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Analyzing Short-Run and Long-Run Causality between FDI Inflows, Labor Productivity and Education in Pakistan

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Abstract

This study empirically analyzes the causal relationship between FDI inflows, labor productivity and education in case of Pakistan using time series data from 1971-2016. The present study concentrates only on labor productivity since Pakistan is a labor abundant country where provision of education is solely the responsibility of Government of Pakistan. For empirical analysis, it uses the latest test for measuring causality i.e., Breitung-Candelon Granger Causality test in frequency domain (both old and new versions). The traditional approach of Johansen Cointegration test has also been applied to check robustness of results. Both versions of BC test, i.e., Breitung and Candelon (2006) and Breitung and Schreiber (2016) suggest a univariate causality running from FDI to labor productivity only, whereas Johansen Cointegration approach suggests a long run relationship among three variables. Therefore government of Pakistan must give proper attention to education sector in order to gain maximum benefits from FDI inflows.

Keywords: FDI inflows, Labor productivity, Education, Causality, Pakistan.
JEL Classification: F20; I24; I22; J24.

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Contents

1. Introduction

The benefits of Foreign Direct Investment Inflows (FDI) and their impact on emerging economies is one of the highly debated topics among researchers and policy makers. Although FDI inflows bring capital and modern technology, but abortive capacity depends on factor productivity because development of an economy is the direct result of an efficient use of its factors of production. According to Kipsang (2015), labor productivity being an indicator of technical efficiency, depicts the varying pattern of factors of production and their use. Without continuous positive growth in labor productivity, economic growth cannot be achieved.

Pakistan is a developing economy having labor as the most abundant factor of production and consequently, the techniques of production are also labor intensive. Theoretically, it can be argued that FDI inflows increase labor productivity by bringing new technology, innovation and R&D. In addition, Multinational Companies (MNCs) also play a vital role in increasing productivity through the channel of training and introduction of new ideas for production based on modern technology. According to Dar *et al.* (2016), the offshoot of globalization is attracting the developing countries to strive for achieving the same level of technological development as that of the developed countries. In order to get maximum benefit from this technological diffusion, sufficient level of human capital development in the recipient country is the pre-requisite so as to remove all hindrances of absorbing the fruits of technological transmission.

On the other hand, the relationship between labor productivity and education cannot be ignored. High level of quality education leads to an increase in labor productivity which in present times of globalization, is also referred to as Human Capital. Nelson and Phelps (1966) in their study concluded that investment in education is directly related to technological progress since educated people act as a catalyst for development of technology which results in economic growth. According to them, the rate of return of the investment on technology directly reflects in the technological progress of the economy. Through investment in education, a society can build more human capital which would result in higher tangible capital through dynamic technology. Though the impact of labor productivity has significant implications on relationship between education and economic growth but no straight-forward formula is available to prepare an index for measuring this relationship between education and the dynamics of production.

Same is the case in Pakistan. On the one hand FDI inflows lead to an increase in labor productivity through technology transfer, establishment of MNC's, technical know-how and training, whereas on the other hand, due to technological backwardness, labor is unable to completely digest the new techniques. On the contrary, government does not make sufficient domestic spending on education which acts as a hurdle in converting labor into human resource. Although no benchmark level of government spending on education, especially in monetary terms, has ever been suggested which could be related to labor productivity, but taking lead from the developed countries, Government of Pakistan must make high school level of education free and compulsory. It has to be ensured that there are no drop-outs and this policy is implemented in letter and spirit. This would go a long way in increasing the labor productivity.

Keeping in view this phenomenon, present study analyzes the dynamic and causal relationship between FDI inflows, labor productivity and education. For this purpose two separate models are constructed. Model 1 analyzes the causality between FDI inflows and labor productivity and Model 2 examines the relationship between labor productivity and education. Since labor productivity is the common factor in both models and focal point of research, major section of literature review shall be throwing light on labor productivity. For empirical analysis, Breitung and Candelon (2006) Granger causality test in the frequency domain has been applied. Later to check the robustness of results, new version of Breitung and Candelon (BC) test suggested by Breitung and Schreiber (2016) has been used. Since BC tests are quite new, therefore the traditional Johansen Cointegration test has also been applied in later part of paper in order to avoid any possibility of error in the empirical results. For this purpose time series data of Pakistan from 1971-2016 has been used.

This study is divided into 7 sections. Section 1 gives the introduction of the topic and explains objective of the study. Section 2 throws light at the relevant literature. Section 3 is based on discussion of literature and explains endeavors of present study. Section 4 discuses empirical analysis in detail along-with the relevant research available on empirical methods being used in this study. In section 5, empirical tests have been applied whereas, results are discussed in section 6. The last section concludes the study. The details of BC graphs and their interpretation are presented in the appendix.

1.1. Objective of Study

This study is an attempt to analyze the relationship between FDI inflows, labor productivity and education in case of Pakistan. The innovative characteristic of this study is its emphasis on labor productivity while most researches are based on Total Factor Productivity (TFP) which includes both labor and capital. Whereas in case of Pakistan, the production function is mainly dependent upon the relationship between labor and output whereas capital is more or less fixed. The use of traditional Cobb Douglas production function may lead to wrong estimations. On the other hand, capital cannot be completely ruled out for which the factor of education has been included which is mainly responsible for converting a simple labor into human resource. Particularly in case of Pakistan labor can benefit from technological spillovers through FDI inflows if it is professionally trained through education. This relationship will be analyzed by examining government spending (percentage of GDP) on education sector. For this purpose, time series data of Pakistan over the period of 1971-2016 has been analyzed. The main focus of the study is Breitung and Candelon test in frequency domain (both old and new version with and without conditions) to empirically analyze this relationship. In addition, since this study is based on time series analysis, the traditional tests for stationarity and Cointegration cannot be ignored.

2. Literature Review

The relationship between FDI inflows, labor productivity and education has been discussed comprehensively in the literature. For an in-depth debate, literature review has been divided into three sub-sections where section 1

discusses the relationship/impact of FDI inflows on labor productivity. Section 2 concentrates on the studies presently available which analyze the relationship and effect of education on labor productivity. These two subsections throw light on international studies related to the subject under discussion. Section 3 purely concentrates on studies related to Pakistan.

2.1. Relationship between FDI Inflows and Labor Productivity

According to Ramirez (2006) FDI inflows bring capital and technical know-how to developing economies which result in an increase in labor productivity. The author empirically analyzed the impact of FDI inflows on labor productivity by taking Chile as the subject country and Cointegration technique as the main test for empirical analysis. The econometric results suggested a positive effect of FDI flows on labor productivity during the time period of 1996-2000.

A comprehensive study by Zhu and Tan (2000) empirically examined the causal relationship between labor productivity and inward FDI for different cities of China. For this purpose they used pooled city level data set with 2032 observations covering a time period of 11 years. Granger causality technique was used by the authors for empirical test. According to them, determinants of labor productivity include level of education, training and infrastructure. Their empirical findings are divided into four parts. According to first finding, FDI intensity in terms of per capita amount has a positive impact on labor productivity. Secondly, the results also suggest that high level of labor productivity attracts more FDI. Thirdly, FDI intensity in terms of geographical size does not affect labor productivity and high level of labor efficiency draws more FDI inflows per unit geographical area. In case of infrastructure, FDI is directly related to areas having better infrastructure. Finally they conclude that coastal cities with better human resource management and good infrastructure, show better performance in case of absorbing the benefits of FDI flows.

Some important implications can be drawn from their study. First labor productivity has a positive relation with FDI flows and vice versa but quality cannot be ignored. Secondly the major finding of their study is related to geographical area. This result can have general implications for developing countries. Geographical areas with better quality of labor/human resource attracts more FDI.

Demeti and Rebi (2014) carried out an empirical analysis to investigate the relationship between FDI and labor productivity in case of Albania. Using the correlation analysis and Granger-Causality test, they found a strong correlation between FDI and labor productivity. Whereas, Granger test indicated a unidirectional causation running from labor productivity to FDI but no evidence of "FDI causes productivity" was suggested by the causality test. According to the authors, the reason for such contradictory results may be due to the limited role of MNCs with high technology in Albania. They suggested that to benefit from FDI, Greenfield FDI must be attracted in industries producing exportable products. This will result in more technology transfer and innovation in local firms. Consequently FDI will have a positive causation with labor productivity of host country.

A detailed and comprehensive study has been undertaken by Mebratie (2010). The author used firm level cross-sectional data for the years of 2003 and 2007 to study South African Manufacturing Industries. Three techniques have been employed for conducting an empirical analysis. In the first case, OLS estimates indicated a positive and significant effect of FDI on labor productivity of domestic firms. In second case, pooled data for two years also gave the same results and suggested a positive and significant relationship between foreign presence and productivity of domestic labor. Contradiction arose between the results obtained through Meta-analysis which indicated no impact (positive or negative) of FDI on labor productivity of domestic firms. Author argues that this is due to the controversial role of MNCs which give importance to their own workers and hence productivity of host country labor is not given importance. On the other hand, due to FDI inflows, technology transfer and innovation takes place resulting in imitation effect; domestic labor learns new techniques which results in an increase of labor productivity of domestic firms. The author finally concludes that foreign firms improve productivity of local workers through training but it may be limited due to limited horizontal linkages [1] between MNCs and domestic firms.

Here an important point is worth mentioning that while discussing about the relationship between FDI inflows and labor productivity, the role of MNCs cannot be ignored but there is no consensus about the exact role of MNCs in increasing the labor productivity since they give more importance to their own workers as compared to workers of host country.

A similar conclusion has been drawn by a study carried out by Contessi and Weinberger (2009) which mainly discusses and analyzes two important macroeconomic relationship; FDI and national growth, MNCs and labor productivity.

The authors throw light on the studies using growth regression approach and conclude that empirical research that makes use of firm and plant level data lead to an evidence of MNCs having more concentration on productivity of labor in their home country as compared to host country, yet there is a limited positive impact on labor productivity of host country.

Mallick (2013) conducted an empirical analyses on OECD regions taking data for 22 years covering a time period from 1990-91 to 2011-12. The author focused on analyzing the relationship between indicators of globalization and labor productivity.

The major indicators included FDI inflows and economic openness. The results of multiple regression model conveyed a positive and significant relationship between indicators of globalization and labor productivity. The author argues that globalization has a positive link with labor productivity through FDI which is responsible for bringing new technology to developing countries as developed countries have better technology as compared to

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1 *In a value chain, horizontal linkages are longer-term cooperative arrangements among firms that involve interdependence, trust and resource pooling in order to jointly accomplish common goals. Both formal and informal horizontal linkages can help reduce transaction costs, create economies of scale, and contribute to the increased efficiency and competitiveness of an industry.*
LINK: https://www.microlinks.org/good-practice-center/value-chain-wiki/horizontal-linkages-overview.
Horizontal, n.d. Horizontal linkages--- overview. Available from https://www.microlinks.org/good-practice-center/value-chain-wiki/horizontal-linkages-overview [Accessed 4th, March, 2017].

emerging economies. Developing countries benefit through spillover effects which increase labor productivity through adoption of latest technology.

Tintin (2012) empirically tested the relationship between productivity spillovers and FDI for 20 countries (10 developed countries and 10 developing countries) over the time period of 1984-2008. The author divided productivity measure into two categories; TFP and labor productivity. The panel Cointegration results indicated a strong significant relationship between FDI and labor productivity through spillover effects but a weak association was observed between FDI and TFP. The findings also suggested that developing countries with good quality of labor benefit more from FDI as compared to low quality labor countries.

Nozuko (2016) conducted an empirical study to examine the impact of FDI on labor productivity in industrial sector of South Africa using time period of 1995-2013. The results of Johansen Cointegration discovered a long run relationship between FDI inflows and labor productivity in case of South Africa. The author also suggested that policy makers should give more importance towards improving labor productivity through professional training in order to increase the growth rate of industrial sector and hence economy as a whole.

2.2. Relationship between Education and Labor Productivity

Role of education in labor productivity cannot be ignored since the factor of education ranks at the top of the list in converting a simple labor/unskilled worker into a human resource who is not only skilled but contributes to economic well-being of country. One of the most renowned research on this topic was carried out by Solow (1956) who debated that fluctuations in national income of a country were significantly dependent upon country's physical and human capital. Berger and Fisher (2013) in their report highlighted that investment in education not only increases economic opportunities for workers but also leads to a high wage rate which contributes to a better living standard.

Jones (2008) carried out an empirical study to investigate the relationship between education, productivity and wages in case of Ghana. The study used a panel of 200 manufacturing firms organized under the World Bank's 'Regional Program for Enterprise Development' (RPED) and collected data during the summer of 1992, 1993 and 1994. The empirical results suggested that a high level of education has a direct and positive relationship with productivity and wage rate.

Most of studies concentrate on relationship between labor productivity, level of education and wage rate but the role of government spending has not been given much importance. On the other hand, this relationship cannot be ignored specially in case of developing economies since they need more educated and skilled labor because most of emerging economies are labor abundant. A study conducted by Arshad and Ab Malik (2015) concluded that high quality of education is directly linked with high labor productivity. Their study used panel data of 14 states of Malaysia for a time period of 2009-2012. Results of Generalized Least Square (GLS) suggested that in order to achieve high labor productivity, government of Malaysia must give attention to health and education sector in order to fulfil their target of achieving the status of developed country by 2020.

Jung and Thorbecke (2003) studied the patterns of public expenditure on education for the economies of Tanzania and Zambia. They suggested that high expenditures on education lead to more employment opportunities and consequently poverty got reduced. Therefore a significant amount of investment in education is required to increase labor productivity otherwise there would be no gains in the form of more employment opportunities.

Baldacci *et al.* (2008) used panel data of 118 developing countries and concluded that spending on education and health have a significant impact on accumulation of human capital. In addition, it leads to a high overall growth of economy.

The available literature mainly analyses the relationship between education and economic growth and where education has been discussed with reference to labor productivity, that discussion has remained restricted to the levels of education (primary, secondary, tertiary, etc.). The government spending on education, particularly in case of developing countries, with the view to enhance labor productivity has not received much attention from the researchers so far. This paper intends to fill up this gap.

2.3. FDI Inflows, Education and Labor Productivity in Case of Pakistan

The relationship between FDI inflows and labor productivity has been well explained by Alam *et al.* (2013) [2], in their own words

"A productive labor force possesses obligatory as well as additional dexterity and has the ability to improve the overall the economic growth of a nation. However, foreign direct investment fits in the relationship between labor productivity and economic growth in the sense that labor productivity is enhanced by the inflow of capital from foreign investors. Hence, labor productivity and foreign direct investment have significant roles to play in the development of the economy."(Page 133)

In case of effects of FDI inflows, most of the studies concentrate on the relationship between FDI inflows and economic growth but the effect on labor productivity has not been given required attention.

Rehman (2016) carried out an empirical analysis using time series data of Pakistan from 1970-2012. The results of VECM suggested that in order to gain from FDI, policy makers must give importance to literacy rate as technological gains are not possible without educated labor.

Mahmood and Chaudhary (2012) conducted an empirical study to find the effect of sector-specific FDI on sector-specific labor productivity. The study is based on primary, secondary and tertiary sectors data covering time period of 1972-2000. ARDL Cointegration results suggested that FDI inflows do contribute to an increase in labor productivity in all sectors of Pakistan.

Choudhry (2009) in his research argues that extent of productivity depends on education level but in case of low income countries, majority of population is employed in agriculture sector and have poor level of education. These countries are unable to enjoy the full benefits of FDI. Author's results are based on an empirical study which attempts to identify the potential determinants of labor productivity for developing economies belonging to

[2] http://pubs.sciepub.com/jbms/1/6/3/#

different income groups. The study uses cross country panel data set of 45 countries for the period of 1980-2005. The empirical results suggest a strong impact of education and FDI on labor productivity but not in case of low income countries which also include Pakistan in data set.

Wahab *et al.* (2013) analyzed the relationship between endowment of human capital, government spending on HRD and productivity of labor force in Pakistan.

They concluded that productivity of labor in case of Pakistan is falling because of low government spending on HRD as percentage of GDP. The only productivity increase has been witnessed in the services sector during the past few decades. They suggest that the governance of public sector education must be improved as it is not only important for attracting foreign investors but also for increasing domestic investment. The authors suggested that labor productivity can be increased by investing in education, health and vocational training.

Ahmad *et al.* (2012) carried out an empirical analysis using time series data of Pakistan from 1971-2007. Their results suggested that FDI inflows play an important role in increasing GDP (economic growth) of Pakistan. Moreover, FDI inflows can stimulate Human Resource Development (HRD) via investment in education and training. This leads to an increase in stock of human capital resulting in high labor productivity and high rate of economic growth through FDI.

Shafique and Hussain (2015) in their study also concluded that FDI inflows increase economic growth of Pakistan but to get maximum benefits from FDI inflows, there must be a proper system for providing education in order to make them skilled. For this purpose, investment in education must be given proper attention as it leads to an increase in labor productivity which in return has positive effects on FDI.

Usman *et al.* (2014) performed a correlation analysis between higher education, infrastructure and FDI using a sample of 22 countries and found a positive correlation between these three variables for the chosen sample of countries. The correlation analysis also suggested that higher education is more significant for attracting FDI as compared to primary education since MNCs hire skilled labor having a high level of education. Based on their results, they recommended that government of Pakistan should give more importance to higher education for attracting more FDI as level of education is directly related to level of productivity leading to an increase in human capital.

Mahmood and Rehman (2012) undertook an empirical analysis using time series data of Pakistan from 1971-2009. Their research basically concentrates on analyzing the impact of human capital on economic development, FDI inflows and domestic investment in Pakistan. For measuring human capital, the proxies used by authors include high school enrolment, other institutional enrolment e.g. secondary, vocational, colleges and universities, the employed labor force and expenditure on education as percentage of GNP. The ARDL approach to Cointegration suggested that human capital enhances economic growth, FDI and domestic investment in Pakistan. All proxies of human capital suggested a positive impact except the expenditure on education. They suggested that enrolment rate must be increased at all levels of education. This would cause growth in workforce having technical skills and know-how and consequently productivity would get enhanced, causing an increase not only in economic development but also in foreign and domestic investment.

Although their research is comprehensive and covers all aspects of human capital but more emphasis is given to other measures for increasing human capital and productivity as compared to government expenditure which is equally important and cannot be ignored.

According to the working paper series of Akram and Khan (1961) the 1973 Constitution of Pakistan makes it mandatory to provide free and compulsory secondary education within minimum possible period. The Constitution further makes it obligatory for the State to make technical and professional education accessible to all on the basis of merit. It further enjoins on the State to enable the people of different areas, through education, training, agriculture and industrial development and other methods to participate fully in the form of National activities including that of women in all the spheres of National life[3]. However, despite these constitutional provisions, successive governments have failed in allocating sufficient resources to education sector which could enhance labor productivity.

Table-1. Expenditures on Education

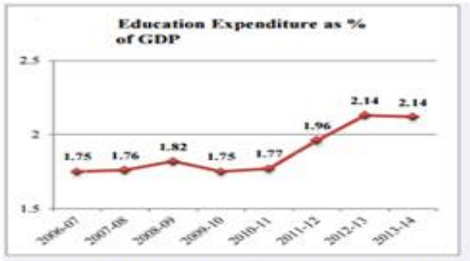
Expenditure on Education				(Rs. million)
Year	**Current**	**Development**	**Total Expenditure**	**As % of GDP**
2006-07	130,313	31,771	162,084	1.75
2007-08	155,622	32,034	187,656	1.76
2008-09	197,723	42,655	240,378	1.82
2009-10	219,933	39,592	259,525	1.75
2010-11	276,239	46,572	322,811	1.77
2011-12	330,228	63,295	393,523	1.96
2012-13	428,944	50,909	479,853	2.14
2013-14	453,735	83,863	537,598	2.14
2014-15 *	219,880	17,556	237,436	-

*July-December (Provisional)

Source: PRSP Budgetary Expenditures, External Finance Policy Wing, Finance Division, Islamabad

Public Expenditure on Education as percentage to GDP is lowest in Pakistan as compared to other countries of the South Asian region. The total expenditure on education has remained around 2.0 percent of GDP for the past decade.

Graph-1. Expenditures on Education as % of GDP



The Government of Pakistan is determined to enhance the allocated resources to education sector by ensuring proper and timely utilization of funds in order to achieve the UNESCO target of 4.0 percent of GDP by 2018. The graph shows that expenditure on education increasing gradually since 2006-07. An increase of 12.03 percent on education related expenditure recorded as it was Rs. 537.60 billion in 2013-14 as compared to Rs. 479.85 billion in 2012-13.

(1) See page 12 for details

(2) Economics Survey of Pakistan (2014-15)

Source Link: http://www.finance.gov.pk/survey/chapters_15/10_Education.pdf

Although no benchmark can be prescribed in monetary terms for allocation to the education sector but the benchmark in terms of the objectives to be achieved is very much specifically prescribed in the Constitution. The State has to allocate that much of resources which would achieve the specified objectives. However, the insufficient expenditure on education as a proxy of human capital suggests that government of Pakistan is not giving required importance to this sector. Very low sums are allocated to education sector. This is also evident from following figures related to government spending on education in case of Pakistan.

Some Important Figures [4]

3. Discussion of Literature and New Dimensions Added by the Present Study

The forgoing discussion of available international literature on the subject reveals that FDI increases labor productivity.

On the other hand, education enhances not only efficiency of labor but also its productivity on account of acquiring new skills and technical know-how. This analysis gets substantiated from the study of developed countries which achieved rapid economic growth by investing higher amounts in education. In case of developing countries, mixed results have been obtained by different researchers but the importance of FDI for developing countries has been accepted by all researchers and policy makers.

In case of Pakistan, it has been argued that FDI inflows do affect labor productivity but the effects may be negative or positive depending on absorptive capacity of new technology. More educated labor has high level of productivity and in this case, benefits from FDI can be achieved in a more efficient way.

Here an important point worth mentioning is that most of the studies have related education with the level (primary, secondary, tertiary etc.) while FDI demands an available package of educated and productive labor having skills and technical know-how. Unfortunately due attention has not been given by the government for providing sufficient financial resources to education sector. The argument is that FDI inflows do not provide funds for higher education, rather MNCs hire educated labor and polish them through training. In this process, a major portion of workforce gets ignored since either they are totally uneducated or have a low level of education making them less productive as compared to those who have attained higher education. This problem can be resolved if Government of Pakistan gives higher priority to education sector and allocates more funds for the growth of education in the country. The other relationship (labor productivity and education) is also dependent on the government spending on education. In literature, most of the studies have 'recommended' that government must give proper attention to education sector if Pakistan wants to attract more FDI as well as more gains from FDI, but there is a lack of empirical work for testing this relationship since level of education has been taken as a proxy measure for higher productivity and HRD. However it is the responsibility of the government to not only provide more opportunities for higher education, but also it must make education free and compulsory at least at the level of high school. Although some vocational training schools have been established in rural areas during the last few years but due to shortage of competent instructors and paucity of funds coupled with low level of education, both of the trainers and trainees, those are far away from providing sufficient number of the professionally skilled workers to the foreign investors.

Living example of this phenomenon can be found in the execution of mega projects under CPEC (China Pakistan Economic Corridor) where a large number of Chinese workers are deployed on account of non-availability of the professionally skilled workers to the required extent.

4. Empirical Analysis

The empirical part is divided into four sections. This paper uses Breitung Candelon test as the main test for empirical analysis; the approach needs to be explained in detail. Therefore in section 1, literature related to frequency domain approach has been discussed, while unit root tests have been applied and analyzed in section 2. As for section 3, it deals with empirical analysis using Breitung and Candelon's Granger causality test (BC) in frequency domain (both old and new versions with and without conditions). Finally section 4 shows the traditional Cointegration test since BC test is quite new especially the latest version by Breitung and Schreiber, therefore the empirical conclusion cannot be drawn solely on the basis of BC test. Two econometric software's have been used for empirical purpose. Unit root tests and Cointegration have been conducted using EViews. Since BC test cannot be applied in EViews, for this purpose gretl has been used.

4.1. What is Frequency Domain Causality Analysis?

Before explaining the framework of causality tests in frequency domain, it is necessary to highlight the difference between frequency domain and time domain. According to Pavia *et al.* (2008) time domain graph shows how a signal changes over time whereas, frequency domain graph shows how much of a signal lies within each given frequency band over a range of frequencies. Regarding causality tests, Granger (1988) is of the view that causality tests can be useful for explaining cause and effect relationship but order of integration and control variables must be handled carefully to get a proper evaluation. Earlier Granger (1969) explains that in case of bivariate causality, the feedback mechanism can be divided into two causal relations. But in case of trivariate relations, the spectrum cannot be considered as a sum of two spectra and results can be misleading due to the influence of third variable. Geweke (1982) on the other hand proposed that the causality between a bivariate series can be measured at a particular frequency by decomposing spectral density;

"In the case of univariate series, the measure of feedback from X to Y at a given frequency is a monotonic transformation of the fraction of the spectral density of Y due to the innovation in X in a bivariate autoregressive representation rotated so that all instantaneous feedback has been removed from the X-to- Y relation." (Page 313)

A similar concept was introduced by Hosoya (1991) where causality between a multivariate stationary series can be examined in both way; overall effect and causality at a given frequency. This framework was later adopted by Breitung and Candelon (2006) to construct a causality test in frequency domain both in short run and long run. Their empirical analysis was based on quarterly data of US economy covering the time period of 1959 (first

quarter) to 1998 (fourth quarter). The traditional test of stationarity suggested presence of unit root and data was converted into first difference of logged series.

The present study uses the same technique to measure the bivariate causality between the series of two models; LFDI↔LPROD and LEDU↔LPROD. Moreover the test uses both 'conditioning out' and 'conditioning' i.e., the causality between two series with and without the presence of exogenous/control variable which in case of first model is LEDU and in case of second model is LFDI.

Adopting the econometric framework used by Fritsche and Pierdzioch (2016) the VMA of a bivariate VAR model is explained by the following equation

$y_t = \Psi(L)\eta_t$,

Where η_t = white noise disturbance

L = lag operator

$\Psi(L)$ = the lag polynomial

Following vector shows the partitioning of $\Psi(L)$ into parts as

$$\Psi(L) = \begin{bmatrix} \Psi_{11}(L) & \Psi_{12}(L) \\ \Psi_{21}(L) & \Psi_{21}(L) \end{bmatrix}$$

Geweke (1982) suggests the following measure for testing Granger non-causality at a specific frequency ω

$M_{y1 \rightarrow y2}(\omega)$

Which can be calculated as

$$M_{y1 \rightarrow y2}\left[(\omega) = 1 + \frac{|\Psi_{12}(\exp(-i\omega))|^2}{|\Psi_{11}(\exp(-i\omega))|^2}\right]$$

Where i = imaginary number

Breitung and Candelon (2006) show that for a given frequency ω_0, $M_{y1 \rightarrow y2}(\omega_0) = 0 \leftrightarrow \Psi_{12}(\exp(-i\omega)) = 0$, which in turn implies (two) linear restrictions on the VMA representations. Graphical analysis has been explained in Appendix. The results are summarized in Table 2.

Same procedure was adopted by Tiwari (2014). The author used frequency domain test to examine the Granger-Causality between primary energy consumption and GDP for the economy of US covering the time period from January 1973 to December 2008. The empirical results suggested that the causal relationship vary across frequencies; short term, medium term and long term.

Mermod and Dudzevičiūtė (2011) carried out an empirical analysis to examine the relationship between consumer confidence, economic growth and retailed sales. Their analysis is based on Granger- Causality tests in both time domain and frequency domain for a sample of both developed and developing economies. According to authors,

"The Granger causality tests indicate whether the past changes in x (y) have an impact on current changes in y(x) over a specified time period. Nevertheless, these test results can provide results on causality over all frequencies. On the other hand, Geweke's linear measure of feedback from one variable to another at a given frequency can provide detailed information about feedback relationships between growth and consumer confidence over different frequency bands." (Page 6)

They argue that frequency domain test is **superior** in the sense that Granger- Causality tests give an average measure of causality whereas frequency domain test decomposes the causality at each frequency. Their study concluded that frequency domain test provides better results as compared to time domain causality test.

Krätschell and Schmidt (2012) in their study, gave similar arguments regarding time domain and frequency domain causality tests. They used frequency domain Granger –Causality test of Breitung and Candelon to analyze both short run and long run causality between energy prices and prices of food commodities. In addition to BC test, they also used Granger- Causality test in time domain to compare the results. According to the authors, frequency domain granger tests is **superior** over time domain granger tests since Granger-Causality tests are constructed on one period ahead forecasts which do not clearly distinguish between short run and long run fluctuations but frequency domain causality tests do not suffer from loss of information as these tests are applied at different frequencies. Their empirical findings also suggested different results based on time domain and frequency domain causality tests.

- **Drawback of Old Version and Introduction of New Version**

According to Breitung and Schreiber (2016) BC test suffers from a drawback; it is designed to test at a single frequency point where as many tests require an interval rather than a single point to get a better insight of causality.

Present study also makes use of the new version along-with the old version. Since it was introduced in recent past, not much literature is available, consequently the framework adopted for carrying out empirical analysis makes use of original empirical framework introduced by Breitung and Schreiber (2016). The null hypothesis in case of new version does not test 'no causality' at frequency ω_0, rather it tests the null hypothesis of no causality in interval (ω_L, ω_u).

In this case the interval has also been defined; number of frequencies in the interval $[0.01; 3.14]$

Lowest frequency starts from 0.01 which is almost 0 and maximum frequency 3.14. It can also be presented as $[0, \Pi]$

One of the most important point mentioned by authors is (in original words)

"Given that strict non-causality over a range of frequencies is impossible in this (linear) framework except if there is no causality at all, accepting the null hypothesis still means that some causality exists in the band of the null hypothesis. For practical purposes it may therefore be advisable to keep the specified frequency band reasonably short." (Page 24)

4.2. Why This Test?

Since the present study is also based on examining bivariate causality, BC tests (old and new version) are used to get a better insight of both short run and long run causality. Moreover, the studies which have used this test have mentioned that why causality test (BC) in frequency domain is superior over traditional Granger-Causality test in time domain (see section 4.1 for details). Application of new version also makes this study more innovative and scientific. Three basic benefits of this approach are; firstly it does not cause any loss of information. Secondly, it gives a better insight of both short run and long run relationship. Most importantly, the new version of BC test covers the minute details, which have been missed by old BC test since new version uses interval frequencies instead of a single frequency point. Moreover, application of both tests with and without conditions of exogenous or control variables will allow comparisons and also check robustness of results.

4.3. Data Details and Sources

- Data for FDI inflows has been extracted from World Development Indicators (WDI), World Bank.

UNIT = Current Bop US Dollars

- Education (government spending as % of GDP) extracted from unesco.org, theglobaleconomy.com and Pakistan Economic survey (various issues)
- Labor Productivity (Labor productivity per person employed in 2015 US$ (converted to 2015 price level with updated 2011 PPPs) extracted from The Conference board 2016.

Following abbreviations have been used for presenting data
FDI = FDI inflows
PROD = Labor Productivity
EDU = Education

- ABBRIVIATIONS FOR TESTS
- ADF = Augmented Dicky Fuller test.
- KPSS = Kwiatkowski–Phillips–Schmidt–Shin test.
- BC = Breitung Candelon test.
- BS = Breitung- Schreiber

(Different notations have been used to differentiate between old (BC) version and new version (BS).

4.4. Model and Hypothesis

Model 1: Relationship between FDI and PROD
Hypothesis: FDI and PROD have bi-directional causality both in short run and long run.
(Positive relationship between FDI and PROD)
Model 2: Relationship between EDU and PROD
Hypothesis: EDU and PROD have bi-directional causality both in short run and long run.
(Positive relationship between EDU and PROD)
As empirical analysis is based on time series data of Pakistan from 1971-2016.
The data is converted into logarithms.
Rationale:-

According to Lütkepohl and Xu (2012) many time series analysis are based on converting series into their logarithms (logs). This transformation is generally considered useful as it tends to stabilize the variance of series.

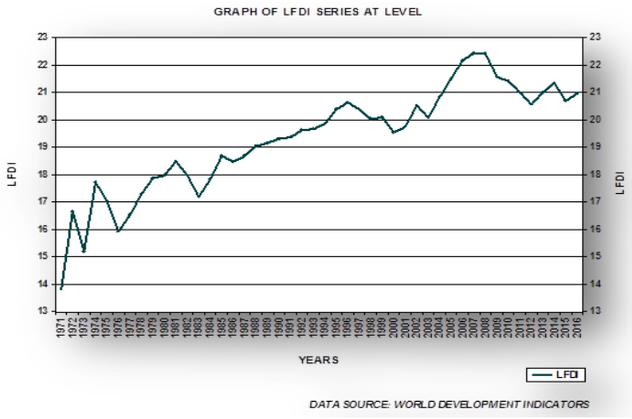
Ariño and Franses (2000) argue that it is a common practice to convert time series into logarithms before carrying out into any empirical analysis. The main reasons behind this strategy is that by doing so, the impact of outliers can be controlled. Moreover, this practice is also helpful in controlling the variance of underlying time series.

Since the present study also uses time series data for empirical analysis, all series are converted into logarithms.

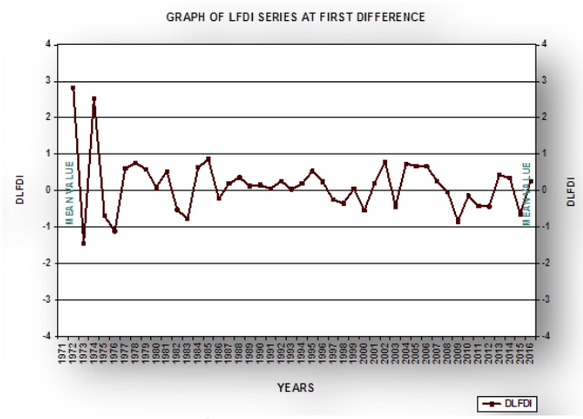
5. Empirical Tests

5.1. Unit Root Tests

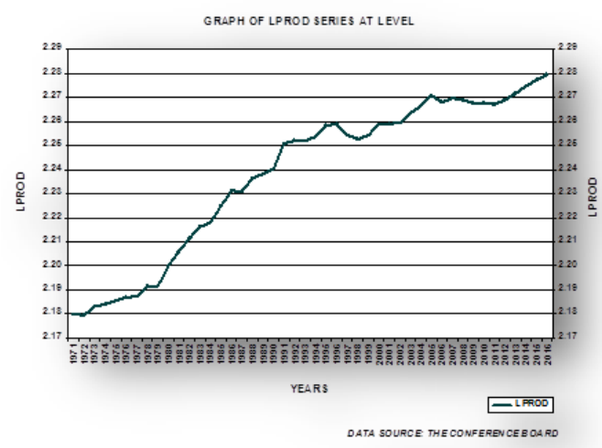
Unit root tests are the first step in any time series empirical analysis. For this purpose, two tests have been applied; ADF test (most common unit root test) and KPSS test (which has an opposite null hypothesis, i.e., series is stationary). Generally graphical analysis is carried out before presenting the test statistic values since it gives a quick idea about stationarity status of data. Also it can be easily observed whether the data has any time trend or deterministic trend which makes it easier to decide for further tests to be applied.



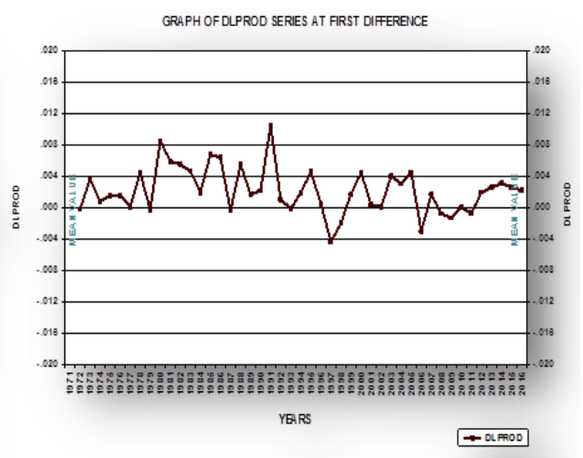
Graph-2. LFDI (Log FDI) AT LEVEL



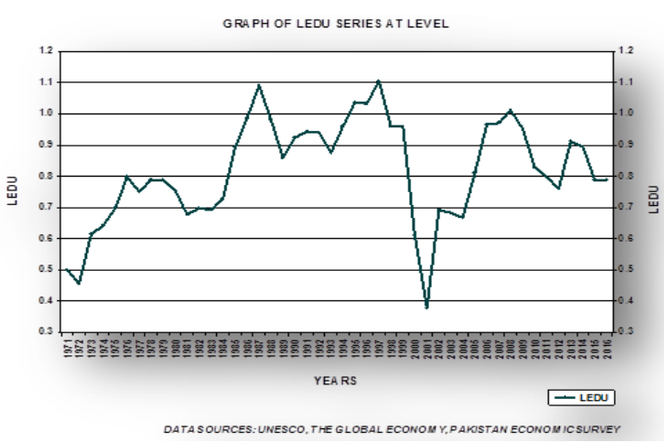
Graph-3. DLFDI (Log DFDI)



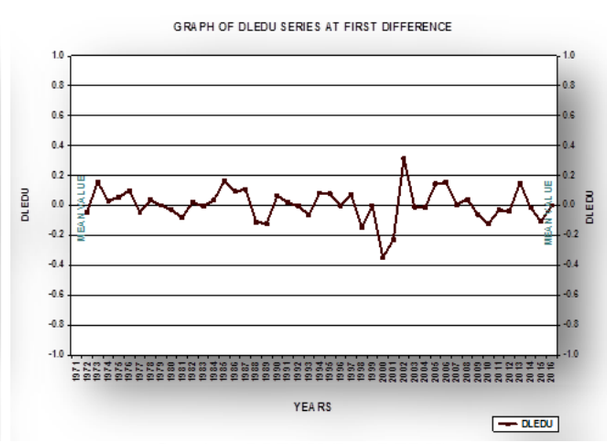
Graph-4. LPROD (Log LPROD) AT LEVEL



Graph-5. DLPROD (Log DLPROD)



Graph-6. LEDU (Log EDU) AT LEVEL



Graph-7. DLEDU (Log DEDU)

The graphical analysis indicates that series contain trend component and they become stationary at first difference To get more clear results (whether series are trend stationary or difference stationary), unit root tests (ADF and KPSS) have been presented in following tables.

Table-2. ADF TEST STATISTIC (*t-values)* Empirical Results

Variables	**At Level**		**At First Difference**		**Order of Integration**
Components of Equation	Trend and Intercept	Intercept	Trend and Intercept	Intercept	
LFDI	-4.57***	-2.98*	-10.87***	-10.84***	I(1)
LPROD	-0.74	-1.76*	-6.00***	-5.64***	I(1)
LEDU	-2.68	-2.85**	-6.06***	-6.01***	I(1)

Source: Author's estimation based on EViews output

- *Null Hypothesis (H_0): Series has a Unit Root (non- stationary)*
- *If t-values (absolute or positive) are greater than critical values at 1%, 5% and 10%, Null hypothesis (H_0) is rejected i.e., series does not have unit root (it is stationary)*

*significant at 10% level of significance
**significant at 5% level of significance
*** Significant at 1% level of significance
Test details: - Schwarz Info Criterion (Automatic)

- Lag Length: - Maximum Lags 9 (Automatic)

Results: Graphical analysis shows that all series have a trend and are not stationary at level. However, the results of ADF test indicate that LFDI is stationary at 1% level if the test includes both trend and intercept. But this is not the case if test includes intercept only. Moreover, LEDU series is stationary at 5% if measured using intercept only. To get same order of integration, all series are tested again at first difference using both trend and

intercept and only intercept. In both cases all series give same result and become stationary at same level of integration. Therefore it can be concluded that all series are integrated of order one i.e., I (1). This leads to application of Cointegration test. But before applying Cointegration test, another test for unit root (KPSS) is used to have a cross check.

Table-3. KPSS (Kwiatkowski-Pillips-Schmedt-Shin) TEST STATISTIC (*LM-stat)* Empirical Results

Variables	**At Level**		**At First Difference**		**Order Of Integration**
Components Of Equation	Trend And Intercept	Intercept	Trend And Intercept	Intercept	
LFDI	0.161***	0.825	0.0529***	0.176***	I(1)
LPROD	0.205***	0.816***	0.103***	0.323***	I(1)
LEDU	0.133***	0.253***	0.035***	0.095***	I(1)

Source: Author's Estimation based on EViews output

- *Null Hypothesis (H_0): Series is stationary (absence of unit root).*
- *If LM-stat value is less than critical values at 1%, 5% and 10%, Null hypothesis (H_0) is accepted i.e., series does not have unit root (it is stationary)*

*significant at 10% level of significance
**significant at 5% level of significance
*** Significant at 1% level of significance
Test details:-

- Spectrum Estimation Method: Barlett Kernel (Default)
- Bandwidth : Newey-West Bandwidth (Automatic)
- Lag Length : 3 (Automatic)

Results: Results of KPSS test are in consistence with both graphical analysis and ADF test. Since KPSS test has an opposite null hypothesis (series is stationary), all series show stationarity at level when both trend and intercept are included, means all series are trend stationary (also evident from Graphical analysis). At first difference, both the graphical analysis and test statistic show that trend has been removed, therefore it is assumed and concluded that all series are integrated of order one i.e. I(1).

After having a detailed analysis of stationarity status of series (both graphically and empirically), further empirical tests can be applied. The following table explains the causality between variables using BC test (old version).

5.2. Breitung Candelon Granger – Causality Test in Frequency Domain (for Details See Appendix)

Table-4. Empirical Results of BC Test

Test Specifications	**Causality Direction**			
Without Condition	Variables			
	FDI→PROD	PROD→FDI	**EDU→PROD**	**PROD→EDU**
At Level	✓	×	×	×
At First Difference	×	×	×	×
WITH CONDITION				
At Level	✓	×	×	×
At First Difference	×	×	×	×

Source: Author's Estimation based on gretl output
✓ = Reject non-causality
× = Do not reject non-causality

To check robustness of results, BC test in frequency band (new version labeled as BS test) is applied and results are shown in Table 5.

5.3. Breitung Candelon Granger – Causality Test
NEW VERSION BY Breitung- Schreiber
(For details see Appendix)

Assessing causality and delay within a frequency band

In this case, instead of a frequency point, a frequency band (interval) is taken to measure Granger – Causality. All details have been mentioned in the literature. The test has been applied both at levels and at first difference using three bands; [0.01, 0.2], [1.8, 2.4] and [1.58, 3.14]. Same analysis is applicable, i.e., movement towards left shows oscillations for long run and towards right, short run oscillations are observed. As shorter frequency is linked to a longer time period (Fritsche and Pierdzioch, 2016) the test starts with a band of lowest frequencies. Second band is for medium and third band, having highest frequency, is used for testing short run causality.

Table-5. Empirical Results of BS Test

Test Specifications	Causality Direction in Frequency Bands			
WITHOUT CONDITION	VARIABLES			
	FDI→PROD	PROD→FDI	EDU→PROD	PROD→EDU
	For Frequency Band [0.01, 0.2]			
At Level	✓	×	×	×
	For Frequency Band [1.8, 2.4]			
	×	×	×	×
	For Frequency Band [1.58, 3.14]			
	×	×	×	×
At First Difference	For Frequency Band [0.01, 0.2]			
	×	×	×	×
	For Frequency Band [1.8, 2.4]			
	×	×	×	×
	For Frequency Band [1.58, 3.14]			
	×	×	×	×
With Condition				
	For Frequency Band [0.01, 0.2]			
	✓	×	×	×
	For Frequency Band [1.8, 2.4]			
At Level	×	×	×	×
	For Frequency Band [1.58, 3.14]			
	×	×	×	×
At First Difference	For Frequency Band [0.01, 0.2]			
	×	×	×	×
	For Frequency Band [1.8, 2.4]			
	×	×	×	×
	For Frequency Band [1.58, 3.14]			
	×	×	×	×

Source: Author's Estimation based on gretl output
✓ = Reject non-causality
× = Do not reject non-causality

5.4. The Traditional Approach- Johansen Cointegration Test

Following are the results of Johansen Cointegration test for model 1 and model 2.

- **Model 1**

As model 1 uses two variables; FDI inflows and labor productivity, the Johansen test empirically analyzes the relationship between these two variables without using the impact of education which is discussed in Model 2.

Table-6. Johansen Cointegration Test for Model - 1

(i) Using LFDI and LPROD

Trace Test And Maximum Eigen Value Test (Results)

Sample (adjusted): 1974 2016 Included observations: 43 after adjustments Trend assumption: Linear deterministic trend				
Series: LFDI LPROD				
Lags interval (in first differences): 1 to 2				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.339472	20.16154	15.49471	0.0092
At most 1	0.052716	2.328726	3.841466	0.1270
Trace test indicates 1 Cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon *et al.* (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.339472	17.83281	14.26460	0.0131
At most 1	0.052716	2.328726	3.841466	0.1270
Max-eigenvalue test indicates 1 Cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon *et al.* (1999) p-values				

Source: Author's Estimation based on EViews output

Table 6 shows that there exists a long run relationship between FDI inflows and labor productivity. Since there can be errors in Cointegration test, VECM (Vector error correction estimates) is carried out to remove all errors and the results are shown in Table 7.

Table-7. Unrestricted Cointegaring Coefficients

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):		
LFDI	LPROD	
-1.911247	9.433070	
-0.803850	8.014995	
Unrestricted Adjustment Coefficients (alpha):		
D(LFDI)	0.328434	0.038980
D(LPROD)	0.005189	-0.005789
1 Cointegrating Equation(s):	**Log likelihood**	**65.44582**
Normalized cointegrating coefficients (standard error in parentheses)		
LFDI	**LPROD**	
1.000000	-4.935559 (0.44766)	
Adjustment coefficients (standard error in parentheses)		
D(LFDI)	**-0.627717** (0.15351)	
D(LPROD)	**-0.009918** (0.00824)	

Source: Author's Estimation based on EViews output

Table-8. Vector Error Correction Model

Vector Error Correction Estimates		
Sample (adjusted): 1974 2016		
Included observations: 43 after adjustments		
Standard errors in ( ) & **t-statistics in [ ]**		
Cointegrating Eq:	**CointEq1**	
LFDI(-1)	1.000000	
LPROD(-1)	-45.27628 (4.31025) **[-10.5043]**	
C	81.95366	
Error Correction:	**D(LFDI)**	**D(LPROD)**
CointEq1	-0.609825 (0.15148) **[-4.02580]**	-0.001062 (0.00086) **[-1.22819]**
D(LFDI(-1))	0.144389 (0.16157) **[0.89368]**	0.001296 (0.00092) **[1.40550]**
D(LFDI(-2))	0.123377 (0.11956) **[1.03192]**	-0.000157 (0.00068) **[-0.22935]**
D(LPROD(-1))	-9.596191 (30.7156) **[-0.31242]**	0.084855 (0.17536) **[0.48388]**
D(LPROD(-2))	-28.85594 (28.8514) **[-1.00016]**	-0.020001 (0.16472) **[-0.12142]**
C	0.184379 (0.11813) **[1.56084]**	0.001995 (0.00067) **[2.95753]**
R-squared	0.367614	0.106228
Adj. R-squared	0.282157	-0.014552
Sum sq. resids	10.36238	0.000338
S.E. equation	0.529211	0.003021
F-statistic	4.301719	0.879517
Log likelihood	-30.41947	191.7042
Akaike AIC	1.693929	-8.637405
Schwarz SC	1.939677	-8.391657
Mean dependent	0.134147	0.002238
S.D. dependent	0.624617	0.003000
Determinant resid covariance (dof adj.)		2.54E-06
Determinant resid covariance		1.88E-06
Log likelihood		161.4146
Akaike information criterion		-6.856491
Schwarz criterion		-6.283077

Source: Author's Estimation based on EViews output
D (differences represent short run time period)

- **Model 2**

Model two is based upon testing the relationship between education and labor productivity, the Cointegration test has been applied and results are shown in Table 8 which indicates existence of a long run relationship between education and labor productivity. Again application of VECM shows error free long run results for second model (Table 8).

Table-9. Johansen Cointegration Test for Model - 2

(ii) Using LEDU and LPROD

Trace Test and Maximum Eigen Value Test (Results)

Sample (adjusted): 1973 2016
Included observations: 44 after adjustments
Trend assumption: Linear deterministic trend
Series: LEDU LPROD
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.277141	16.41007	15.49471	0.0363
At most 1	0.047262	2.130254	3.841466	0.1444

Trace test indicates 1 **Cointegrating eqn(s)** at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon *et al.* (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.277141	14.27982	14.26460	0.0497
At most 1	0.047262	2.130254	3.841466	0.1444

Max-eigenvalue test indicates **1 Cointegrating eqn(s)** at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon *et al.* (1999) p-values

Source: Author's Estimation based on EViews output

Table-10. Unrestricted Cointegrating Coefficients

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LEDU	**LPROD**
-6.741064	0.148046
2.992155	-3.927138

Unrestricted Adjustment Coefficients (alpha):

D(LEDU)	0.053880	-0.009455
D(LPROD)	0.005149	0.005458

1 Cointegrating Equation(s): Log likelihood 137.9505

Normalized Cointegrating coefficients (standard error in parentheses)

LEDU	**LPROD**
1.000000	-0.021962 (0.13369)

Adjustment coefficients (standard error in parentheses)

D(LEDU)	**-0.363207** (0.10369)
D(LPROD)	**-0.034711** (0.02819)

Source: Author's Estimation based on EViews output

Table-11. Vector Error Correction Model

Vector Error Correction Estimates
Sample (adjusted): 1973 2016
Included observations: 44 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LEDU(-1)	1.000000	
LPROD(-1)	-0.021962 (0.13369) [-0.16427]	
C	-0.620356	
Error Correction:	D(LEDU)	D(LPROD)
CointEq1	-0.363207 (0.10369) [-3.50294]	-0.034711 (0.02819) [-1.23137]
D(LEDU(-1))	0.227252 (0.14392) [1.57898]	0.042690 (0.03913) [1.09103]
D(LPROD(-1))	-0.075420 (0.56213) [-0.13417]	0.115503 (0.15283) [0.75578]
C	0.007589 (0.01925) [0.39432]	0.018453 (0.00523) [3.52676]
R-squared	0.241079	0.068777
Adj. R-squared	0.184160	-0.001064
Sum sq. resids	0.416388	0.030776

S.E. equation	0.102028	0.027738
F-statistic	4.235466	0.984761
Log likelihood	40.09392	97.40116
Akaike AIC	-1.640633	-4.245507
Schwarz SC	-1.478434	-4.083308
Mean dependent	0.007523	0.021109
S.D. dependent	0.112958	0.027723
Determinant resid covariance (dof adj.)		
Determinant resid covariance		6.48E-06
Log likelihood		137.9505
Akaike information criterion		-5.815931
Schwarz criterion		-5.410433

Source: Author's Estimation based on EViews output

For both models, Johasen Cointegration test and VECM indicate that there exists a long run relationship between FDI inflows, labor productivity and education in case of Pakistan. Empirically the focal variable of labor productivity is affected by both FDI inflows and education, which supports the main idea of present study.

6. Discussion of Results

According to empirical findings of Breitung and Candelon (2006) test, evidence of causality is found only in case of FDI affecting productivity when test is conducted at level using both components of test, i.e., with and without condition of exogenous/control variable. There is no evidence of either uni-directional or bi-directional causality between other variables. Same results are obtained in case of Breitung and Schreiber (2016) Granger-Causality test in frequency domain (using a frequency band). A uni-directional causality runs from FDI to productivity for frequency band of $[0.02, 0.2]$ representing a long run time period when analyzed at level. This test also uses both the components of test, i.e., with and without condition of exogenous variable. There is no causality in case of other frequency bands (medium term or short term) whether the test uses first differences or conditions. Details are mentioned in appendix.

Regarding time period, 0.01 corresponds to 628 periods wavelength (app 52 years for annual data). 0.2 represents 32 periods (3 years).

1.8 = 3.5 periods (app)
2.4 = 3 periods (app)
1.58 = 4 periods (app)
3.14 = 2 periods (app)

Considering the results of traditional tests, i.e., Johansen Cointegration, there is an evidence of long run relationship between FDI inflows, labor productivity and education. Although the lags are different for both models, yet the evidence of a relationship between variables cannot be ignored.

7. Conclusion and Policy Recommendations

The empirical findings of BC test suggest that FDI inflows increase labor productivity in Pakistan, whereas no causality has been observed between education and productivity. Whereas the relationship is evident in case of Johansen Cointegration test. The difference in results may be due to the difference in approach, yet the results of Cointegration test cannot be ignored and it can be concluded that FDI inflows affect labor productivity and that the labor productivity also gets affected by education in case of Pakistan. This is consistent with the actual scenario of Pakistan. The government of Pakistan is hardly spending 2 percent of GDP (on average) on education. A large number of teenagers are out of schools. Labor, though abundant, but on account of being unskilled, and mostly illiterate, does not get jobs in the organizations set up by MNCs as a result of FDI. In Pakistan different systems of education are in vogue simultaneously i.e. Religious schools called Madrasas, government schools and private institutions. Religious schools are managed by NGOs and mostly are run by contributions from the community and children of lower strata of the society seek admission in such institutions where religious education is free. Most of the government schools charge nominal fees but lack proper facilities and are generally considered to be of low quality. There is mushroom growth of private educational institutions but those are invariably very costly which a common man cannot afford. In the recent past technical and vocational institutions have also come up, both in the public and some in private sector. The institutions in the private sector, being costly, are beyond the reach of common man. On account of paucity of funds as well as scarcity of trained staff and equipment, the institutions in the public sector are still far away from catering to the requirements of the projects set-up by the foreign investors. The empirical analyses has led to the conclusion that FDI increases labor productivity both over long and short run time period. Since the government of Pakistan is spending a small portion of its GDP on education, educated and professionally skilled workforce is not available in sufficient numbers to absorb the technological spillovers from FDI. Another important reason behind this unique causality is related to training being provided by foreign investors which leads to increase in productivity of labor. Moreover, technology transfer leads to innovation and R&D which results in establishment of export promotion and import substitution industries either at small scale or large scale depending on absorptive capacity. Although the quality may differ, yet the benefits are gained by the educated workers leading to an increase in productivity. This is not the case in education sector since low level of education makes the available labor force ineligible for working with foreign investors and MNCs resulting in unemployment. If government of Pakistan wants to achieve maximum gains from FDI, it must allocate proper funds to education sector that can allow an unskilled worker to convert into human resource, which also acts like capital for any economy. For education to become a source of increase in productivity, same level of education is required in government schools as it is being offered by private institutions. Moreover, proper planning is essential keeping in view the economic development plans for the future, say 25 years, so that the required number of educated and professionally trained personnel are available for each sector of the economic development plan. While preparing the economic development plan for future, the estimated inflow of FDI has to

be figured in, including the possible sectors and sub-sectors which would be attracting the FDI and it would be possible to estimate the productivity level and to prepare the education plan accordingly so that the required number of educated and skilled workforce is available.

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Appendix

Detailed results of Breitung Candelon Granger – Causality test in Frequency Domain

Test specifications (for all tests):-
Lag order = 3
Frequency Points = 50
Significance level = 0.05

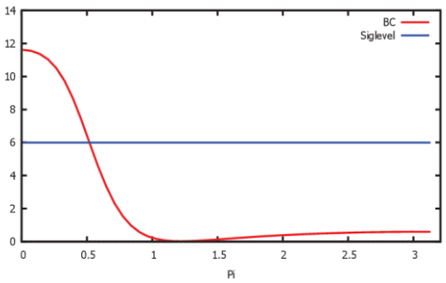
(i) Without condition of exogenous/control variable

- At Level

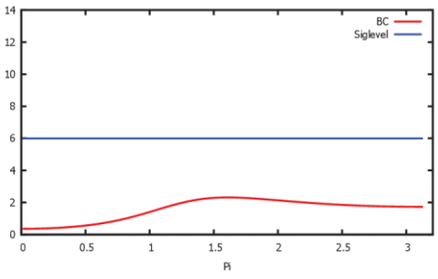
Graphical Properties: BC = Breitung Candelon test statistic
Siglevel = Significance level
Pi = Frequency
Null Hypothesis = No causality

Values above the threshold means that the hypothesis of no causality is rejected. Movement towards left side means long run causality and movement towards right side means short run causality.

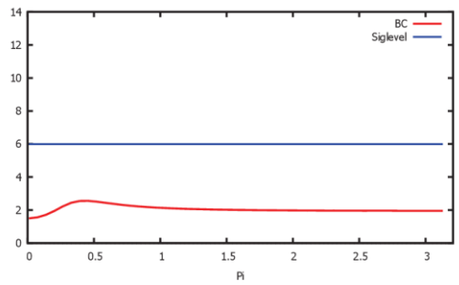
(i) LFDI→LPROD



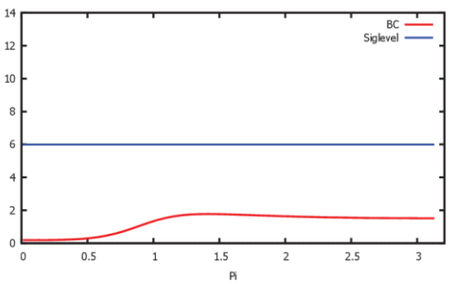
(ii) LPROD → LFDI



(iii) LEDU → LPROD

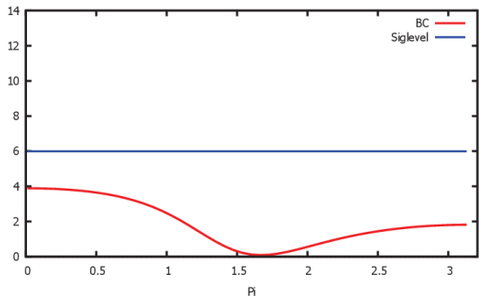


(iv) LPROD → LEDU

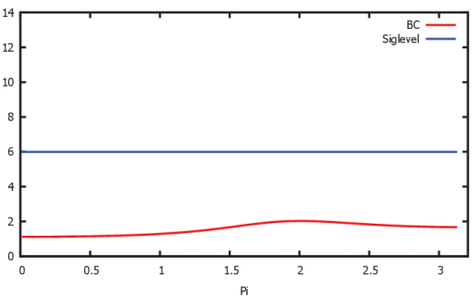


- At First Difference

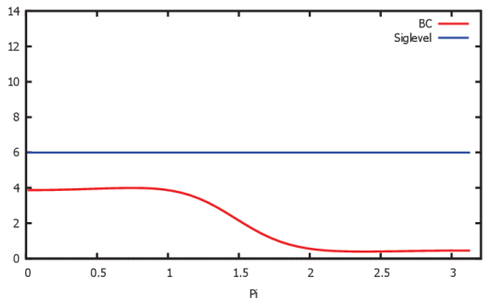
(i) DLFDI → DLPROD



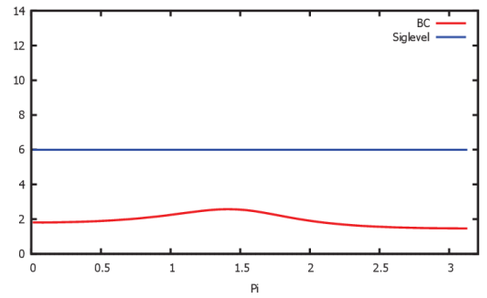
(ii) DLPROD → DLFDI



(iii) DLEDU → DLPROD



(vi) DLPROD → DLEDU



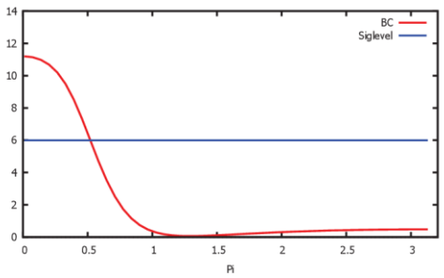
Interpretation of Results:

Referring to long run and short run analysis carried out by Krätschell and Schmidt (2012) the evidence of granger causality can be found only in case of LFDI→LPROD in the range of [0, 0.5]. As this is a bivariate system, therefore two graphs are shown for each case. The frequencies on x-axis range from [0-3.2]. Since the time period and frequencies are determined using the formula $\omega = 2\Pi/T = 2\Pi f$, Time period T can be determined through $T=2\Pi/\omega$. If frequency is 0.5, it corresponds to time period (T) of more than 12 months. Movement towards left side represents long periods and the movement towards right shows short run. In all other cases, test statistic is below significance level, therefore there is no strong evidence of Granger-Causality.

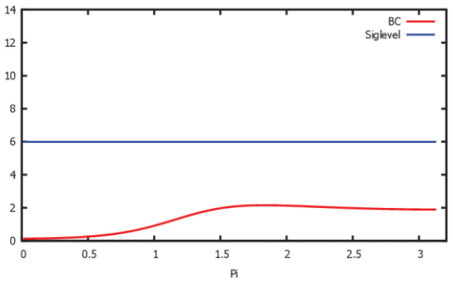
(ii) With condition of exogenous/control variable

- At Level

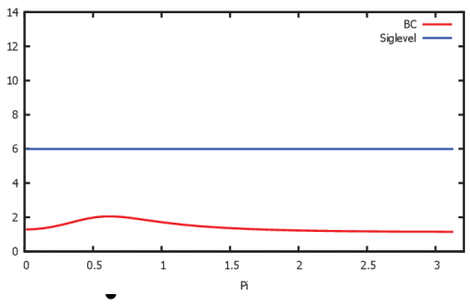
(i) LFDI→LPROD (EXOG=LEDU)



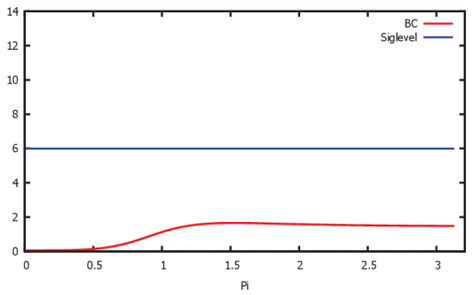
(ii) LPROD→LFDI (EXOG=LEDU)



(iii) LEDU→LPROD (EXOG=LFDI)

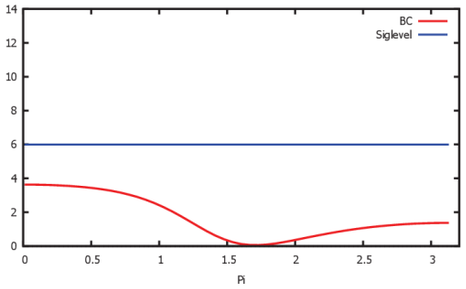


(iv) LPROD→LEDU (EXOG=LFDI)

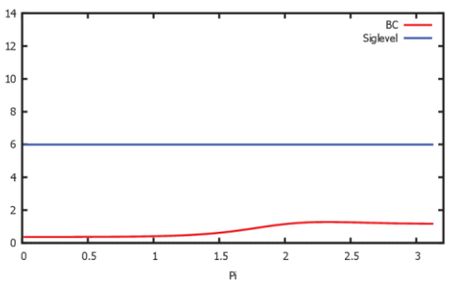


- At First Difference

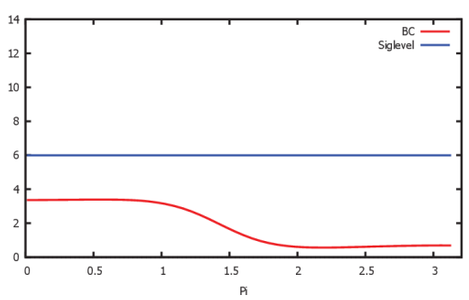
(i) DLFDI→DLPROD (EXOG=DLEDU)



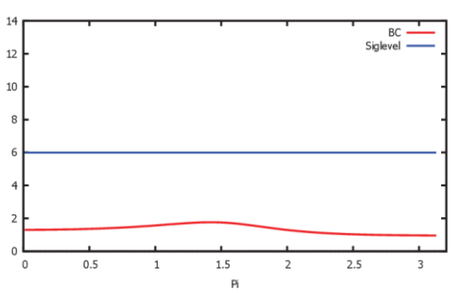
(ii) DLPROD→DLFDI (EXOG=DLEDU)



(iii) DLEDU→DLPROD (EXOG=DLFDI)



(vi) DLPROD→DLEDU (EXOG=DLFDI)



Interpretation of Results:

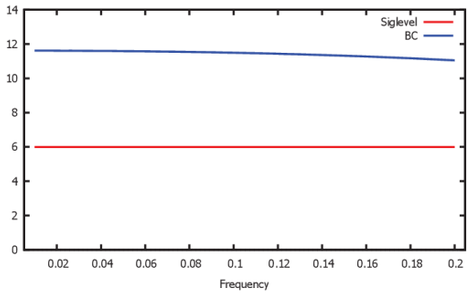
There is not much difference in results as compared to previous analysis (without condition). The evidence of Granger- Causality can be found only in case of LFDI→LPROD in the range of [0, 0.5]. Since all graphs show bivariate relationships, the evidence of bivariate causality is present only in (i) where rest of the graphs do not show a strong evidence (or no evidence) of Granger - Causality at least in long run. The empirical testing is same in this case also. Same analysis is used to measure time period and frequencies.

Detailed results of Breitung Candelon Granger – Causality test:
NEW VERSION BY Breitung- Schreiber
Assessing causality and delay within a frequency band

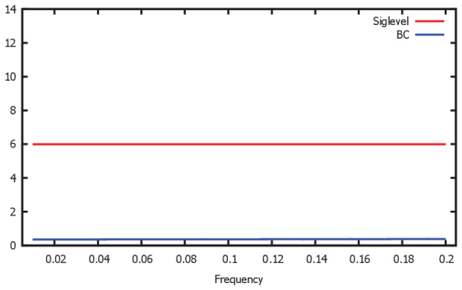
Without Condition of Exogenous/control variables

- At Level (with interpretations)
- Frequency Band [0.01, 0.2]

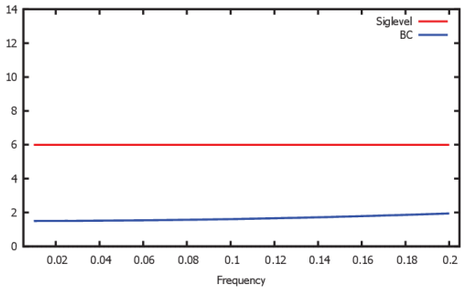
(i) LFDI→LPROD



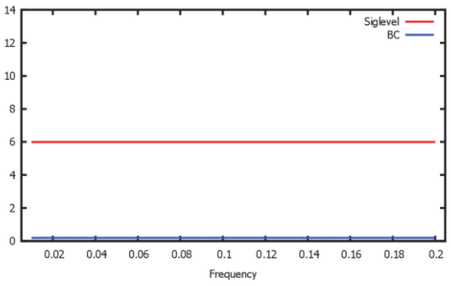
(ii) LPROD→LFD



(iii) LEDU→LPROD



(iv) LPROD→LEDU

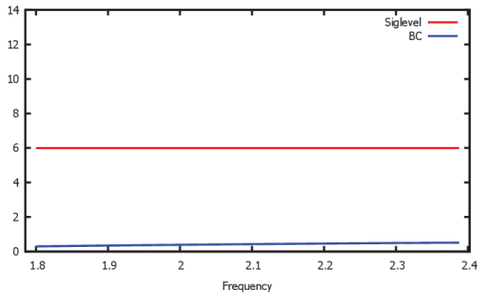


Results:-

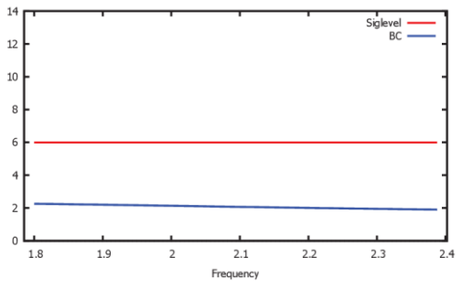
(i) Reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

- Frequency Band [1.8, 2.4]

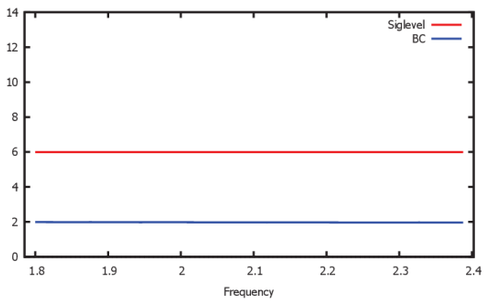
(i) LFDI→LPROD



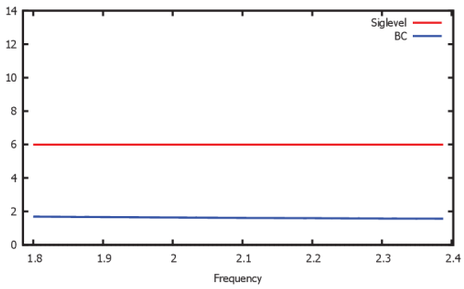
(ii) LPROD→LFDI



(iii) LEDU→LPROD



(iv) LPROD→LED

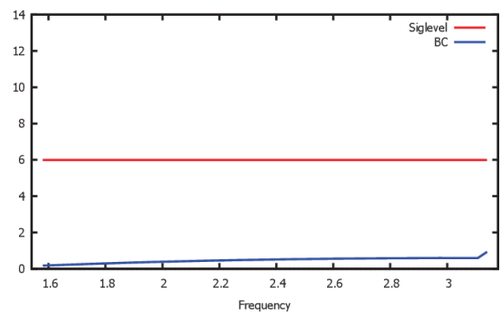


Results:-

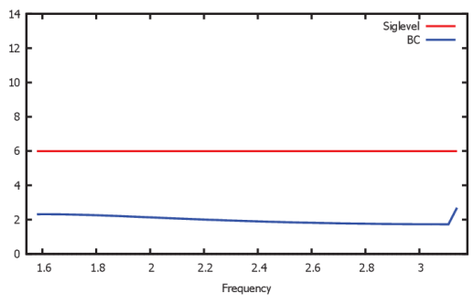
(i) Do not reject non-causality.
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

- Frequency Band [1.58, 3.14]

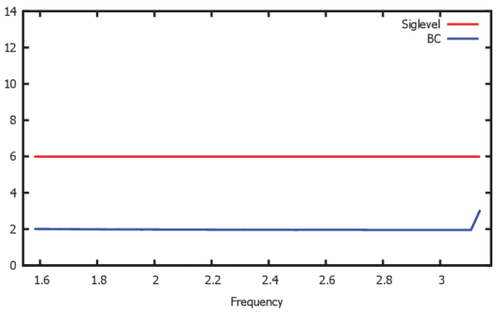
(i) LFDI→LPROD



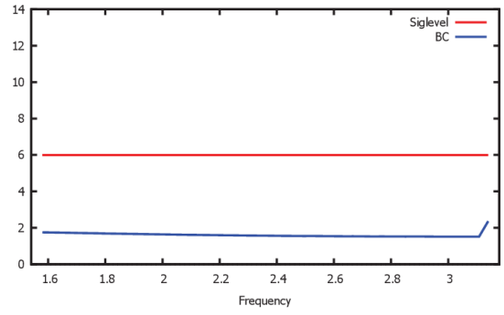
(ii) LPROD→LFDI



(iii) LEDU→LPROD



(iv) LPROD→LEDU



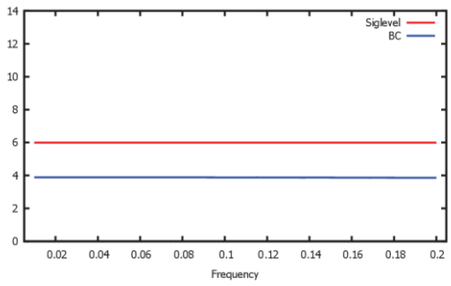
Results:-

(i) Do not reject non-causality.
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

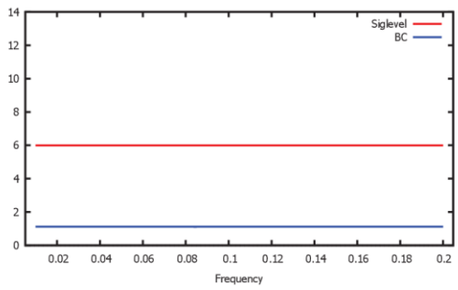
➢ t First Difference (with interpretations)

- Frequency Band [0.01, 0.2]

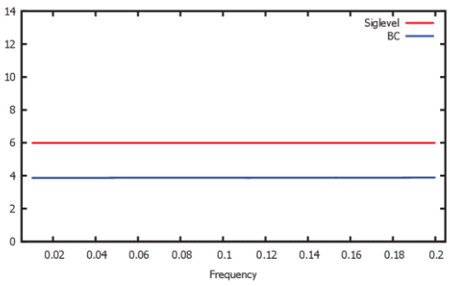
(i) DLFDI→DLPROD



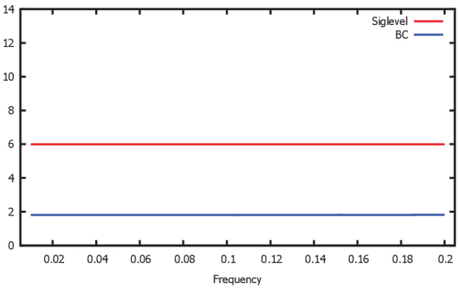
(ii) DLPROD→DLFDI



(iii) DLEDU→DLPROD



(iv) DLPROD→DLEDU



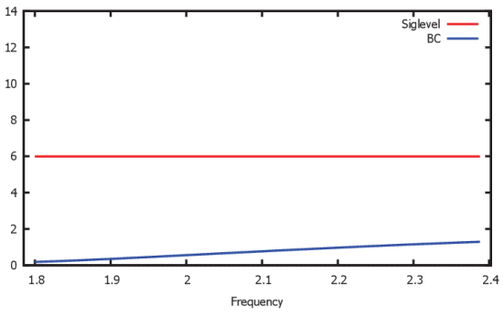
Results:-

(i) Do not reject non-causality.
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

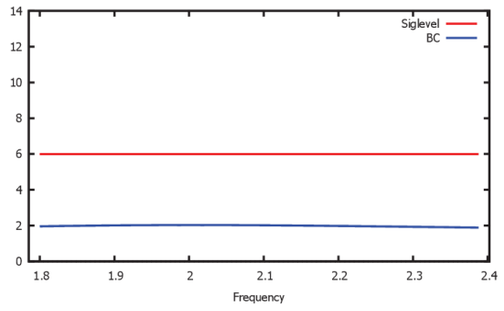
NOTE: (i) and (iii) are different graphs but values are very close.

- Frequency Band [1.8, 2.4]

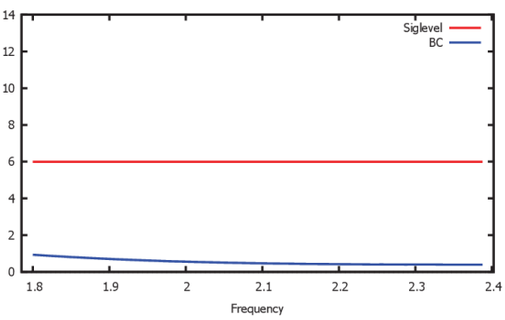
(i) DLFDI→DLPROD



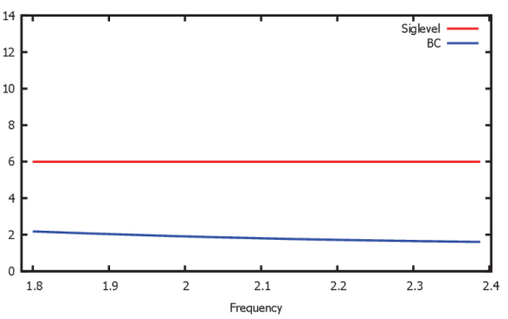
(ii) DLPROD→DLFDI



(iii) DLEDU→DLPROD



(iv) DLPROD→DLEDU



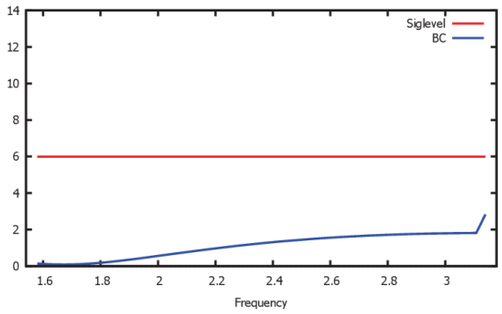
Results:-

(i) Do not reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.

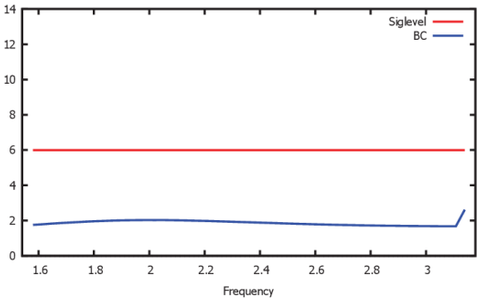
(iv) Do not reject non-causality.

- Frequency Band [1.58, 3.14]
-

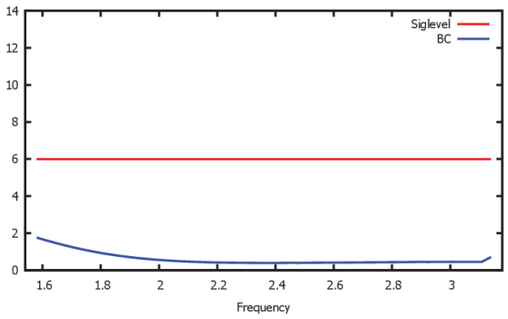
(i) DLFDI→DLPROD



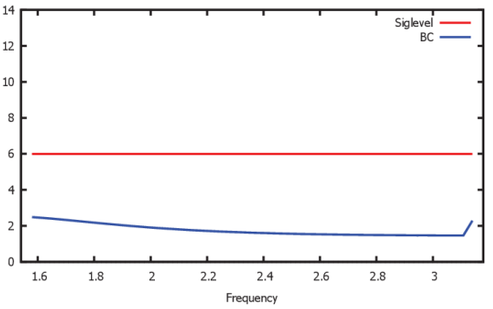
(ii) DLPROD→DLFDI



(iii) DLEDU→DLPROD



(iv) DLPROD→DLEDU



Results:-

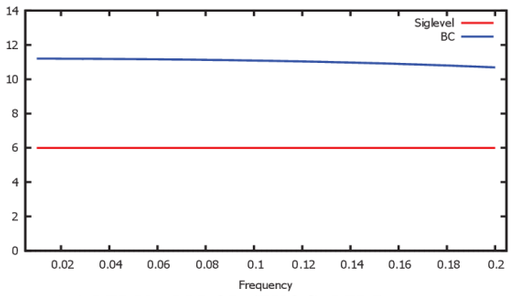
(i) Do not reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

<u>With Condition of Exogenous/control variables</u>

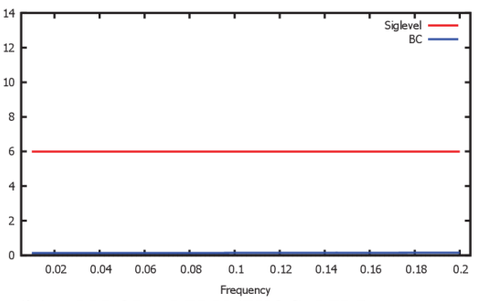
➢ <u>At Level (with interpretations)</u>

- Frequency Band [0.01, 0.2]

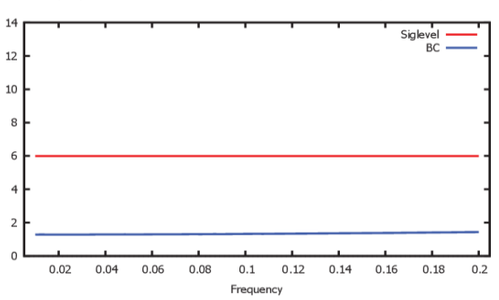
(i) LFDI→LPROD (EXOG=LEDU)



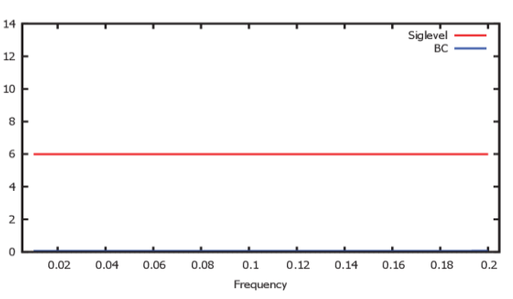
(ii) LPROD→LFDI (EXOG=LEDU)



(iii) LEDU→LPROD (EXOG=LFDI)



(iv) LPROD→LEDU (EXOG=LFDI)

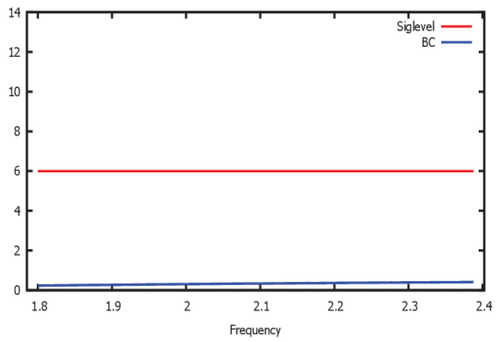


Results:-

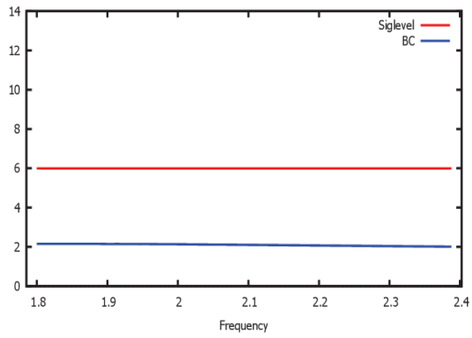
(i) Reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

- Frequency Band [1.8, 2.4]

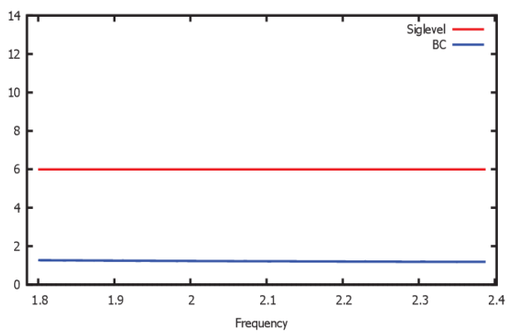
(i) LFDI→LPROD (EXOG=LEDU)



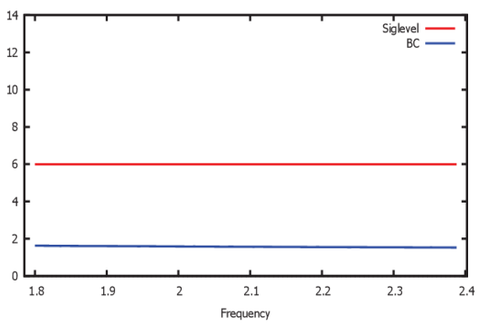
(ii) LPROD→LFDI (EXOG=LEDU)



(iii) LEDU→LPROD (EXOG=LFDI)



(iv) LPROD→LEDU (EXOG=LFDI)

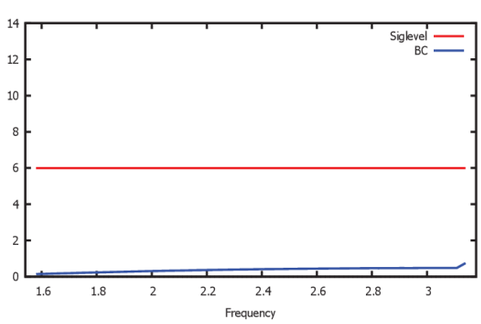


Results:-

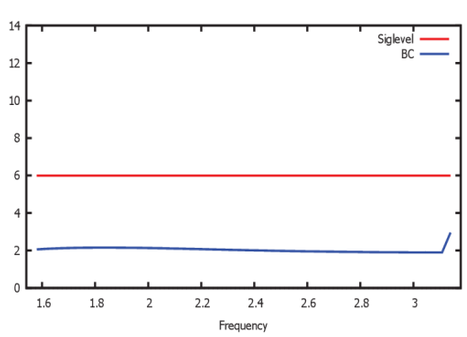
(i) Do not reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

- Frequency Band [1.58, 3.14]

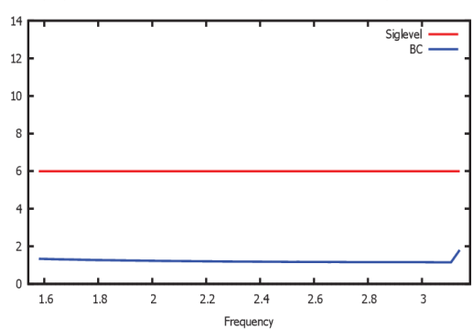
(i) LFDI→LPROD (EXOG=LEDU)



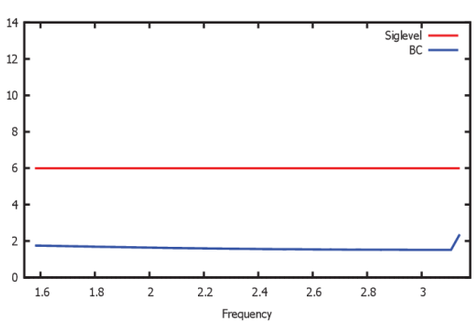
(ii) LPROD→LFDI (EXOG=LEDU)



(iii) LEDU→LPROD (EXOG=LFDI)



(iv) LPROD→LEDU (EXOG=LFDI)



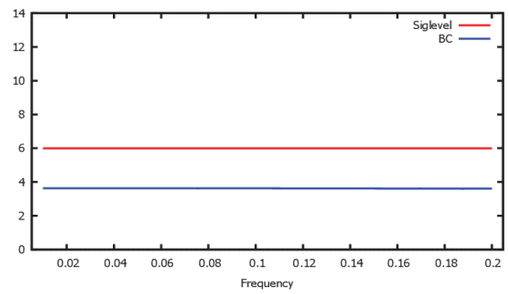
Results:-

(i) Do not reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

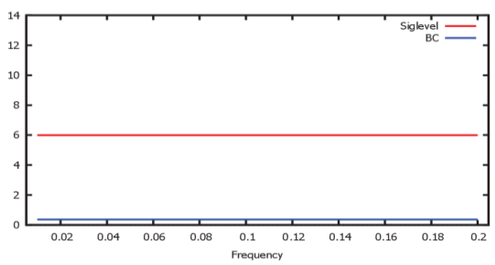
➢ <u>At First Difference (with interpretations)</u>

- Frequency Band [0.01, 0.2]

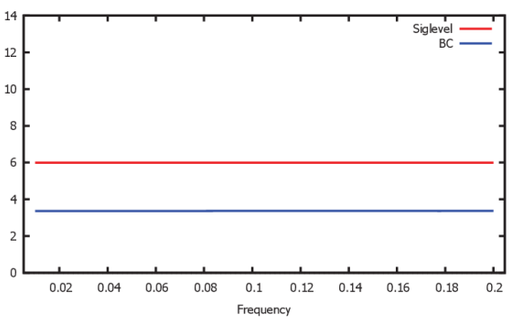
(i) DLFDI→DLPROD (EXOG=DLEDU)



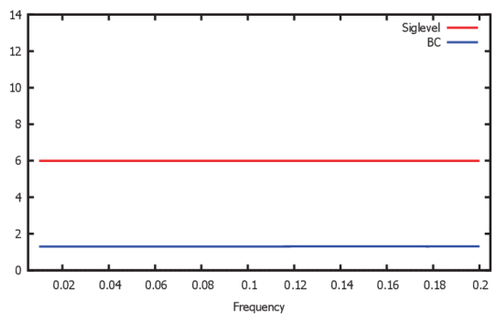
(ii) DLPROD→DLFDI (EXOG=DLEDU)



(iii) DLEDU→DLPROD (EXOG=DLFDI)



(iv) DLPROD→DLEDU (EXOG=DLFDI

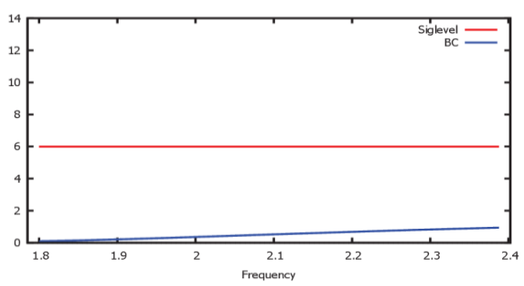


Results:-

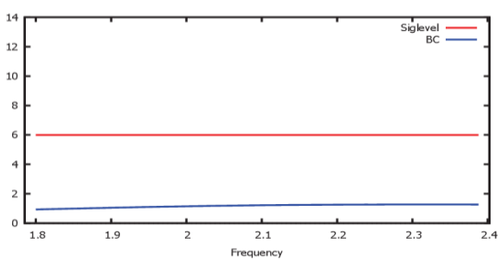
(i) Do not reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

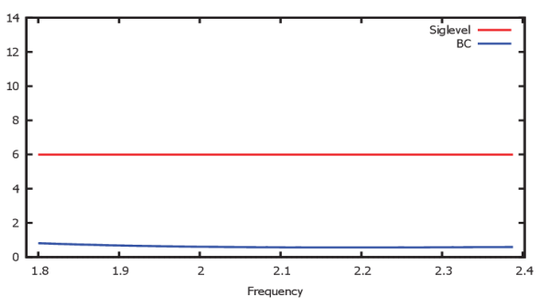
- Frequency Band [1.8, 2.4]

(i) DLFDI→DLPROD (EXOG=DLEDU)

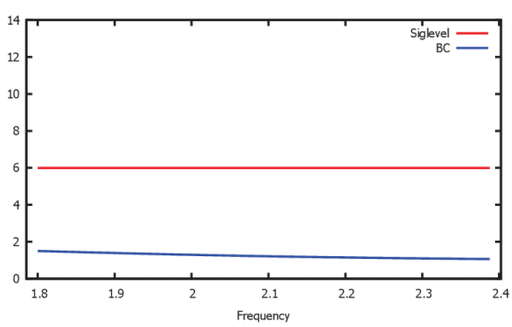


(ii) DLPROD→DLFDI (EXOG=DLEDU)





(iii) DLEDU→DLPROD (EXOG=DLFDI)



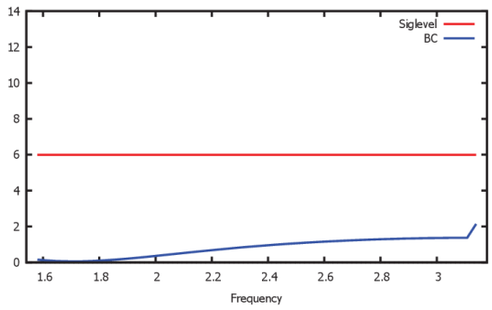
(iv) DLPROD→DLEDU (EXOG=DLFDI

Results:-

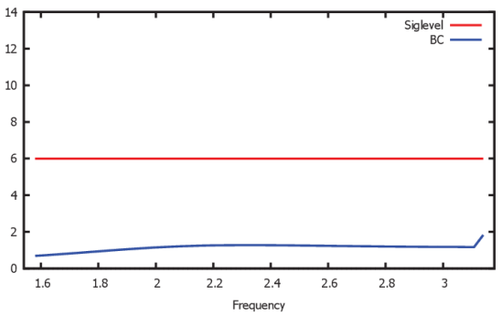
(i) Do not reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

- requency Band [1.58, 3.14]

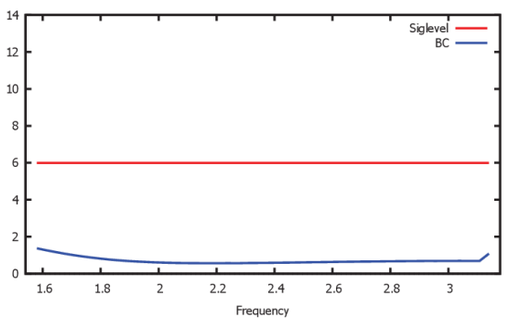
(i) DLFDI→DLPROD (EXOG=DLEDU)



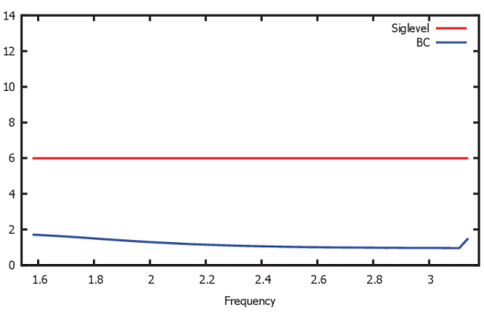
(ii) DLPROD→DLFDI (EXOG=DLEDU)



(iii) DLEDU→DLPROD (EXOG=DLFDI)



(iv) DLPROD→DLEDU (EXOG=DLFDI



Results:-

(i) Do not reject non-causality
(ii) Do not reject non-causality.
(iii) Do not reject non-causality.
(iv) Do not reject non-causality.

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