

IMPACT OF HIGH-TECH EXPORTS ON ECONOMIC GROWTH: EMPIRICAL EVIDENCE FROM PAKISTAN

Impacto das exportações de alta tecnologia no crescimento econômico: evidências empíricas do Paquistão

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Abstract: The goal of this study is to explore the impact of high tech exports on economic growth of Pakistan. To examine this relationship, data are collected from World Bank database, State Bank of Pakistan data source and Statistical Bureau of Pakistan. Time span of study is consisting of 20 years from 1995 to 2014. By using ordinary least square (OLS) with robust standard error, results confirm that there is a positive and statistically significant impact of high tech exports on economic growth. Although Pakistan is an agriculture country and its economic growth is largely depend upon farming, but for long run economic growth, Pakistan has to increase its high tech exports.

Key Words: High Tech Exports, Economic Growth, Pakistan

Resumo: O objetivo deste estudo é explorar o impacto das exportações de alta tecnologia sobre o crescimento econômico do Paquistão. Para examinar esta relação, são utilizados dados do Banco Mundial, do banco estatal do Paquistão e do Bureau de Estatística do Paquistão. O período de estudo vai de 1995 a 2014. Utilizando a técnica estatística de mínimos quadrados (OLS) com erro padrão robusto, os resultados confirmam que existe um impacto positivo e estatisticamente significativo das exportações de alta tecnologia no crescimento econômico. Embora o Paquistão seja um país agrícola e seu crescimento econômico dependa em grande parte da agricultura, tudo indica que para o crescimento econômico de longo prazo, o Paquistão precisa aumentar suas exportações de alta tecnologia.

Palavras-Chave: Exportações de alta tecnologia, Crescimento Econômico, Paquistão.

Recebido em: 03/01/2017

Aceito em: 31/03/2017

INTRODUCTION:

Economic development of any country is depend upon many factors like human resource, natural resource, capital formation, technological development, social and political factors. Among them technological development is considering the most important factor in current era. Innovative/technological development of a country can be identified through its potential of producing and exporting of high tech supplies (Gökmen & Turen, 2013). According to the Russian Classification of Economic Activities high tech industries consist of (Frolov & Lebedev, 2007);

- Arms and ammunition production
- Production of engines and turbine other than aircraft
- Automobile and motorcycle engines;
- Production of centrifuges, calendars, and vending machines
- Manufacturing of nuclear reactors and its components
- Manufacturing of helipad, aircraft, and other flying machines
- Manufacturing of spacecraft including boosters
- Manufacturing of automobile

Last three decades witness rapid economic growth among developing countries. Researcher reported the reason behind was exports. This phenomenon is called Export Led Growth (ELG) (Sara et al., 2012). Export Led Growth (ELG) theory states that country's exports lead to economic growth (McCann, 2007). Exports are the key element for country's long term wealth and growth. Especially for small and open economies, high tech exports are necessary to compete internationally and gain high economic growth (Czarnitzki & Wastyn, 2010). Enrichment of exports in developing countries is based upon capability to establish and maintain competitive advantage through speedy response to change in market environment (Li, 2011). In these days, country's competitive advantage in intercontinental trade cannot only attain through resources but it can be creating through prudence, perseverance and relation with world economies (Beise, 2005).

In last decades, many countries attain economic progress by enhancing their innovative exports. For example Taiwan and Malaysia substantially change their economies from agriculture to industrial and from low tech to high tech sectors. Among fast growing countries, exports are the key factor for economic growth. In worldwide competition, countries develop, retain and expand their capability of high tech exports. That farther leads to long term competitive position and economic growth (Sara et al., 2012).

Positive relationship between high technology exportation and economic performance were largely identified in past studies (Eaton & Kortum, 2001; Falk, 2009; Spulber, 2008; Yoo, 2008; Zhang, 2007). As literature found the positive impact of manufacturing high exports on economic growth but this impact become negative in case of primary products (Herzer et al., 2006). Asian region is also heading towards innovation. In 2002 R&D in Asia was 1.2 % of GDP, but at the end of 2009 it reached to 2.3% of GDP, which were close to OECD countries (Ismail, 2013). Pakistan also has contribution in Asian high tech exports. Last ten years witness the consistent growth of Pakistan's industrial R&D, high technology exports and economic growth. (Chapter 5 Table 1)

The purpose of this study is to identify the relationship between high tech exports and economic growth of Pakistan. Time series data for 20 year (1995 to 2014) are collected through World Bank, State bank of Pakistan and Statistical Bureau of Pakistan. By using diverse range of control variables, we found positive impact of high tech exports on economic growth of Pakistan. Results also identify that agriculture productivity in Pakistan contribute more than high tech exports. But still to attain long term economic growth, there is need to increase high tech export together with agricultural productivity.

The remaining portion of study is ordered as follow. In the subsequent section we discuss literature review regarding high tech exports-economic growth. In section 3 hypotheses and theoretical framework are developed. In section 4 detail methodology, variable definition, models developments. Section 5 consists of empirical analysis of data and results explanation. In last section we conclude this study by summarize, limitations and future research directions.

LITERATURE REVIEW:

Archibugi and Michie (1998), explained two characteristics of innovative countries; first is trade improvement and second is capability to specialize. Both factors play an important part for attaining high economic growth. In a study of Plümpner and Graff (2001), impact of export specialization on economic growth was investigated. Sample of study was consisting of 90 countries from 1980 to 1990. Researcher concluded that contrary to neoclassical economics, specialization in trade had positive impact on economic performance.

Cuaresma and Wörz (2005), examined the effect of high tech exports on productivity, efficiency and economies of scale. They found positive effect of high tech exports and negative effect of low tech exports on economic growth. The reason for better performance of high tech export is due to productivity differentiation between domestic and international competition. Santos et al. (2013), evaluated the effect of export structure on growth in EU countries. Researchers used data of 23 European countries from 1995 to 2010. Results showed that export diversification towards high technology significantly increase growth level.

Prospective innovation and its large scale commercialization determine long term country's competitiveness which further leads to economic development and growth. In a research on Russian economy Frolov and Lebedev (2007), examined the impact of high tech exports on the growth rate and structure of economy. Results indicated that export promotion and import subsidization play an important part to faster growth in short and medium run. Same results also explained by Cuaresma and Wörz (2005) among 45 developed and developing countries from 1981 to 1997.

According to Adam Smith and his theories of specialization "Trade is the engine of economic growth". It not sample as it seem to be that increase in exports and be sure about economic growth, but the export concentration and export composition leads to growth. Mccann (2007), explained the importance of exports composition on the growth of economy. He used panel data of 50 countries for the year comprised of 1980, 1985, 1990, 1995 and 2000. The results suggested that in order to change the status of undeveloped, countries need to diversify their export from low tech to high tech products. Heckseher Ohlin theory states that the only difference between nations is the country's composition of goods produced. Developed countries produced high tech goods because of high capital to labor ratio and skilled to unskilled labor ratio.

Human capital and R&D contributes to technological expansion across nations. Each Country has different level of technological advancement. Rodriguez and Wilson Iii (2000), for the first time divide 110 nations as per technological achievements in the Index of Technological Progress (ITP). Gani (2009), used the index and studied the impact of high technology exports on per capita economic growth. Researcher used cross country data of 45 countries from 1996 to 2004. He divided data into three categories i-e technological leaders, potential leaders and dynamic adopter. Regression result showed that high tech exports had significant positive effect on growth of technological leaders and positive but insignificant effect on growth of potential leaders.

Chinese economy is an interesting case for scholar in respect of high tech export and economic growth. After the implementation of trade openness policy, Chinese economy grew a lot. Sun and Heshmati (2010), performed empirical analysis to find effect of international trade on economic growth in 31 Chinese regions from 2002 to 2007. Study revealed that net exports and high tech exports had positive effect on region's efficiency. They farther elaborated that Chinese outstanding economic growth is witness of globalize trade and dynamic trade policy. In another study Cuaresma and Wörz (2005), examined the effect of technological content exports on GDP growth among 45 countries from 1981 to 1997. Results suggested that high technological intensive exports lead to long term economic growth.

Past studies Feenstra, R. C. et al. (1999), Feenstra, R. C. and Rose (2000), Feenstra, R. and Kee (2004) and Feenstra, R. and Kee (2005) identified that openness in trade turn to exports variety, which contributes to boost Total Factor Production (TFP) and per capita income. Lee (2011), empirically investigated the extent in technological characteristics required that can affect the country's economic growth. Using data set of 71 countries with a time frame ranging from 1970 to 1974 and 2000 to 2004, researcher found that as opposite to low tech exports increase in high tech exports impact more rapidly to economic growth.

Export led growth theory states that there is correlation between export and economic growth (Lamfalussy, 1963). More specifically high tech exports have more influence on economic growth as compare to medium and low tech exports. Emine and Topcu (2012), investigated the impact of high and low tech manufacturing industry exports on economic growth. Their data set included 22 developing countries from 1998 to 2006. By using OLS and PCSE models, results showed that high tech exports instead of low tech exports had significant effect on economic growth performance of developing countries. These results are consistent with study of Lucas (1988) and Young (1991), in which authors stated that a country's growth will be increase with higher rate due to specialized technology export as compare to low technology exports.

HYPOTHESES DEVELOPMENT:

According to classic theory of foreign trade, International trade of innovative and specialized products exhibits country's competitive advantage which is the key element of economic growth. Emine and Topcu (2012) and Grossman and Helpman (1991) farther stated that competition expand markets and number of trading partners also increased. These expansions attract investment from inside and outside of country which play an important role in economic growth. According to the comparative advantage model (Lucas, 1988; Young, 1991), two nations involved in trade activities have different level of growth. Developed countries specialized in high technological production (high ratio of human capital and product substitutability) and having high competitive advantage, so the effect of free trade is positively influence economic growth. On the other hand developing countries specialized in low technological production (low ratio of human capital and product substitutability) and have low competitive advantage, so in end result free trade has negatively impact on growth of economy.

Innovative countries have two advantages; improved trade terms and product specialization capability (Archibugi & Michie, 1998). As per export led growth theory (ELG) by Lee (2011) in the context of technology; countries with technological specialized new/high tech products (i-e pharmaceuticals, electronics, aircraft etc.) faced high repaid economic growth. On the other hand, countries with tradition/low tech products (i-e food, textile etc.) experienced low repaid growth. Numerous studies carried out to examine the impact of high tech exports on economic growth. Most of the studies are conducted on developed countries like European or OECD countries. Only few studies conducted on developing and Asian countries especially Pakistan. Irrespective of developed or developing country, results are consistent i-e high tech exports have positive effect on economic growth (Al-Marhubi, 2000; Bonaglia & Fukasaku, 2003; Calder, 1995; Cuaresma & Wörz, 2005; Dalum et al., 1999; Eaton & Kortum, 2001; Fagerberg, 2000; Falk, 2009; Feenstra, R. & Kee, 2005, 2008; Frensch & Wittich, 2009; Greenaway et al., 1999; Griliches, 1994; Hall & Mairesse, 1995; Hatzichronoglou, 1997; Hausmann et al., 2007; Hummels & Klenow, 2005; Laursen, 2000; Mccann, 2007; Okimoto, 1989; Rodrik, 2006; Spulber, 2008; Yoo, 2008; Zhang, 2007).

Through above said discussion and past studies we can draw our hypothesis as;

H1: There is positive and significant impact of high tech exports on economic growth.

METHODOLOGY:

To testify the relationship among high tech exports and economic growth we utilize secondary country level data collected through World Bank database, State Bank of Pakistan, and Statistical Bureau of Pakistan. The data related to variables are gathered from 1995 to 2014 (20 year) and analyze by using Augmented Dickey Fuller Test for Unit Root and Ordinary least square for regression. We develop following econometric model for regression analysis.

$$\text{Gross Domestic Product} = \beta_0 + \beta_1 \text{ High Tech Exports} + \beta_2 \text{ Government Spending} + \beta_3 \text{ Agriculture Productivity} + \beta_4 \text{ External Debt} + \beta_5 \text{ Political Stability} + \varepsilon \quad (1).$$

Sr.#	Variable Name	Notation	Measurement
1	Gross Domestic Product	GDP	Log GDP (Current PKR)
2	High Tech Exports	HTE	Log of high tech exports
3	Government Spending	GS	Log government spending (% of GDP)
4	Agriculture Productivity	AP	Log of Agriculture productivity per worker (PKR)
5	External Debt	EDGNI	Log of external debt % of GNI
6	Political Stability	PS	Political Stability Index

- We utilize gross domestic product as dependent variable. Literature review indicated that many researchers used GDP as proxy of economic growth. We use log value of GDP (current PKR).
- We use log value of high tech exports as explanatory variable. A high tech export is the proxy frequently used in past studies as technology exportation.
- Based on past studies we use bunch of control variables.
 - o Government Spending: Government spending includes expenditure on defense, infrastructure, security, law and order etc. made by a government for the benefit of countryman as well as for state safety. According to previous literature there is positive/negative relationship between government spending and economic growth. For regression analysis we use log value of annual government spending. (Alexiou, 2009; Wu et al., 2010)
 - o Agriculture Productivity: Agriculture based economies are largely depends upon farming yield. This is the key element for growth development among these countries. So increase in agriculture productivity will increase economic growth. We use log of agriculture productivity per worker to determine its impact on economic growth. (Awokuse, 2009; Odetola & Etumnu, 2013)
 - o External Debt: External debt means the amount of money taken by country in form of loan from any country or financial institution. External debt is helpful for short run economic growth but for long run it became worse. Pakistan is among highly debt recipient country from IMF and other international financial institution. Its short run impact is to streamline project with consistency but in long run large portion of national income goes to pay debt. We use external debt as percentage of gross national income in this study. (Akram, 2011; Atique & Malik, 2012; Kasidi & Said, 2013)

o Political Stability: Political stability refers to the condition in which all elements of government are working according to their specified procedures. Government is elected through proper election system, complete its tenure and farther election is conducted in fare means. According to the previous literature there is positive relationship between political stability and economic condition. Political stability encourages local and foreign investment. Industries also work in productive manner that foster profitability. For our analysis we use political stability index developed by world economic forum.(Aisen & Veiga, 2013; Qureshi et al., 2010)

EMPIRICAL RESULTS AND ANALYSES:

In table 1 summary of variables are presented. It contains number of observation, average value, standard deviation, minimum and maximum value of all variables used in the study. Data from 1995 to 2014 (20 years) are used for analysis. High technology exports of Pakistan are representing average value of 14725.68 million PKR. Minimum value is 1433.68 million PKR and maximum value is 35443.46 million PKR.

Table1: Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
High Tech Exports (M PKR)	20	14725.68	10771.86	1433.68	35443.46
Gross Domestic Product (B PKR)	20	8807.5158	3553.9290	4603.17	15225.66
Government Spending (% of GDP)	20	9.604	1.2337	7.78	12
Agriculture value added per worker (PKR)	20	76371.14	19370.18	57068.04	109917.94
External Debt (% of GNI)	20	33.6721	8.0354	22.77	46.51
Political Stability Index	20	-2.1871	0.5413	-2.81	-1.14

High Tech Exports: annual high technology exports, Gross Domestic Product: GDP at current price, Government Spending: annual government spending % of GDP, Agriculture Productivity: annual Agriculture productivity per worker (PKR), External Debt: annual External debt (% of GNI), Political Stability Index: Political Stability Index developed by World economic forum

Gross domestic product of Pakistan shows persistent increase from 1995 to 2014. Average GDP (constant PKR) of Pakistan is 8807.5158 billion PKR. Government spending also increases consistently from 8.46 % (of GDP) to 12 % (of GDP). Average spending during the study period is 9.604 % of GDP. Being an agricultural country, Pakistan has averagely 76371.1377 rupee agriculture productivity per worker. Maximum productivity is 109917.942 rupee and minimum productivity is 57068.0415 rupee. Average External debt of Pakistan from 1995 to 2014 is 33.6721 % of gross nation income with a minimum value of 22.77% and maximum value of 46.51%. Value of political stability index presented score of -2.1871 averagely with minimum of -2.81 and maximum of -1.14 score. It indicates critical political situation in Pakistan.

In this section impact of R&D Investment on high tech exports is evaluated. For this, we use time series data, in which some time non-stationary problem exist. This problem leads to biased estimates. A large number of unit root tests are suggested in past studies, but among them ADF test is widely used. Table 2 show values of Augmented Dickey Fuller (ADF) test for unit root for all variables. This test indicates that all the variables used in regression model are stationary at level point.

Table 2: Augmented Dickey Fuller Test for Unit Root

Variables	Intercept/Trend	ADF- Stat	Critical Value 5% & 10%	Stationary
LGDP	Intercept & Trend	-4.5639	-3.8753	Level
			-3.3883	
LHTE	Intercept & Trend	-6.7507	-3.9333	Level
			-3.4200	
LGS	Intercept & Trend	-3.7683	-3.7911	Level
			-3.3422	
LAP	Intercept & Trend	-4.3394	-3.9333	Level
			-3.4200	
LEDGNI	Intercept & Trend	-3.5821	-3.8753	Level
			-3.3883	
PS	Trend	-2.7747	-3.1753	Level
			-2.7289	

LHTE: log of annual high technology exports, Government Spending: annual government spending % of GDP, Agriculture Productivity: annual Agriculture productivity per worker (PKR), External Debt: annual External debt (% of GNI), Political Stability Index: Political Stability Index developed by World economic forum

Values of ADF unit root test are reported in table 2. All the variables are stationary at level point and there is no unit root issue among variables. In table 3 correlation between variables are explained through Pearson correlation matrix with significance level. Pearson correlation is largely used technique to identify the multi-collinearity issues among variables. It also indicates positive and negative relationship between variables. As results reported in table 3, independent variables and control variables are positive and statistically significant with dependent variable, except external debt with is significantly negative relation with dependent variable. Which indicate that increase/decrease in independent and control variables will increase/decrease dependent variables.

Table 3: Pearson Correlation Matrix

	LGDP	LHTE	LGS	LAP	LEDGNI	PS
LGDP	1.0000					
LHTE	0.9627***	1.0000				
LGS	0.8536***	0.7695***	1.0000			
LAP	0.7190***	0.5023*	0.7662***	1.0000		
LEDGNI	-0.9048***	-0.8564***	-0.7055***	-0.6232**	1.0000	
PS	-0.9082***	-0.9141***	-0.7475***	-0.5959**	0.7363***	1.0000

LHTE: log of annual high technology exports, Government Spending: annual government spending % of GDP, Agriculture Productivity: annual Agriculture productivity per worker (PKR), External Debt: annual External debt (% of GNI), Political Stability Index: Political Stability Index developed by World economic forum

*Significant at 10% level

**Significant at 5% level

***Significant at 1% level

Sometime correlation techniques are not exhibit true picture of relationship between variables. So for detail and accurate results it is needed to use regression analysis. According to the assumption of OLS variables must be stationary at level point. By analyzing unit root among variables through ADF-test we found that all variables are stationary at level point. So we use ordinary least square (OLS) with robust standard error technique to evaluate the impact of high technology exports on economic growth. Table 4 reports the results of OLS regression and expected relation of explanatory variables with dependent variable as per past studies. Variables coefficients (β), robust standard error and t-stat (with significant level) are also expressed.

As reported in table 4, after controlling several variables (government spending, agricultural productivity, external debt, political stability) we found positive, statistically significant and consistent with past studies, impact of high tech exports on economic growth of Pakistan (Al-Marhubi, 2000; Bonaglia & Fukasaku, 2003; Calder, 1995; Cuaresma & Wörz, 2005; Dalum et al., 1999; Eaton & Kortum, 2001; Fagerberg, 2000; Falk, 2009; Feenstra, R. & Kee, 2005, 2008; Frensch & Wittich, 2009; Greenaway et al., 1999; Griliches, 1994; Hall & Mairesse, 1995; Hatzichronoglou, 1997; Hausmann et al., 2007; Hummels & Klenow, 2005; Laursen, 2000; Mccann, 2007; Okimoto, 1989; Rodrik, 2006; Spulber, 2008; Yoo, 2008; Zhang, 2007).

Table 4: Regression Analysis

Variable	Expected Sign	Coefficient	Robust Std. Error	T-Stat
LHTE		0.0963	0.0260	3.70***
LGS		-0.0073	0.0744	-0.10
LAP		0.9594	0.2147	4.47***
LEDGNI		-0.1410	0.0647	-2.18*
PS		-0.0327	0.0165	-1.98*
Constant		-1.0788	0.6939	-1.55
F-value				734.24
R²				0.8903

LHTE: log of annual high technology exports, Government Spending: annual government spending % of GDP, Agriculture Productivity: annual Agriculture productivity per worker (PKR), External Debt: annual External debt (% of GNI), Political Stability Index: Political Stability Index developed by World economic forum

*Significant at 10% level

**Significant at 5% level

***Significant at 1% level

Regression analysis reports that 1% increase in high tech exports will increase in economic growth (GDP) by 0.096%. In the situation of Pakistan high tech exports presented very nominal contribution towards economic growth. There are two reasons behind this, firstly high tech exports of Pakistan is very low. Secondly Pakistan is an agricultural country, being an agricultural country its economy growth is largely depends upon farming. As shown in table 4, agriculture productivity per worker increase by 1% will increase economic growth of Pakistan by 0.95% which is more than high tech exports. Literature studies also elaborated same relationship between agriculture productivity and economic growth. (Awokuse, 2009; Odetola & Etumnu, 2013)

Large portion of government spending of Pakistan belongs to defense, infrastructure, security, law & order etc. These projects are long run and have positive/negative effect on economic growth. Our analysis also shows that 1% increase in government spending will decrease economic growth by 0.007%. External debt is some time good for short term government cash flow but in long run it usually has negative effect on government earning and economic growth. Pakistan has stuck in debt since 1995. Every next year there is increase in amount of debts. As per our regression analysis results 1% increase in external debt (% of GDP) will decrease economic growth by 0.14%. Results also present negative effect of political stability on economic growth. The reason for negative relationship is that we use political stability index which show negative score for Pakistan's political stability. So increase in negative value will explain higher political instability. Our study model also pass F-stat with 1% significance level. R-square for model is 89% which is quite large enough to explain impact of explanatory variables on dependent variable. These regression results are consistent with our hypothesis i-e there is positive relationship between High tech exports and economic growth in Pakistan.

CONCLUSION:

The purpose of this study is to investigate impact of high tech exports on economic growth of Pakistan. For this we use annual country level high tech exports and economic growth. For data collection we use World Bank database, State Bank of Pakistan data resources and Statistical Bureau of Pakistan. Period of study consist of 20 years ranging from 1995 to 2014. For statistical analysis we use Augmented Dickey Fuller, Pearson correlation matrix and ordinary least square with robust standard error technique. To inspect aforesaid hypothesis we employ diverse control variables (Government Spending, Agriculture Productivity, External Debts, and Political Stability) and found significantly positive impact of high tech exports on economic growth.

Key findings of study indicate that agriculture productivity per worker has higher impact on economic growth of Pakistan as compare to high tech exports. There are two basic reasons behind this outcome; firstly Pakistan is an agricultural country and being an agricultural country its economy is largely depends upon farming. Secondly Pakistan still has poor performance in high tech exports as compare to other countries. Low level of high tech exports of Pakistani industry is due to nominal investment in corporate research and development. Industrial R&D is an important driver to enhance high tech exports by product and process innovation. There is massive competition in foreign markets for developing countries like Pakistan, but R&D innovative activities can be helpful to release competition up to some extent. For the survival in high tech international markets, Pakistani industries have to invest substantially in R&D and innovation activities.

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