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Impact of Technological Progress on International Trade in Pakistan: An Empirical Analysis

Asmia Bibi[1], Mehwish Shaheen[1] and Aftab Ahmed[2]

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Abstract

The study aims to identify the impact of technological progress on international trade in Pakistan over the time span from 1990 to 2021. The study employed linear regression model to find the relationship among the variables like technological progress, foreign direct investment (FDI), economic growth, local investment and international trade. The results indicate that the impact of technological progress on international trade is positive and significant for the specified period in Pakistan. The findings also show that FDI, economic growth, and capital formation have a positive effect on international trade.

Key words: Technological Progress, Trade, Foreign Direct Investment, Economic growth, Pakistan

1. Introduction

The incorporation of technology in production processes has transformed the global trade landscape. It has facilitated the development of new products and services, allowing firms to offer innovative and differentiated goods in the international market. Trade advancement of a country depends upon different factors but the most influential factor of them is technology

[1] Scholars, Department of Economics, University of Chitral.
[2] Lecturer, Department of Economics, Punjab Group of Collages, M.B.Din.

Email for Correspondence: asmiabibi11@gmail.com

which has significant impact on trade in the modern era. Technology has revolutionized trade by making it faster, more efficient, and more accessible. It has also created new markets and opportunities for business to grow and expand. Over the past decades technology has had a profound impact on trade in Pakistan. With advancement in communication, transportation, and logistics, businesses have been able to expand their reach and tap into new markets. The rapid progress in technology motivates the economic development and financial innovations (Nasir et al. 2020).

Technological progress includes the innovation and development of technology over different periods of times. It is the process by which new and more effective ways of doing things, creating products, or delivering services leading to increased efficiency, productivity, and often, improvements in the quality of life are developed. Technological progress is a fundamental driver of societal and economic development, influencing various aspects of human life, industry, and the global economy.

Invention is simply the new scientific discoveries while innovation refers to the use of these scientific discoveries in the production of goods and services. It helps in improvement and modernization of production techniques. Therefore, it is considered as a key to driving economic growth and advancing human progress. It plays a crucial role in propelling economies forward and improving the overall well-being of societies, and it leads to technological progress (Kayal 1999). Invention and innovation are the main drivers through which technological progress takes place (Haq 2018).

Trade refers to the exchange of goods and services between individuals, businesses, or countries. It's an abecedarian profitable exertion that has been a part of mortal civilization for centuries. Trade occurs when one party provides goods or services to another in return for something of value, usually money or other goods and services. The essence of trade lies in the mutual benefit that both parties derive from the exchange. Trade is a dynamic and essential aspect of the global frugality, contributing to economic development, job creation, and the exchange of ideas and cultures. It plays a crucial role in shaping the interconnectedness of nations and fostering cooperation in the international arena (Vijayasri 2013).

According to the 'World Trade Organization Report 2018', delve into the far-reaching consequences of digital technologies, specifically focusing internet, artificial intelligence (AI), 3D printing, and Block chain on international trade are need of time. The report examined how these technologies influence costs of trade and effects form of goods and services traded and overall structure of global trade. Furthermore, it estimated the potential effects of these technologies on global trade in the next 15 years. In essence, the rapid development of digital technologies has the capacity to profoundly reshape international trade dynamics, presenting opportunities and challenges that will likely shape the future of global commerce.

According to Usman (2017), technological development of a country can be identified through its potential of producing and exporting of high-tech supplies. Exports play substantial role in improving country's economic situation.

According to 'Economic Survey of Pakistan', the goods export witnessed a growth of about 27 percent and amounted to 23.7 billion US dollars during 2021 -2022. Imports of the country were also raised significantly. The trade deficit experienced a significant increase of about 56 percent which is historically high figure of about 30 billion dollars.

Moreover, Foreign Direct Investment (FDI) plays an important role in many developing countries like Pakistan to reduce trade barriers. FDI is a major and important tool for developing the economies like Pakistan. It improves job opportunities and enhances the ability of production with technological transformation. It polishes labor skills and capability to work. FDI works as an intermediary between local economy and international economy (Qayyum and Mahmood, 2013).

According to Arshad (2012), FDI supplies the basic inflow of capital that will benefit the balance of payment of any country. It also plays a key role for enhancing technical activities, improving managerial skills, promoting the commercial process, and works as a channel for classical export. Moreover, according to a study by Bakari and Sofien (2019), local investment plays a crucial role in the improvement of a country's trade. It also plays an important role to improve economic performance and therefore trade by attracting foreign investors and expanding local businesses in Pakistan.

Likewise, economic growth can raise household demand and purchasing power, both domestically and internationally. The demand for goods and services increases due to an increase in economic growth. It provides a way for the enhancement of businesses and improves production and thus plays a vital role in improving trade performance (Abendin and Duan, 2021).

Most of the previous studies conducted research on trade by using variables such as export, digital finance, human capital, trade openness. These studies include (Sultanuzzaman et al., 2019), Marquez (2010), Zhang et al. (2022), (Marquez and Zarzoso 2010), Banerjee and Roy (2014), Kere and Zongo (2023), and Lawal and Ezeuchenne (2017). Less number of studies has used variables such as technological progress, foreign direct investment, economic growth and local investment to find the impact especially for a developing country like Pakistan. To fill this gap, this study aims to analyze the impact of technological progress on trade in Pakistan by using current data set available. The present study highlights the impact of technological progress on international trade in Pakistan by using the data from 1990 to 2021. The study has also analyzed the effect of some other variables such as economic growth, local investment and foreign direct investment. This shows that the present study has contributed in the literature by introducing some more important variables in the model.

The organization of the paper is as follows. Section two consists of literature review. Section 3 presents data and methodology. Section 4 consists of analysis section five presents discussion. Section 6 provides Conclusion, recommendations and limitations. List of references is given at the end.

2. Literature Review

This section reviews the empirical studies available on explaining the relationship between technological progress and global trade.

Banerjee and Roy (2014) analyzed how technological advancement, human capital, and trade contributed to shaping the long-term growth of India, by using time series data for the years 1950 to 2010. The employed auto regressive distributed lag model to analyze the data. The outcomes indicated that variables such as trade, technological progress, and human capital play important

role in examining long run growth in India. The most significant one is human capital which plays a crucial role while determining economic growth in the long run.

Jalles and Tavares (2015) examined the factors that lead to technological progress. The study investigated the link between the variables such as trade, social capital, and total factor productivity as a proxy of technological progress for 59 poor and rich countries by employing time series data covering the period from 1970 to 2007. The study used Leaners (1983) Extreme Bound Analysis (EBA) and Levin and Renets (1992) Empirical Applications to analyze the relationship between the variables. The findings show that trade is a major determining factor of technological progress in developed and developing countries while scale of production has no impact on technological progress of both rich and poor countries but it can be negative in case of poor countries. Furthermore, social capital indicates similar impact for both type of countries.

Butyter and Wachowska (2015) examined the linkage between international trade and innovation which is measure by level of patents assessment in Ukraine, during 2004 and 2013. Pearson correlation coefficient is calculated to find the link between import and export commodities. The quantity of invention is taken for the safeguard of patents by the individuals in Ukraine. The analysis concluded that technologically advanced countries can play a positive significant role in increasing innovation in the country.

Dutta et al. (2017) analyzed the connection between local investment, trade, FDI, and economic growth in Bangladesh by employing time series data spanning from 1976 to 2014. The study used unit root tests, Co-integration method, and Granger Causality tests and Vector Error Correction Model to analyze the relationship among the variables. The finding reveals uni-directional causality from FDI to economic growth and from domestic investment and economic growth towards international trade while a two-way causality is identified between domestic investment and economic growth as well as between FDI and international trade. On the whole, a significant positive relationship was found among the variables.

The association between global trade and technology has been studied by Ghanbari and Ahmadi (2017). Two methods are included in the study, one method analyze that how technological difference influence the difference in trade operation among nations, while the other method indicates that international distinction in technical advancement and innovation is a source for

global trade activities. Research and development are used as a proxy for innovation. The study analyzed the impact of innovation on international trade in industries based on high technology in Iran, Japan, Korea, and Australia. The analysis found that innovation is a main factor that better determine the trade. The paper concluded that there exists significant positive relationship between innovation and export for industries of the above mentioned countries.

Study by Rijesh (2020) investigated the effect of import of technology on Indian manufacturing export with respect to trade liberalization by using panel data from 1995 to 2016. The econometric analysis used for estimating the panel data are Ordinary Least Square (OLS) and Tobit regression method. The result indicated a significant impact of technology import on exports of capital goods in Indian manufacturing sector. Furthermore, this study showed a major impact of research and development on exports in India.

Similarly, Fauzel (2022) examined patterns of trade that are affected by technological progress in COMESA from 1990 to 2017. For estimation, a dynamic vector error correction regression model (PVECM) is used. The findings reveal the positive influence of technological advancement on trade in the region of COMESA. The research shows that trade in the long run positively affects the domestic investment and economic growth while further analysis is required in short run. Furthermore, the study concludes that not only technological progress influence trade, but trade can also cause technological progress. Thus this results in a two-way connection between foreign trade and technological progress.

Kere and Zongo (2023) investigated that digital technology effect African trade. The research utilizes time series data spanning from 2000 to 2018 with variables like digital technology, trade, ICT, and growth. The econometric model used to check the effect of digital finance on 48 Sub Saharan African countries intra-trade is gravity model. The finding indicates that information and communication technology uses, especially use of internet is positively and significantly related with exports while it has negative impact on primary import and overall commodities. Moreover, those who are using landline telephone also have negative impact on intra-African trade, and the use of mobile phone services enhance the exports. The study concluded that the availability of electricity leads to positive effects on export goods, and it can decrease the cost of trade in Africa.

3. Data and Methodology

This study investigates the relationship between technological progress and volume of trade in context of Pakistan. The study used time series data obtained from the *World Bank Indicators.* Data has been analyzed for years 1990 to 2021 to study the impact of technological progress on international trade in Pakistan.

The Model

The variables used in this research include volume of trade (dependent variable), and technological progress, foreign direct investment, economic growth, and local investment are independent variables.

Dependent Variable

Volume of Trade

The dependent variable is volume of trade. This explains the difference between the volume of exports and imports. Goods and services which are bought from other countries instead of purchasing domestically produced goods are called imports. Imports lead to outflow of funds from the domestic country. The exports are the goods and services which are produced domestically but are sold to the residents of the other countries. This indicates the inflow of funds to the domestic country.

Explanatory variables

Technological Progress

According to theoretical perspective, technological progress is an influential factor for determining the level of trade to gain better productivity. Advancement in technology can increase the productivity of a country and enable it to produce goods of best quality which enhance trade in the global market (Spulber 2008). Factors such as modification and addition of new technology can impact the level and combination of imports and exports in an economy. An improvement in technologies can help economies to produce goods of better quality. It can,

therefore, enhancing the volume of trade. This indicates that technological progress and level of trade are expected to have positive association with each other. For example, Iyoha and Okim (2017) examined that betterment in trade occurs by investing in and improving technological progress and innovation. Innovation (as Patents number of resident) is taken as a proxy for technological progress in this study.

Foreign Direct Investment

The purpose of adding this variable is to analyze the connection between FDI and volume of trade. The positive relationship between FDI and trade is expected. That is the foreign direct investment is likely to have positive impact on the dependent variable. A study by Ghosh (2007) found that there exists a positive relationship between FDI and volume of trade. FDI inflows are used as a percentage of gross domestic product in the study.

Economic Growth

GDP is used as proxy to measure the economic growth which can help to investigate the link between economic growth and volume of trade in Pakistan. Higher productivity is expected to increase the volume of the trade. Trade has the capability to improve the production of goods and services and can help to allocate the resources more efficiently, (Afolabi et al. 2017).

Gross Domestic Capital Formation

The positive relationship is expected to prevail between gross domestic capital formation (GDCF) and the dependent variable. According to the World Bank, gross domestic capital formation comprises of outlays on addition to the fixed assets of the economy plus net changes in inventories. It includes land improvements, plants, machineries, equipment purchase, construction of roads, railways etc., including school, hospitals and industrial buildings. Gross domestic capital formation is used as a proxy for local investment Local investment is a major factor of development especially economic development in a country. It can enhance productive capacity in an economy by introducing efficient goods. Besides, it helps to improve the performance of trade sector, specifically the exports and imports (Bakari et al. 2020). GDCF as a percentage of GDP is used to measure local investment.

Econometric Model

We have a simple linear regression model.

$$TRADE = F(Xi, Xj) \quad (1)$$

Where *Xi, Xj* are the independent variables.

$$Trade = \beta 0 + \beta 1\ TPxt + \beta 2FDIxt + \beta 3GDPxt + \beta 4GDCFxt + \varepsilon_t \quad (2)$$

Where

Trade= is dependent variables

β0 is intercept,

β1= is slope of TP (technological progress).

β2= is slope of FDI (foreign direct investment).

β3= is slope of GDP (gross domestic product).

β4=is slope of GDCF (gross domestic capital formation).

ε_t= is error term or random disturbance term.

Variables of the model are given in Table 1.

Table 1: Table of Variables

Abbreviation	Variables	Data Source
TRADE	Volume of trade	World Bank Indicators
TP	Technological progress	World Bank Indicators
FDI	Foreign Direct Investment	World Bank Indicators
GDP	Gross domestic product	World Bank Indicators
GDCF	Gross domestic fixed formation	World Bank Indicators

4. Results and Discussion

The study used descriptive statistics to analyze the yearly based data and performed linear regression to examine the relationship between the key variables. These statistical techniques interpret that technological progress has a significant effect on trade in Pakistan. FDI is

positively related with the volume of trade in Pakistan. Descriptive statistics are presented in Table 2.

Table 2 shows the complete in-depth explanation of descriptive statistics for all the variables included in the study. The descriptive statistics calculate means which give the average value of the variables and range which show the maximum and minimum values, for the given variables such as volume of trade, technological progress, FDI, local investment, and economic growth.

Table 2: Descriptive Statistics

Variables	Observations	Mean	Minimum	Maximum
Trade	32	0.775	24.702	38.499
TP	32	1.313	16	426
FDI	32	0.052	0.375	3.668
GDP	32	0.001	9.950	13.410
GDCF	32	0.131	14.121	20.685

Unit root test is applied to find the stationary of data. The results of Dicky Fuller unit root test are presented in Table 3. The results show that data is stationary at level. So we can apply linear regression technique to estimate the data.

Table 3: Results of Unit Root Test

Variables	T values	5% level	Order of integration
Trade	-3.152	-2.775	I(0)
TP	-6.234	-2.313	I(0)
FDI	-4.123	-3.052	I(0)
GDP	-6.567	-3.001	I(0)
GDCF	-4.567	-2.131	I(0)

The study has used simple linear regression (OLS) to investigate the relationship between the variables used in this study. Ordinary Least Squares regression (OLS) is a common technique for estimating coefficients of linear regression equations which describe the relationship between one or more independent quantitative variables and a dependent variable (simple or multiple linear regression). And it enables us to identify that how dependent variable is affected by the changes in independent variables. The estimation results of OLS are presented in Table 4. Table shows that value of R^2 is quite high. This indicates that more than 80 percent variation in model is explained by the independent variables. Value of R square measures that how variation in dependent variable is explained by the variation in independent variables. Its value ranges from 0 to 1. If the value is higher it analyzes that the model fitness is good. If the value of R square is equal to 1 then it means that the independent variables explain all the variation in the dependent variable.

It has been found that technological progress, domestic productivity and foreign direct investment place strong positive impact on the volume of trade in Pakistan. The intercept term indicates that there are other variables that effect the dependent variables but are not included in the model.

Innovation as patents number of residents is independent variables which are used as a proxy for the main variable technological progress. The results show that technological progress exerts positive and significant impact on the volume of trade in Pakistan. Innovation creates jobs, drives efficiency, reduces poverty, and transforms global trade. It leads to improve standards of living through effect on global trade. Hence technological innovation exerts profound effect on trade. Technological progress has a noteworthy effect on trade in Pakistan. It indicates a statistically positive and significant effect on trade. Technological progress is likely to have 15 percent increases in the dependent variable keeping all other independent variables constant. A study by Fauzel (2022) indicated a positive relationship between technological progress and volume of trade. As a country develops technologically, it tends to innovate and produce new products. Initially, these products are likely to be consumed domestically, but as technology spreads and matures, the country may begin exporting these products contributing to increased trade.

Gross domestic product is another independent variable that exerts positive effect on the dependent variable. T - value for GDP shows that it has statistically significant contribution in determining volume of trade. This indicated that higher production level will lead to higher

volume of exports in the country. It has been found that higher level of aggregate productivity in the country will have positive impact on the overall magnitude of trade of a developing economy like Pakistan. Our analysis of trade performance can also be supported by previous studies such as Javed et al. (2012). This study indicated a significant linkage between economic growth and volume of trade. This argument can be supported by Solow growth model, which offers meaningful perception into the positive impact of economic growth on trade and recommend that the economic growth is motivated by allocating or investing in physical capital and focusing on technological enhancement. Nation can improve output and its productivity by the accumulation of capital and adaptation of new technologies. A country can gain valuable improvement in trade and global market competitiveness by enhancing better quality of goods and services.

Table 4: Estimates of Ordinary Least Square

Independent variables	Coefficients	T - values
TP	0.1596	1.967**
GDP	0.0042	1.708***
GDCF	0.0030	1.597
FDI	0.1002	1.745***
Constant	0.5670	2.003*
N	32	
R^2	0.8220	

Note: * indicates that t values are significant at 1 percent level, ** indicates that t values are significant at 5 percent and *** show that they are significant at 10 percent level.

Furthermore, it has been also observed that local investment (capital formation) can boost the dependent variable. Local investment places a positive impact on volume of trade in Pakistan. It is an important factor that plays a major role in the development of trade in the country. The result is supported by the analysis of Dutta et al. (2017). Their study reveals a positive and significant connection between trade and local investment. Export-Led Growth hypothesis support the statement “local investment is positively related with trade”. This theory elaborates that when a country boosts up its industrial sector by investing more in this sector, the potential

to produce goods and services for export increases. This enhances the economic growth and international trade. This indicates that improvement of local investment in export-oriented industries can improve a country's capability to participate in trade and gain benefits from international trade.

FDI plays a vital role in boosting the overall productivity of the economy and hence leads to improve the volume of trade. Foreign direct investment can play a crucial role for improving trade performance and attract foreign trade in the country. The results indicate that FDI has significant impact of 10 percent in determining volume of trade. The result is supported by the study of Hailu (2010). This study found a significant positive relation between FDI and trade. Adopting internalizing process, firms can boost up their production efficiency, save cost, and therefore their competitiveness in the foreign market improves. The producers can produce more goods and services which leads to the increase in trade of the country.

5. Conclusion and Recommendations

This research examines the repercussion of technological advancement on volume of trade in the context of Pakistan. The time series data from the period 1990 to 2021 was used for the purpose of analysis. The results indicate that technological progress, foreign direct investment and gross domestic product exert positive impact on the dependent variable. Technological progress has a noteworthy effect on trade in Pakistan. The result of technological progress indicates a statistically positive and significant effect on the volume of trade. Technological progress is a crucial factor that can improve trade performance and promote opportunities for it in a developing economy like Pakistan. The study by Ghanbari and Ahmadi (2017) found similar findings. Similarly, Fauzel (2022) examined that trade is affected by technological progress. For estimation, a dynamic vector error correction regression model (PVECM) was used. The findings revealed the positive influence of technological advancement on trade in the region of COMESA.

The results showed that other variables like foreign direct investment and gross domestic product also place significant and positive influence on the dependent variable. This indicates that foreign direct investment and economic growth are likely to exert higher impact on the volume

of trade. Dutta et al. (2017) found that there prevail causal relationship between FDI, economic growth and international trade.

There is a need to improve the role of government sector to focus on the adoption of technological progress. That is, government can take better steps to improve the technological progress so that it can play better role in the improvement of volume of trade in Pakistan.

Limitation of the Study

The study does not include the other important variable like labor force participation in the model. If included, this variable is expected to exert an important effect in the analysis. Moreover, the study includes data set comprising of 1990-2021. This may be extended like 1980 to 2023. It is suggested that bi-directional relationship should be analyzed in future studies.

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