

Role of Innovation in Hi-Tech-Exports of a Nation

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Abstract

The purpose of this paper was to look at the relationship between innovative capability of a country and share of high-technology products in its exports of manufactured goods. The paper discusses the role of exports in growth of some of the fast developing countries in recent years. Export market preservation and expansion of high-technology products is discussed. An empirical model with high technology exports as a percentage of the total manufactured exports of a country as the dependant variable and seven independent variables shows that level of high-technology exports of a country is significantly affected by the innovative capability of that country.

Keywords: Innovation, Technology, Market preservation, Exports

1. Introduction

During the last three decades, the developing countries with most rapid economic growth also had substantial growth in exports. Researchers have shown that in the 1980's and 1990's rapid increase in exports was the primary reason for economic success of these developing countries. Chow and Kellman (1993) examined reasons behind the success of the Newly Industrialized Countries (NICs) - Hong Kong, Singapore, South Korea, and Taiwan- and came to the conclusion that increased exports were the vehicle of growth of these countries. This is vividly illustrated by the success of South Korea, and Taiwan. During the 1950s, these two countries embraced the import substitution policy of industrialization. In short, local communities began producing goods and services for local consumption versus relying on export markets for provision of goods and services (Bellows & Hamm, 2000). This practice by itself added little benefit to the local community as seen in small increases in endogenous purchases that in limited fashion increased supporting income multipliers (Cooke & Watson, 2011). Soon the policy makers in these developing countries realized this policy was not significantly contributing to their economic growth. For many countries, implementing import substitution has resulted in capital intensive expenditures and contributed very little towards reducing poverty and income inequality. As a result, in the 1960s these countries shifted to the policy of growth through exports. In 1960, South Korea had

exports of \$32 million. These increased to \$65 billion in 1990, \$172 billion in 2000, and 376 billion in 2007 (UNCTAD, 2008). Taiwan's exports increased thirty fold between 1965 and 1990. As another example, in recent years, China's impressive growth has also been accompanied by export growth from \$26 billion in 1985 to \$249 billion in 2000, and \$1,218 in 2007 (UNCTAD, 2008). A study by Sara, Cheng, and Newhouse (1995) reported essentially the same conclusion for the success of four other Asian countries - Indonesia, Malaysia, Philippines, and Thailand- that grew rapidly during the last two decades of the twentieth century. The main vehicle of growth for these regional areas has been attributed to increases in exports along with increases in its dual constituent, import substitution (Cooke & Watson, 2011).

Export enhancement in developing nations is most successful if the exporting nation has the ability to establish competitive advantage in a niche area and has the capability to quickly respond to market changes in the importing country (Li, 2011). It is this 'response' that drives continued innovation through research and development in the exporting country (Wang, Chin, Tzeng, 2010). The multi-national partnership driven by a market economy facilitates innovation on the part the exporting company as they are charged with developing new processes for channel distribution as well as end unit enhancements. These market driven innovations can lead to increased profitability and market share (Wang, Chin, Tzeng, 2010). To some extent, these innovations may be reliant upon the importing company's technology infrastructure for developmental success. In this case, it is likely to observe export innovations spawned from the uncertainty of a long-term importing relationship with one nation or exporting technology created as a brand enhancement. This writing looks at the relationship between innovative capability of a country and share of high-technology products in its exports of manufactured goods. Export market preservation and expansion of high-technology products is discussed as factors encouraging innovation by necessity.

2. Establishing Competitive Advantage

The recent history of economic development leads one to conclude that classical theories about comparative advantage emphasizing natural resources and other cost factors have lost their validity. Today, the level of competitive advantage a nation can achieve in international trade does not necessarily depend upon the level of resources it inherits, but resources it can create through foresight, perseverance and linkages with the world economies (Beise, 2005). Competitive advantage can be gleaned from the innovative products and services that create growth and jobs (Cesen, 2010). During the last quarter of the twentieth century we saw countries with similarities in history and geography take different directions in development. For example, Malaysia and Myanmar (formerly Burma), both former British colonies and with similar locational and natural resource advantages, took different directions in economic development. While Malaysia has been moving towards prosperity, Myanmar is mired in poverty. Malaysia followed the path of growth through exports. On the other hand leaders of Myanmar decided to have a closed economy. While Malaysia's exports increased from \$13 billion in 1980 to \$29 billion in 1990 (a 223% increase), Myanmar's exports decreased from \$477 million to \$328 million.

It is clear from the recent history of economic development that the leaders of a developing country should not be content to ask questions about a country's position in today's global economy. Rather, questions should be considered regarding the global economy of five, ten, or fifteen years in the future. The type of questions that should be asked are: In what industries should the country compete in the global economy of the future? What competitive edge should the country's firms have that will make them unique compared to firms of other developing countries? What countries will be its main competitors in the years to come? What infrastructure, labor skills, and technology will it have to develop to compete in a world where customers and products are constantly changing? Many economic development writers and advisors write and speak about competitive advantage of nations. But nations do not compete with each other. It is the individual firms in those nations that fight the competitive battles. For example, the Republic of Taiwan does not compete with Japan for share of the Asian computer market. It is Taiwanese computer companies that compete against the Japanese computer manufacturers. Kenya does not compete with India for shares of the world tea market. It is the tea plantations of Kenya and India that compete with each other to harvest, process, and deliver to the consumers the best quality tea at a competitive price. Thus, the unit of analysis in seeking keys to a country's growth and prosperity must start with its firms. The question of interest is what conditions in a country will make its firms more competitive in the global economy.

In the last few decades we have witnessed a group of countries making substantial economic progress by increasing their export competitiveness by moving up the value chain. For example, Taiwan has moved from agricultural based economy to a manufacturing based economy. In the early 1950s, agricultural commodities accounted for 90% of Taiwanese exports, but by 1990 the share of agricultural commodities from Taiwan had

dropped to less than 10%, while that of manufactured goods accounted for more than 90% (Chow and Kellman, 1993). In the case of Malaysia, a recent member of high growth countries, in 1960 rubber, palm oil, timber, and tin accounted for over 90% of \$1.2 billion of total exports. By 1994, manufactured exports had captured almost 80% of the \$58.6 billion of export volume and Malaysia became the world's largest exporter of semi-conductors (The Economist, July 8, 1995).

3. Predictors of Success

The above examples illustrate that the stock of a country's current resources is not a good indicator of success of export competitiveness in the future. This illustration underscores the importance of the economic development queries previously stated – specifically queries related to competitive positioning. In a global economy, the ideas can be transferred across borders. Thus, the key to success is the ability to acquire the resources in response to changing comparative advantage and using them efficiently. The star exporters of the last two decades have been resource-poor countries such as South Korea, Hong Kong, Singapore and Taiwan. In a global economy, ideas can be transferred across borders, adapted and upgraded to ensure competitive advantage. A country starting behind in export competitiveness can close the gap without having to reinvent the wheel. By using the latest technology and management practices, firms in these countries are able to produce world class products at competitive prices. This allows them to increase the share of high technology goods and services in their exports. As an illustration, the comparative advantage of Korea and Taiwan began to shift in the seventies and eighties. This was a period of rising wages and increasing momentum of labor movement in these countries (See Table 1). In addition, governments in these countries started enforcement of environmental controls. All this resulted in a gradual loss of the competitive advantage these countries enjoyed in production using traditional factors such as labor and natural resources.

Insert Table 1 here

Chow and Kellman (1993) used Balassa's measure of revealed comparative advantage (RCA) to examine shifts in comparative advantage of NICs in Asia between 1965 and 1990. An increasing RCA index over time for a product indicates that the country is moving towards comparative advantage for that product. Tables 2 and 3 show RCA indices of Korea and Taiwan for selected years from 1970 to 1990. The RCA analysis performed by Chow and Kellman was calculated on basis of 100 products. The results presented in Tables 2 and 3 have been aggregated into 13 major product groups. RCA figures in the table are based on exports to OECD countries. It is clear from Tables 2 and 3 that during the early period Korea and Taiwan had RCA in product groups that are generally considered to be labor-intensive such as clothing, textile, and footwear. Their comparative advantage started to change in the seventies. By the 1980's the relative competitiveness of factor –intensive products such as textiles, clothing, and resource-based products started to decline substantially. On the other hand, the relative competitiveness of capital and technology intensive products such as metal manufactures, electrical machinery, and miscellaneous manufactures, rose substantially during that period. The response of business firms in Korea and Taiwan was to start locating production or assembly plants to manufacture labor-intensive goods in ASEAN countries that had taken competitive advantage from them. At the same time production and exports from Korea and Taiwan shifted to capital and technology intensive goods, such as new materials and microelectronics. The footwear industry vividly illustrates the shift in comparative advantage and investment overseas by Korean firms. In the 1980s Korea was the world's leader in the manufacture of athletic shoes. Hundreds of Korean firms made shoes for the likes of Nike and Reebok for sale around the globe. But rising wages priced the country's shoes out of much of world market. As a result in the early nineteen nineties most of the production was shifted to Indonesia where the average assembly line worker in the shoe industry made \$40 a month compared to \$800 a month in Korea (The Wall Street Journal, October 7, 1993). In the case of Taiwan, increase in relative wages in the 1980's forced labor-intensive industries to move to South-East Asia (Chen 1991). Most of this investment went to Malaysia, Philippines, and Thailand, mainly in textiles and chemicals.

During the period under discussion, Korea and Taiwan were losing international competitive advantage in labor and factor intensive products to four ASEAN countries: Indonesia, Malaysia, Philippines, and Thailand. Using the RCA similarity criteria, Chow and Kellman concluded that by the late nineteen eighties and early nineteen nineties Thailand and Malaysia, and to some extent Indonesia and the Philippines, had successfully emulated the competitive position Korea and Taiwan had in the nineteen seventies and eighties. The 1990 RCA patterns of Thailand and Malaysia were most closely related to Korea's RCA of 1975. The same pattern was evident relative to Taiwan but for a different point in time. Thailand and Malaysia's RCA patterns were found to be most closely related with Taiwan's 1980 pattern. The RCA indices for Indonesia and the Philippines were highly correlated with those of the Korea and Thailand in the nineteen sixties.

Insert Table 2 here

Insert Table 3 here

4. Innovation and High Technology Exports

As discussed in the previous section, in recent years, exports have been the engine of growth in a number of fast growing countries. In today's age of global competition, countries preserve and expand their share of the export markets by developing the capability to compete successfully in new, high productivity segments of industries. As a result, fast growing countries have recently increased the share of high-technology products in their total exports. As an illustration, Table 4 shows that during the last decade of the twentieth century fast growing ASEAN countries consistently increased their share of high-technology in manufactured goods exports.

Insert Table 4 here

In recent years technology and innovation have been cited as important drivers of a country's long-term competitive positioning regarding global markets. Jeffery Immelt, CEO of General Electric Corp. stated "Companies and countries that really play offense vis-a-vis technology and innovation are going to come out ahead" (The Economist, 2008). In its "The Global Competitiveness Report 2008-2009" the World Economic Forum concluded that in the long-run a country's competitive standing can only be expanded with technological innovation (Sala-I-Martin et al., 2008). In the last two decades, Michael Porter's research on the broad question of how an economy progresses has received a great deal of attention. In an in-country research in ten countries he studied the patterns of industry success as well as national policies that achieved success (Porter, 1990). In his model, Porter discusses four distinct stages of national competitiveness in global markets: factor-driven, investment-driven, innovation-driven, and wealth-driven. According to Porter, a nation makes advances in the first three stages and the fourth stage is "of drift and decline". Many of the advantages in the first two stages are static and passive. These advantages can be imitated by firms in other countries. The advantages resulting from the innovation-driven stage upgrade the competitive position of a country's firms.

In this paper we discuss the role of innovation in high-technology exports of a country. In the long run, a nation's higher order competitive advantage can be built only with innovation. A nation's firms must use technical innovation to develop cutting-edge products and processes. In Porter's innovation-driven competitiveness discussed above, firms not only create technology, but improve technology available in other nations. This is because globalization has brought down geographic and market boundaries, thereby improving a company's ability to innovate by borrowing ideas. In a survey by McKinsey and Co. executives see innovation as the most important way for companies to stay competitive in today's global business environment (The McKinsey Quarterly, 2006). National advantage based on factor costs is easy to replicate. But higher order advantage that can, for example, help establish brand name products can be difficult to replicate and bring competitive advantage to a country's firms. As an illustration, in their early years of development, Korean electronic firms had not developed sustainable advantage and competed on the basis of labor costs. But this advantage started eroding when Japanese, American, and European firms launched manufacturing operations in other Asian countries such as, Malaysia, Indonesia, and Thailand. In response to this threat, Korean firms such as Samsung used innovation to develop cutting-edge products and processes that increased their share of high-technology export products in Korea. In today's global competition, countries will have to maintain and expand their share of high- technology products as a percentage of total exports. We believe that innovative capability is an important determinant of a country's ability to design, produce and export high technology products. In the next section we use an empirical model to test the relationship between innovation and high-technology exports of a country.

5. Empirical Model

Below is a brief explanation of the variables we believe are important determinants of the level of high-technology exports of a country. These variables are used in the empirical model presented in this section and based on 2008 Index of Economic Freedom, Global Competitiveness Report (2008-09) and World Development Indicators.

5.1 Innovation

In today's globalized economy a country's competitiveness in the export markets depends to an increasing extent on their innovative potential. Technical innovation helps a country's firms develop cutting-edge products and processes that can successfully compete in global markets. Innovative capability is particularly crucial for countries that plan to increase the share of high technology products in their total exports.

5.2 Business Sophistication

Business sophistication depends on a country's quality of business networks and supporting industries. A country with a network of suppliers and firms with high quality operations and strategies will create opportunities for innovations.

5.3 Training and Education

The quality of labor force in an economy is critical for competitiveness. In a fast changing global economy that requires technological adaptation by firms, a pool of well educated employees provides opportunities for innovative capability. Thus, we expect a positive relationship between the quality and quantity of higher education provided in a country and innovation capability of that country.

5.4 Technological Readiness

Technological readiness refers to factors that increase technological capacity of a country. This includes stock of technology available in a country and the penetration rate of information and communication technologies. We expect a positive relationship between state of technological readiness of a country and innovation capability of that country.

5.5 Infrastructure

Firms need good infrastructure such as dependable electricity supply, good and reliable telecommunications networks, and good transportation networks to develop and use innovative products and processes. Thus, we would expect a positive relationship between quality of infrastructure and innovative capability of a country.

5.6 Business Freedom

Business freedom measures how easy it is to start and close a business. It appears that impediments to starting, or closing a business would discourage entrepreneurs and existing business from upgrading their products and operations by investing in the latest technology.

5.7 Trade Freedom

Business firms in a country with fewer barriers to international trade will be able to appropriate and improve technology and ideas available in other nations. This will enhance their ability to increase the share of cutting-edge products and services in their exports.

In Table 5, we present the dependent variable (high technology exports as a percentage of the total manufactured exports of a country) and seven variables used to predict this variable. The World Economic Forum has been measuring national competitiveness for over two decades. The methodology has changed over the years, by incorporating the latest thinking about what derives the underlying productivity of a nation. Since 2001, the methodology has been based on a model developed by Jeffery Sachs and John McArthur, called the Growth Competitiveness Index (GCI). The GCI uses a combination of hard data and data drawn from the World Economic Forum's Executive Opinion Survey. The Survey attempts to capture concepts for which hard data may not be available. In addition, it has data on other variables essential for competitiveness for a country's business firms. We used the World Economic Forum data for innovative capability of countries and seven independent variables. The data on two variables (business freedom and trade freedom) was obtained from the "2008 Index of economic Freedom" compiled by the Heritage Foundation. The data on the dependant variable (high technology exports as a percentage of total manufactured exports of a country) was obtained from 2008 world development indicators published by the World Bank. We were able to obtain usable data for 120 countries from the three data sources discussed in this section.

Table 5 below provides variable names, and definitions for data used for 120 countries.

Insert Table 5 here

Insert Table 6 here

6. Empirical Results

Data from 120 countries were analyzed using regression based on seven variables – innovation, business sophistication, training and education, technological readiness, infrastructure, business freedom, and trade freedom. Countries analyzed represented varying stages of economic development.

Innovation proved to be an important determinant of the level of high technology exports of a country ($p < .05$). Whether novel or incremental, changes that add value and are not easily duplicatable will have a positive effect on an economy.

Business sophistication was not proven to be a significant determinant of the level of high technology exports of a country. Business sophistication as described in this writing infers markets nearing or emerged in the maturity stage of the product life cycle. Because the businesses are already mature and have reached a level of business sophistication, sometimes through Darwinian activity, it is unlikely that a country with a network of suppliers and firms with high quality operations and strategies will create opportunities for innovations. This is particularly true if the countries operate in a closed economy or highly governmentally regulated society.

Like the variable business sophistication, Business Freedom as a determinant of the level of high technology exports of a country proved not significant and boasted a negative coefficient. Looking at these two variables one can infer that the countries' system of government may have some bearing on high technology exports.

Training and Education did not prove to be a significant determinant of the level of high technology exports of a country. The statistical insignificance of this variable was aligned with the relatively small coefficient value (.838). This finding differs from Robson, Haugh & Obeng (2009) who concluded in a study of 496 entrepreneurs in Ghana that innovation was positively related to level of education. This same study however cautions that training may detract from innovative opportunities and focus instead on perfecting rote processes.

Overall results of regression for our empirical model are presented in Table 6. Five of the seven variables in our model have the predicted sign. Two variables, BUS SOPH and BUS FRE did not have the predicted sign. With regards to the individual coefficient estimates, the most noteworthy result is that variable INNOV is positive and significant at less than 0.05 level. Consequently, these results provide empirical support for the argument that innovation capability of a country is a strong determinant of the share of high-technology products in exports of manufactured goods of a country. The signs of the four coefficients estimates of the six remaining variables are as hypothesized. But none of these variables are significant at less than 0.40 level. Two variables (BUS SOP and BUS FRE) did not have the predicted signs. BUS SOP is significant at 0.410 level. Thus, the role of this variable is also inconclusive in predicting the level of high technology exports of a country. Variable BUS FRE also did not have the predicted sign and is significant at 0.124 level. We had expected "Business Sophistication" – quality of business networks and supporting industries will be conducive to increasing the level of high technology exports of a country. But our empirical model did not bear this out.

7. Conclusion

Over the years a number of studies have come to the conclusion that developing countries with rapid economic growth also had substantial growth in exports. In recent years the composition of the exports of these countries has also been changing. The percentage of high-technology products as share of manufactured exports has been growing. In today's global competition, countries will have to maintain and expand share of high- technology products as a percentage of their total exports. We believe that innovative capability is an important determinant of a country's ability to design, produce and export high technology products. In this paper we attempted to look at the relationship between innovation capability of a country and high-technology products as a share of total manufactured goods exports. The results of the regression with high technology products as a percentage of the total manufactured goods exports as the dependant variable, and seven independent variables, that we believe are important determinants of the level of high-technology exports of a country were presented in Table 6. Innovation capability of a nation was the only variable significant at less than 0.05. Thus, we can conclude that the innovative capability of a country is a significant determinant of the share of high-technology products in exports of manufactured products of a country. These results should be useful for policy makers in countries using exports as an engine of economic growth. Since high-technology products will comprise a larger share of manufactured exports of these countries, policy makers should concentrate in developing conditions that improve the innovative capability of their country.

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Table 1. Growth Rates of Wages in Korea and Taiwan, 1985-1989 (Percentage)

Country	1985	1986	1987	1988	1989
Korea	9.2	8.2	10.1	15.5	18.7
Taiwan	1.4	8.1	11.1	12.0	9.3

Source: Japan Economic Journal, December 11, 1989, p.9

Table 2. Revealed Comparative Advantage of Korea: 1970-1990

Product Group	1970	1975	1980	1985	1990
Chemicals	0.10	0.15	0.26	0.18	0.25
Metal Manufac.	0.24	0.69	1.48	1.69	1.35
Nonferrous metals	0.10	0.04	0.10	0.06	0.09
Textiles	2.45	2.15	1.80	1.37	1.13
Nonelectrical mach.	0.02	0.10	0.11	0.30	0.53
Electrical mach.	0.86	1.44	1.52	1.64	1.67
Transport equip.	0.00	0.02	0.03	0.07	0.28
Precision instrumt.	0.14	0.38	0.41	0.39	0.39
Clothing	7.42	6.39	5.62	4.66	3.47
Furniture	0.05	0.24	0.28	0.34	0.40
Footwear	2.27	4.35	5.89	5.63	6.63
Resource-based prd.	1.83	0.88	0.72	0.57	0.44
Misc. manufactures	3.36	2.08	1.59	1.71	1.60

Source: Chow and Kellman, 1993.

Table 3. Revealed Comparative Advantage of Taiwan: 1970-1990

Product Group	1970	1975	1980	1985	1990
Chemicals	0.17	0.13	0.17	0.14	0.19
Metal Manufac	0.28	0.40	0.69	1.01	1.16
Nonferrous metals	0.04	0.02	0.02	0.07	0.15
Textiles	1.46	1.22	0.83	0.78	0.88
Nonelectrical mach	0.12	0.21	0.33	0.67	1.14
Electrical mach	2.76	2.20	2.03	1.61	1.57
Transport equip	0.07	0.08	0.13	0.17	0.27
Precision instrumt.	0.21	0.46	0.58	0.67	0.75
Clothing	7.17	5.21	3.54	2.63	1.58
Furniture	1.67	1.36	2.37	3.50	2.73
Footwear	5.57	6.72	7.23	6.12	3.61
Resource-based prd.	1.12	0.75	0.83	0.73	0.58
Misc. manufactures	1.71	2.30	2.64	2.22	2.05

Source: Chow and Kellman, 1993.

Table 4. High-Technology Exports (% of Manufactured Exports)

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Indonesia	2	3	4	6	7	9	11	10	10	16
Malaysia	38	38	41	44	46	44	49	55	59	60
Philippines	32	28	30	32	35	58	66	72	75	73
Thailand	21	22	20	24	24	29	31	34	32	33

Source: World Development Indicators, World Bank 2009.

Table 5. Variable Definitions

VARIABLE	DEFINITION
HI TECH EX	High technology exports as a percentage of the total manufactured goods exports of a country (3)
INNOV	An index of innovative capability of a country (2)
BUS SOP	An index business sophistication of a country (2)
TRAIN/ED	An index of the quality of training and education of a country's labor force (2)
TECRED	An index of the quality of existing technologies in a country (2)
INFR	An index of the quality of infrastructure of a country (2)
BUS FRE	An index of ease of conducting business in a country(1)
TRD FRE	An index of tariffs and non-tariff barriers as impediments to trade in a country.(1)

Sources:(1) 2008 Index of Economic Freedom, Holmes, Feulner, and O'Grady, Heritage Foundation, Washington D.C. 2008

(2) The Global Competitiveness Report 2008-2009: World Economic Forum, Geneva, Switzerland. 2008.

(3) World Development Indicators, World Bank, Washington D.C., 2008. The specification of the equation in the model with is given below and the results of regression analysis are presented in Table 6.

$$HI\ TECH\ EX = f(INNOV, BUS\ SOP, TRAIN/ED, TECRED, INFR, BUS\ FRE, TRD\ FRE)$$

Table 6. Regression Results

Variables	Coefficient	T-statistic	Significant
INTERCEPT	-9.720	-0.429	0.669
INNOV	12.714	2.338	0.022*
BUS SOP	-5.311	-0.829	0.410
TRAIN/ED	0.838	0.159	0.874
TECRED	1.370	0.224	0.823
INFR	0.007	0.018	0.986
BUS FRE	-0.294	-1.553	0.124
TRD FRE	0.153	0.650	0.517

R² =.298

*Significant at the 0.05 level