Shahabadi *et al.*
Journal of Innovation and Entrepreneurship (2023) 12:54
https://doi.org/10.1186/s13731-023-00318-8

Journal of Innovation and Entrepreneurship

RESEARCH Open Access

The effect of the national brand on high-tech exports in selected countries

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Abstract

High-tech exports play a crucial role in the growth and prosperity of the national economy due to higher added value and higher profitability. However, gaining a competitive advantage and increasing high-tech exports is arduous because of the highly competitive environment in global markets. In addition, increasing the value of the national brand through the improvement of foreign customers' mental image of products made in a specific country, can play an undeniable role in the improvement of customer's loyalty and growth of high-tech exports. In this paper, we evaluate the impact of the national brand on high-tech exports in 12 countries with the most valuable nation-brand, using panel data and a generalized method of moments (GMM), during the period 2015–2021. The results showed the positive and significant impact of the national brand in this group. It means that although improvement of the national brand stimulates the demand for high-tech products from foreign customers, countries that have had more capacity to increase the production and supply of these products have been more successful in meeting the created surplus demand. Therefore, developing countries should take action to improve the national brand, by moving towards a knowledge-based economy, and at the same time, they have to increase their capacity of production and supply of high-tech products to be able to meet the demands of these products in global markets.

Keywords: High-tech exports, Intellectual property rights, National brand, Real exchange rate

JEL Classification: F14, M16, F31, K11

Introduction

During the recent years, export development has attracted huge attention of researchers as they have found the crucial benefits of export development in the economic growth of different countries. The benefits can be summarized as follows: (1) increasing the employment, (2) providing a comparative advantage in the production of export products, (5) achieving higher efficiency and increasing the productivity of production factors, (4) optimal use of actual and potential facilities, (6) increasing competition between producers and improving quality of products, (7) utilizing advanced technology, (8) attracting foreign investment, and (9) expansion of domestic markets (Balassa, 1978). High-tech exports also come with additional benefits which stems from the industrial

activities and their vital roles on other sectors of the economy, such as increasing the productivity and expansion of businesses (Gani, 2009). Accordingly, many economic experts believe that future of economic developments depends on the growth of knowledge-based activities, including development of high-tech industries and their influence on all areas of production and exports. Brands are one of a firm wide intangible resources that give a noteworthy point of distinction and sustainable competitive advantage (Steenkamp, 2014). On the other hand, sustained development within the globalization of markets requires the improvement of universal brands for firms to be able to compete overseas (Christodoulides et al., 2015). Through the examination of firms' situations, outside components related to firms' competitive advantage and success can be decided (Myers et al., 2007). In addition, firms' capability to improve their worldwide competitiveness is inherently connected to their comprehension of the outside components influencing them. Therefore, competitive advantage and observed difference in products are progressively centered on "technological characteristics and effects of unobservable resources" (Popoli, 2015). In line with Resource-Based Theory, it is concluded that competitive advantage is based on optimizing substantial and intangible assets to "earn higher benefits, extend brands' share, and increment their long-term success" (Greco et al., 2013).

Given that, competitiveness is an important factor in gaining more market share and exports development. In the meantime, national brand promotion can increase the national competitiveness and expand the amount of exports by reducing search costs, satisfying foreign customers, and maintaining their loyalty (Ökten et al., 2019). Thus, increasing the competitiveness, penetration in international markets, and export growth have been considered impossible without creating a strong and positive national brand (Tan et al., 2015). However, the emphasis on the role of the national brand in the development of exports remains limited to theoretical issues, and to the best of our knowledge, there is no study on the impact of national brand on high-tech exports using empirical data. Therefore, we aim to cover this research gap and attempt to study this issue in the form of an inter-country study that consists of 12 countries with most valuable nation-brand, during the period of 2015–2021. The countries are: United States, China, Japan, Germany, United Kingdom, France, India, Canada, Italy, South Korea, Australia, Spain.

In this paper, we review the literature, and provide the reader with preliminary intuition in Sect. "Theoretical background on high-tech exports". The following section presents a background for the subject matter, and Sect. "Research methodology" explains the research methodology. Finally, the results are discussed, and the paper is concluded by giving few recommendations in Sects. "Descriptive statistics" and "Results", respectively.

Theoretical background on high-tech exports

An evaluation of the structure of world commodity exports shows that global trade is moving towards high-tech products (Mehregan et al., 2011), because high-tech exports have less price and market fluctuations, providing a continuous and stable export condition. In addition, high-tech exports owing to their reliance on science and technology have greater profitability than the export of other products. Increasing

the social, political and cultural influence of the exporting country in the destination country is another benefit of high-tech exports, which rarely occurs in the export of raw materials. Unlike high-tech products, raw and natural products can be easily found, produced, and exported to different areas and have many alternatives. More importantly, the export of raw materials happens once and the destination country does not need after-sale services. However, high technology exporting, especially capital equipment, requires a variety of services, such as training, technical consulting, repair, assembly, etc., leading to double exports and higher returns. In addition, high-tech exports are directly related to the growth of productivity and improving the economic growth. Preventing the sale of raw materials, diversifying exports and reducing the degree of vulnerability of the economy to external shocks are other benefits of developing high-tech exports (Tebaldi, 2011). Therefore, maximizing the benefits of exports in developing countries depends on changing their export structure in various fields, such as turning exports based on simple goods, agricultural products, natural resources, and raw materials towards high-tech exports. For instance, recent achievements of the export development in Southeast Asia are partly attributed to using high-tech exports, new production methods, new management skills, new marketing methods, and national brand growth (Matthee & Naudé, 2007).

Empirical evidence shows that most of the developing countries suffer from a solely dependence on exports of raw materials, such as oil, as the only comparative advantage. Similarly, crude oil stands for more than 90% of total export of Azerbaijan, Algeria, Iraq, Kuwait and Venezuela; more than 80% of exports of Saudi Arabia, Oman, Qatar, Nigeria and Yemen; and more than 70% from Iran during the period of 2011–2018. However, only 10% of the total exports of "developed" oil-producing countries such as the United States were dependent on oil exports (World Bank Database, 2018). Various studies have tried to identify the reason for this difference to increase the high-tech exports and consequently accelerate the economic growth in developing countries. The most important factors are identified as follows:

1. Real exchange rate: adjusting the exchange rate in proportion to the inflation rate increases the competitiveness of high-tech products in global markets and also, through increasing the export profitability, the incentive of companies to invest in high-tech industries increases; therefore, the total amount of exports would be increased to a great extent (Hooy et al., 2015).
2. Trade openness: growth of the economy by facilitating and accelerating process of importing intermediate goods, capital tools, reverse engineering, and imitating foreign technologies and their applications in the production process of high-tech industries can expand the exports of these industries (Mehrara et al., 2017; Sandu & Ciocanel, 2014; and Tebaldi, 2011).
3. Attracting foreign direct investment: increasing the attraction of foreign direct investment, and providing the required financial resources for high-tech industries provide a great opportunity for acquiring technical knowledge, implementing new production methods, and better management of multinational companies; consequently, establishing high-tech industries and increasing the exports of these indus-

tries (Bayracattan & Bidirdi, 2018; Garces & Adriatico, 2019; Gökmen & Turen, 2013; Kabaklarli et al., 2017; Tebaldi, 2011).

The present study is focused on the impact of the national brand on high-tech exports, which is unprecedented. Therefore, in the following, the concept of the national brand is defined and the mechanism of its impact on high-tech exports is explained. The concept of national branding was first added to the encyclopedia of management vocabulary by English researcher Anholt (2007). According to him, the national branding refers to creating people who pay attention to the success of a country and believe in its prospects. Accordingly, the national brand contains a special competitive identity for the products produced in each country, and can eliminate the existed misconceptions about a country, guide them, and highlight the country's position in the target markets (Anholt, 2007). In addition, the national brand concept is exactly the same as the brand concept, including identity and sustainable performance as a goods' quality indicator (Kim, 2006).

Also, a positive national brand is a competitive advantage, in other words, a competitive identity that can develop businesses and attract more investments; promote the goals of the tourism industry and improve public diplomacy; advocate for the interests of the export industry and boost the national identity and self-esteem (Moilanen & Rainisto, 2009). Therefore, the national brand as one of the main pillars of national reputation in areas such as public diplomacy, cultural relations, investment, export, tourism, and economic development have attracted huge attention of researchers, and also can have positive effects on high-tech exports. Another reason for this huge impact is the increasing competition in global markets, which has made economic savings and cost reductions the top priorities for companies to overcome competitors and attract customers; however, retaining current customers, costs much less than attracting new ones (Pappu & Quester, 2016). In addition, increasing value of national brand by improving mental image of international audiences towards the products made in the brand's country, helps maintaining the loyalty of foreign customers (Gustafsson et al., 2005; Worm & Srivastava, 2014).

In addition, improving the national brand by creating superior value for loyal foreign customers, encourages them to pay more, with less sensitivity, to buy the brand of their choice which increases the demands of export for high-tech products (De Chernatony & McDonald, 1992; Usakli & Baloglu, 2011). From an economic point of view, improving the national brand image reduces the search costs for the consumer, internally (the time required to think about the product) and externally (the time required to select the product), causing an increase in the export of high-tech products (Barnes & Higgins, 2017). Therefore, similar to a low-quality product that does not have the possibility of a long-term and continuous presence in domestic and foreign markets, without creating a strong national brand, it is not possible for a country's high-tech products to be present and penetrate in international markets. Increasing the value of a national brand by providing useful information to foreign customers helps them to purchase the best product and promotes high technology exports (Fetscherin & Toncar, 2010).

Literature review

High-tech exports

The determinants of exports specifically in high-tech exports have been studied precisely, and some of the most important ones are mentioned below. However, a scientific and systematic study of the impact of the national brand on high-tech exports using empirical data has rarely seen in these studies.

Garces and Adriatico (2019) showed that FDI and ODA had a positive and significant effect on high-tech exports. However, GDP has a negative impact on high-tech exports. In addition, Energy investment had no effect on high-tech exports development. Bayraktutan and Bıdırdı (2018) in their research, showed that the number of patents was one of the main determinants of high- and medium-tech exports in both groups of countries. Sezer (2018), investigated the effect of R&D[1] costs and the number of R&D eligible labor on high-tech exports in the BRICS[2] (Brazil, Russia, India, China, and South Africa) countries for the period of 1996–2014. Results showed that R&D costs and the number of R&D eligible labor have a positive effect on high-tech exports. Kabaklarli et al. (2017), analyzed the factors affecting high-tech exports in selected countries of the OECD.[3] Results showed that enhancing the patent registration process and FDI plays an important role in boosting high-tech exports; however, the economic growth and rate of financial return has no effect on high-tech exports. Mehrara et al. (2017), considering the importance of high-tech export's role in economic growth, studied the determinants of high-tech exports in 24 developing countries over the period of 1996–2013. Results indicated that rule of law (period of institutional quality), human capital, imports (replacing economy openness), and GDP with 100% probability were the most important variables influencing high-tech exports in developing countries. Alagöz et al. (2016) studied the relationship between R&D costs and high-tech export advancement in E7 member countries (Indonesia, Brazil, Turkey, China, Russia, Mexico, and India). The results showed that China has the highest share of R&D costs and high-tech exports among E7 countries. Sandu and Ciocanel (2014) investigated the relationship between high-tech exports and some of the key drivers of innovation in EU countries. Results of the econometric data analysis showed that both public and private R&D costs, human resources employed in scientific activities, and the tendency to develop the international business relationships, as the key drivers of innovation, have a clear relationship with increasing high-tech exports in the EU countries. In addition, R&D costs of private organizations have a greater effect on high-tech exports in comparison with public organization's R&D costs. Gökmen and Turen (2013), studied FDI, economic freedom, and human development variables' relationship with high-tech exports. Results indicated that this relationship is statistically positive and significant. In addition, the causality test results showed that FDI, economic freedom, and human development had a unilateral causality relationship with high-tech exports in the long-run. Tebaldi (2011) investigated the factors affecting high-tech exports in selected countries. Based on the results, human capital,

[1] Research and Development.

[2] The acronym is coined to associate five major emerging economies: Brazil, Russia, India, China, and South Africa.

[3] The Organization for Economic Co-operation and Development.

FDI, and trade openness are the most important factors which influence the high-tech exports in global markets.

Even so, the study on the determinants of high-tech exports is considered to be shallow, yet. Zhang (2007), Srholec (2007), and Braunerhjelm and Thulin (2008) are few examples of the studies which empirically investigated those determinants. Zhang (2007), found that FDI and infrastructure inflows are remarkable elements in describing the high-tech exports. Nevertheless, the experimental examination of Zhang (2007) were subject to major specification and endogeneity issues that normally torment OLS estimations. Srholec (2007) estimated a parsimonious model and demonstrated that a country's technological capabilities which measured by enrollment in higher education, granted patents, and computer accessibility; have a significant positive effect on the high-tech exports. Srholec also showed that the economy size plays a noteworthy role in determination of high-tech exports. Braunerhjelm and Thulin (2008) found that investment in R&D is a key element in high-tech exports determination in OECD countries, whereas the market size does not affect high-tech trade.

Brand

Here, the studies in the field of brand and competitiveness in international trade are reviewed. Howard (1977) explains that the plausibility of making a competitive advantage based on brand value lies absolutely within the components of emotional and cognitive discernment and that the trust creation by the organization will be grounded precisely in these components. The decerned mark can at that point be surveyed utilizing the Attitude Model based on the interaction of three components: cognition, affectivity, and connectivity (Rosenberg & Hovland, 1960; Schiffman & Kanuk, 2007).

Knight (2003) argues that internationalization is explained by the capacity of companies to comprehend the contrasts between markets and how they can accomplish a competitive advantage based on recognized and separated brands (Popoli, 2015). Holt et al. (2004)) contend that brand value is indeed more important in a universal setting, with higher competitiveness levels. Hence, it ought to pass on a combined and coherent thought that it must be adjusted to domestic specificities, i.e., it ought to be situated to the markets in which it works (Kirca et al., 2005), guaranteeing a successful reaction to consumers' needs and demands (Kohli & Jaworski, 1990). Thus, for the brand success, trust, loyalty, and value are fundamental factors to consider (Botha et al., 2020), it must be kept in mind that "brands are critical for the firm's success as they become the major source of differentiation between other competitive offerings in the market" (Beig & Nika, 2019, p. 1). The brand, therefore, takes a leading part in characterizing sustained and separated worldwide strategies (Fakhrutdinova et al., 2014; Holt et al., 2004), which can lead to competitive advantage (Morgan & Pritchard, 2004).

Rua and Santos (2022), analyze the relationship between brand and competitive advantage (through differentiation) and the intervening impact of positioning and market attitude in this relationship. The results demonstrate that brand contains a significant direct effect on competitive advantage through differentiation.

Pyper et al. (2022), utilizes a contingency-based approach to explain the link between international strategic brand management and export performance. The discoveries

support the argument that the connection between ISBM and export performance is dependent on specific external environmental moderating elements.

Suorsa (2017), investigated effect of national brand on Finnish food exports. Data were collected through interviews with food experts and managers of food export companies. Results showed that Finnish national brand and Finnish food culture were not internationally known. For this reason, some Finnish food exporters do not highlight the origin of their products, or attribute it to larger geographical areas, such as Nordic countries to increase their exports, especially to distant markets. In addition, national brand of the exporting country is not the determinative factor in the decision to buy food, and the taste and quality of the food are much more important. Furthermore, results showed that although the Finnish national brand is not important in food marketing, the brand 's value is largely based on facts.

A review of previous studies shows, they not only evaluated the impact of the brand on the export of some specific industries, such as food, but also, they studied the export of small and medium enterprises using historical data. However, determining the impact of national brand on high-tech exports using empirical data in the form of inter-country study is unprecedented. As discussed in the previous sections, strengthening the national brand could theoretically lead to the development of high-tech exports. Therefore, the present study tried to cover the identified research gap and provide a more accurate estimation of the national brand's impact on high-tech exports by empirically examining this issue for policy purposes.

Research methodology

Model presentation

The model used in this paper is a panel data type that can provide a more efficient estimation, due to the limitation of the variance heterogeneity problem, decrease in the coherence between variables, and increase in the degree of freedom over cross-sectional and time series data (Baltagi, 2005). The panel data consists of both static and dynamic types. The model of this paper is dynamic in which the dependent variable's lag appears as the explanatory variable on the right side to clear the relationships between the variables (Arellano & Bond, 1991). This is because many of the economic variables, including high-tech exports, are naturally dynamic, and their performance of the previous period can be extended to the next period.

However, in the dynamic panel model, due to the addition of the lagged dependent variable, it is not possible to use conventional estimation methods, such as ordinary least squares (OLS), least-squares dummy variables (LSDV), and generalized least squares (GLS). Indeed, the random component correlates with the lagged dependent variable and the estimation results are distorted. Therefore, Arellano and Bond (1991) proposed an estimator called Generalized Method of Moments (GMM) which, not only solves correlation problem between the independent variable and the error component, also it eliminates endogenous problem and variance heteroscedasticity of the model. This estimator works on both fixed and random effects and does not require the Hausman test, because in dynamic panel models, there is a relationship between error term and explanatory variables (Hayashi, 2011). In addition, this method is often used when the number

of cross-sectional variables (N) is greater than the number of times (T) ($T < N$), similar to the condition, which this study has been carried out.

Particularly, we utilize two step difference GMM (Arellano & Bond, 1991). This approach disposes of the impact of imperceptible firm-specific impacts through first differencing and employments instruments that are uncorrelated with the error term.

With these explanations, the sub-form of the high-tech export equation inspired by the Sezer (2018), Bayraktutan and Bıdırdı (2018), Kabaklarli et al. (2017), Mehrara et al. (2017), Alagöz et al. (2016), Sandu and Ciocanel (2014), Gökmen and Turen (2013), and Tebaldi (2011) works are presented as follows:

$$\mathrm{HTE} = \mathrm{f}(\mathrm{NB}, \mathrm{RER}, \mathrm{INF}, \mathrm{OPEN}, \mathrm{FDI}) \tag{1}$$

$$\mathrm{NB} \geq 0, \mathrm{RER} \geq 0 \mathrm{INF} \geq 0, \mathrm{OPEN} \geq 0, \mathrm{FDI} \geq 0$$

$$\frac{\partial \mathrm{HTE}}{\partial \mathrm{NB}} > 0, \frac{\partial \mathrm{HTE}}{\partial \mathrm{RER}} > 0, \frac{\partial \mathrm{HTE}}{\partial \mathrm{INF}} > 0, \frac{\partial \mathrm{HTE}}{\partial \mathrm{OPEN}} > 0, \frac{\partial \mathrm{HTE}}{\partial \mathrm{FDI}} > 0$$

$$\begin{aligned} \log(\mathrm{HTE}_{\mathrm{it}}) =& \beta_0 + \beta_1 \log(\mathrm{HTE}_{\mathrm{it}-1}) + \beta_2 \log(\mathrm{NB}_{\mathrm{it}}) \\ &+ \beta_3 \log(\mathrm{RER}_{\mathrm{it}}) + \beta_4 \log(\mathrm{INF}_{\mathrm{it}}) \\ &+ \beta_5 \log(\mathrm{OPEN}_{\mathrm{it}}) + \beta_6 \log(\mathrm{FDI}_{\mathrm{it}}) + U_{it} \end{aligned} \tag{2}$$

$$U_{it} = v_i + e_{it} \tag{3}$$

where t denotes time, i refers to the country, U_{it} stands for model error term that includes country-specific fixed effects (v_i) and error residual term (e_{it}). In addition, all variables are logarithmically assigned to simply interpret the coefficients, since the logarithmic form represents the percentage change of the dependent variable vs the percentage change of the explanatory variable.

HTE (high-tech export) has been considered as a dependent variable representing the percentage of high-tech export of total manufactured exports for the selected country. $\mathrm{HTE}_{it\text{-}1}$ is a high-tech export of last year, as an independent variable appears on the right side of the equation.

NB[4] is the explanatory variable that is used as the national brand value of the selected countries published by the Brand Finance Institute. It should be noted that this institute, established in 1996 and headquartered in the UK, is one of the trademark rating institutions in various fields, e.g., auto parts, information technology, civil engineering, food, etc. Each year, having measured the total value of brands available in different countries, the institute calculates the brands' intangible asset value, and ranks and publishes them as the National Brand Value. In addition, the published index consists of three main sectors: (i) products and services, (ii) investment, (iii) society, which each of them is subdivided into tourism, market, government, people, and skills, and also the subdivisions are divided into individual criteria. Finally, the score for each criterion is calculated from 100, and by summing the scores of all criteria, the score of the overall national brand

[4] . National brand.

index is obtained, which is assigned a score of AAA + (brand exceptional strength) to d (brand failure). Therefore, based on the mechanism outlined above, with the improvement of the national brand, the high-tech export is expected to be expanded.

However, defining an appropriate model that can explain the changing behavior of high-tech export requires considering the other effective factors that are defined as control variables. These variables are selected based on the theoretical export principles and following empirical studies, and the principle of non-autocorrelation between the explanatory variables. Since the mechanism of each variable's effect was explained in the section of theoretical foundations, it is avoided to discuss it again here:

RER stands for the real effective exchange rate (Rasoulinezhad & Kang, 2016), and is expected to have a positive effect on high-tech export.

INF is the inflation, following Narayan and Bhattacharya (2019) study, in the research model.

OPEN denotes the economy's degree of openness that follows Mehrara et al. (2017), Sandu and Ciocanel (2014), and Tebaldi (2011) study, in the research model.

FDI represents attraction of foreign direct investment follows Garces and Adriatico (2019), Bayraktutan and Bıdırdı (2018), Kabaklarli et al. (2017), Gökmen and Turen (2013), and Tebaldi (2011).

In addition, high-tech export data, real exchange rates, inflation rate, and the degree of economy openness are from the World Bank database,[5] national brand value data are from the Brand Finance Institute database,[6] and foreign direct investment data have been extracted from the United Nations Conference on Trade and Development (UNCTAD) database.

This research is intended to be done because of its applicable and useful results. To make it crystal clear, the results can be applied to the growth of high-tech exports in selected countries. It is descriptive–analytical in terms of nature, since it describes and analyzes the relationship between the variables, using secondary statistics without interference and manipulation. We use multivariate regression analysis (the core of econometric studies), panel data approach, GMM, and Stata software to estimate the effect of national brand on high-tech exports. The statistical sample of this paper consists of 12 countries[7] with the most valuable brands whose data are available over the period of 2015–2021. Due to the lack of re-access to the data of the website https://brandfinance.com and the availability of the data, these countries have been selected.[8]

Descriptive statistics

High-tech export

High-tech export is the dependent variable of the research, which is the percentage of high-tech export to the total manufactured exports, has been used as a proxy variable. To get to know the status of this variable in the selected countries, the data of

[5] . http://data.worldbank.org/data-catalog/world-development-indicators

[6] . https://brandfinance.com

[7] . United States, China, Japan, Germany, United Kingdom, France, India, Canada, Italy, South Korea, Australia, Spain.

[8] In the data source, https://brandfinance.com, national brand data is only available for these 12 selected countries in the period 2015–2021, and the statistics of other countries are not accessible to the authors.

Table 1 Percentage of high-tech exports in selected countries (2015–2021)

Country	2015 (First year)	2021 (Last year)	Average	
			Rank	Value
United States	21.38094	17.79831	6	19.589625
China	30.42194	31.55354	2	30.98774
Japan	18.01897	17.75832	7	17.888645
Germany	17.82123	14.88065	8	16.35094
United Kingdom	22.32275	22.98226	4	22.652505
France	28.18461	23.51648	3	25.850545
India	8.021879	11.33194	10	9.6769095
Canada	14.82805	16.05509	9	15.44157
Italy	8.150901	8.343208	11	8.2470545
South Korea	31.21078	36.32822	1	33.7695
Australia	19.68531	20.98753	5	20.33642
Spain	6.887358	7.170207	12	7.0287825

Source: Brand Finance (https://brandfinance.com)

Table 2 Status of brand index (in million dollar) in selected countries (2015–2021)

Country	2015 (First year)	2021 (Last year)	Average	
			Rank	Value
United States	20,162,059.3	24,811,194.4	1	22,486,627
China	7,102,045.18	19,851,298.4	2	13,476,672
Japan	3,057,530.44	4,424,452.19	4	374,099,132
Germany	4,426,636.88	4,335,167.58	3	438,090,223
United Kingdom	3,051,983.4	3,729,492.18	5	339,073,779
France	2,341,045.8	2,975,416.04	6	265,823,092
India	2,267,878.11	2,182,347.89	7	2,225,113
Canada	2,155,069.18	2,145,269.37	8	215,016,928
Italy	1,557,011.75	1,984,996.52	9	177,100,414
South Korea	1,188,591.73	1,710,001.39	11	144,929,656
Australia	1,452,431.47	1,497,614.21	10	147,502,284
Spain	1,088,591.73	7.170207	12	12,732,027

Source: Brand Finance (https://brandfinance.com)

the beginning, the end and the average in the period are presented in Table 1. Based on this representation, among the 12 selected countries, South Korea, China, and Japan have the highest and Spain, Italy, and India have the lowest average shares of high-tech exports from manufactured exports, respectively.

National brand

In this research, the value of the national brand of the selected countries is used as a proxy for the brand. One more time, to familiarize with its status in the selected countries, the data of this variable for the beginning, the end and the average of the period are presented in Table 2. Based on the fact that the data are available for just these 12 countries, the national brand of United States of America and China have the highest

Table 3 Status of real effective exchange rate in selected countries (2015–2021)

Country	2015	2021	Average	
	(First year)	(Last year)	Rank	Value
United States	109.9043	115.384	3	112.6442
China	129.9965	127.0995	2	128.548
Japan	69.42399	70.63422	12	70.02911
Germany	92.53919	97.61179	7	95.07549
United Kingdom	113.772	102.3779	4	108.075
France	92.04891	94.1596	9	93.10426
India	91.91	103.99	5	97.95
Canada	83.13927	84.57655	11	83.85791
Italy	93.89119	94.79443	8	94.34281
South Korea	142.0539	138.9746	1	140.5143
Australia	89.86736	90.5881	10	90.22773
Spain	93.71338	96.95667	6	95.33503

Source: World Bank (https://datacatalog.worldbank.org)

Table 4 State of economic openness in selected countries (2015–2018)

Country	2015	2021	Average	
	(first year)	(last year)	Rank	Value
United States	76.2	74.8	4	75.5
China	53.7	58.4	11	56.05
Japan	73.3	74.1	5	73.7
Germany	73.8	72.5	6	73.15
United Kingdom	75.8	78.4	3	77.1
France	62.5	65.7	9	64.1
India	54.6	56.5	12	55.55
Canada	78	77.9	2	77.95
Italy	61.7	64.9	10	63.3
South Korea	71.5	74	7	72.75
Australia	81.4	82.4	1	81.09
Spain	67.6	69.9	8	68.75

Source: World Bank (https://datacatalog.worldbank.org)

average value, while South Korea and Spain have the lowest average value during the study period.

Real effective exchange rate

The real effective exchange rate is one of this research's control variables that measures the price of a basket of goods and services in the country compared to the same basket of goods and services in a foreign country. To get to know the status of this variable in selected countries during the period of 2015–2021, the data of the beginning, end, and the average of the period are presented in Table 3. According to the available data, South Korea and China have experienced the highest average real

Table 5 Status of attracting foreign direct investment (BoP, current US$) in selected countries (2015–2021)

Country	2015	2021	Average	
	(first year)	(last year)	Rank	Value
United States	467,625	367,376	1	417,500.5
China	135,577	180,957	2	158,267
Japan	2975.528	24,652.03	10	13,813.78
Germany	30,540.88	31,266.81	6	30,903.85
United Kingdom	39,185.7	27,561.5	5	33,373.6
France	45,364.69	14,192.89	7	29,778.79
India	44,064.1	44,735.15	4	44,399.63
Canada	43,835.97	59,675.71	3	51,755.84
Italy	19,635.12	8487.346	9	14,061.23
South Korea	4104.1	16,819.7	11	10,461.9
Australia	29,580.27	25,085.18	8	27,332.73
Spain	8558.748	9777.243	12	9167.996

Source: UNCTAD (https://www.unctad.org/fdistatistics)

effective exchange rate (depreciation of the national currency), and Japan and Canada have experienced the lowest average real effective exchange rate (depreciation of the foreign currency).

Degree of economic openness

The degree of openness of the economy is another control variable of the research, which is the sum of exports and imports divided by the gross domestic product and demonstrates the amount of connection of an economy with the outside world. To get familiar with the status of this index in the selected countries during the period of 2015–2021, again the data of the beginning, end, and the average are presented in Table 4, according to which, Australia and Canada have experienced the highest, and India and China the lowest average economic openness, respectively.

Foreign direct investment

Foreign direct investment is another control variable of the research model, that represents the accumulated foreign investment attracted by the countries. According to Table 5, United States and China, have attracted the highest, and South Korea and Spain the lowest average foreign direct investment, respectively.

Inflation

Inflation is the last control variable of the research model; based on the information in Table 6, India and America have the highest, and France and Japan the lowest average inflation rate, respectively.

Table 6 Status of inflation rate in selected countries (2015–2021)

Country	2015 (first year)	2021 (last year)	Average	
			Rank	Value
United States	0.118627	4.697859	2	2.408243
China	1.437024	0.981015	9	1.20902
Japan	0.79528	− 0.23335	12	0.280965
Germany	0.514421	3.14297	5	1.828696
United Kingdom	0.368047	2.518371	7	1.443209
France	0.037514	1.642331	11	0.839923
India	4.906973	5.131407	1	5.01919
Canada	1.125241	3.395193	3	2.260217
Italy	0.03879	1.873783	10	0.956287
South Korea	0.706332	2.498333	6	1.602333
Australia	1.508367	2.86391	4	2.186139
Spain	− 0.50037	3.093135	8	1.296383

Source: World Bank (https://datacatalog.worldbank.org)

Table 7 Correlation coefficients

	LHTE	LNB	LRER	LOPEN	LFDI	LINF
LHTE	1					
LNB	0.370780	1				
LRER	0.485022	0.41813	1			
LOPEN	0.092621	0.468799	0.127842	1		
LFDI	0.098105	0.532246	0.307093	0.441402	1	
LINF	− 0.173883	0.018600	0.051544	− 0.140033	0.170216	1

Source: Research findings

L refers to logarithmic

Results

Since the usual econometric methods are based on the assumption of stationary variables, in case of non-stationary data, the mean, variance and autocorrelation structure change over time, result in inaccurate t test, F test, and statistical inference, and thus, a false regression is possible. Therefore, this issue must be considered before estimating the static model of the variables. However, in the present study, since the study period is less than 10 years, no stationary test is necessary (Wooldrige, 2008).

Furthermore, since panel data are the result of combining the data of different regions (selected countries) over time (2015–2021), the capability of combining these data has been examined by performing the F-Limmer test, which showed that the computational F values were higher than the table value. Therefore, the H0 hypothesis (equality of y-intercepts) was rejected, and the group effects (model estimation as panel data) were accepted.

The results of correlation between explanatory variables are demonstrated in Table 7. The correlation coefficients are medium, so the multicollinearity problem is not significant here. Difference GMM estimation approach in model estimation eliminates unobservable factors. This approach with robust standard error improves the results which are shown in Table 3.

Table 8 Difference GMM estimation results

Dependent variable = LHTE	**Independent variable**		
Explanatory variables	**Coefficient**	***T*-Statistic**	***P* value**
LHTE(-1)	0.386**	2.90	0.007
LNB	0.278**	2.89	0.007
LRER	0.595*	4.263	0.000
LINF	− 0.038**	− 2.485	0.019
LOPEN	0.184**	2.019	0.053
LFDI	− 0.01	− 0.370	0.713
Sargan test statistic (*p* value)	0.13		
AR(1)	0.049		
AR(2)	0.996		
Number of Observation	60		
Number of groups	12		

Source: Research findings (*1, **5% significance level)

Dependent variable: LHTE: Logarithmic High Tech Export

L refers to logarithmic

Table 9 System GMM estimation results (robustness test)

Dependent variable = LHTE	**Independent variable**		
Explanatory variables	**Coefficient**	***T*-Statistic**	***P* value**
LHTE(-1)	0.486*	3.10	0.000
LNB	0.107*	3.68	0.000
LRER	0.131**	2.37	0.020
LINF	− 0.037*	− 6.535	0.000
LOPEN	0.103**	4.127	0.000
LFDI	0.050*	3.789	0.000
Difference Sargan test statistic (*p* value)	0.22		
AR(1)	–		
AR(2)	–		
Number of Observation	76		
Number of groups	12		
Number of instruments	9		

Source: Research findings (*1, **5% significance level)

Dependent variable: LHTE: Logarithmic High Tech Export

L refers to logarithmic

Finally, the research model was estimated using GMM. Before the estimation, two tests were carried out to confirm the suitability of the GMM for estimating the model: first, the Sargan test was done to prove the validity condition of the over-diagnosis, i.e., the validity of the instrumental variables, Whose H0 indicates the appropriateness of the instrumental variables. In this study, the values greater than 5% possibility of Sargan statistic indicated that the non-correlation of the tools with error terms could not be rejected. As a result, the tools used in the estimated model are valid. Second, the first-order AR(1) and the second-order AR(2) were applied, where according to Arellano and Bond (1991), in estimating GMM, error terms must have first-order serial correlation and no second-order serial correlation. Results showed that AR(1)

autoregressive coefficient was significant, and AR(2) autoregressive coefficient was not significant. Therefore, there is no explicit estimation bias in the estimation, and the results are reliable.

Summarized results of the difference GMM estimation is presented in Table 8. Except FDI which is insignificant, other estimated coefficients are significant and their signs are as expected. In robust test, all coefficients are significant, the signs are as predicted, and the results are more desired.

Because of the AR(1) and AR(2) values, there is no autocorrelation between residual terms. Sargan test results shows the instrument variables are valid.

As it is illustrated in Table 9, the GMM estimation results with robust standard error are confirming results in Table 8 and are more convincing. The difference sargan test result shows the validity of used instrument variables.

Discussion

Based on the results of the model for the selected countries which are illustrated in Table 9, the following can be stated. The effect of the dependent variable of the previous period, i.e., the share of high-tech exports from the total manufactured exports in one period, on the dependent variable in the next period is positive and significant. So that, a 1% increase in the share of high-tech exports in the total manufactured exports in the previous period, causes this variable to increase by 0.486% in the next period. The fact is, the rise of high-tech exports in one period before the existence of a suitable platform, push the industries for more high-tech exports in the next period. In addition, regarding the national brand variable, 1% increase in the value of the national brand in the studied period has caused a 0.107% increase in the share of high-tech exports in the total manufactured exports. Furthermore, if the variable of real effective exchange rate increases by 1% in the studied period, the dependent variable increases by 0.131% in the group of selected countries. Another issue is the effect of the degree of openness of the economy on high-tech exports. According to the results, a 1% increase in the degree of openness of the economy causes a 0.13% increase in the dependent variable. Besides, regarding the effect of foreign direct investment on high-tech exports, a 1% increase in the attraction of foreign direct investment has led to an increase of 0.05% in the share of high-tech exports. In addition, a 1% increase in inflation has led to a decrease in high technology exports by 0.037%.

As can be observed in the results, the national brand has a positive and significant effect on high-tech exports in the groups of selected countries. The point is that the national brand highlights the international prestige of a country, and it is an important factor to attract the attention of audiences. Indeed, the increase of the country's prestige for high-tech products not only acts as a competitive advantage to retain previous customers, and attract new ones in global markets, but also it highly increases the exports. However, it should be mentioned that the estimated coefficient of this variable is approximately high in selected countries. As mentioned above, the real effective exchange rate has also, a positive and significant effect on high-tech exports in the selected countries. It should be pointed out that increase in the real effective exchange rate makes the high-tech industries' producers prefer to export their product to foreign markets, instead of selling it in domestic ones, to earn a higher income. This result can be attributed to the

fact that in developed countries, high-tech industries are less dependent on imported inputs; therefore, rise of exchange rates and higher prices of imported inputs have a lower impact on high-tech exports.

According the results, inflation has also demonstrated a negative and significant effect on high-tech exports in elected countries, following theoretical background. About positive and significant impact of degree of economy openness, it can be mentioned that the opening up of the economy not only has made it easier to access the imported inputs and new technical knowledge but also it has caused to identify the tastes and needs of customers in global markets, leading to the growth of high-tech exports and higher estimated coefficient in selected countries.

Conclusion

In the further analysis of the results, the following can be pointed out as conclusions of this research. The effect of the dependent variable with a break (the share of high-tech exports in the total manufactured exports in the previous period) on high-tech exports in the current period is positive and significant. Because, the increase in high-tech exports in a time period, indicates the existence of a suitable foundation for this improvement, which became a basis for increasing this type of export in the next period. The effect of the brand on high-tech exports in selected countries is positive and significant, which is consistent with the results of the studies carried out by Suorsa (2017), Fetscherin and Toncar (2010). The national brand is a representative of the inter-country interaction, dignity and international prestige of the country which owns it. The increase in its value through the channel of improving competitive advantage, maintaining the loyalty of previous customers, and acquiring the trust of new customers, has assisted the development of export markets for high-tech products. In addition to that, the effect of the real effective exchange rate on high-tech exports is positive and significant, which is consistent with the results of the studies of Hunegnaw (2017), Wondemu and Potts (2016). The increase in the real effective exchange rate is associated with the cheaper production of high-tech products in the global markets and the increase in their competitiveness, which has led to the growth of the export of these type of industries. In these countries, high-tech industries are less dependent on imported inputs, and the negative effects of an increase in the real effective exchange rate and an increase in the price of imported inputs on their high-tech exports are negligible.

The effect of the degree of openness of the economy on high-tech exports in the group of selected countries is positive and significant, which is consistent with the results of the studies of Mehrara et al. (2017), Sandu and Ciocanel (2014), and Tebaldi (2011). Improving the openness of the economy with easier access to imported inputs and new technical knowledge and greater familiarity with the tastes and needs of customers in global markets has led to the growth of high-tech exports. Furthermore, the effect of attracting foreign direct investment on high-tech exports in the selected countries is positive and significant, which is consistent with the results of studies by Garces and Adriatico (2019), Bayraktutan and Bıdırdı (2018), Kabaklarli et al. (2017), Gökmen and Turen (2013), and Tebaldi (2011). The increase in attracting capital from the channel of multinational companies equipped with more advanced technologies and new management methods has given rise to the growth of the productivity of high-tech industries

and the increase in their production. Since these companies often take distribution channels in global markets under control, and are well aware of foreign trade arrangements, obtaining capital through them has brought about the development of high-tech exports. In these countries, due to having skilled and educated human resources, there is more preparation to gain benefit from the opportunity to learn and attain technology and technical knowledge; in addition, foreign direct investment is often attracted to high-tech industries. Therefore, FDI's impact on high-tech exports is also greater.

Abbreviations

GMM	Generalized method of moments
FDI	Foreign direct investment
ODA	Official development assistance
GDP	Gross domestic production
R&D	Research and Development
BRICS	Is the acronym coined to associate five major emerging economies: Brazil, Russia, India, China, and South Africa.
OECD	The Organization for Economic Co-operation and Development
BMA	Bayesian model averaging approach
WALS	Weighted-average least square
E7	Member countries (Indonesia, Brazil, Turkey, China, Russia, Mexico, and India)
EU Countries	The EU countries are: Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden
OLS	Ordinary least squares
LSDV	Least-squares dummy variables
GLS	Generalized least squares
HTE	High-tech export
HTE_{it-1}	High-tech export of last year
NB	National brand
RER	Real effective exchange rate
IPR	Intellectual property rights
OPEN	Openness
UNCTAD	United Nations Conference on Trade and Development

Acknowledgements
Not applicable.

Author contributions
AS had the idea for the article, SA performed the literature search and data analysis, and AS, SG, MS drafted and critically revised the work. The authors' share is as follow A.SH.: 30%, SH.A.:30%, S.GH.:20%, and M.SH.:20%.

Funding
No funding was obtained for this study.

Availability of data and materials
The data source is available in the text of the article.

Declarations

Competing interests
The authors declare that they have no competing interests.

Received: 5 August 2021 Accepted: 11 August 2023
Published online: 31 August 2023

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