High technology export and high technology export impact on growth

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ABSTRACT

The term high-tech, covering the high-tech industry and the information-intensive service sector, is based on advanced scientific and technological expertise that requires science, technology and innovation (STI), and is based on Research & Development expenditure. Sectoral, product and patent approach are used for classification by OECD and European Union. Literature review on high-tech show that countries focusing on Research and Development Expenditures and new patents have succeeded in increasing their high-tech exports as well. Turkey is one of the countries where the levels of high-tech export is not at the desired levels yet therefore the government must give incentives for Research and Development expenditures and new patents for innovation, as high-tech export affects GDP growth positively.

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Introduction

High-technology, known as the term 'high-tech' in the literature, covers the high-tech industry and the information-intensive service sector. The definition of high technology covers economic, employment and science, technology and innovation. Science, technology and innovation (ITI) data describe production and service activities, products traded and patents selected according to their technological intensity. High technology is based on advanced scientific and technological expertise that requires more research and development expenditure (Keeble and Wilkinson, 2000).

OECD started using industries as technology criterion, R & D intensity (ratio of R & D expenditure to output value) as a criterion, in eleven countries, where industries are classified into 3 categories: high, medium and low technology (OECD, 1994), then the European Union began to use the common classification method (OECD, 2005).

In the literature, there are many classifications using different criteria for the classification of technology-based industries (Abbott, 1991), (Archibugi, 2001), (Castellacci, 2004), (Grupp, 1995), (Guerrieri and Milana, 1995), (Marsili, 2001), (Peneder, 2003). Davis, (1982) in the classification of finished products, used direct R & D expenditure according to the value of products sent and indirect R & D in intermediate products. The top ten products corresponding to the US Department of Commerce's Standard Industrial Classification (SIC) have been identified as high-tech. Pavitt (1984), depending on the technology resources has classified as; the nature of the technology produced in a sector and the characteristics of the firms that innovate, for example, size and main activities of industries in four categories, supplier-dominated (textiles), scale-intensive (automobiles), science-based (pharmaceutical) and specialist suppliers (instruments, machines).

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OECD, using technology intensity i.e. R & D intensity (ratio of R & D expenditure to output value) as a criterion, classified industries into 3 categories in eleven countries as: high, medium and low technology (OECD, 1994), then started using the common classification method in collaboration with European Union (oecd.org, 2005).

European Union classification and definition examples of the European Union are given in Turkey as well due to Turkey's membership of EU Customs Union (EU, 2007). In order to define the high technology density, three approaches are used in the European Union as sectoral approach, product approach and patent approach. The product approach considering the level of technological intensity of manufacturing industry products and similarly identifies trade in high-tech products. The advanced technology product list is based on the calculation of R & D intensity by product groups (R & D expenditure / total sales). Groups classified as high-tech products are grouped on the basis of Standard International Trade Classification (2018). The patent approach examines whether the patent is advanced technology and also defines biotechnology patents. In patent grouping, International Patent Classification, such as biotechnology patents, is grouped on the basis of 8th Edition (2018). High-tech International Patent Classification (IPC) groups in the following technical fields are defined as: Aviation, communication technology, computer and automatic operating equipment, laser, microorganism and genetic engineering, and semiconductors. (Europe: High-tech)

Using the Statistical Classification of Economic Activities in the European Community (European Community, NACE Rev.2), it is grouped according to the technological intensity levels of the manufacturing industry (R & D expenditure / Value Added) by 2 or 3 digit levels. Production activities are grouped as 'high technology', 'medium high technology', 'medium low technology' and 'low technology'.

In the European Union, high-tech products are divided into nine groups according to the International Trade Classification (SITC - Rev. 4): aerospace, computer and office machinery, electronic-telecommunications, pharmacy, scientific instruments, electrical machinery, chemistry, non-electrical machinery and armament. Service activities are grouped under two main groups as knowledge knowledge-intensive services (KIS) and 'less knowledge-intensive services (LKIS). These groups are defined as similar to the 2-digit level as in NACE Rev.2.

High technology exports and economic growth

The ability of a country to export is defined as international competitiveness (Trabold, 1995). Macroeconomic competition is associated with the country's international trade (Dosi, Pavitt and Soete, 1990). Growth in macroeconomic competition is driven by a country's openness to international competition, labor productivity, technology transfer and access to new information (Bernard, Jensen, Redding, & Schott, 2007). The rapid increase in exports is seen in emerging economies such as the newly industrialized countries Hong Kong, Singapore, South Korea and Taiwan (Chow and Kellman, 1993) and four other Asian countries: Indonesia, Malaysia, the Philippines and Thailand (Sara, Cheng and Newhouse, 1995) shows that it contributes to the rapid production and economic growth of these countries (Cooke and Watson, 2011). While South Korea exported 32 million dollars in 1960, increased to 65 billion dollars in 1990, 172 billion dollars in 2000 and 572 billion dollars in 2014. Taiwan's exports rose from \$ 19 billion in 1980 to \$ 313 billion in 2014 (UNCTAD, 2015).

Although exports have been regarded as an engine of economic growth since the 1960s, structural change and development in exports have been emphasized for economic development (Hausmann, Hwang and Rodrik, 2007). Malaysia, for example, has shifted from a primary-product-based economy to a production-based economy. 90% of the total exports of \$ 1.2 billion in 1960 was rubber, timber, palm oil and tin, while it accounted for 80% of total exports of \$ 98.2 billion in 2000 and 61% of total exports of \$ 234 billion in 2014. Malaysia is one of the largest semiconductor exporters in the world, with a global market share of up to 15% in 1990 and 7% in 2013 (Abad, Amalu, Kitamura and Simalabwi, 2015).

But the dimensions of competition with the new economic system have also changed, and international competition with the new economic system is called as "digital economy", "high technology economy", "information technology economy", "knowledge based economy" or "network economy" (Tapscott, 1997) and international competition is now converted into a ruthless, destructive, violent competition (Brahm, 1995).

Science and technology will continue to be the core competitiveness element of an economy (Ahuja, 2008), (Johnson, Porter, Roessner, Newman and Jin, 2010), (OECD, 1999). Exports and increasing technology intensity are seen as an important driving force of economic growth (World Bank, 2009). The advanced technology sector constitutes a large part of the export dynamics (Carolyn, 2001), (Lopez, 2005).

Despite the financial and economic crisis, during the period 2005-2012, the EU-27's production index for the high-tech and medium-high-tech industries increased by 26% and 7%, respectively, while for the medium-low technology and low-tech 6 narrowed. The average annual growth rate of high-tech industries is 3.3% (Jaegers, Lingua and Amil, 2013).

Most of the inventions are produced by advanced technology industries, including new products and new processes that lead to more efficient use of resources, expanded market share and even access to new markets for firms (Seyoum, 2004).

Many researchers have emphasized that specialization in advanced technological fields, especially in countries that adopt export-based growth strategies (Hobday, 2001), and has been reported to be positively associated with other economic activities such as economic growth etc (Eaton and Kortum, 2001), (Falk, 2009), (UNIDO, 2002), (Yoo, 2008). For the period of 1986-1994, the first

fifty (Sweden, Japan, Korea, Finland, USA, etc.) show that the innovative countries (in terms of R & D intensity and the number of scientists and engineers) experience three times higher growth rates than the rest of the world (OECD, 1999). Falk (2009), on the basis of 5-year average panel data for 22 OECD countries between 1980 and 2004, concluded that the share of high-tech industry exports in total producer exports had a positive impact on GDP growth, applying a dynamic growth model.

High technology research

High-tech is usually defined or correlated with Research and Development expenditures and number of patents and

Research on R D Expenditures

As a result of the econometric analyzes conducted for the relationship between R & D expenditures and high technology exports, a co-integration and a two-way causality relationship between R & D expenditures and high technology exports have been identified (Özçelik and Aslan, 2018). Countries Research and Development intensity as per OECD Main Science and Technology Indicators Database is given below. Turkey's level is not at the desired level yet.

Figure 1: R&D Intensity (OECD Countries and Selected non-member economies, 2015; *Source:* OECD Main Science and Technology Indicators Database, February 2017 (https://www.oecd.org/sti/inno/DataBrief_MSTI_2017.pdf).

Landesmann and Pfaffermayr (1997), in their study of 1967-1987 data and eight of OECD countries, investigated the possible effects of R & D expenditures on the export demand elasticity of AIDS (Almost Ideal Demand System) model and showed that non-electric machines had positive export performance for 4 countries. It increased the export performance of electrical machines for 2 countries and decreased for 2 countries. Research of the relationship between high-tech goods exports and the size of the country covering 19 OECD countries with the panel data analysis between 1981-1999 show that 1% increase in R & D spending, cause 3% increase in advanced technology exports of goods. The size of the country did not affect the export of high-tech products (Braunerhjelm and Thulin, 2008). Another research about the relationship between R & D expenditures and exports of goods, and exports of information and communication technology and high technology exports, covering 1990-2005 data of OECD countries with panel data analysis found that there is a high positive relationship between exports of goods and information technology, high technology exports and R & D expenditures (Özer and Çiftçi, 2009). R & D expenditure and the causal relationship between Turkey's exports covering 25 sub-sectors between 1996-2008 with Generalized Moment Method (GMM) estimation and Wald test causality analysis show that R & D expenditure has a unilateral causal correlation on exports (Yıldırım and Kesikoğlu, 2012). Another research in the manufacturing industry, covering exports of Turkey from 1995 to 2005 with panel data analysis of R & D spending impact on exports show that considerable portion of the effect is created delayed (Uzay et al., 2012).

In addition to the impact of R & D expenditures on high-tech product exports and Information and Communication Technologies, the effects of foreign trade balance on economic growth as well was investigated with eleven developing countries of Asia with Eberhardt-Bond Panel AMG method covering 1996/2012 years show that 1% increase in exports of advanced technology goods, increase high-tech products export 6.5%, increase information and communication technology exports 0.6%, and increase economic growth 0.43%.(Göçer, 2013). A research on the relationship between R & D expenditure and advanced technology exports in G-8 countries by panel data analysis between 1996 and 2011, stated that R & D expenditure positively affected the export of advanced technology products and causality relationship (Kılıç et al., 2014).

Patent Related Research

The patent application number and trade relationship with data between 1980-2013 in Turkey, was investigated with VECM (vector error correction model) results show that patent number, and foreign trade, has a positive relationship in long-term (Özsağır and Çütücü, 2015).

The relationship between R & D expenditures, patent application, openness and high technology exports between the years 2001-2011 with the panel FMOLS and panel DOLS method analysis of BRICT countries, show that R & D expenditures and openness

affect high-tech exports positively in the longterm but the coefficient of the patent application was not significant (Kızılkaya et al., 2016).

The relationship between the number of patent applications and export, has been analyzed of panel data between 1996-2013 for five East Asian countries and Turkey, with Cointegration Test; show that there is a long-term relationship between variables, and Granger Causality Test was used to determine the unilateral causality relationship between the number of patent applications from exports. According to the FMOLS test results, the 1% increase in the number of patent applications in the long-term increased exports 0.85% in the overall panel and according to the Panel DOLS test results has increased exports 1.12% (Yıldırım, 2016). In order to measure innovation performance in the high-tech sector related to European Union countries, patent applications between 1994-2011, received patents and trademark (trade mark) applications through panel data, using fixed effect and random impact model result show that the number of employees in the high technology industry affect the number of patents positively, but R & D expenditures per capita has a negative impact. However, education, government's R & D expenditures, economic development, the number of employees in science and technology and the level of export did not affect the high-tech innovation performance (Baeusu et al., 2015).

The World Intellectual Property Organization, defined technology transfer as a key objective for the Development Agenda. Technology transfer can be achieved if patent reform in developing countries helps these countries to attract foreign high-tech exports. Encouragingly, the results of this study show that patent reform in low-middle-income countries attracts new firms to the market, and reform in low-income and upper-middle-income countries encourages existing trading partners to increase their export volume. These results show that policies to harmonize patent regimes are actually beneficial in increasing high-tech exports to developing countries (Briggs, 2013). Zhang et al suggested that the effect of innovation mechanisms on the survival of firms is insufficient in the current literature, especially in the case of a rapidly developing economy. In their study, Chinese high-tech young innovative companies (start-up) between 2007-2013, using a unique out-level firm-level data set to investigate the effect of internal and external innovation mechanisms, using separate latent time-hazard model for particularly the less understood factors of innovation efficiency and trade spread, showed that the outputs of larger and older technology-intensive firms tend to be less likely. The results found that innovation, measured by patents, innovation efficiency and firms' import and export activities, could increase the survival rate of Chinese high-tech firms. This means that policy makers need to focus on supporting both internal and external innovation mechanisms to improve the survival of domestic high-tech firms (Zhang et al., 2018).

Other Research

Shan et al. (2018), in their research to evaluate the contribution of technological entrepreneurship to national development of China, who adopted technological entrepreneurship as a national strategy for economic development, have used a statistical definition, contribution rate, gray absolute correlation and elastic factor analysis. As a result of the research, the number of technology enterprises have increased and their contribution to the country's output value, export, employment and tax has increased and as a result industrial output value of technological entrepreneurship from 2010 to 2014 accounted for 41.49% of the average GDP growth, there is a high correlation with a correlation coefficient of 0,8296 gray, between technological entrepreneurship and economic growth, has significant contributions the promotion of foreign trade, technological entrepreneurship and technological progress. Furthermore, it has been found that the inventions patents constitute about 71% of the domestic inventions patents, and the total export value of high-tech products is about 22.6%.

Sawhney and Kahn (2012), in their research of the US imports of high-tech wind and solar power equipment, between 1989-2010, investigated the panel of importing countries' determinant factors; the size of the country, the sector-specific US FDI (foreign direct investment / capital) output and domestic wind and solar power production generation. The US imports of both categories, which differ between the core balance of high-tech and system equipment, have increased markedly higher than in relatively poor countries, particularly China and India. The research results show that larger countries exported significantly more, that US foreign direct investment played an important role in the export of high-tech equipment for poor countries, and that domestic renewable energy production of the exporting countries also played an important role for the core wind and solar technology.

Lee, (2011), empirically examines the extent to which technological features in exports affect trade-based economic growth models across countries. The data of the Balassa index, which differentiates a comparative advantage of a country, was obtained for industries grouped by technological intensity. The regression results, which have been based on a sample of 71 countries since 1970, show that economies tend to grow faster if they are increasingly specialized in high-tech exports, unlike traditional or low-tech. The findings show that parameter heterogeneity and internality of export structures should be taken into consideration as well as the presence of various control variables. Amador (2012) compares the energy content of 30 developed and developing economies in manufacturing exports and examines the evolution from 1995 to 2005, combining information from OECD input-output matrices and international trade data from 17 manufacturing sectors.

In addition, proposes a methodology for solving export structure and sectoral energy efficiency (EE) impacts to present results by technological categories.

The study concludes that Brazil, India and especially China have a high energy content in manufacturing exports, which rose from 1995 to 2005. In contrast, Europe and North America, there were many developed economies with lower energy content than the world average in 1995, and these countries strengthened their position as an exporter with relatively low energy use. The contribution

of export structure and energy efficiency effects in explaining the differences in the energy content of exports draws attention to China's situation. This country increased relative energy use in the export of all technological product categories. This effect was strengthened by the stronger export expertise in high-tech products and was hampered by a relatively lower specialization in medium-tech products.

Conclusion

Although there are different classifications, three approaches are used in the European Union as sectoral, product and patent approaches to define high technology density. Research on high-tech exports is grouped mainly under on Research and Development expenditures and patent. The OECD reports that innovative countries (in terms of Research & Development intensity and the number of scientists and engineers) experience a three-fold higher growth rate than the rest of the world. For this reason, countries must emphasize to R & D investments, support patent studies and specialize in advanced technological investments in their exports. Turkey is one of the countries who must focus more and give incentives on research and development expenditures and patents, as high-tech export play a vital role in country's growth.

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