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DOES TECHNOLOGICAL ADVANCEMENT REALLY AFFECTS ECONOMIC GROWTH OF PAKISTAN?

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ABSTRACT- *In this research paper, we have tried to see whether technological progress really affects the economic growth of Pakistan or not. Different variables like Education expenditure, patents applications, Foreign Direct investment, unemployment and R&D expenses were chosen to check the impact of technology on economic growth. Time series data, for the period 1998-2018, was used in this study. We used Unit root test to check stationarity among variables while ARDL models and Bound test were used to explore short run and long run relationship between technology and economic growth. We found positive relationship between research and development (R&D) and innovations and in turn inventions can boost GDP rate.*

Keywords: Technology, innovation, R&D, education expenditure**,** FDI, Economic Growth.
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1.INTRODUCTION:

1.1. Background of study:

In the economic advancement, innovations play a major role and increase technical changes among the people of different nations. Without technology life can no more exist. Every day research is adding more value to innovations and inventions but in our country this sector of economy is not developing as fast it should be. Main reason is less awareness, poor literacy rate, poor infrastructure, no research on IT and no motivation for those who are making economic inventions like many Pakistani students invented innovative products. In this paper we will explore whether technological advancement really affect the economic growth of Pakistan. Now developing economies like India has developed its IT sector and hence its economy is earning $100 billion plus from the export of IT products. Advanced nations are also growing due to new inventions daily but their speed is slowing due to aging population. Pakistan is blessed with more young talent as compared to any other country in Asia; hence by using their talent we can boost our GDP growth.

1.2. Main Research Questions:

Main research questions are stated as under: -

(i) Does technological advancement really affect the economic growth of Pakistan?

(ii). How can technology be boosted?

(iii). What is the link between R&D and technology?

1.3 Objectives of study:

The objectives of this study are outlined in the following: -

- To check the relationship between technological advancements and

economic growth in Pakistan.

- To check the effect of technology on economic growth of Pakistan?
- To investigate allocation of budget for Research and Development in Pakistan.
- To make recommendations for improvement in the current state of technology in Pakistan.

1.4 Scope of study:

The scope of this study is large because its results can help the policy makers how to expedite of innovations in Pakistan and develop talents to obtain sustainable economic growth. Although the results of this study are specific to Pakistan but they can be generalize to other developing countries as well.

2. LITERATURE REVIEW:

Adam Smith (1776) is a well-known economist, who wrote the book *The Wealth of Nations*, in 1776, which is all about the economic growth. It was the era of first Industrial revolution when he wrote this book. As a keen observer he observed the relationship between technical advancement and economic growth. Currently we can see that Economists emphasize on increasing capital per worker and technical advancement but from reading Smith we came to know that it's not a new concept. According to (Smith, 1776) economic growth and growth of capital per worker are closely related to each other. Both concepts are essential for growth of any economy or country. Modern growth theory not only admits this relationship but also take guidance from this old concept.

Schumpeter (1911) was follower of Marx and he believes that innovations in technology and industrial growth are interrelated.

Innovations are vital elements for an economic growth. He discussed it in "Theory of Economic Development". He mainly focused on capitalism, Democracy and socialism and made about two arguments. He analyzed how these three sectors of an economy are influenced by the use of technology and technical driving forces. In real world today we can say that technology becomes most essential element for development of nations but it varies from time and intensity.

Technological advancement and economic growth analysis was done by Carl Marx (1932). According to Marx to win the rival war technological advancement is an essential element in an economy. Due to competition pressure firms are forced to adopt the latest technology, and in long run it will be beneficial. But there was an issue that by increasing productivity using technology unemployment will also be increase. Due to automation many disputes raised in that era. Ultimately it was considered that unemployment is not raised as proportion to the development in economy. In modern theory of growth this only issue of unemployment was hidden because modern growth theory assumes that there is full employment in the economy. In the end of 19th century many economists lost their interest in economic growth due to various reasons. After World War II, economists started taking interest in the relationship between technological advancement and economic growth.

As per Dahlman, Ross-Larsen and Westphal (1985), monetary development cannot be raised on local level. The exchange of innovation could be progressively viable given that securing capacities are created in the nation. They contend that designing items and procedures is n't at the focal point of the technological improvement required for fruitful

industrialization. It is at the periphery. What is the main point in getting the abilities required for effective generation and venture?" As stated previously, together with manufacturing sector, technology is in extricably related to enterprise efficiency and competitive development. Worldwide experts recommend that the most aggressive and propelled economies are those that are at the cutting edge of the innovative advancement. Technological advancement is a key component in enhancing profitability, and thus development that make it possible to enhance intensity of innovation.

According to Hoppit (1990) the normal perspective on the modern revolution is changed because of diverse directions and static values that existed in the past. The revolution required here were intricate as well as expenses, both in the long and short run. In any case, the advancement based upon new gauges of economic productivity, for example efficiency development. The development in profitability can emerge out of new techniques or expanding assets, or both. Whatever the case might be it is true that attitude, new technology, new generation methods play a vital role.

Hoppit, (1990) stated that the crops production in Britain in eighteenth century rose but its as same as the high level of industrial production. The fast growth in industry was due to new inventions and innovations.

Young (1993) says that new technologies are not durable as compared to the older technologies and only used in narrow functions. Later on, improvements were made for development of new technologies more viable and now they dominate older ones and are being used on large scale. For example, we can analyze the steam engine made by James Watt in 1765

that was used for pumping water in mines. It was power consumer and designed on piston. It was not able to be used on large scale even it was invented after the inventions of Wilkinson1 in 1776. Even after such inventions system was not converted into capital from labor but it was becoming a factory system. Leadership and organizational techniques are required for such conversion at large scale operations.

Jones (1995a) explained the differentiating connection between innovation and GDP growth that is purely similar to the efficiency sector. Data and correspondence innovation instruments help people and leaders to elevate their ability to 'think all inclusive' and to speak with various gatherings for finding the potential answers for the practical advancement.

According to Kestemont & Hecq, (1996) advancing data innovation is an approach to build up the procedure of basic leadership for improving its outcome solid and less hazardous. The technological progress gives amazing results to practical advancement. The significant factor for Britain at the time of the first industrial revolution was the organization of designers and business people (for example, Bolton-Watt association), which was one of the most significant authoritative procedures for foundation and remove from new creative firms.

Freeman and Soete (1997) explained that the of condition influencing modern advancement in the Industrial Revolution is as yet significant for progress today. In spite of the fact that England was on the cutting edge of Industrial Revolution, other modern countries in Europe didn't fall behind. They were also making efforts to catch Britain.

According to Crafts, (1998) revolution is composed of two main labels that are technological innovations and structural changes in

employment. Technological changes are helpful to get rid from Malthusian trap in which population is equal to the output growth level hence there is no change in income per capita. People moved towards urban and industrialized areas to earn their livelihood, it was a major move that was not happened before in any advance country. Industrial revolution was none except a swift or move. Each innovation has its own limited life span and after completion of that life span it is replaced by new one. It's a complex process and specific time is required for diffusion of an older technology. Some time there is minor impact of very important innovations. Complete potential of technology can be realized after it became economical and easily available.

Landes (2003) suggested that factory was a pivot point between inventions and innovations and it will lead towards further transformation. New equilibrium was established after this transformation and industrial revolution. Then again, "small scale developments" are created through resulting improvement, adjustment, and use of IT, regularly including learning by doing and learning by utilizing.

The advancement frameworks must accomplish more than improving innovation to advance reasonable improvement, and the advances must be likewise available and well-adjusted, particularly for utilizing poor people, at that point they should incorporate into neighborhood settings which will shift monetarily, politically and socially (Harindranath & Sein, 2007).

According to Stojkove (2008) stated that economy can be divided into three sectors: Manual Production, Machine Age, Automotive production. Basic cause of first industrial revolution was introduction of

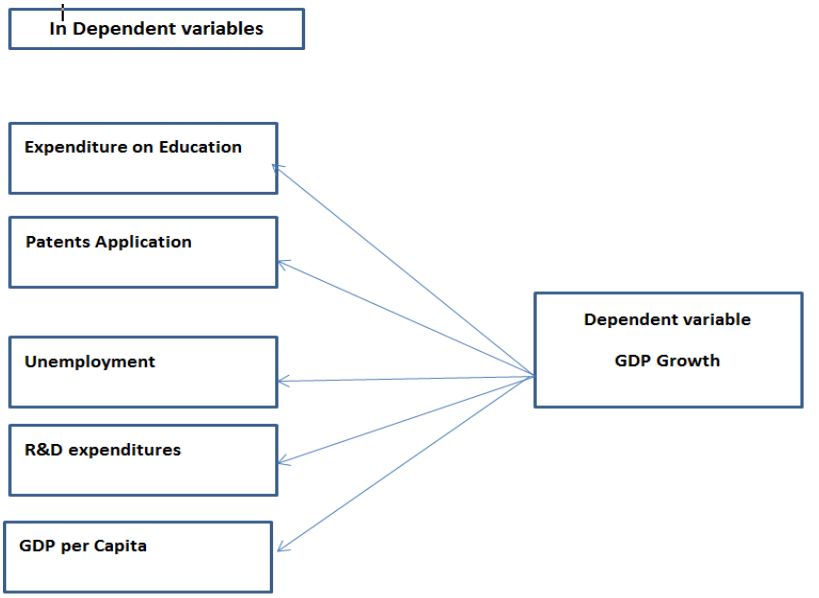
steam engine and production through industrial system design. This mechanism replaced the manufacturing system of production. This revolution was started at the end of XVIII century and it brought significant changes in social and economic lives of people, physical efforts were replaced by machines, child labor started, females were hired, new concept of employment was introduced and people were deployed in different sectors. Consequently, unemployment increased production standards were imbalanced. Second revolution was the age of automation. Automation proved helpful for many dying economies as it boosts up the GDP of many poor countries. I It's becoming tough to get complete knowledge because the world is going to become global village due use of technology.

Palos-Sanchez, P.R. (2017) mentioned the current trends of cloud computing to save the data and save economic resources from wastage. Their research was consisted of pointing out barriers in the cloud computing technique.

Majeed, M.T.; Ayub, T (2018) studied about the ICT indicators and economic growth on regional and international level. They used sample of 150 countries to analyzed by using OLS. They concluded that as compared to developed nations emerging nations are earning more from IT because these nations are leapfrogging in IT.

3. CONCEPTUAL MODEL:

The conceptual model of this study is given below in Figure 1:



4. RESEARCH METHODOLOGY:

4.1 Nature of Study:

This study is quantitative in nature and we will use quantitative method in it.

4.2 Type of Data:

Time series data is used to study the variables presented in the econometric model.

4.3 Sample of study:

We used 20 years' data for the period 1998-2018 as a sample of study

4.4 Selected Variables:

In this study to analyze the effect of technology on the economic growth, GDP growth is taken as a dependent variable while, GDP per capita, R&D Expenditure, Education Spending, and Patent applications and

unemployment rate were taken as explanatory variables. The variables, their description and sources are given in table 1.

Table 1: Selected variables

Symbols	Variable Description	Units	Source
1:Unemp	Unemployment	Percentage of labor force	WDI
2: P	Patent Application	Number of Application	WDI
3: EOE	Expenditure on Education	%age of GNP	WDI
4: GDP per capita	GDP per capita	GDP/Population	WDI
5: R&D	Research and Development expenditure	Investment level on R&D	WDI
6: GDP	Gross Domestic Product	GDP = C + I + G + (X – M)	WDI

4.5 Econometric model:

In this study, we used multiple regression analysis to analyze relationship between variables and it is given in the following equation: -

$GDP = \beta_0 + \beta_1 (GDP\_PC)i + \beta_2 (R\_D\_EXP)i + \beta_3 (UNEMP\_R)i + (P)i + \beta_5 (EDU)i + \varepsilon i$

Where GDP is the dependent variable, β_0 is the intercept, β_1 is the slope, GDP per capita, Education spending, patent applications, Research and Development and unemployment rate are independent variable, and *e* is an error or residual term used in this model.

4.6 Analytical Techniques:

We have used the following analytical techniques to analyze data: -

1. Descriptive statistics.

2. Unit Root Test.

3. ARDL Model.

4. Bound Test.

5. E-View software.

4.7. Hypothesis of study:

The hypothesis of this study are given below: -

H_0: Technological growth does not affect the economic growth of Pakistan.

H_1: Technological growth affects the economic growth of Pakistan.

5. DATA ANALYSIS:

5.1. Descriptive statistics:

The results of descriptive statistics are given in table 2:

Table 2: Descriptive statistics of variables

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	EXPENDITU...	FDI	GDP_GRO...	GDP_PER_...	PATENTS	R_D	UNEMPLOY...
Mean	11.89311	1.225465	4.258324	2.090336	117.1905	0.295589	1.375190
Median	11.51398	0.888761	4.396457	2.223277	109.0000	0.280000	0.746000
Maximum	15.44552	3.668323	7.667304	5.222981	209.0000	0.632500	3.566000
Minimum	8.489880	0.382827	1.606692	0.328923	44.00000	0.109190	0.398000
Std. Dev.	1.900802	0.955992	1.719075	1.505248	57.67202	0.140458	1.124803
Skewness	0.185379	1.567275	0.239770	0.557327	0.214982	0.752794	1.015330
Kurtosis	2.406469	4.128698	2.343004	2.248920	1.637790	2.967842	2.302541
Jarque-Bera	0.428523	9.711943	0.578902	1.580751	1.785425	1.984351	4.033775
Probability	0.807137	0.007782	0.748675	0.453674	0.409543	0.370769	0.133069
Sum	249.7552	25.73476	89.42480	43.89706	2461.000	6.207360	28.87900
Sum Sq. Dev.	72.26097	18.27842	59.10437	45.31545	66521.24	0.394570	25.30362
Observations	21	21	21	21	21	21	21

Explanation of Results:

Descriptive statistics are used for different purposes:

1) It provides basic information about all variables presented in the model.
2) It shows the potential relationships between different variables.
3) It provides information about measure of central tendency and measure of dispersion.

Mean in the descriptive table tell us the average value of each variable. Like Mean of Patents is the highest amount all values. Median tells us the middle value of each variable in the model. Maximum and minimum values represent the smallest and largest value of each variable in the sample. Standard deviation shows the deviation from the sample mean with respect to each variable. Skewness represents whether it is normally distributed or not. Normal Skewness value is 0. Except FDI and unemployment all variables in the data are normally skewed. Kurtosis value implies the distribution of return. Extreme values of Kurtosis represent the extreme return. The normal range for Skewness and kurtosis is below +1.7 and above -1.5. Patents Kurtosis value is in normal range that is 1.63. Jarque-Bera is a statically measure that tell us the difference of Skewness from those normally distributed. Hence, this test results show that except FDI all variables are normally distributed. It is also known as goodness of fit test. Probability value helps us to accept or reject the null hypothesis. P value less than 0.05 implies to reject the null hypothesis.

5.2 Unit Root Test Results:

The results of unit root test are shown in Table 3:

Table 3: Results of Unit Root Test

Variable name	**Stationary @ level P value**	**Stationary @1st difference P value**
Unemployment	0.09	✓ 0. 0002
Patents	0.07	✓ 0. 001
Expenditure on Education	✓ 0.002	
GDP per capita	0.10	✓ 0. 004
R&D	0.09	✓ 0. 002

Table 3 shows the results of stationary of all variables included in the study. We used Unit root test to check whether the variables are stationary or not. Checking stationary value of all the variables is very essential because in the absence of stationary data can contain the trend that in turn produce superious results. In order to avoid fake result, we checked all the variables by applying unit root test and results show that all variables other than expenditure on education are stationary at level. Expenditure on education is stationary at level. In this way we rejected the null hypothesis H_0 and H_1 hypothesis because data is stationary.

5.3 Optimum Lags:

Table 4: Optimum Lags

VAR Lag Order Selection Criteria
Endogenous variables: GDP_GROWTH__ANNUAL___ PATENTS R_D UNEMPLOY...
Exogenous variables: C
Date: 08/31/19 Time: 17:01
Sample: 1998 2018
Included observations: 18

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-132.7770	NA	46.82410	15.19745	15.39531	15.22473
1	-99.46667	48.11497*	7.261039	13.27407	14.26338	13.41049
2	-76.16828	23.29839	4.509033*	12.46314	14.24389	12.70868
3	-50.35268	14.34200	4.671271	11.37252*	13.94471*	11.72719*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The lag length is number of terms that back down the AR process for which you want to test for serial correlation between the data. In other words we can say that it is comparison of time series data with lagged series data and we chose optimal from them. According to the table in this data we will use the optimal lag 3 according to AIC.

5.4 ARDL Model:

The results of ARDL model are shown in Table 5:

Table 5: Results of ARDL Model

EViews - [Equation: UNTITLED Workfile: THESIS DATA::Untitled\]

File Edit Object View Proc Quick Options Window Help

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Dependent Variable: GDP_GROWTH__ANNUAL___
Method: ARDL
Date: 08/23/19 Time: 20:23
Sample (adjusted): 2002 2018
Included observations: 17 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): PATENTS R_D
Fixed regressors: C
Number of models evalulated: 100
Selected Model: ARDL(4, 2, 4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP_GROWTH__ANNUAL___(...	0.896230	0.248314	3.609260	0.0226
GDP_GROWTH__ANNUAL___(...	-0.365674	0.365352	-1.000880	0.3735
GDP_GROWTH__ANNUAL___(...	-0.274860	0.488228	-0.562975	0.6035
GDP_GROWTH__ANNUAL___(...	0.479268	0.250728	1.911504	0.1285
PATENTS	0.000924	0.005174	0.178646	0.8669
PATENTS(-1)	0.006768	0.008902	0.760325	0.4894
PATENTS(-2)	-0.009811	0.009606	-1.021380	0.3648
R_D	1.700815	6.685751	0.254394	0.8117
R_D(-1)	-5.845929	5.574247	-1.048739	0.3535
R_D(-2)	1.732062	4.368904	0.396452	0.7120
R_D(-3)	-10.59648	4.820327	-2.198292	0.0928
R_D(-4)	6.314460	5.338216	1.182878	0.3024
C	3.772706	1.705953	2.211495	0.0915

R-squared	0.967349	Mean dependent var	4.527756
Adjusted R-squared	0.869398	S.D. dependent var	1.757403
S.E. of regression	0.635106	Akaike info criterion	2.012444
Sum squared resid	1.613439	Schwarz criterion	2.649607
Log likelihood	-4.105771	Hannan-Quinn criter.	2.075779
F-statistic	9.875795	Durbin-Watson stat	2.270221
Prob(F-statistic)	0.020067		

*Note: p-values and any subsequent tests do not account for model selection.

Table 5 explains the results of ARDL model. In this model R^2 shows 96% variation in dependent variable is due to independent variables. Other variables are also showing that H_1 hypothesis is true because that states technology and economic growth are directly linked with each other. Sign of variables also represents the short run relationship of all variables. As the data in table shows that patents affect the GDP growth 86% while R&D also has significant impact of 81% on GDP. The Value of Durbin Watson is greater than 2 and it indicates negative autocorrelation between variables.

5.5. Bound Test Results:

Table 6. Bound Test results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.964648	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	17		Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028
			Finite Sample: n=30	
		10%	2.915	3.695
		5%	3.538	4.428
		1%	5.155	6.265

Bound test is helpful for checking the long term relationship between variables along with ARDL model. In this test, we have checked that F-statistics value and upper and lower limit values. If value of F-statistics is more than the value of upper limit it shows that variables have long run relationship and impact of explanatory variable on dependent variable. In this test value of F statistics is 5.96 that is higher than the value of upper limit which is 3.6.

6. FINDINGS:

As per ARDL model, the value of R^2 (96%) shows the goodness of fit of the model and significant effect of independent variables on dependent variables. H_1 hypothesis is accepted because technology and economic growth are directly linked with each other and are significant. positive sign of variables also shows short run relationship between all variables. As the table shows that patents affect the GDP growth by 86% while R&D has also

significant impact of 81% on GDP. Hence, these results show that we will reject the null hypothesis which states that there is no long term relationship between Patents and GDP in the model and accept H_1 that states Patents and GDP have long term relationship and have significant affect on each other.

6. CONCLUSIONS:

This paper focused on the role of technology and its impact on the economic growth of Pakistan. On the basis of study results it is concluded that technological advancement is basic determinant in the economic growth of Pakistan. For technological advancement, R&D expenditure is very essential to enhance the level of innovations in the country. Quality education plays a vital role to promote R&D. Since 1947 no government has planned about the research and development because a meager amount of budget is allocated for it. In order to boost GDP and national income of Pakistan investment in R&D needs to be increased. Policy makers need to rethink about this neglected sector and take lesson from Indian economy that spends a hefty amount on R & D and earns $100 billion from IT exports every year.

7. Recommendations:

On the basis of analysis, we would like to make the following recommendations: -

► It is recommended to enhance the computer literacy because without knowledge of computer skills we cannot move fast in the race of technology.

► Pakistan's economy is mostly based on agricultural products. Hence, we need to digitalize the agribusiness by providing latest tools and techniques for raising the produce

► We must opt such fiscal policies that can raise the budget of research and development, so that we can establish more research centers and can produce more innovative goods.

► We should develop "advanced to e-government structure" by using technology. It will do more efficient job than traditional and hence economic growth will be boosted.

► Pakistani government must set up to tax free IT zones and invite foreign investor to pace with the digital advancement.

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CONTRIBUTION OF AUTHORS AND CONFLICT OF INTEREST

This research work was carried between collaboration of two authors.

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