global economy (Lee & Falahat, 2019). Digitalization can be considered a tool for promoting internationalization (Dethine et al., 2020). During the time of crisis, digitalization can help to attenuate the adverse influence of COVID-19 on exports by facilitating access to goods and services (OECD, 2020). There are more efficient movements of goods across borders due to the leverage of digital technologies. Digitalization makes the border processes transparent and accessible to a trader. Furthermore, digitalization helps to reduce physical contacts that are especially vital for the micro-and small-and medium-sized firms being hit strongly by the health crisis.

This paper is the first effort to empirically analyze the effects of digital transformation on export values and export diversification. Another contribution of this paper is from a theoretical aspect when we combine both a resource-based view and a dynamic capability view to investigate the relationship between digitalization and exports. In this paper,

export diversification is captured by the diversification index used to reflect what extent the structure of exports by-products of a particular economy differs from the world pattern. To provide further exploit on the sources of digitalization-export diversification, we investigate impacts of digitalization on export values in different sectors and on the factors, which can be considered as critical determinants of export activities, such as export cost and export time to deal with documentary and border compliance, competence, and quality of logistic services and quality of trade and transport-related infrastructure. We apply various econometric techniques to a sample of 23 European countries during the period 2015–2020. Specifically, the panel corrected standard errors (PCSE) model is selected to address the issues related to cross-sectional dependence. For a robustness check, our study also applies the panel corrected standard errors (PCSE) model to examine our findings when we take the presence of heteroscedasticity and fixed effects into account. All independent variables are lagged by one period to resolve endogeneity. To resolve the endogeneity, we also utilize the two-step general method of moment (two-step GMM). Since we expect that there is a nonlinear relationship between digitalization and export diversification, the squared terms of variables capturing the process of digital transformation are added into the theoretical model. For simulation purposes, we utilize the predictive margins analysis.

In this article, we make at least two contributions to the existing literature. To our best knowledge, this paper is the first to empirically analyze the nonlinear association between digitalization and export diversification. The mechanism to explain the positive effects of digitalization on exporting activities is also provided. Specifically, digitalization leads to a reduction in export cost and export time to deal with documentary and border compliance as well as improvements in competence and quality of logistic services and quality of trade and transport-related infrastructure, thus enhancing exports. In other words, the development of export activities requires a long and persistent pursuit of the digital transformation process. Our paper is an effort to overcome difficulties arising from the data limitation by strictly following the empirical econometric approach and applying the various techniques that are appropriate to the data with the presence of the cross-sectional dependence as an effort to control potential issues, such as multicollinearity, heteroskedasticity, and endogeneity.

The remaining of the paper is structured as follows. Section 1 provides a review of relevant literature. Section 2 and 3 describe the model, data, and estimation method, respectively. Section 4 reports empirical results and discussion. The last Section concludes the paper.

1. Literature review and hypothesis development

1.1. Theoretical framework

The two-strand of theories, the new trade, and endogenous growth theories, have affirmed export diversification (Krugman & Venables, 1995). The monopolistic competition trade model developed is considered as the workhorse model in new trade theory. However, there exists considerable heterogeneity associated with productivity and firm size within industries, thus this trade theory failed to explain the stylized empirical facts. Melitz (2003) developed the heterogeneous firm trade model (HFTM) that introduced the self-selection mechanism to link trade costs to aggregate trade. Decreasing trade costs led to a diminish in export

productivity, and then firms' export decisions. A rise in the number of exporters led to a growth in the diversification of a country's exports. Both extensive and intensive margins of trade were influenced by the change in trade costs (Melitz, 2003), but this theory still failed to explicitly explain the impacts of trade costs on the intensive margin. Overcome limitations of prior theories, Lawless et al. (2019) contended that total exports can be affected by trade costs in two ways: (i) the export productivity threshold and (ii) the sales of existing exporters. The highly-productive firms force low-productive firms to leave the market. Such changes can lead to a rise in export at the intensive margins when existing products become more concentrated. However, changes in intensive margins are difficult to predict if there are effects of variable costs on intensive margin.

Trade costs argued in trade theories are important to explain export diversification. These trade costs include fixed entry costs and variable costs. The former arises from expenditure to set up distributional channels, costs of document preparation, port procedures, and other bureaucratic work related to exporting. Put it differently, the weak and poor institutional system causes firms to pay these costs. Hence, an improvement of institutional quality/efficiency helps producers to adjust their production structures to the international environment and optimally allocate their resources, thus it augments diversification of economic activities. The latter costs are determined by the behavior of all exporters. Melitz (2003) argues that variable costs are of the per, unit "iceberg" type (e.g., tariffs, transport costs), while Samuelson (1952) defines iceberg variable costs as an ad valorem tax equivalent.

1.2. Digitalization and export performance

Based on the heterogeneous trade model and prior theoretical models, we attempt to explain the link between digitalization and export/trade. Previous studies indicate that these fixed and variable costs can be affected by the digital transformation process. In particular, Freund and Weinhold (2004) demonstrate that the Internet stimulates trade by reducing market-specific fixed costs of trade as well as improving competitive advantages obtained from the Internet. In a similar spirit, Bojnec and Ferto (2010) also indicate the positive, significant, time-varying increasing influences of the Internet on exports of food due to its effects on market-specific entry costs for the food industry.

Digitalization significantly changes the way that businesses operate globally (Dethine et al., 2020) and provides businesses with a competitive advantage in the global economy (Lee & Falahat, 2019). Digitalization can also be seen as the means for promoting internationalization (Dethine et al., 2020). During the time of uncertainty, digitalization can help attenuate the adverse influence on exports by facilitating access to goods and services (OECD, 2020). There are more efficient movements of goods across borders due to the leverage of digital technologies. Digitalization makes the border processes more transparent and accessible to traders. Applying digital technologies to production and business processes has enhanced the productivity and efficiency of communication between customers and suppliers (Rehnberg & Ponte, 2018).

The digital economy has increased because of the fourth industrial revolution, offering up new business models with more valuable resources (Bettiol et al., 2020). New technologies such as robotics, component manufacturing, the Internet, big data, and artificial intelligence

are widely applied to manufacturing. Enterprises gradually adapt to technology's assistance, increasing the efficiency of their manufacturing and business operations. The model of applying technology in production and business has changed the structure and process of cross-border business (Alcácer et al., 2016).

As revealed by Laplume et al. (2016), digital transformation by applying new technologies to the production process has the potential to turn the trend of global specialization into different fragmentation. These production fragments can be scattered to many places and reach closer to consumers. Multinational organizations such as Amazon and Alibaba take advantage of the benefits of digital platforms to deliver products to customers more swiftly and conveniently. If firms want to access global markets more easily and efficiently, they implement the digital transformation and reach a certain level (Strange & Zucchella, 2017).

Exporting firms have been able to promote their products to foreign countries more effectively and extensively as technology and advertising have advanced. It encourages businesses to expand to collect more data, although it also makes product distribution more complicated due to the strong internationalization process with diverse competitions.

New technical technologies will increase production efficiency, therefore technological innovation is a must if organizations wish to compete in today's highly competitive global market. Technological change is a prerequisite for export performance (Azar & Ciabuschi, 2017). To get a competitive advantage, firms must differentiate themselves by charging premium prices, operating at reduced costs, or doing both. As a result, the company can make a lot of money and grow much faster than its competitors in the field (Porter & Heppelmann, 2014). Increasing innovation adoption and digital transformation is one approach that allows exporting firms and their country to achieve higher growth (Azar & Ciabuschi, 2017).

Dalenogare et al. (2018) contend that digitalization is an important stage of industrialization. Integrating product manufacturing processes can help a company achieve higher industrial efficiency. Big data, the Internet, artificial intelligence, and other representatives of digitalization will create positive performance allowing better communication and deployment of technology applications for the exporting company. To achieve optimal adaptation to foreign markets, enterprises should partially innovate their technology systems instead of completely and radically innovating (Azar & Ciabuschi, 2017).

1.3. Digitalization and export diversification

The adoption of digitalization can have a significant impact on enterprises, even beyond the company's borders. Chiarvesio and Romanello (2018), however, show that digitalization has no significant effect on globalization. Different researchers dispute the transnational impact of digital technology from various perspectives. According to Rehnberg and Ponte (2018), technology can alter how production is constrained by geography and time, which affects the location and scale of production activities. The potential influence of big data on exports is discussed by Strange and Zucchella (2017). Companies can observe new trends in other countries without having to sell their products there. As a result, they can more efficiently distribute items to numerous places throughout the world while also streamlining production processes. Data analysis and well-executed research efforts will aid firms in realizing potential benefits, particularly for those looking to extend their distribution market. Emerging markets

with the potential for rapid development will be a once-in-a-lifetime opportunity for businesses wishing to expand, especially if existing enterprises in such regions are underperforming (Strange & Zucchella, 2017).

Increasing interdependencies among organizations make the public more concerned about sustainable development and the role of cybersecurity (Sulich et al., 2021). Given the importance of sustainable development, the environmental goods and services sector (GGS) has become an emerging and important one, especially in the European Union (Hilty et al., 2011; Scholz, 2017; Sergi et al., 2019). The network entities and the development of the ICT sector are considered critical factors in improving environmental management and protection, thus fueling the GGS. The Sustainable Development Goals (SDGs) in the firms' strategies (Sołoducho-Pelc & Sulich, 2020) and digitalization (Sulich et al., 2021) significantly enhance the GGS. Therefore, the development of environmental technologies and the firms' cybersecurity play a vital role in helping them achieve sustainable development (Sulich et al., 2021).

Industry 4.0 substantially promotes automation and enhances communication, self-monitoring, and smart machines that help address potential issues (Awan et al., 2021). Industry 4.0, in combination with the circular economy, demonstrates a novel industrial paradigm that enables novel natural resource strategies (Centobelli et al., 2020). In the literature, scholars often refer to Jevons paradox (Hovardas, 2016), highlighting the approach's limitations, focusing on technological efficiency solely to obtain sustainability (Hilty et al., 2011). The most challenging issue of implementing the digital transformation process in almost all areas of modern life is ensuring security in cyberspace in the area of biosecurity, thus obtaining the SDFs. For European countries, a combination of internal and external security (Sulich et al., 2021) and the need to develop consistent policies in this security context (Bossong & Rhinard, 2013) are prerequisites to using digitalization to achieve sustainability.

Digitalization influences the environment by the diverse transmission mechanisms. *First*, technology application enhances the efficiency of e-waste collection and recycling or reuse of used materials, thus creating a circular economy (European Commission, 2021b). Digitalization is vital in solving pressing environmental problems such as solid waste, e-waste, food waste, and agricultural waste (Ferrari et al., 2020; Sharma et al., 2020; Wen et al., 2021). A favorable perspective is that digital technology supports minimized pressure on the natural environment and biodiversity. According to Pontones-Rosa et al. (2021), the prevalence of ICT usage improves the effectiveness of public policies and citizens' perceptions through the visualization and communication of biological data or viable digital business models that prevent biodiversity loss. Moreover, applying digitalization to harmful environmental activities improves operational cost reduction, worker safety (El-Haggar, 2007; Zhang et al., 2017), or minimizing resource utilization and degradation (Roy & Singh, 2017). Based on the findings of Feroz et al. (2021), many researchers have recently been interested in the impact of digitalization on the relationship between ecosystems and human well-being, because they allow them to resolve the problem of lack of resources, traffic congestion, and air pollution (Ha, 2022; Honarvar & Sami, 2019).

The literature also indicates the effects of digitalization on trade performance (Azar & Ciabuschi, 2017; Bettiol et al., 2020) and trade diversification (Chiarvesio & Romanello, 2018). Since the importance of digitalization in augmenting sustainable development, we believe that the digital transformation process appears to have an influence on the GGS.

2. Empirical methodology

The panel data regression used to investigate the nexus between digitalization and exports can be written as follows:

$$EX_{it} = \beta_0 + \beta_1 DM_{i,t} + \beta_3 GDP_{i,t} + \beta_4 FDI_{i,t} + \beta_5 REER_{i,t} + \beta_6 SAVE_{i,t} + \beta_7 INFLA_{i,t} + \beta_8 URBAN_{i,t} + \beta_9 Industry_{i,t} + \zeta_t + \eta_i + \varepsilon_{ijt}, \quad (1)$$

where i and t respectively denote country *i* and year *t*. ζ_t and η_i are added into the model to capture the country and year fixed effects, and ε_{ijt}, is the error term. The dependent variable, EX_{it} = {*EX_Diver*, *EX_Value*}, consist of export diversification (*EX_Diver*) and export values (*EX_Value*). *EX_Diver* is the diversification index used to reflect what extent the structure of exports by-products of a particular economy differs from the world pattern. This data is calculated based on *UNCTADStat* Merchandise Trade Matrix. *EX_Value* is the natural logarithm of total export values of goods and services at the constant 2010 US dollar.

Digitalization variable

Our key contribution to the literature is to examine the influences of digitalization, $DM_{i,t}$, which consists of different activities related to the digital transformation process: connectivity (*CONN*), use of the internet (*INTER*), human capital (*HUSKILL*), business digitization (*DIGICOM*), and digital public services[1] (*DIGIPUB*). These indicators capture the digital performance of 27 member countries (including the United Kingdom) of the European Union, which are sourced from various surveys, for example, Eurostat – Community survey on ICT usage in Households and by Individual, Eurostat – ICT Enterprises survey, eGovernment Benchmarking Report from 2015 to 2020. *CONN* denotes the share of households subscribing to fixed broadband or with coverage by 4G. *HUSKILL* is the percentage of the population owning basic and above basic digital and software skills. *INTER* captures information about internet users or the proportion of people who do only activities, such as reading news, playing music, videos and games, video on demand, video calls, using social networks, doing an online course, and online transactions, such as banking, shopping, and selling online. *DIGIBUSI* is the weighted average of two sub-dimensions: the information about businesses using electronic information sharing, social media, and big data, and the proportion of SMEs selling online and their total turnover from e-commerce. *DIGIPUB* is the share of administrative steps associated with major life events like birth of a child, new residence, or the share of public services needed for starting a business and for conducting regular business operations that can be done online.

Regarding other control variables, we base on theories of international trade and empirical studies in the literature, such as Agosin et al. (2012), Cadot et al. (2011), Espoir (2020), Gnangnon (2019), and Parteka and Tamberi (2013) to select explanatory variables. In particular, the set of explanatory variables includes the income level (*GDP*) measured by the real gross domestic product per capita at the constant 2010 price as in Cadot et al. (2011) and Parteka and Tamberi (2013) and many other studies. We follow Ali et al. (2016) and Branstetter (2006) to examine the effects of net flow of Foreign Direct Investment (*FDI*)

[1] The detailed description of methodology used to compute this index is provided in Digital Economy and Society Index [DESI] (2020).

measured as the share of GDP. Other main macroeconomic indicators: real effective exchange rate[2] (*REER*), saving (*SAVE*) as the share of GDP, inflation (*INFLA*) measured by the annual percentage change of GDP deflator[3] as in Ben Hammouda et al. (2006). In addition, some demographic variables, such as the urbanization level (*URBAN*) measured by the share of population living in the urban area over the total population and the industrialization level (*INDUS*) measured by the value-added to GDP are also incorporated into the baseline model. These variables are available from World Development Indicators (WDI). To conduct the robustness check on estimation results in the baseline model, we added other variables one by one into the baseline model. We follow Cabral and Veiga (2010) to consider the influences of political and institutional variables, including the level of democratization (*DEMO*) measured by the democratization index and corruption index measured by the corruption perception index (*CORR*), which respectively take from the Finnish Social Science Data Archive (FSSDA) and Transparency International (TI). Other variables capturing the costs of export include export costs to comply with border compliance (*EC_Border*) and documentary compliance (*EC_Document*). These two export costs are sourced from the WDI. As revealed by Krugman and Venables (1995), and Venables and Limão (2002), these costs have an impact on the specialization level of a nation. The higher costs decrease the variety of products exported to other countries. Parteka and Tamberi (2013) use the sample of developing and developed countries to show the negative association between export costs and export diversification. The detailed descriptions of included variables are demonstrated in Table 1. The final sample include 138 observations covering 23 countries from 2015 to 2020. The correlation matrix between all variables is displayed in Table 2. Table 2 reveals that there is a positive association between digitalization and life expectancy.

The trends of the mean value of DESI, export value and export diversification over years and countries are demonstrated in Panel A and B of Figure 1, respectively. The mean values of DESI of 23 European countries increase slightly from 2015 to 2020. By comparing the trend of DESI and export values, the two series move together from 2015 to 2019 but there exists an opposite trend between the two series in 2020. By contrast, export values increase dramatically during the 2015–2019 period before experiencing a fall in 2020. By contrast, the export diversification level of these countries fluctuates significantly as compared to the previous series. After experiencing a reduction in 2016, the export diversification index reaches a peak in 2018. Since then, we witness a decreasing trend of this index toward the end of our sample. By comparing the trend of DESI and export diversification, the two series move together from 2016 to 2018, while there exists an opposite trend between the two series during the 2018–2020 period. Figure 1 also displays the distribution of means of DESI and export values and export diversification index in the 23 European countries. It can be seen that the European countries with high DESI have more considerable export values than those with low DESI. Figure 2b suggests that the European countries in our sample have a high export diversification index. The figures also reveal that the European countries with high DESI have a high level of export diversification. However, many other European countries have a low DESI

[2] The less export diversification stems from a higher uncompetitive exchange rate (Ferdous, 2011). On the other hand, a lower exchange rate can promote the diversification of export products and trading partner (de Piñeres & Ferrantino, 1997).

[3] We use GDP deflator instead of consumer price index due to the data availability in 2020.

but still obtain a high level of export diversification. This figure may suggest that the nexus between digitalization and export diversification exist for countries with a high development level of digitalization. For countries with low diversification, this relationship is not clear.

Table 1. Description of variables

Variable	Definition	Measure	Source	Obs	Mean	SD	Min	Max
EX_Diver	Export diversification	The diversification index[4]	UNCTAD	138	4.24	0.95	2.95	6.67
EX_Value	Export values	The natural logarithm of exports of goods and services (constant 2010 US dollar)	WDI	138	5.14	1.31	2.79	7.60
DM	DESI overall index	The weighted average of the five main DESI dimensions (Desi1-5)	DESI (2020)	138	9.28	2.07	5.49	14.49
CONN	Connectivity	The weighted average of fixed broadband take-up, fixed broadband coverage, mobile broadband, and broadband price index	DESI (2020)	138	10.29	2.61	4.36	16.46
HUSKILL	Human capital	The weighted average of internet user skills and advanced skills and development	DESI (2020)	138	11.33	2.77	6.82	17.93
INTER	Use of internet services	The weighted average of internet use, activities online, and transactions	DESI (2020)	138	7.55	1.79	3.26	11.39
DIGICOM	Business Digitization	The weighted average of business digitization and e-commerce	DESI (2020)	138	7.13	2.50	3.06	13.17
DIGIPUB	Digital public services	The e-Government score	DESI (2020)	138	8.80	2.26	3.09	13.09
GDP	Real output growth	The real GDP per capital (constant 2010 US dollars)	WDI	138	35.32	22.01	7.66	111.15
FDI	Net inflow of foreign direct investment	The proportion of GDP	WDI	138	2.70	38.19	–291	162.58
REER	Exchange rate	The real effective exchange rate index (2010 = 100)		138	95.64	4.53	85.45	113.76

[4] The diversification index indicates to what extent the structure of exports by product of a particular economy differs from the world pattern.

End of Table 1

Variable	Definition	Measure	Source	Obs	Mean	SD	Min	Max
SAVE	Saving	The gross domestic saving (% of GDP)	WDI	138	25.56	8.42	5.90	54.41
INFLA	Inflation	The annual percentage change of GDP deflator	WDI	138	1.78	1.46	–1.46	6.78
URBAN	Urbanization	The urban population growth (annual %)	WDI	138	0.59	0.90	–0.85	4.19
INDUS	Industrialization level	The value added of industry sector to GDP	WDI	138	0.21	0.06	0.10	0.34
EC_Border	Export costs: border compliance	The cost to export, border compliance (US$)	WDI	115	80.62	131.34	0.00	370.00
EC_Document	Export costs: documentary compliance	The cost to export, documentary compliance (US$)	WDI	115	13.12	18.98	0.00	51.70
DEMO	Level of democratization	The index of democratization	FSSDA	132	1.64	0.51	1.00	3.00
CORR	Corruption perception index	The indexed is scaled from 1 to 100, where 0 means the highest level of perceived corruption	Transparency International	137	110.80	5.17	99.94	127.04

Note: The information used to calculate the overall DESI index and its dimensions is sourced from various surveys, including Eurostat – Community survey on ICT usage in Households and by Individual, Eurostat – ICT Enterprises survey, eGovernment Benchmarking Report. WDI: World Development Indicator; FSSDA: Finnish Social Science Data Archive; WBGI: World Bank Group Indicator.

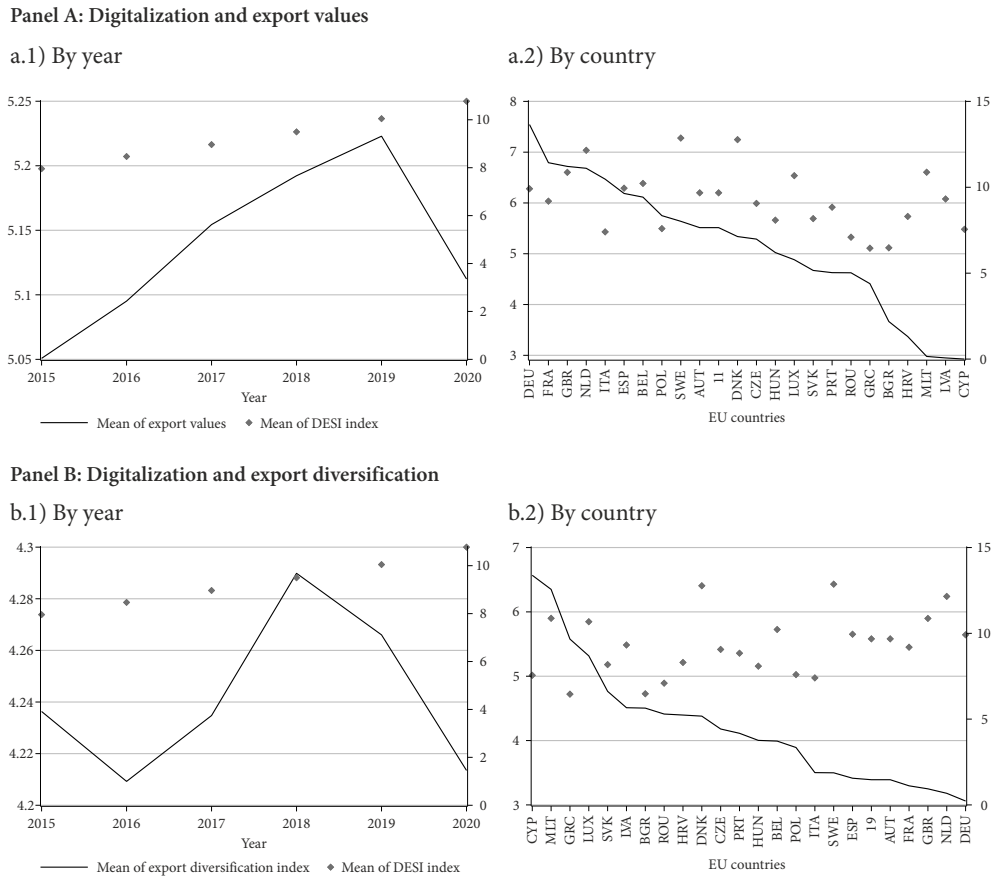
To check for cross-sectional dependence and then the stationarity test of data with the existence of CD, the cross-sectional dependence (CD) tests are developed by Pesaran (2021), and the Im-Pesaran-Shin unit root test (Im et al., 2003) is performed in turn. The results are presented in Table 3. The results suggest that except *URBAN* and *INDUS*, most of the variables have the existence of CD. In addition, the unit root test results are also shown in Table 3. In addition, the unit root test results are also shown in Table 3, the stationarity of several variables is demonstrated. Likewise, for the first difference of variables, we conduct these stationarity tests, and the results reveal that all variables are stationary after taking the first level of difference.

Since the existence of the CD and the stationarity of the variables are confirmed, following Beck and Katz (1995) and Canh and Thanh (2020), our article selects the panel corrected standard error (PCSE) model for our sample. Since both the tests and applied methods require strongly balanced data, we strictly follow the empirical procedure to clean data by removing countries that have a gap, missing observations, or outliers. After cleaning the data, the number of European countries used to perform the empirical estimations in the next step is 23.

Table 2. Correlation coefficients

	EX_Diver	EX_Value	DM	CONN	HUSKILL	INTER	DIGICOM	DIGIPUB	GDP	FDI	REER	SAVE	INFLA	URBAN	INDUS
EX_Diver	1														
EX_Value	−0.806***	1													
DM	−0.243**	0.317***	1												
CONN	−0.204*	0.170*	0.784***	1											
HUSKILL	−0.253**	0.362***	0.885***	0.495***	1										
INTERACTI	−0.164	0.284***	0.935***	0.646***	0.904***	1									
DIGICOM	−0.197*	0.342***	0.848***	0.449***	0.776***	0.802***	1								
DIGIPUB	−0.148	0.136	0.784***	0.665***	0.539***	0.632***	0.606***	1							
GDP	−0.0958	0.368***	0.609***	0.414***	0.665***	0.633***	0.465***	0.364***	1						
FDI	−0.0419	0.112	0.0562	0.0827	0.0449	0.0616	0.0148	0.0214	0.255**	1					
REER	−0.265**	0.131	0.209*	0.282***	0.128	0.102	0.106	0.231**	0.192*	−0.141	1				
SAVE	0.0925	0.0378	0.411***	0.395***	0.477***	0.402***	0.197*	0.158	0.650***	0.287***	0.134	1			
INFLA	−0.108	−0.00170	0.0917	0.336***	0.00413	−0.0180	−0.0874	0.0463	−0.163	−0.110	0.196*	0.186*	1		
URBAN	0.254**	0.0298	0.525***	0.231**	0.619***	0.525***	0.459***	0.393***	0.596***	0.0768	−0.0392	0.589***	−0.0400	1	
INDUS	−0.479***	0.267**	−0.202*	−0.0296	−0.178*	−0.274**	−0.206*	−0.287***	−0.41***	−0.0308	0.0988	−0.0569	0.296***	−0.501***	1

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.



Note: The mean value of export values and export diversification is on the left-right scale, and the mean value of DESI is on the right-hand scale.

Figure 1. Distribution of digitalization index and export by year and country

The information about these countries are summarized in Table A1 in Appendix. As displayed in Eq. (1), all explanatory variables are lagged by one period to address endogeneity stemming from the simultaneous relationship between digitization and exports or the data limitation. For robustness check purposes, we conduct similar estimates in the paper to check the accuracy of the findings by using Feasible Generalized Least Squares (FGLS) model and a two-step system GMM to solve the potential issue of heteroscedasticity and fixed effects, and endogeneity (Gala et al., 2018; Nguyen et al., 2020; Sweet & Eterovic, 2019). Besides, we add the explanatory variables to the estimates step by step to perform the sensitivity analysis.

Regarding the CD test, the null hypothesis is that the cross-section is independent. P-value is closed to zero, implying that data are correlated across panel groups.

Table 3. Cross-sectional dependence tests and stationary tests

Variable (in level)	CD-test, Pesaran (2004)	Levin-Lin-Chu unit-root test (Adjusted t*)	Im-Pesaran-Shin test (Z-bar)	Variable (in difference)	Levin-Lin-Chu unit-root test (Adjusted t*)	Im-Pesaran-Shin test (Z-bar)
EX_Diver	2.36***	–35.20***	–24.86***	DEX_Diver	–13.68***	–2.02**
EX_Value	30.76***	–12.36***	–6.69***	DEX_Value	–6.25***	–6.85***
DM	38.24***	14.32	12.86	DDM	–22.91***	–6.13***
CONN	37.36***	4.92	15.01	DCONN	–9.40***	–1.80**
HUSKILL	22.25***	–9.17***	0.49	DHUSKILL	–17.65***	–5.18***
INTER	33.49***	–3.08***	5.33	DINTER	–18.02***	–6.44***
DIGICOM	33.99***	–1.84**	3.07	DDIGICOM	–15.44***	–9.72***
DIGIPUB	36.99***	3.88	12.35	DDIGIPUB	–14.08**	–3.56***
GDP	29.45***	–65.89***	–37.28***	DGDP	–13.13***	–7.40***
FDI	1.65*	–40.14***	–9.57***	DFDI	–18.22***	–7.14***
REER	12.47***	–50.38***	–9.96***	DREER	–12.89***	–4.10***
SAVE	6.61***	10.24	5.06	DSAVE	–8.62***	–1.73*
INFLA	8.13***	–21.12***	–70.51***	IDNFLA	–11.63***	–2.65**
URBAN	0.83	–25.97***	–19.46***	DURBAN	–3.75***	–1.51*
INDUS	1.09	–0.39	–8.73***	DINDUS	–50.76***	–10.87***

Note: Regarding the CD test, the null hypothesis is that the cross-section is independent. P-value is closed to zero, implying that data are correlated across panel groups. Regarding CIPS (Pesaran Panel Unit Root Test with cross-sectional and first difference mean), the null hypothesis is "panels are homogeneous non-stationary". Regarding Levin-Lin-Chu unit-root test, the null hypothesis is "Panels contain unit root" and the alternative hypothesis is "Panel are stationary".

3. Empirical results

3.1. Baseline results

The results of estimating the impact of digitization on exports are displayed in Table 4. The results show that digital transformation has a positive and significant effect on export value. On the contrary, its effect on export diversification is negative and significant. Specifically, when the DESI composite index increased by one unit, the export value increased by 20 percent. while this increase reduces the export diversification index by 0.17 points. Regarding, the magnitude of the impact of the DESI overall index and aspects of digital transformation such as connectivity (*CONN*), use of the internet (*INTER*), human capital (*HUSKILL*), business digitization (*DIGICOM*), and digital public services (*DIGIPUB*), the business digitization plays the most important role in enhancing the export values, while the online transactions reduce the export diversification the most. Our findings suggest that the digital transformation process could enhance the value of export but reduce the diversification of export. The positive influences of digitalization on the export value can be explained by advantages from a high competition in the foreign markets due to technological changes (Azar & Ciabuschi, 2017), the cost reduction (Porter & Heppelmann, 2014), or a higher industrial

efficiency (Dalenogare et al., 2018). The positive nexus between digitalization and export value is consistent with prior studies, such as Özsoy et al. (2022) in the developing countries or Solomon and van Klyton (2020) in African countries. However, these papers are disadvantages when only using information and communication technologies (ICT) as a proxy for digitalization. Our paper highlights that these effects are conditional on the sectors that implement the digital transformation process. We emphasize the role of integration of technologies into the business and public sector. Furthermore, we also content that, in the early stages of the development of international trade, it is appropriate to aim to increase export value. However, countries should concentrate more on diversifying exports and improving export quality in the following steps. As we contend, export diversification only increases if digitalization develops to a certain extent. The implementation of the digital transformation to a certain level allows countries to access global markets more easily and efficiently (Strange & Zucchella, 2017).

Regarding the influence of other control variables, the industrialization level (*INDUS*) is the factor that has the largest and significant influence on both the value and the export diversity. Specifically, the regression coefficients of the *INDUS* indicator ranged from 16.94 to 17.60 for export value. Meanwhile, those coefficients range from –12.03 to –10.14 for export diversification[5]. It suggests that the industrialization level has a positive impact on the export value and a negative impact on export diversification (both are statistically significant). Besides, the Foreign Direct Investment (*FDI*), the urbanization level (*URBAN*), and the income level (*GDP*) also have significant and positive effects on export values. It implies that increases in the FDI inflows, the income level, and the share of the population living in the urban area over the total population facilitate the promotion of export values. By contrast, the saving (*SAVE*) is significantly negative. while real effective exchange rate (*REER*) and (*INFLA*) had no or no significant impact on export value in our sample. On the effect of export diversity, most of the indicators are negative and significant except for the effect of saving which is positive.

As in our prior argument, we predict that there exists a non-linear relationship between digitization and export diversification. Thus, the following analysis focuses on analyzing the non-linear impact of digital transformation activities on exports. To do this, we add the squared terms of the variable representing the digital transformation process to our theoretical model. Then we display the results in Table 5. The results indicate that while all digital transformation activities still have negative and significant impacts on export diversity as in Table 4, almost all of the squared terms, except for digital public service (Column 6-*DM5*) are positive and significant. The findings imply that there is indeed a non-linear relationship between digital transformation and export diversification, and they follow a U-shaped pattern. In other words, the digital transformation process initially reduces the diversity of exports, but up to a certain threshold, digitization expands that diversity. To illustrate these findings, we perform predictive margins analysis for digitization and export diversification

[5] We perform the regression to show the nonlinear reverted-U- shaped association between industrialization and export diversification. We confirm this nonlinear reverted-U- shaped association. The results can be provided upon the request. Our findings stay in line with Aditya and Acharyya (2013), Imbs and Wacziarg (2003) and Mosikari and Eita (2020).

then show the results in Figure 2. That figure provides evidence for a U-shaped relationship between export diversification and digital transformation activities. The findings of our paper are critical in the views of policymakers in selecting the strategic direction in the pursuit of export diversification. Rather than an increase in export value, export diversification can reduce the volatility of export earnings, limit adverse influences of external shocks and promote sustainable development (Hong, 2021). Therefore, export diversification plays an essential role in enhancing economic growth (Hodey et al., 2015).

Overall, probably noticed that there is a positive linear relationship between export value and digitization. While that relationship is non-linear for digital transformation and export diversification. Nonetheless, this U-relationship only appears when digitization activities, namely digital connectivity, the human with digital skills, use of internet services, or digital public services reach a certain value. The findings provide empirical evidence in the case of European countries that digitalization can improve exporting activities. Regarding export diversification, it is required to implement the digital transformation activities to a certain level. Otherwise, digitalization even negatively affects export diversification.

To explore the source of export diversification, we examine how digitization affects export value in different sectors, thereby providing further insights into the relationship between digital transformation and export diversification. Given differences in some exporting sectors, we propose whether the positive influences of digitalization on export diversification only happen in some specific sectors. Specific export sectors considered in this section include agriculture and raw materials, high-technology, information and communication technology, manufacturing, insurance, and financial services, and international tourism. The results are reported in Table A2 in Appendix. The results show that in the fields of agriculture and raw materials, high technology, and technology and information engineering (ICT), most digital transformation activities have significant and positive impacts on export value in these sectors. In other words, digitalization immediately improves the performance of these sectors. Our findings are consistent with those of Özsoy et al. (2022), which demonstrate that use the ICT to reveal its significant influence on the export of high-tech products. Meanwhile, for the remaining industries, which are manufacturing, insurance and financial services, and international tourism, there is a non-linear relationship with digitalization. Particularly, in these sectors, digitization only has a positive impact on their values of export when the digital transformation reaches a certain value then its impact is negative. Our findings recommend that the pursuit of the digital transformation process in these sectors requires a consistent process with sufficient time. Otherwise, digitalization even adversely impacts these sectors. Notably, in all industries, e-Government always plays a principal role. A long delay and complex administration procedure are always hinder the export activities of countries (Ha et al., 2021). Our findings suggest that an integration of high technology in the public sector is the most important to resolve these issues.

In the following analysis, we shed more light on transmission channels, through which digitalization can promote exports. These transmission channels consist of export cost and time on the relationship between digitization and export to solve border and document compliance issues as well as improve competence and quality of logistics service and the quality of infrastructure related to trade and transport. These variables are available from the WDI.

Table 4. Digitalization and export: The panel-corrected standard error estimates

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export Value						Export Diversification					
L.DESI	0.20***	0.11***	0.15***	0.06	0.20***	0.10***	−0.17***	−0.09***	−0.12***	−0.15***	−0.08***	−0.11***
	(0.018)	(0.031)	(0.025)	(0.043)	(0.018)	(0.019)	(0.018)	(0.020)	(0.013)	(0.013)	(0.012)	(0.013)
L.GDP	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	−0.02***	−0.03***	−0.02***	−0.02***	−0.03***	−0.03***
	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
L.FDI	0.00*	0.00*	0.00**	0.00*	0.00*	0.00*	−0.00***	−0.00**	−0.00***	−0.00**	−0.00***	−0.00**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.REER	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.03***	−0.03***	−0.04***	−0.04***	−0.03***	−0.03***
	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)
L.SAVE	−0.12***	−0.12***	−0.12***	−0.13***	−0.12***	−0.13***	0.07***	0.08***	0.07***	0.08***	0.07***	0.07***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)	(0.007)	(0.008)	(0.007)	(0.006)
L.INFLA	0.03	0.05	0.03	0.04	0.05	0.03	−0.08*	−0.04	−0.08*	−0.10**	−0.10**	−0.08**
	(0.040)	(0.043)	(0.040)	(0.041)	(0.038)	(0.041)	(0.042)	(0.047)	(0.046)	(0.049)	(0.041)	(0.039)
L.URBAN	0.43***	0.43***	0.41***	0.43***	0.37***	0.46***	0.04	−0.15**	0.09	−0.03	0.00	0.01
	(0.077)	(0.077)	(0.079)	(0.074)	(0.079)	(0.087)	(0.070)	(0.058)	(0.065)	(0.066)	(0.069)	(0.069)
L.INDUS	17.40***	17.60***	17.19***	17.44***	16.94***	17.50***	−10.76***	−11.84***	−10.14***	−11.48***	−11.20***	−12.03***
	(0.587)	(0.498)	(0.615)	(0.518)	(0.612)	(0.507)	(0.511)	(0.316)	(0.647)	(0.442)	(0.392)	(0.304)
Observations	115	115	115	115	115	115	115	115	115	115	115	115
R-squared	0.592	0.593	0.592	0.592	0.596	0.592	0.581	0.552	0.581	0.566	0.551	0.567
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1;
DM is the DESI overall index. DM1 is Connectivity calculated based on the weighted average of the following dimensions: fixed broadband take-up, fixed broadband coverage, mobile broadband, and broadband price index. DM2 is Human capital calculated based on the weighted average of the following dimensions: internet user skills and advanced skills and development. DM3 is an online transaction. DM4 is the Integration of digital technology services calculated based on the weighted average of the following dimensions: business digitization and e-commerce. Finally, DM5 is digital public services calculated by taking the score for e-Government.

The results are exposed in Table A3 in Appendix. Based on the results, the promotion of digitization contributes to a significant reduction in costs and time for exports, thereby improving export performance. Moreover, it also boosts the logistics performance index, which also creates an impetus for export activities performance.

For the robustness check, we re-estimate the model by adding other explanatory variables, including export costs to comply with documentary compliance (*EC_Document*), border compliance (*EC_Border*), the level of democratization (*Democracy*) and the corruption perception index (*Corr_CPI*), and the results are presented in Table A4 in Appendix. Adding these explanatory variables hardly changes the impact of digital transformation on export diversity. Their relationship is still non-linear as mentioned above. However, when the *EC_Document* and *EC_Border* variables are added, the marginal effect is stronger. Subsequently,

Table 5. A nonlinear effect of digitalization and export diversification: The panel-corrected standard error estimates

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	DM	DM1	DM2	DM3	DM4	DM5
	Export Diversification					
L.DESI	–0.76***	–0.86***	–0.43***	–0.62***	–0.12*	–0.36***
	(0.207)	(0.311)	(0.161)	(0.231)	(0.069)	(0.085)
L.DESI^2	0.03***	0.04**	0.01*	0.03**	0.00	0.02***
	(0.011)	(0.015)	(0.007)	(0.015)	(0.004)	(0.005)
L.GDP	–0.02***	–0.03***	–0.02***	–0.03***	–0.03***	–0.03***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)
L.FDI	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***	–0.00**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.REER	–0.02***	–0.01**	–0.03***	–0.03***	–0.03***	–0.02***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.005)	(0.004)
L.SAVE	0.07***	0.08***	0.08***	0.08***	0.07***	0.07***
	(0.008)	(0.005)	(0.011)	(0.011)	(0.007)	(0.006)
L.INFLA	–0.09*	–0.03	–0.11*	–0.13*	–0.11**	–0.07*
	(0.051)	(0.040)	(0.067)	(0.070)	(0.047)	(0.040)
L.URBAN	0.08	–0.01	0.08	–0.02	0.01	0.02
	(0.078)	(0.070)	(0.076)	(0.072)	(0.076)	(0.062)
L.INDUS	–10.74***	–10.08***	–10.34***	–11.80***	–11.13***	–12.03***
	(0.564)	(0.754)	(0.692)	(0.497)	(0.452)	(0.316)
Observations	115	115	115	115	115	115
R-squared	0.599	0.599	0.589	0.579	0.551	0.574
Number of countries	23	23	23	23	23	23

Note: standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1;
DM is the DESI overall index. DM1 is Connectivity calculated based on the weighted average of the following dimensions: fixed broadband take-up, fixed broadband coverage, mobile broadband, and broadband price index. DM2 is Human capital calculated based on the weighted average of the following dimensions: internet user skills and advanced skills and development. DM3 is an online transaction. DM4 is the Integration of digital technology services calculated based on the weighted average of the following dimensions: business digitization and e-commerce. Finally, DM5 is digital public services calculated by taking the score for e-Government.

instead of adding explanatory variables, we use alternative econometric techniques including the FGLS model and two-step system GMM for robustness check as shown in Table A5. In short and persistent dynamic panels, the use of lags of each variable can be weak instruments for the first differenced variables, hence producing biased results as argued by Bond et al. (2001). To resolve this issue, we follow Arellano and Bover (1995) and Blundell and Bond (1998) to develop the two-step system GMM. This method is considered to be suitable for short dynamic panel (Roodman, 2009) as we have in this article. It is also critical to

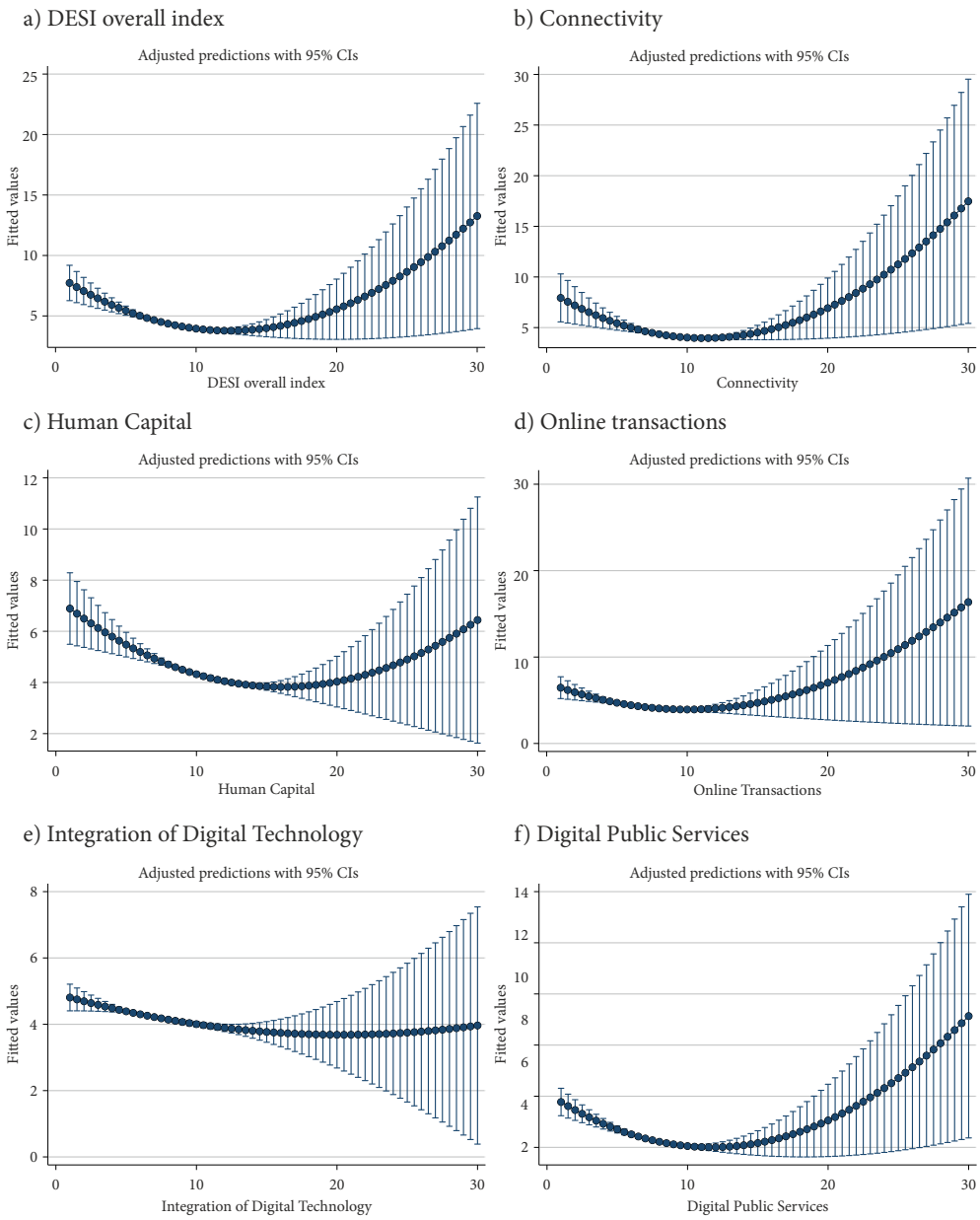


Figure 2. Predictive margin of digitalization on export diversification

employ the two-step GMM to resolve unobserved heterogeneity and endogeneity arising in our model (Blundell & Bond, 1998; Roodman, 2009). This study uses the approach of the two-step system GMM with the Windmeijer (2005) correction and a collapsed instrument set as in Roodman (2009). The extra instrument sets used in the two-step system GMM can correct the bias estimation. Various tests, including Hansen test of over-identifying restrictions (Parente & Santos Silva, 2012), Difference-in-Hansen test of the extra instruments (Roodman, 2009) are conducted to show the validity of used instruments. Regarding the FGLS estimation, its results give the same findings as those in Tables 4 and 5. However, for the two-step system GMM, although the impact direction of the digitized operational variables remains the same, the effects are not significant as before.

3.2. The moderating impacts of the COVID-19 health crisis

In terms of the impact of the COVID-19 pandemic, we divide the entire sample into two subsamples: before and during the pandemic. As COVID-related data available only for 2020 are too few observations to draw definite conclusions, our findings are for reference purposes only. The study in the future should focus on this issue by using a more appropriate database. Furthermore, the implications of Figure 1 suggest that the COVID-19 health crisis might cause a change in these relationships, thus it is critical to analyze to re-check our conclusions by only focusing on the period before 2020. We reveal the results in Table 6. Similar to the above analyses, we also evaluate the linear and non-linear effects of digitization on export diversity (in Panel A and Panel B, respectively). Similar to the above analysis, we also evaluate the linear and non-linear effects of digitization on export diversity (in Panel A and Panel B respectively). In the pre-pandemic period, digital transformation still has significant negative (linear) effects on export diversity. However, during the pandemic, these variables are no longer significant. In terms of non-linear effects, during the COVID-19 period, we only find the nonlinear effects of digital connectivity and integration of digital technology services on exports, whilst the remaining activities are statistically insignificant. Moreover, the findings imply the U-shaped relationships between connectivity and integration of digital technology services with export diversity. That relationship is clearly illustrated in Figure 3. These findings support the conclusion that digital connectivity and the integration of digital technology into business and commerce play momentous roles in export diversification during the COVID-19 period.

We utilize the FGLS in these estimations due to the short-time period. DM is the DESI overall index. DM1 is Connectivity. DM2 is Human capital. DM3 is an online transaction. DM4 is the Integration of digital technology services calculated based on the weighted average of the following dimensions: business digitization and e-commerce. Finally, DM5 is digital public services calculated by taking the score for e-Government.

Table 6. Digitalization and export diversification: Before and during the COVID-19 pandemic

Panel A. Linear effect

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Before the COVID-19						During the COVID-19					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export Diversification											
L.DESI	–0.22***	0.02	–0.16***	–0.11	–0.11**	–0.14***	–0.19	–0.06	–0.14	–0.01	–0.04	–0.03
	(0.081)	(0.062)	(0.055)	(0.084)	(0.048)	(0.047)	(0.180)	(0.089)	(0.105)	(0.161)	(0.108)	(0.129)
L.GDP	–0.01	–0.02***	–0.01	–0.01*	–0.02***	–0.02***	–0.01	–0.03*	–0.01	–0.03	–0.02	–0.03*
	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)	(0.021)	(0.014)	(0.019)	(0.017)	(0.018)	(0.014)
L.FDI	–0.00	0.00	–0.00	0.00	0.00	0.00	–0.00	–0.00	–0.00	–0.00	–0.00	–0.00
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
L.REER	–0.03*	–0.04**	–0.04**	–0.04**	–0.04*	–0.03	–0.02	–0.02	–0.02	–0.02	–0.02	–0.01
	(0.021)	(0.022)	(0.021)	(0.022)	(0.021)	(0.021)	(0.032)	(0.032)	(0.031)	(0.033)	(0.033)	(0.034)
L.SAVE	0.01	–0.04**	0.00	–0.02	–0.01	–0.01	–0.01	–0.02	–0.01	–0.03	–0.02	–0.02
	(0.023)	(0.020)	(0.022)	(0.022)	(0.020)	(0.020)	(0.042)	(0.041)	(0.039)	(0.041)	(0.040)	(0.041)
L.INFLA	0.02	0.03	0.00	0.02	–0.02	0.01	–0.04	–0.04	–0.04	–0.06	–0.06	–0.06
	(0.071)	(0.080)	(0.072)	(0.074)	(0.076)	(0.070)	(0.128)	(0.132)	(0.127)	(0.131)	(0.131)	(0.132)
L.URBAN	0.38***	0.32**	0.45***	0.32**	0.37***	0.38***	0.42**	0.32	0.47**	0.35*	0.37*	0.35*
	(0.140)	(0.146)	(0.147)	(0.142)	(0.142)	(0.139)	(0.207)	(0.202)	(0.217)	(0.209)	(0.219)	(0.203)
L.INDUS	–8.05***	–6.89***	–7.20***	–7.59***	–7.55***	–9.04***	–4.11	–4.29	–2.91	–4.21	–4.26	–4.42
	(1.784)	(1.807)	(1.732)	(1.848)	(1.769)	(1.854)	(3.798)	(3.859)	(3.873)	(3.893)	(3.886)	(4.009)
Constant	11.39***	11.06***	11.69***	11.69***	11.32***	10.73***	8.88***	8.68***	8.69***	8.27***	8.16***	8.18***
	(1.952)	(2.024)	(1.954)	(2.062)	(1.967)	(1.932)	(2.996)	(3.065)	(2.912)	(3.166)	(2.997)	(2.999)
Observations	92	92	92	92	92	92	22	22	22	22	22	22
Number of countries	23	23	23	23	23	23	22	22	22	22	22	22

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

End of Table 6

Panel B. Nonlinear Effects

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Before the COVID-19						During the COVID-19					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export Diversification											
L.DESI	–0.66*	–1.16***	–0.14	–0.36	–0.32	–0.61**	–1.31	–1.95***	–0.14	–0.53	–1.07**	–1.06
	(0.367)	(0.322)	(0.264)	(0.331)	(0.228)	(0.248)	(0.839)	(0.736)	(0.502)	(1.037)	(0.532)	(1.034)
L.DESI2	0.02	0.06***	–0.00	0.02	0.01	0.03*	0.06	0.08***	0.00	0.03	0.06**	0.05
	(0.019)	(0.017)	(0.011)	(0.022)	(0.015)	(0.016)	(0.041)	(0.031)	(0.021)	(0.062)	(0.031)	(0.053)
L.GDP	–0.01*	–0.03***	–0.01	–0.01**	–0.02***	–0.02***	–0.02	–0.02**	–0.01	–0.03*	–0.03*	–0.03*
	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)	(0.021)	(0.012)	(0.020)	(0.020)	(0.017)	(0.014)
L.FDI	0.00	0.00	–0.00	0.00	0.00	0.00	–0.00	–0.00	–0.00	–0.00	0.00	–0.00
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)
L.REER	–0.03	–0.02	–0.04**	–0.04*	–0.04*	–0.02	0.01	0.00	–0.02	–0.01	–0.01	–0.01
	(0.022)	(0.022)	(0.021)	(0.022)	(0.021)	(0.021)	(0.034)	(0.030)	(0.035)	(0.034)	(0.030)	(0.034)
L.SAVE	0.01	–0.03	0.00	–0.02	–0.02	–0.02	–0.02	–0.02	–0.01	–0.03	–0.05	–0.03
	(0.023)	(0.019)	(0.022)	(0.022)	(0.021)	(0.021)	(0.041)	(0.036)	(0.039)	(0.040)	(0.040)	(0.041)
L.INFLA	0.01	0.02	0.00	0.00	–0.04	0.03	–0.14	0.00	–0.04	–0.12	–0.31*	–0.09
	(0.071)	(0.074)	(0.073)	(0.077)	(0.079)	(0.070)	(0.141)	(0.117)	(0.156)	(0.175)	(0.173)	(0.132)
L.URBAN	0.42***	0.51***	0.45***	0.34**	0.43***	0.38***	0.53**	0.49***	0.48**	0.39*	0.68***	0.38*
	(0.142)	(0.145)	(0.147)	(0.144)	(0.154)	(0.136)	(0.214)	(0.189)	(0.227)	(0.227)	(0.256)	(0.201)
L.INDUS	–7.91***	–4.60**	–7.19***	–7.64***	–7.23***	–8.43***	–2.09	–0.90	–2.90	–3.33	1.58	–3.71
	(1.774)	(1.793)	(1.732)	(1.843)	(1.796)	(1.846)	(3.932)	(3.626)	(4.082)	(4.235)	(4.646)	(3.981)
Constant	12.57***	13.58***	11.63***	12.42***	11.99***	11.99***	12.44***	16.39***	8.70***	10.03**	12.15***	12.72**
	(2.165)	(2.004)	(2.250)	(2.272)	(2.091)	(2.006)	(3.877)	(4.016)	(3.196)	(4.671)	(3.422)	(5.359)
Observations	92	92	92	92	92	92	22	22	22	22	22	22
Number of countries	23	23	23	23	23	23	22	22	22	22	22	22

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

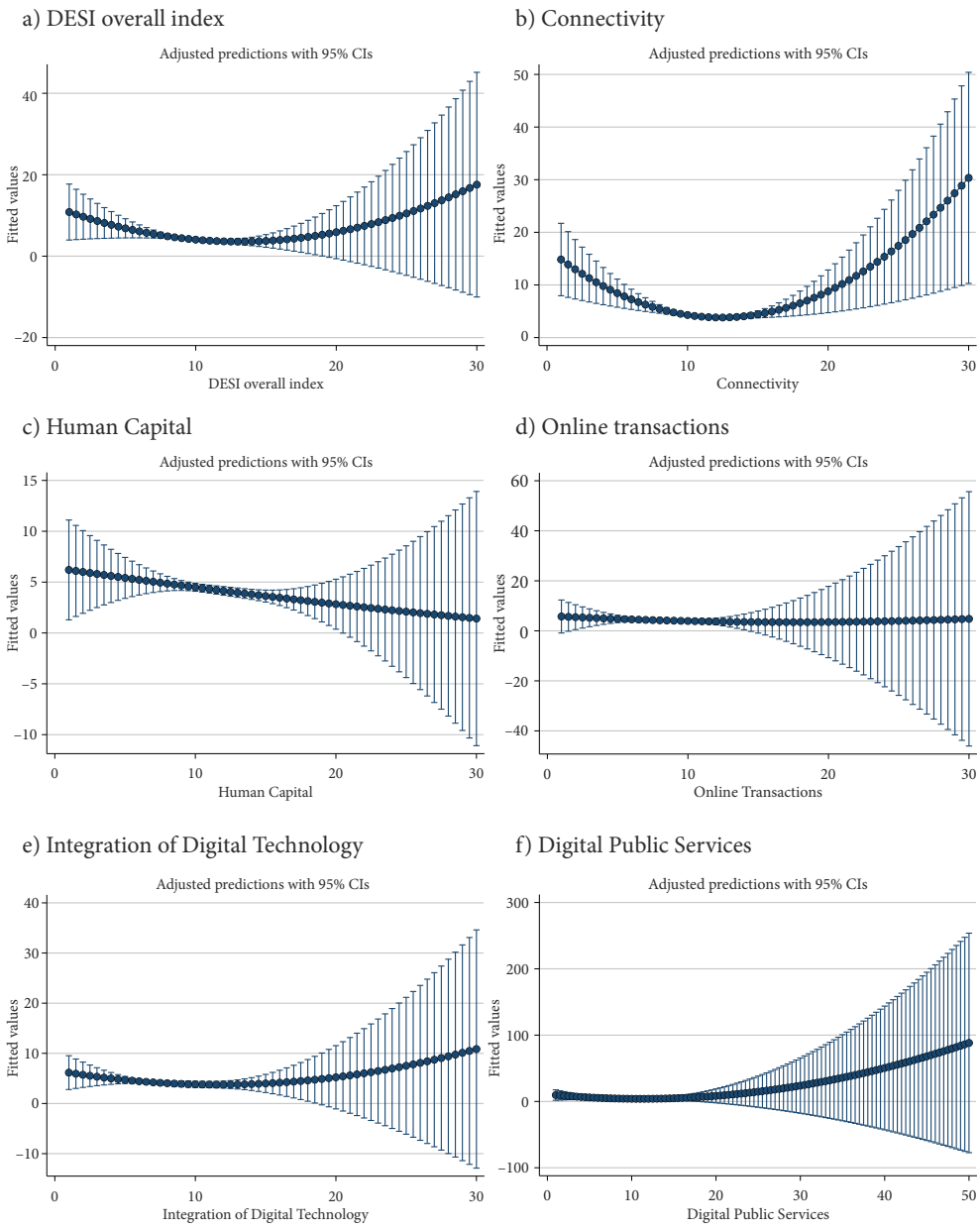


Figure 3. Predictive margin of digitalization on export diversification during the time of COVID-19 pandemic

Conclusions

We are the first to empirically analyze the nexus of digital transformation and exports. By using the international sample of 23 European countries covering the period starting from 2015 to 2020, we reveal interesting findings. First, the terrible state of export values could be improved by promoting digital transformation. However, the non-linear reverted U-shaped relationship between digitalization and export diversification suggests that positive effects only appear when the digital transformation process, especially in digital connectivity, humans with digital skills, use of internet services, or digital public services reaches a certain threshold. Second, the role of digital connectivity and the integration of digital technology into business and commerce becomes especially important for export diversification during the COVID-19 pandemic. Third, we provide evidence that digitalization leads to a reduction in export cost and export time to deal with documentary and border compliance as well as improvements in competence and quality of logistic services and quality of trade and transport-related infrastructure, thus enhancing exports.

On the policy front, by identifying ways affected and opportunities of digitization to exports, the government can support the promotion of export activities through accelerating the digital transformation process. Especially during the time of the quick spread of COVID-19 and its consequences to the global economy, digital activities, such as digital connectivity and integrating digital technology into business and commerce, digital public services become more essential to combat the COVID-19 and attenuate the consequences on the economy in general and exports in particular. Promoting these activities in the right way will create an impetus for deteriorating the adverse impact of the disease on export activities. In addition, we strongly encourage governments to improve digital public services as it is also an important set of factors affecting export value in most industries. The digital transformation process is becoming an inevitable trend of the world, and a quick and strong expansion in both breadth and depth is an urgent need for each country to survive during the time pandemic and recover quickly after that as well. The implementation of digital transformation in all aspects of the economy and policy measures aimed at encouraging businesses to do so is extremely necessary. The implementation of digital transformation in various aspects of the economy and policies aimed at encouraging enterprises to adapt so is extremely necessary.

The findings of our research could be interpreted in light of two limitations. First, we utilized the archival data accumulated only for the European Union area. It is essential to consider the role of digitalization in improving export activities in developing areas, where involvement in the international trading network is still limited. However, the surveys that followed stringent guidelines to collect information about the digital transformation process in developing economies are not available. Second, further channels may exist through which digitalization affects exporting activities. It is necessary to consider the effects of the level of economic development, economic complexity performance, and the effectiveness of government policies on the nexus between digitalization and exports. The study taking these channels into account is expected to provide more insightful lessons for economists and policymakers in designing the policy to promote digital transformation. Future research may explore the data sources to collect more information about digitalization in developing countries and examine the role of digitalization in this area.

References

Aditya, A., & Acharyya, R. (2013). Export diversification, composition, and economic growth: Evidence from cross-country analysis. *The Journal of International Trade & Economic Development*, *22*(7), 959–992. https://doi.org/10.1080/09638199.2011.619009

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

Alcácer, J., Cantwell, J., & Piscitello, L. (2016). Internationalization in the information age: A new era for places, firms, and international business networks? *Journal of International Business Studies*, *47*(5), 499–512. https://doi.org/10.1057/jibs.2016.22

Ali, M., Cantner, U., & Roy, I. (2016). Knowledge spillovers through FDI and trade: The moderating role of quality-adjusted human capital. *Journal of Evolutionary Economics*, *26*(4), 837–868. https://doi.org/10.1007/s00191-016-0462-8

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(1), 29–51. https://doi.org/10.1016/0304-4076(94)01642-D

Awan, U., Sroufe, R., & Shahbaz, M. (2021). Industry 4.0 and the circular economy: A literature review and recommendations for future research. *Business Strategy and the Environment*, *30*(4), 2038–2060. https://doi.org/10.1002/bse.2731

Azar, G., & Ciabuschi, F. (2017). Organizational innovation, technological innovation, and export performance: The effects of innovation radicalness and extensiveness. *International Business Review*, *26*(2), 324–336. https://doi.org/10.1016/j.ibusrev.2016.09.002

Baker McKenzie. (2020, April 8). *Beyond COVID-19: Supply chain resilience holds key to recovery*. Chicago, IL. LMIC-CIMT. Retrieved August 7, 2021, from https://lmic-cimt.ca/now-of-work/baker-mckenzie-2020-april-8-beyond-COVID-19-supply-chain-resilience-holds-key-to-recovery-chicago-il/

Bayram, M., Springer, S., Garvey, C. K., & Özdemir, V. (2020). COVID-19 digital health innovation policy: A portal to alternative futures in the making. *OMICS: A Journal of Integrative Biology*, *24*(8), 460–469. https://doi.org/10.1089/omi.2020.0089

Beck, N., & Katz, J. N. (1995). What to do (and not to do) with time-series cross-section data. *American Political Science Review*, *89*(3), 634–647. https://doi.org/10.2307/2082979

Ben Hammouda, H., Karingi, S., Njuguna, A., & Sadni Jallab, M. (2006). *Diversification: Towards a new paradigm for Africa's development* (MPRA Paper No. 13359). University Library of Munich, Germany. https://ideas.repec.org/p/pra/mprapa/13359.html

Bettiol, M., Capestro, M., Marchi, V. D., & Maria, E. D. (2020). *Industry 4.0 investments in manufacturing firms and internationalization* ("Marco Fanno" Working Papers No. 0245). Dipartimento di Scienze Economiche "Marco Fanno." https://ideas.repec.org/p/pad/wpaper/0245.html

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Bojnec, S., & Ferto, I. (2010, March). Market-creating effect of the internet on food trade. In *84th Annual Conference.* Edinburgh, Scotland, 91958. Agricultural Economics Society. https://ideas.repec.org/p/ags/aesc10/91958.html

Bossong, R., & Rhinard, M. (2013). The EU internal security strategy: Towards a more coherent approach to EU Security? *Studia Diplomatica*, *66*(2), 45–58.

Branstetter, L. (2006). Is foreign direct investment a channel of knowledge spillovers? Evidence from Japan's FDI in the United States. *Journal of International Economics*, *68*(2), 325–344. https://doi.org/10.1016/j.jinteco.2005.06.006

Cabral, M. H., & Veiga, P. (2010). *Determinants of export diversification and sophistication in Sub-Saharan Africa* (FEUNL Working Paper Series No. 550). SSRN. https://doi.org/10.2139/ssrn.1665116

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

Canh, N. P., & Thanh, S. D. (2020). Financial development and the shadow economy: A multi-dimensional analysis. *Economic Analysis and Policy*, *67*, 37–54. https://doi.org/10.1016/j.eap.2020.05.002

Centobelli, P., Cerchione, R., Chiaroni, D., Del Vecchio, P., & Urbinati, A. (2020). Designing business models in circular economy: A systematic literature review and research agenda. *Business Strategy and the Environment*, *29*(4), 1734–1749. https://doi.org/10.1002/bse.2466

Chiarvesio, M., & Romanello, R. (2018). Industry 4.0 technologies and internationalization: Insights from Italian companies. In R. van Tulder, A. Verbeke, & L. Piscitello (Eds.), *International business in the information and digital age* (Vol. 13, pp. 357–378). Emerald Publishing Limited. https://doi.org/10.1108/S1745-886220180000013015

Dalenogare, L. S., Benitez, G. B., Ayala, N. F., & Frank, A. G. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, *204*, 383–394. https://doi.org/10.1016/j.ijpe.2018.08.019

Daszak, P. (2012). Anatomy of a pandemic. *The Lancet*, *380*(9857), 1883–1884. https://doi.org/10.1016/S0140-6736(12)61887-X

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

Dethine, B., Enjolras, M., & Monticolo, D. (2020). Digitalization and SMEs' export management: Impacts on resources and capabilities. *Technology Innovation Management Review*, *10*(4), 18–34. https://doi.org/10.22215/timreview/1344

Digital Economy and Society Index. (2021). *Shaping Europe's digital future. DESI*. Retrieved April 3, 2022, from https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2021

Dingel, J. I., & Neiman, B. (2020). How many jobs can be done at home? *Journal of Public Economics*, *189*, 104235. https://doi.org/10.1016/j.jpubeco.2020.104235

El-Haggar, S. (2007). *Sustainable industrial design and waste management: Cradle-to-cradle for sustainable development*. Academic Press. Retrieved November 20, 2021, from https://www.elsevier.com/books/sustainable-industrial-design-and-waste-management/el-haggar/978-0-12-373623-9

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

European Commission. (2021a). *EU citizens: Over half seek health information online. Products Eurostat News*. Retrieved October 6, 2021, from https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20220406-1

European Commission. (2021b). *European Green Deal: Commission adopts new proposals to stop deforestation, innovate sustainable waste management and make soils healthy for people, nature and climate*. Brussels. Retrieved November 20, 2021, from https://ec.europa.eu/commission/presscorner/detail/en/IP_21_5916

Ferdous, F. B. (2011). Export diversification in East Asian economies: Some factors affecting the scenario. *International Journal of Social Science and Humanity*, *1*(1), 13–18. https://doi.org/10.7763/IJSSH.2011.V1.3

Fernandes, N. (2020). *Economic effects of coronavirus outbreak* (*COVID-19*) *on the World Economy* (IESE Business School Working Paper No. WP-1240-E). SSRN. https://doi.org/10.2139/ssrn.3557504

Feroz, A. K., Zo, H., & Chiravuri, A. (2021). Digital transformation and environmental sustainability: A review and research agenda. *Sustainability*, *13*(3), 1530. https://doi.org/10.3390/su13031530

Ferrari, F., Striani, R., Minosi, S., De Fazio, R., Visconti, P., Patrono, L., Catarinucci, L., Esposito Corcione, C., & Greco, A. (2020). An innovative IoT-oriented prototype platform for the management and valorisation of the organic fraction of municipal solid waste. *Journal of Cleaner Production*, *247*, 119618. https://doi.org/10.1016/j.jclepro.2019.119618

Ford, T. E., Colwell, R. R., Rose, J. B., Morse, S. S., Rogers, D. J., & Yates, T. L. (2009). Using satellite images of environmental changes to predict infectious disease outbreaks. *Emerging Infectious Diseases*, *15*(9), 1341–1346. https://doi.org/10.3201/eid/1509.081334

Freund, C. L., & Weinhold, D. (2004). The effect of the Internet on international trade. *Journal of International Economics*, *62*(1), 171–189. https://doi.org/10.1016/S0022-1996(03)00059-X

Gala, P., Camargo, J., Magacho, G., & Rocha, I. (2018). Sophisticated jobs matter for economic complexity: An empirical analysis based on input-output matrices and employment data. *Structural Change and Economic Dynamics*, *45*, 1–8. https://doi.org/10.1016/j.strueco.2017.11.005

Gnangnon, S. K. (2019). Aid for trade and export diversification in recipient-countries. *The World Economy*, *42*(2), 396–418. https://doi.org/10.1111/twec.12711

Gopinath, G. (2020). Limiting the economic fallout of the coronavirus with large targeted policies. In R. Baldwin & B. Weder di Mauro (Eds.), *Mitigating the COVID economic crisis: Act fast and do whatever it takes* (pp. 41–48). CEPR Press.

Guerrieri, V., Lorenzoni, G., Straub, L., & Werning, I. (2020). *Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages?* (Working Paper No. 26918). National Bureau of Economic Research. https://doi.org/10.3386/w26918

Ha, L. T. (2022). Are digital business and digital public services a driver for better energy security? Evidence from a European sample. *Environmental Science and Pollution Research*, *29*, 27232–27256. https://doi.org/10.1007/s11356-021-17843-2

Ha, L. T., Dung, H. P., & Thanh, T. T. (2021). Economic complexity and shadow economy: A multidimensional analysis. *Economic Analysis and Policy*, *72*, 408–422. https://doi.org/10.1016/j.eap.2021.09.011

Hilty, L., Lohmann, W., & Huang, E. M. (2011). Sustainability and ICT – An overview of the field. *Notizie Di Politeia*, *27*(104), 13–28.

Hodey, L. S., Oduro, A. D., & Senadza, B. (2015). Export diversification and economic growth in Sub-Saharan Africa. *Journal of African Development*, *17*(2), 67–81. https://doi.org/10.5325/jafrideve.17.2.0067

Honarvar, A. R., & Sami, A. (2019). Towards sustainable smart city by particulate matter prediction using urban Big Data, excluding expensive air pollution infrastructures. *Big Data Research*, *17*, 56–65. https://doi.org/10.1016/j.bdr.2018.05.006

Hong, P. M. (2021). The importance of export diversification for developing ASEAN economies. *Perspective*, *80*, 1–15. https://think-asia.org/handle/11540/13803

Hovardas, T. (2016). Two paradoxes with one stone: A critical reading of ecological modernization. *Ecological Economics*, *130*, 1–7. https://doi.org/10.1016/j.ecolecon.2016.06.023

Ibn-Mohammed, T., Mustapha, K. B., Godsell, J., Adamu, Z., Babatunde, K. A., Akintade, D. D., Acquaye, A., Fujii, H., Ndiaye, M. M., Yamoah, F. A., & Koh, S. C. L. (2021). A critical analysis of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies. *Resources, Conservation and Recycling*, *164*, 105169. https://doi.org/10.1016/j.resconrec.2020.105169

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

Imbs, J., & Wacziarg, R. (2003). Stages of diversification. *American Economic Review*, *93*(1), 63–86. https://doi.org/10.1257/000282803321455160

Jebril, N. (2020). *World Health Organization declared a pandemic public health menace: A systematic review of the coronavirus disease 2019 "COVID-19"* (ID 3566298). SSRN. https://doi.org/10.2139/ssrn.3566298

Krugman, P., & Venables, A. J. (1995). *The seamless world: A spatial model of international specialization* (Working Paper No. 5220). National Bureau of Economic Research. https://doi.org/10.3386/w5220

Laplume, A. O., Petersen, B., & Pearce, J. M. (2016). Global value chains from a 3D printing perspective. *Journal of International Business Studies*, *47*(5), 595–609. https://doi.org/10.1057/jibs.2015.47

Lawless, M., Siedschlag, I., & Studnicka, Z. (2019). Firm strategies in expanding and diversifying exports. *The World Economy*, *42*(2), 349–375. https://doi.org/10.1111/twec.12702

Lee, Y., & Falahat, M. (2019). The impact of digitalization and resources on gaining competitive advantage in international markets: Mediating role of marketing, innovation and learning capabilities. *Technology Innovation Management Review*, *9*(11), 26–39. https://doi.org/10.22215/timreview/1281

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

Mosikari, T. J., & Eita, J. H. (2020). Modelling asymmetric relationship between exports and growth in a developing economy: Evidence from Namibia. *South African Journal of Economic and Management Sciences*, *23*(1), a2905.

Nguyen, C. P., Schinckus, C., & Su, T. D. (2020). The drivers of economic complexity: International evidence from financial development and patents. *International Economics*, *164*, 140–150. https://doi.org/10.1016/j.inteco.2020.09.004

OECD. (2020). *Leveraging digital trade to fight the consequences of COVID-19*. Retrieved August 6, 2021, from https://www.oecd.org/coronavirus/policy-responses/leveraging-digital-trade-to-fight-the-consequences-of-COVID-19-f712f404/

Özsoy, S., Ergüzel, O. Ş., Ersoy, A. Y., & Saygılı, M. (2022). The impact of digitalization on export of high technology products: A panel data approach. *The Journal of International Trade & Economic Development*, *31*(2), 277–298. https://doi.org/10.1080/09638199.2021.1965645

Parente, P. M. D. C., & Santos Silva, J. M. C. (2012). A cautionary note on tests of overidentifying restrictions. *Economics Letters*, *115*(2), 314–317. https://doi.org/10.1016/j.econlet.2011.12.047

Parteka, A., & Tamberi, M. (2013). What determines export diversification in the development process? Empirical assessment. *The World Economy*, *36*(6), 807–826. https://doi.org/10.1111/twec.12064

Pesaran, M. H. (2021). General diagnostic tests for cross-sectional dependence in panels. *Empirical Economics*, *60*(1), 13–50. https://doi.org/10.1007/s00181-020-01875-7

Pontones-Rosa, C., Pérez-Morote, R., & Santos-Peñalver, J. F. (2021). ICT-based public policies and depopulation in hollowed-out Spain: A survey analysis on the digital divide and citizen satisfaction. *Technological Forecasting and Social Change*, *169*, 120811. https://doi.org/10.1016/j.techfore.2021.120811

Porter, M. E., & Heppelmann, J. E. (2014, November 1). How smart, connected products are transforming competition. *Harvard Business Review*. https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

Ranney, M. L., Griffeth, V., & Jha, A. K. (2020). Critical supply shortages – The need for ventilators and personal protective equipment during the COVID-19 pandemic. *New England Journal of Medicine*, *382*(18), e41. https://doi.org/10.1056/NEJMp2006141

Rehnberg, M., & Ponte, S. (2018). From smiling to smirking? 3D printing, upgrading and the restructuring of global value chains. *Global Networks*, *18*(1), 57–80. https://doi.org/10.1111/glob.12166

Roodman, D. (2009). How to do Xtabond2: An introduction to difference and system GMM in stata. *The Stata Journal*, *9*(1), 86–136. https://doi.org/10.1177/1536867X0900900106

Roy, V., & Singh, S. (2017). Mapping the business focus in sustainable production and consumption literature: Review and research framework. *Journal of Cleaner Production*, *150*, 224–236. https://doi.org/10.1016/j.jclepro.2017.03.040

Samuelson, P. A. (1952). The transfer problem and transport costs: The terms of trade when impediments are absent. *The Economic Journal*, *62*(246), 278–304. https://doi.org/10.2307/2227005

Scholz, R. W. (2017). Digital threat and vulnerability management: The SVIDT method. *Sustainability*, *9*(4), 554. https://doi.org/10.3390/su9040554

Sergi, B. S., Popkova, E. G., Bogoviz, A. V., & Litvinova, T. N. (2019). Future outlines in the sphere of education in the age of the information economy. In *Understanding Industry 4.0: AI, the Internet of things, and the future of work* (pp. 73–78). Emerald Publishing Limited. https://doi.org/10.1108/978-1-78973-311-220191022

Sharma, G. D., Yadav, A., & Chopra, R. (2020). Artificial intelligence and effective governance: A review, critique and research agenda. *Sustainable Futures*, *2*, 100004. https://doi.org/10.1016/j.sftr.2019.100004

Sohrabi, C., Alsafi, Z., O'Neill, N., Khan, M., Kerwan, A., Al-Jabir, A., Iosifidis, C., & Agha, R. (2020). World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). *International Journal of Surgery*, *76*, 71–76. https://doi.org/10.1016/j.ijsu.2020.02.034

Sołoducho-Pelc, L., & Sulich, A. (2020). Between sustainable and temporary competitive advantages in the unstable business environment. *Sustainability*, *12*(21), 8832. https://doi.org/10.3390/su12218832

Solomon, E. M., & van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities Policy*, *67*, 101104. https://doi.org/10.1016/j.jup.2020.101104

Strange, R., & Zucchella, A. (2017). Industry 4.0, global value chains and international business. *Multinational Business Review*, *25*(3), 174–184. https://doi.org/10.1108/MBR-05-2017-0028

Sulich, A., Rutkowska, M., Krawczyk-Jezierska, A., Jezierski, J., & Zema, T. (2021). Cybersecurity and sustainable development. *Procedia Computer Science*, *192*, 20–28. https://doi.org/10.1016/j.procs.2021.08.003

Sweet, C., & Eterovic, D. (2019). Do patent rights matter? 40 years of innovation, complexity and productivity. *World Development*, *115*, 78–93. https://doi.org/10.1016/j.worlddev.2018.10.009

Venables, A. J., & Limão, N. (2002). Geographical disadvantage: A Heckscher–Ohlin–von Thünen model of international specialisation. *Journal of International Economics*, *58*(2), 239–263. https://doi.org/10.1016/S0022-1996(01)00168-4

Webster, R. G. (1997). Predictions for future human influenza pandemics. *The Journal of Infectious Diseases*, *176*(Suppl 1), S14–S19. https://doi.org/10.1086/514168

Wen, H., Lee, C.-C., & Song, Z. (2021). Digitalization and environment: How does ICT affect enterprise environmental performance? *Environmental Science and Pollution Research*, *28*, 54826–54841. https://doi.org/10.1007/s11356-021-14474-5

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, *126*(1), 25–51. https://doi.org/10.1016/j.jeconom.2004.02.005

Zhang, Y., Ren, S., Liu, Y., & Si, S. (2017). A big data analytics architecture for cleaner manufacturing and maintenance processes of complex products. *Journal of Cleaner Production*, *142*(Part 2), 626–641. https://doi.org/10.1016/j.jclepro.2016.07.123

APPENDIX

Table A1. Countries in the sample

EU countries		
Austria	Greece	Latvia
Belgium	Croatia	Malta
Bulgaria	Hungary	Netherlands
Czech Republic	Iceland	Poland
Denmark	Ireland	Portugal
Spain	Italy	Slovak Republic
Estonia	Lithuania	Slovenia
United Kingdom	Luxembourg	Sweden

Table A2. Digitalization and export values in each sector

Panel A. Agriculture and raw materials

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	DM	DM1	DM2	DM3	DM4	DM5
	Agriculture Sector					
L.DESI	0.53***	0.75***	0.14**	0.43***	–0.20***	0.27***
	(0.094)	(0.109)	(0.069)	(0.104)	(0.063)	(0.054)
L.GDP	–0.01	–0.03***	0.00	–0.01	0.01*	0.01
	(0.009)	(0.006)	(0.007)	(0.008)	(0.007)	(0.008)
L.FDI	0.00**	0.00	0.00	0.00	–0.00	0.00
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
L.REER	0.13***	0.07**	0.15***	0.16***	0.16***	0.12***
	(0.038)	(0.035)	(0.037)	(0.038)	(0.037)	(0.027)
L.SAVE	0.09***	0.09***	0.15***	0.12***	0.23***	0.13***
	(0.029)	(0.020)	(0.032)	(0.032)	(0.034)	(0.028)
L.INFLA	0.12	–0.29***	0.10	0.14**	–0.05	0.12
	(0.081)	(0.099)	(0.080)	(0.058)	(0.101)	(0.127)
L.URBAN	–2.38***	–1.87***	–2.33***	–2.24***	–2.08***	–2.35***
	(0.169)	(0.124)	(0.157)	(0.163)	(0.119)	(0.205)
L.INDUS	–23.40***	–23.60***	–25.98***	–23.79***	–27.04***	–22.07***
	(2.984)	(2.093)	(2.614)	(3.131)	(2.429)	(2.326)
Observations	99	99	99	98	99	99
R-squared	0.518	0.639	0.485	0.505	0.495	0.508
Number of countries	23	23	23	23	23	23

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Panel B. Manufacturing sector

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Manufacturing Sector											
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
L.DESI	−0.60*	0.27	−0.73***	−0.59**	0.06	−0.53**	16.35***	10.13**	12.38***	10.97***	6.83***	4.75***
	(0.355)	(0.380)	(0.265)	(0.231)	(0.168)	(0.259)	(3.455)	(4.186)	(1.815)	(2.271)	(2.352)	(1.104)
$L.DESI^2$							−0.93***	−0.51**	−0.58***	−0.80***	−0.46***	−0.34***
							(0.195)	(0.212)	(0.090)	(0.163)	(0.168)	(0.081)
L.GDP	0.27***	0.23***	0.29***	0.27***	0.25***	0.24***	0.32***	0.27***	0.32***	0.35***	0.28***	0.23***
	(0.035)	(0.044)	(0.027)	(0.026)	(0.030)	(0.031)	(0.029)	(0.041)	(0.028)	(0.028)	(0.032)	(0.030)
L.FDI	−0.00	0.01	−0.01	−0.00	0.01	0.00	−0.01	0.01	−0.02	−0.01	0.00	−0.00
	(0.010)	(0.008)	(0.011)	(0.008)	(0.009)	(0.006)	(0.011)	(0.008)	(0.016)	(0.010)	(0.009)	(0.006)
L.REER	0.41***	0.34***	0.39***	0.37***	0.37***	0.44***	0.15	0.22*	0.33***	0.31***	0.34***	0.41***
	(0.119)	(0.102)	(0.121)	(0.124)	(0.128)	(0.133)	(0.118)	(0.121)	(0.109)	(0.103)	(0.127)	(0.126)
L.SAVE	0.00	−0.15**	0.06	−0.02	−0.12*	0.01	0.10	−0.19***	0.01	0.00	0.03	0.16*
	(0.093)	(0.068)	(0.105)	(0.067)	(0.063)	(0.077)	(0.063)	(0.072)	(0.109)	(0.039)	(0.085)	(0.094)
L.INFLA	1.04***	0.97**	0.94***	0.99***	1.13***	1.00***	1.03***	0.82*	1.61***	1.67***	1.75***	0.78**
	(0.304)	(0.403)	(0.326)	(0.278)	(0.318)	(0.372)	(0.270)	(0.448)	(0.327)	(0.389)	(0.511)	(0.377)
L.URBAN	4.19***	4.11***	4.65***	4.04***	3.95***	4.28***	2.48***	2.29**	4.33***	2.89***	1.85*	4.18***
	(0.715)	(0.838)	(0.822)	(0.729)	(0.714)	(0.732)	(0.773)	(1.008)	(0.670)	(0.799)	(1.069)	(0.745)
L.INDUS	230.30***	234.34***	232.46***	230.13***	233.67***	225.23***	221.40***	211.44***	231.00***	231.43***	222.33***	217.46***
	(11.298)	(11.134)	(11.185)	(10.719)	(10.913)	(9.966)	(10.425)	(12.238)	(9.784)	(10.335)	(12.114)	(10.962)
Observations	98	98	98	98	98	98	98	98	98	98	98	98
R-squared	0.707	0.706	0.710	0.707	0.706	0.709	0.760	0.734	0.760	0.740	0.729	0.720
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel C. High-technology sector

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	DM	DM1	DM2	DM3	DM4	DM5
	High-technology Sector					
L.DESI	1.63***	0.44**	1.91***	2.17***	0.30	−0.30
	(0.389)	(0.219)	(0.381)	(0.296)	(0.273)	(0.217)
L.GDP	−0.17***	−0.14***	−0.21***	−0.21***	−0.12***	−0.12***
	(0.028)	(0.037)	(0.025)	(0.028)	(0.031)	(0.033)
L.FDI	−0.01	−0.02	0.00	−0.00	−0.02	−0.03
	(0.016)	(0.017)	(0.015)	(0.012)	(0.018)	(0.018)
L.REER	−0.14	−0.10	−0.11*	−0.04	−0.07	−0.02
	(0.091)	(0.100)	(0.063)	(0.054)	(0.104)	(0.120)
L.SAVE	0.19*	0.45***	0.04	0.16**	0.43***	0.56***
	(0.103)	(0.059)	(0.117)	(0.067)	(0.106)	(0.102)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	DM	DM1	DM2	DM3	DM4	DM5
	High-technology Sector					
L.INFLA	–0.03	–0.43	0.29	0.23	–0.04	–0.27
	(0.288)	(0.326)	(0.369)	(0.217)	(0.387)	(0.310)
L.URBAN	2.50***	3.24***	1.23	2.83***	2.87***	3.20***
	(0.761)	(0.688)	(0.952)	(0.739)	(0.796)	(0.672)
L.INDUS	–27.14***	–34.77***	–31.95***	–23.19***	–34.19***	–40.36***
	(4.602)	(3.327)	(4.476)	(4.489)	(4.482)	(5.793)
Observations	91	91	91	91	91	91
R-squared	0.365	0.322	0.467	0.405	0.321	0.321
Number of countries	23	23	23	23	23	23

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel D. Information and communication technology (ICT) sector

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	ICT goods Sector						ICT service Sector					
L.DESI	0.65***	0.98***	0.39***	1.52***	–0.11	0.41**	0.79***	0.57***	0.04	0.45***	0.23*	0.34***
	(0.177)	(0.224)	(0.127)	(0.263)	(0.146)	(0.161)	(0.224)	(0.093)	(0.139)	(0.108)	(0.135)	(0.060)
L.GDP	–0.15***	–0.18***	–0.15***	–0.20***	–0.12***	–0.13***	0.03***	0.01***	0.05***	0.04***	0.05***	0.05***
	(0.020)	(0.027)	(0.019)	(0.027)	(0.018)	(0.019)	(0.007)	(0.005)	(0.009)	(0.011)	(0.011)	(0.013)
L.FDI	0.01	0.00	0.01	0.02	0.00	–0.00	0.01***	0.01***	0.01	0.01***	0.01**	0.00***
	(0.008)	(0.006)	(0.008)	(0.012)	(0.008)	(0.006)	(0.004)	(0.002)	(0.004)	(0.002)	(0.003)	(0.001)
L.REER	–0.01	–0.06	0.01	0.04	0.01	0.05*	–0.02	–0.02	0.03	0.02	0.03	–0.01
	(0.033)	(0.045)	(0.038)	(0.068)	(0.024)	(0.027)	(0.035)	(0.024)	(0.027)	(0.021)	(0.026)	(0.033)
L.SAVE	0.10	0.10***	0.13*	–0.01	0.25***	0.31***	–0.19**	–0.10**	0.00	–0.09**	–0.04	–0.06
	(0.072)	(0.030)	(0.069)	(0.090)	(0.068)	(0.058)	(0.089)	(0.048)	(0.083)	(0.046)	(0.067)	(0.044)
L.INFLA	–0.46	–1.02**	–0.43	–0.23	–0.59	–0.60	0.61*	0.14	0.30	0.56**	0.45	0.29
	(0.396)	(0.473)	(0.402)	(0.308)	(0.490)	(0.414)	(0.336)	(0.232)	(0.349)	(0.239)	(0.339)	(0.238)
L.URBAN	2.86***	3.53***	2.71***	2.93***	3.13***	3.28***	–2.09***	–1.08***	–1.67***	–1.82***	–1.85***	–1.89***
	(0.326)	(0.540)	(0.308)	(0.409)	(0.381)	(0.411)	(0.350)	(0.091)	(0.353)	(0.178)	(0.324)	(0.253)
L.INDUS	23.10***	22.00***	20.46***	28.41***	19.24***	13.83***	39.71***	36.92***	34.14***	37.16***	35.33***	39.77***
	(2.949)	(3.516)	(2.822)	(4.128)	(3.206)	(2.612)	(2.743)	(1.631)	(1.759)	(2.638)	(1.937)	(1.878)
Constant	–1.82	2.26	–2.38	–9.59	–0.42	–1.55	–0.18	1.46	–1.86	–2.15	–1.98	–0.67
	(3.362)	(3.661)	(3.644)	(6.572)	(2.409)	(2.273)	(2.738)	(2.260)	(2.387)	(2.274)	(2.415)	(2.819)
Observations	92	92	92	92	92	92	46	46	46	46	46	46
R-squared	0.394	0.455	0.390	0.476	0.377	0.397	0.317	0.321	0.299	0.303	0.304	0.316
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel E. Insurance and financial services sector

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Insurance and financial services Sector											
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
L.DESI	–2.70***	–0.44	–0.97***	–0.57	–1.93***	–1.76***	3.60	2.64*	2.76	4.92	–2.07*	6.58***
	(0.389)	(0.386)	(0.325)	(0.560)	(0.288)	(0.160)	(2.450)	(1.346)	(2.345)	(2.996)	(1.257)	(2.307)
L.DESI^2							–0.33***	–0.15**	–0.16*	–0.37**	0.01	–0.52***
							(0.128)	(0.075)	(0.096)	(0.174)	(0.076)	(0.145)
L.GDP	0.37***	0.27***	0.31***	0.27***	0.30***	0.26***	0.38***	0.28***	0.32***	0.30***	0.30***	0.25***
	(0.048)	(0.039)	(0.054)	(0.059)	(0.040)	(0.037)	(0.044)	(0.038)	(0.048)	(0.050)	(0.040)	(0.039)
L.FDI	–0.01	0.02	0.00	0.01	–0.01	0.01	–0.01	0.02	–0.00	0.01	–0.01	–0.00
	(0.026)	(0.021)	(0.027)	(0.026)	(0.024)	(0.015)	(0.025)	(0.020)	(0.026)	(0.024)	(0.024)	(0.014)
L.REER	0.23*	0.20	0.16	0.17	0.19	0.33***	0.10	0.13	0.09	0.11	0.19	0.27***
	(0.124)	(0.124)	(0.122)	(0.121)	(0.115)	(0.108)	(0.125)	(0.114)	(0.118)	(0.109)	(0.114)	(0.080)
L.SAVE	–0.55***	–0.98***	–0.81***	–0.96***	–0.64***	–0.69***	–0.53***	–1.01***	–0.83***	–0.95***	–0.64***	–0.48***
	(0.141)	(0.116)	(0.148)	(0.175)	(0.108)	(0.087)	(0.145)	(0.117)	(0.159)	(0.186)	(0.098)	(0.114)
L.INFLA	1.67**	2.14**	1.75**	1.85**	0.89	1.59***	1.74**	2.08**	2.02**	2.18*	0.87	1.20*
	(0.751)	(0.915)	(0.774)	(0.873)	(0.660)	(0.570)	(0.862)	(0.909)	(1.001)	(1.130)	(0.759)	(0.645)
L.URBAN	5.89***	4.95***	5.94***	5.23***	6.17***	5.80***	5.30***	4.50***	5.65***	4.80***	6.21***	5.70***
	(0.684)	(0.570)	(0.642)	(0.607)	(0.617)	(0.656)	(0.590)	(0.556)	(0.630)	(0.573)	(0.623)	(0.684)
L.INDUS	–43.89***	–33.95***	–32.69***	–35.59***	–41.15***	–57.09***	–46.45***	–39.66***	–33.61***	–35.19***	–40.86***	–66.36***
	(4.551)	(3.501)	(3.927)	(4.259)	(3.539)	(4.162)	(4.126)	(4.444)	(3.673)	(3.590)	(4.165)	(5.089)
Observations	114	114	114	114	114	114	114	114	114	114	114	114
R-squared	0.718	0.681	0.690	0.681	0.736	0.723	0.730	0.686	0.698	0.692	0.736	0.763
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel F. International tourism

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	International Tourisms											
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
L.DESI	–0.16	–0.99***	2.61***	0.78	–0.20	–1.01***	8.72***	–8.49**	6.32***	6.21***	10.56***	–4.79***
	(0.259)	(0.181)	(0.462)	(0.538)	(0.335)	(0.236)	(1.771)	(3.346)	(1.594)	(1.741)	(2.017)	(1.750)
L.DESI^2							–0.49***	0.41**	–0.18**	–0.39***	–0.76***	0.25**
							(0.111)	(0.184)	(0.078)	(0.126)	(0.166)	(0.105)
L.GDP	–0.28***	–0.21***	–0.41***	–0.31***	–0.28***	–0.32***	–0.23***	–0.28***	–0.38***	–0.24***	–0.21***	–0.33***
	(0.035)	(0.033)	(0.032)	(0.039)	(0.032)	(0.042)	(0.041)	(0.037)	(0.042)	(0.053)	(0.039)	(0.040)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	International Tourisms											
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
L.FDI	–0.02	–0.01	–0.01	–0.02	–0.02	–0.03**	–0.02	–0.02	–0.02	–0.02	–0.03	–0.03**
	(0.014)	(0.014)	(0.020)	(0.014)	(0.015)	(0.016)	(0.016)	(0.016)	(0.017)	(0.013)	(0.023)	(0.013)
L.REER	0.17**	0.17***	0.39***	0.25***	0.19*	0.32***	0.20***	0.24**	0.43***	0.31***	0.32***	0.30***
	(0.071)	(0.060)	(0.075)	(0.080)	(0.096)	(0.086)	(0.050)	(0.104)	(0.078)	(0.074)	(0.062)	(0.097)
L.SAVE	0.05	0.07	–0.78***	–0.13	0.08	0.22**	0.01	0.26**	–0.74***	–0.17*	0.20	0.16
	(0.092)	(0.059)	(0.135)	(0.114)	(0.138)	(0.099)	(0.093)	(0.120)	(0.141)	(0.095)	(0.153)	(0.101)
L.INFLA	–1.69***	–1.12***	–0.68**	–1.47***	–1.79***	–1.96***	–1.57***	–1.25***	–0.56*	–1.05***	–0.53*	–1.79***
	(0.413)	(0.251)	(0.291)	(0.396)	(0.552)	(0.510)	(0.310)	(0.255)	(0.300)	(0.266)	(0.305)	(0.554)
L.URBAN	0.09	–0.37	–1.08	–0.15	0.10	2.11	–2.31	1.30	–2.04	–2.18	–4.20**	2.51
	(1.569)	(1.410)	(1.655)	(1.653)	(1.530)	(1.661)	(1.646)	(1.380)	(1.645)	(1.959)	(1.653)	(1.818)
L.INDUS	–107.76***	–100.10***	–102.84***	–103.26***	–109.82***	–119.40***	–116.56***	–92.47***	–106.10***	–105.59***	–129.29***	–115.44***
	(5.939)	(5.832)	(9.194)	(6.406)	(8.398)	(6.660)	(5.637)	(7.563)	(7.965)	(5.602)	(9.799)	(6.756)
Observations	70	70	70	70	70	70	70	70	70	70	70	70
R-squared	0.543	0.553	0.599	0.546	0.544	0.566	0.563	0.578	0.606	0.556	0.661	0.578
Number of countries	18	18	18	18	18	18	18	18	18	18	18	18

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table A3. Transmission channels

Panel A. Cost to export: Documentary compliance

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)	(11)	(12)
	Linear Effects						Nonlinear Effects				
	DM	DM1	DM2	DM3	DM4	DM5	DM1	DM2	DM3	DM4	DM5
	Export Cost: Documentary compliance										
L.DESI	–0.79*	1.79***	1.01***	0.65**	–3.43***	–0.83***	–6.15**	–19.34***	–9.14***	–11.12***	14.55**
	(0.410)	(0.515)	(0.261)	(0.323)	(0.444)	(0.150)	(2.744)	(2.605)	(1.676)	(1.230)	(5.850)
L.DESI^2							0.42***	0.92***	0.69***	0.54***	–1.01***
							(0.156)	(0.121)	(0.109)	(0.083)	(0.364)
L.GDP	–0.26***	–0.43***	–0.38***	–0.33***	–0.18**	–0.24***	–0.47***	–0.57***	–0.41***	–0.11	–0.15**
	(0.069)	(0.095)	(0.057)	(0.069)	(0.088)	(0.075)	(0.105)	(0.075)	(0.077)	(0.088)	(0.062)
L.FDI	–3.59**	–0.61	–0.99	–2.14	–6.71***	–4.91***	0.62	6.08***	0.12	–6.83***	–10.35***
	(1.579)	(2.046)	(1.164)	(1.496)	(1.592)	(1.470)	(2.288)	(1.869)	(1.762)	(1.505)	(0.885)
L.REER	–4.31***	–2.82***	–3.22***	–3.61***	–5.29***	–4.50***	–1.94**	–1.18**	–2.87***	–4.68***	–7.15***
	(0.432)	(0.563)	(0.250)	(0.314)	(0.346)	(0.248)	(0.766)	(0.488)	(0.382)	(0.366)	(0.692)
L.INFLA	–25.15***	–43.70***	–41.50***	–31.69***	–15.97	–28.27***	–36.38***	–70.67***	–42.40***	–13.32	–6.75
	(7.909)	(7.459)	(8.755)	(8.194)	(10.415)	(8.000)	(6.221)	(6.382)	(7.420)	(9.547)	(9.645)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)	(11)	(12)
	Linear Effects						Nonlinear Effects				
	DM	DM1	DM2	DM3	DM4	DM5	DM1	DM2	DM3	DM4	DM5
	Export Cost: Documentary compliance										
L. URBAN	−13.28***	−12.64***	−9.91***	−11.48***	−19.17***	−12.27***	−13.89***	−10.17***	−11.99***	−16.78***	−13.01***
	(3.430)	(3.415)	(3.213)	(3.129)	(5.016)	(3.161)	(3.697)	(3.181)	(3.284)	(4.866)	(3.102)
L. INDUS	−2.31***	−2.76***	−2.38***	−2.36***	−2.54***	−2.28***	−2.68***	−2.36***	−2.45***	−2.66***	−2.25***
	(0.319)	(0.381)	(0.295)	(0.309)	(0.382)	(0.303)	(0.336)	(0.339)	(0.336)	(0.380)	(0.341)
Observations	88	88	88	88	88	88	88	88	88	88	88
R-squared	0.285	0.300	0.288	0.285	0.368	0.288	0.308	0.382	0.300	0.390	0.343
Number of countries	22	22	22	22	22	22	22	22	22	22	22

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel B. Cost to export: Border Compliance

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export Cost: Border Compliance											
L.DESI	−13.90***	−7.90**	13.03***	8.42***	−15.41***	−23.58***	28.05*	−72.78***	−3.08	41.98***	22.33*	50.86**
	(3.076)	(3.642)	(2.633)	(2.315)	(1.926)	(1.362)	(16.345)	(27.437)	(4.833)	(9.939)	(11.408)	(22.371)
$L.DESI^2$							−2.31**	3.47**	0.73***	−2.36***	−2.66***	−4.87***
							(0.901)	(1.473)	(0.245)	(0.671)	(0.929)	(1.428)
L.GDP	−0.31	−0.63	−2.15***	−1.51***	−0.59	0.77	−0.23	−0.99*	−2.30***	−1.24***	−0.91	1.18***
	(0.342)	(0.473)	(0.243)	(0.341)	(0.485)	(0.507)	(0.335)	(0.558)	(0.245)	(0.333)	(0.576)	(0.456)
L.FDI	−26.94***	−15.82*	11.90***	−3.00	−26.45***	−75.94***	−31.59***	−5.81	17.50***	−10.75**	−25.84***	−102.27***
	(5.975)	(8.106)	(3.797)	(5.341)	(6.872)	(8.025)	(5.345)	(10.339)	(4.725)	(5.141)	(7.399)	(8.795)
L.REER	1.01	4.24	17.18***	12.10***	2.42	−9.35***	−0.99	11.43**	18.79***	9.59***	−0.56	−22.16***
	(2.769)	(3.016)	(2.599)	(1.769)	(1.567)	(1.873)	(2.779)	(4.605)	(3.011)	(1.887)	(2.472)	(4.001)
L.INFLA	−558.11***	−584.98***	−792.74***	−665.94***	−581.71***	−594.08***	−531.65***	−525.12***	−815.83***	−629.25***	−594.70***	−489.90***
	(23.786)	(34.625)	(14.495)	(27.271)	(39.709)	(25.596)	(26.334)	(39.700)	(12.885)	(30.572)	(47.269)	(33.522)
L. URBAN	−51.77**	−34.51**	−3.90	−24.25	−66.26**	−33.03	−52.42**	−44.72**	−4.11	−22.49	−77.98**	−36.58*
	(23.249)	(17.220)	(22.039)	(20.415)	(26.948)	(22.773)	(23.161)	(20.474)	(22.310)	(19.666)	(30.731)	(20.907)
L. INDUS	−9.08***	−8.21***	−10.13***	−9.86***	−10.74***	−7.51***	−9.77***	−7.60***	−10.11***	−9.54***	−10.15***	−7.39***
	(1.210)	(1.631)	(0.909)	(1.100)	(1.599)	(1.104)	(1.395)	(1.586)	(0.954)	(1.007)	(1.477)	(1.190)
Observations	88	88	88	88	88	88	88	88	88	88	88	88
R-squared	0.250	0.246	0.258	0.243	0.282	0.322	0.255	0.260	0.259	0.247	0.296	0.356
Number of countries	22	22	22	22	22	22	22	22	22	22	22	22

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel C. Time to export: Documentary compliance

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export time: Documentary compliance											
L.DESI	0.08***	0.02	0.19***	0.22***	−0.06***	−0.06***	0.03	0.08	−0.51***	0.00	−0.04	0.67***
	(0.015)	(0.025)	(0.014)	(0.012)	(0.009)	(0.006)	(0.061)	(0.078)	(0.105)	(0.057)	(0.034)	(0.229)
$L.DESI^2$							0.00	−0.00	0.03***	0.01***	−0.00	−0.05***
							(0.003)	(0.005)	(0.006)	(0.004)	(0.003)	(0.014)
L.GDP	−0.02***	−0.02***	−0.03***	−0.02***	−0.01***	−0.01***	−0.02***	−0.02***	−0.04***	−0.03***	−0.01***	−0.01**
	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)
L.FDI	−0.13**	−0.22***	0.04	−0.13***	−0.32***	−0.41***	−0.12**	−0.23***	0.28***	−0.08*	−0.32***	−0.67***
	(0.054)	(0.065)	(0.047)	(0.042)	(0.040)	(0.051)	(0.051)	(0.075)	(0.076)	(0.048)	(0.040)	(0.068)
L.REER	−0.02	−0.05**	0.05***	0.02	−0.09***	−0.11***	−0.02	−0.06*	0.12***	0.03**	−0.09***	−0.24***
	(0.020)	(0.025)	(0.013)	(0.012)	(0.014)	(0.015)	(0.019)	(0.031)	(0.028)	(0.015)	(0.016)	(0.037)
L.INFLA	−8.98***	−8.65***	−10.61***	−9.00***	−8.22***	−8.34***	−9.01***	−8.69***	−11.62***	−9.23***	−8.23***	−7.31***
	(0.268)	(0.272)	(0.419)	(0.349)	(0.360)	(0.321)	(0.275)	(0.241)	(0.503)	(0.309)	(0.374)	(0.317)
L. URBAN	−0.17	−0.27**	0.20	0.03	−0.38***	−0.26**	−0.17	−0.26**	0.19	0.02	−0.39**	−0.29***
	(0.114)	(0.119)	(0.123)	(0.101)	(0.146)	(0.123)	(0.115)	(0.125)	(0.140)	(0.106)	(0.155)	(0.112)
L. INDUS	0.06***	0.06***	0.07***	0.07***	0.07***	0.08***	0.07***	0.06***	0.07***	0.07***	0.07***	0.08***
	(0.010)	(0.015)	(0.011)	(0.010)	(0.010)	(0.011)	(0.011)	(0.014)	(0.011)	(0.010)	(0.010)	(0.009)
Observations	88	88	88	88	88	88	88	88	88	88	88	88
R-squared	0.244	0.236	0.322	0.306	0.247	0.245	0.244	0.236	0.381	0.309	0.247	0.312
Number of countries	22	22	22	22	22	22	22	22	22	22	22	22

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel D. Time to export: Border compliance

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export time: Border compliance											
L.DESI	−1.04***	0.34	0.90***	0.86***	−1.95***	−1.83***	6.69***	−6.47**	2.53***	6.85***	1.11	5.03**
	(0.250)	(0.395)	(0.184)	(0.184)	(0.172)	(0.154)	(2.154)	(2.912)	(0.400)	(1.118)	(1.073)	(2.078)
$L.DESI^2$							−0.43***	0.36**	−0.07***	−0.42***	−0.22**	−0.45***
							(0.120)	(0.157)	(0.020)	(0.080)	(0.085)	(0.135)
L.GDP	−0.05*	−0.14***	−0.18***	−0.15***	−0.04	0.04	−0.04	−0.18***	−0.17***	−0.10***	−0.07	0.07***
	(0.028)	(0.043)	(0.020)	(0.021)	(0.037)	(0.028)	(0.027)	(0.051)	(0.019)	(0.020)	(0.046)	(0.026)
L.FDI	−2.59***	−0.77	0.21	−0.67	−3.53***	−6.44***	−3.44***	0.28	−0.36	−2.05***	−3.48***	−8.86***
	(0.662)	(0.837)	(0.469)	(0.454)	(0.616)	(0.496)	(0.582)	(1.052)	(0.494)	(0.451)	(0.670)	(0.731)
L.REER	−0.08	0.70**	1.08***	0.84***	−0.31**	−0.90***	−0.45*	1.46***	0.92***	0.39**	−0.55**	−2.09***
	(0.238)	(0.316)	(0.181)	(0.134)	(0.140)	(0.154)	(0.240)	(0.505)	(0.197)	(0.164)	(0.233)	(0.374)
L.INFLA	−44.06***	−53.18***	−60.75***	−52.71***	−42.56***	−46.63***	−39.19***	−46.90***	−58.41***	−46.16***	−43.61***	−37.03***
	(1.980)	(3.133)	(1.242)	(1.811)	(4.476)	(1.659)	(2.363)	(3.660)	(1.138)	(2.213)	(5.126)	(2.810)
L. URBAN	−5.20***	−4.04***	−1.80	−2.83**	−7.86***	−3.79***	−5.32***	−5.11***	−1.78	−2.51**	−8.82***	−4.11***
	(1.398)	(1.171)	(1.163)	(1.135)	(2.053)	(1.337)	(1.456)	(1.487)	(1.146)	(1.043)	(2.440)	(1.230)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Linear Effect						Nonlinear Effect					
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export time: Border compliance											
L. INDUS	−0.48***	−0.62***	−0.56***	−0.54***	−0.65***	−0.36***	−0.61***	−0.56***	−0.56***	−0.48***	−0.60***	−0.34***
	(0.109)	(0.167)	(0.084)	(0.091)	(0.140)	(0.090)	(0.135)	(0.165)	(0.082)	(0.082)	(0.134)	(0.092)
Observations	88	88	88	88	88	88	88	88	88	88	88	88
R-squared	0.151	0.145	0.154	0.149	0.229	0.203	0.173	0.163	0.156	0.168	0.240	0.238
Number of countries	22	22	22	22	22	22	22	22	22	22	22	22

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Panel E. Logistics performance index:

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Competence and quality of logistics services						Quality of trade and transport–related infrastructure					
L.DESI	0.09***	0.03**	0.06***	0.08***	0.06***	0.04***	0.08***	0.03***	0.07***	0.09***	0.04***	0.02
	(0.015)	(0.014)	(0.019)	(0.024)	(0.007)	(0.008)	(0.015)	(0.005)	(0.010)	(0.016)	(0.011)	(0.018)
L.GDP	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.03***	0.02***	0.02***	0.03***	0.03***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
L.FDI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−0.00	0.00	0.00	−0.00	−0.00
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
L.REER	0.00	−0.00	0.00	0.00	0.00	−0.00	−0.01*	−0.01***	−0.00	−0.00	−0.00**	−0.01***
	(0.005)	(0.004)	(0.006)	(0.006)	(0.004)	(0.004)	(0.003)	(0.002)	(0.005)	(0.004)	(0.002)	(0.002)
L.SAVE	−0.04***	−0.04***	−0.03***	−0.04***	−0.03***	−0.03***	−0.04***	−0.04***	−0.04***	−0.04***	−0.04***	−0.04***
	(0.008)	(0.007)	(0.008)	(0.009)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.006)	(0.006)
L.INFLA	−0.03	−0.04	−0.03	−0.02	−0.01	−0.03	−0.03	−0.04	−0.02	−0.02	−0.01	−0.02
	(0.029)	(0.029)	(0.031)	(0.037)	(0.029)	(0.026)	(0.029)	(0.029)	(0.030)	(0.038)	(0.029)	(0.028)
L.URBAN	0.15**	0.22***	0.12	0.19**	0.12	0.15**	0.14***	0.21***	0.09***	0.17***	0.12***	0.15***
	(0.072)	(0.055)	(0.089)	(0.078)	(0.080)	(0.071)	(0.039)	(0.046)	(0.033)	(0.048)	(0.037)	(0.032)
L.INDUS	5.54***	5.91***	5.29***	5.85***	5.34***	5.95***	4.63***	4.98***	4.21***	4.92***	4.58***	4.99***
	(0.554)	(0.482)	(0.637)	(0.594)	(0.559)	(0.473)	(0.386)	(0.405)	(0.368)	(0.502)	(0.360)	(0.406)
Constant	1.77***	2.37***	1.73**	1.66**	1.67***	2.01***	2.58***	3.14***	2.37***	2.38***	2.64***	2.90***
	(0.630)	(0.432)	(0.760)	(0.679)	(0.500)	(0.435)	(0.278)	(0.213)	(0.456)	(0.324)	(0.148)	(0.132)
Observations	46	46	46	46	46	46	46	46	46	46	46	46
R-squared	0.795	0.758	0.790	0.786	0.792	0.775	0.763	0.737	0.781	0.766	0.748	0.739
Number of countries	23	23	23	23	23	23	23	23	23	23	23	23
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table A4. Digitalization and export diversification: A robustness check by adding more explanatory variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	DM	DM1	DM2	DM3	DM4	DM5	DM	DM1	DM2	DM3	DM4	DM5
	Export Diversification											
L.DESI	–0.94***	–1.14***	–0.60***	–0.87***	–0.05	–0.44***	–0.43***	–0.40**	–0.07	–0.25	–0.15***	–0.36***
	(0.239)	(0.382)	(0.209)	(0.283)	(0.072)	(0.138)	(0.156)	(0.178)	(0.150)	(0.168)	(0.055)	(0.087)
L.DESI^2	0.04***	0.06***	0.02**	0.05***	0.00	0.02***	0.02**	0.02*	0.00	0.01	0.01**	0.01**
	(0.013)	(0.020)	(0.009)	(0.018)	(0.004)	(0.008)	(0.009)	(0.008)	(0.007)	(0.011)	(0.004)	(0.006)
L.GDP	–0.02***	–0.03***	–0.02***	–0.02***	–0.03***	–0.03***	0.00	0.00	0.00	–0.00	–0.00	0.00
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.002)	(0.004)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)
L.FDI	–0.00*	–0.00**	–0.00*	–0.00**	–0.00*	–0.00*	–0.00**	–0.00**	–0.00**	–0.00**	–0.00**	–0.00**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.REER	–0.01*	–0.01	–0.03***	–0.03***	–0.03***	–0.02***	–0.00	0.00	–0.01	–0.01	–0.00	0.01
	(0.009)	(0.008)	(0.009)	(0.008)	(0.006)	(0.006)	(0.007)	(0.008)	(0.006)	(0.006)	(0.006)	(0.008)
L.SAVE	0.09***	0.09***	0.09***	0.10***	0.08***	0.08***	0.04***	0.04***	0.04***	0.04***	0.03***	0.03***
	(0.009)	(0.004)	(0.013)	(0.014)	(0.008)	(0.007)	(0.007)	(0.009)	(0.010)	(0.009)	(0.007)	(0.005)
L.INFLA	–0.09	–0.05	–0.13	–0.17*	–0.12**	–0.10*	0.04	0.10	0.06	0.04	0.06	0.09**
	(0.063)	(0.040)	(0.080)	(0.093)	(0.058)	(0.058)	(0.057)	(0.066)	(0.080)	(0.068)	(0.050)	(0.042)
L.URBAN	–0.11*	–0.08	–0.12	–0.20**	–0.18**	–0.11*	–0.12	–0.22***	–0.15*	–0.14*	–0.12	–0.09
	(0.068)	(0.053)	(0.093)	(0.098)	(0.071)	(0.061)	(0.077)	(0.077)	(0.086)	(0.083)	(0.083)	(0.071)
L.INDUS	–10.25***	–8.60***	–9.44***	–10.99***	–10.81***	–11.21***	–5.92***	–5.48***	–5.75***	–6.46***	–5.67***	–5.63***
	(0.178)	(0.784)	(0.280)	(0.290)	(0.274)	(0.158)	(0.440)	(0.773)	(0.660)	(0.639)	(0.661)	(0.553)
L.EC_Document	–0.00	–0.00	–0.00	0.00	0.00	0.01***						
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)						
L.EC_Border	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***						
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)						
L.Democracy							0.67***	0.70***	0.73***	0.79***	0.87***	0.77***
							(0.103)	(0.100)	(0.110)	(0.111)	(0.148)	(0.108)
L.Corr_CPI							–0.05***	–0.06***	–0.06***	–0.06***	–0.06***	–0.07***
							(0.013)	(0.010)	(0.017)	(0.014)	(0.012)	(0.015)
Observations	91	91	91	91	91	91	109	109	109	109	109	109
R-squared	0.663	0.676	0.675	0.673	0.610	0.634	0.597	0.604	0.580	0.580	0.581	0.632
Number of countries	23	23	23	23	23	23	22	22	22	22	22	22

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5. Digitalization and export diversification: A robustness check by using alternative econometric techniques

Panel A. The feasible generalized least square estimates

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	DM	DM1	DM2	DM3	DM4	DM5
	EX_Diver					
L.DESI	–0.76***	–0.86***	–0.43***	–0.62***	–0.12*	–0.36***
	(0.207)	(0.311)	(0.161)	(0.231)	(0.069)	(0.085)
L.DESI^2	0.03***	0.04**	0.01*	0.03**	0.00	0.02***
	(0.011)	(0.015)	(0.007)	(0.015)	(0.004)	(0.005)
L.GDP	–0.02***	–0.03***	–0.02***	–0.03***	–0.03***	–0.03***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)
L.FDI	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***	–0.00**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.REER	–0.02***	–0.01**	–0.03***	–0.03***	–0.03***	–0.02***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.005)	(0.004)
L.SAVE	0.07***	0.08***	0.08***	0.08***	0.07***	0.07***
	(0.008)	(0.005)	(0.011)	(0.011)	(0.007)	(0.006)
L.INFLA	–0.09*	–0.03	–0.11*	–0.13*	–0.11**	–0.07*
	(0.051)	(0.040)	(0.067)	(0.070)	(0.047)	(0.040)
L.URBAN	0.08	–0.01	0.08	–0.02	0.01	0.02
	(0.078)	(0.070)	(0.076)	(0.072)	(0.076)	(0.062)
L.INDUS	–10.74***	–10.08***	–10.34***	–11.80***	–11.13***	–12.03***
	(0.564)	(0.754)	(0.692)	(0.497)	(0.452)	(0.316)
Observations	115	115	115	115	115	115
R-squared	0.599	0.599	0.589	0.579	0.551	0.574
Number of countries	23	23	23	23	23	23

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Panel B. Two-step system GMM

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	DM	DM1	DM2	DM3	DM4	DM5
	EX_Diver					
L.EX_Diver	0.98***	1.03***	0.97***	1.04***	1.02***	1.05***
	(0.043)	(0.066)	(0.087)	(0.111)	(0.134)	(0.066)
DESI	–0.11*	–0.07**	–0.04**	–0.09**	–0.16**	–0.17**
	(0.093)	(0.060)	(0.040)	(0.067)	(0.064)	(0.081)
$DESI^2$	0.00**	0.00**	0.00**	0.00*	0.01*	0.01*
	(0.005)	(0.003)	(0.006)	(0.012)	(0.010)	(0.005)
GDP	0.01***	0.00*	0.01*	0.01	0.01	0.01**
	(0.002)	(0.003)	(0.003)	(0.004)	(0.006)	(0.003)
FDI	–0.00	–0.00	–0.00	–0.00	–0.00	–0.00
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
REER	–0.01	–0.01	–0.01	–0.01	–0.01	–0.01
	(0.009)	(0.008)	(0.009)	(0.009)	(0.011)	(0.010)
SAVE	–0.01*	–0.00	–0.00	–0.01	–0.02	–0.01**
	(0.004)	(0.005)	(0.006)	(0.008)	(0.013)	(0.007)
INFLA	–0.01	–0.02	–0.01	–0.02	–0.02	–0.00
	(0.031)	(0.032)	(0.025)	(0.035)	(0.036)	(0.026)
INDUS	1.60**	2.04**	1.49	1.92	1.86	2.13**
	(0.773)	(0.791)	(0.989)	(1.400)	(1.944)	(0.908)
Observations	115	115	115	115	115	115
Number of countries	23	23	23	23	23	23
AR (1): p-value	0.056*	0.051*	0.059*	0.051*	0.049*	0.063*
AR (2): p-value	0.455	0.635	0.386	0.763	0.458	0.638
Hansen test: p-value	0.550	0.181	0.460	0.291	0.850	0.181
Diff-Hansen test: p-value	0.728	0.462	0.728	0.661	0.129	0.360

Note: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.