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The Growth Effect of Foreign Direct Investment: Evidence from Time-Frequency Analysis

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Abstract

The impact of FDI inflow on the economy of the host country had not been clearly defined, especially in the empirical literature. Most of the empirical results from past studies are distorted by model misspecification and endogeneity problems. To find a cure for these deficiencies, this study uses an unconventional methodology called wavelet coherence to examine the nexus between FDI inflows and per capita income growth in three African countries (The Gambia, Ghana, and Senegal. Wavelet coherence is a localized correlation in time-frequency space that examines the dynamic nexus between two time series. Most traditional econometric methods that were used to study the nexus between FDI inflows and income assumed that the series are stationary, however, most economic time series are not stationary, hence, this makes most traditional methods ineffective in finding the nexus between FDI and income. The use of wavelet coherence can overcome this challenge because it does not require the assumption of stationarity of the data.

The empirical results of the study showed that the impact of FDI inflows depends on the degree to which the FDI is a complement or a substitute for domestic investment. Senegal where FDI complements domestic investment in enhancing growth derived more benefit from FDI inflows than The Gambia where FDI inflows substitute domestic investment and Ghana where FDI inflows had no impact on domestic investment. The causality between per capita income growth and per stock of FDI inflows runs from per stock of FDI inflows or the two series move together.

Keywords: Economic Growth, Foreign Direct Investment, Wavelet Coherence, Causality, Phase Difference, The Gambia, Ghana, Senegal

1. Introduction

The importance of capital accumulation and technology in promoting economic growth or sustaining economic growth has been emphasized by all economic growth models (Harrod, 1939; Domar, 1946; Solow 1956; Romer1989). It is from the recommendations of these different economic growth models that over the past decades all countries of different sizes have opened their national border to foreign direct investment (FDI) and even gone to extra mile to ensure that the internal domestic policies are favourable to FDI (UNCTAD, 1999c). Since 1998 one hundred and three countries have provided tax treatments to foreign firms that have their production or administrative premise in the host country. Countries provide incentives to attract FDI with the notion that FDI brings in the needed inputs such as capital and technology to start or sustain economic growth. However, the real impact of FDI on the economy of the host country is ambiguous, especially in the empirical literature (UNCTAD, 1999c).

According to Bloomström & Kokko (1998), Pessoa (2007), and Wang (2009), the impact of FDI on the income of the host country is ambiguous. It is due to these mixed results in the empirical results that motivate this study to find out the real impact of per stock of FDI inflows on per growth. The mixed empirical results are due to the use of different estimation techniques most of which suffer from model misspecification and endogeneity problem. To avoid these methodological problems, this study used an unconventional methodology called wavelet coherence.

Moreover, the study also tests the hypothesis that the impact of FDI on the growth of the host country depends on whether FDI inflows complement or substitute domestic investment (De Mello, 1999). Also, Touray (2020) studied the impact of FDI inflows on The Gambian economy. The result of the study shows that the effect of FDI inflows on the economy of The Gambian economy depends on the level of complementarity and substitution between FDI inflows and domestic investment. This study tested this hypothesis and confirmed that the ultimate impact of FDI on growth depends on the interaction between FDI and domestic investment.

This study is structured as follows. Section two gives a brief literature review on the nexus between FDI and economic growth. Section three explains the methodology adopted to find the empirical nexus between FDI inflows and the per growth of the host countries. Section four explains the empirical results. Sectıon five analyzes, and compares the empirical results and, section six concludes the paper and gives recommendations.

2. Literature Review

2.1 Theoretical Literature Review

To establish the theoretical nexus between economic growth and FDI, the study follows the theoretical framework developed by Barro and Sala-i-Martin (1995) and the technological model suggested by Hermes and Lensik (2003) and Borensztein, De Gregorio, and Lee (1998). The framework is shown in equation (1):

Borensztein, E., De Gregorio, J., & Lee, J.-W. (1998).

$$g = \frac{1}{\theta}\left[\ (L/\vartheta)\ .A^{1/(1-\alpha)}\ .\ \left(\frac{1-\alpha}{\alpha}\right).\ \alpha^{2/(1-\alpha)} - \rho\right] \quad [1]$$

Where:

θ θ is the inverse of the inter-temporal elasticity of substitution.

ρ ρ is the household rate of time preference

A A is the overall level of productivity or efficiency

ϑ The cost of research and development or inventing a new product

L L is the total amount of labour input and is assumed to be constant.

α Measures the capital's share of income ($0 < \alpha < 1$)

Equation (1) shows that the determinants of economic growth are: the household preference parameters (θ and ρ), the overall level of production technology (A), and the cost of inventing a new product (ϑ). If people have more willingness to save (lower θ and ρ), advanced technology (higher A), and lower cost of inventing new goods (lower ϑ), the economy will experience economic growth and vice-versa. How FDI inflows affect economic growth depends on how FDI affects the determinant of economic growth rate (θ, ρ, A, and ϑ).

Borensztein, et al (1998) stated that the cost of R & D, ϑ, is inversely related to the number of foreign firms in the host country. Therefore, the link between growth and FDI can be modeled as:

$$\vartheta = f\ (FDI) \qquad \text{Such that } \frac{\partial\vartheta}{\partial FDI} < 0 \quad [2]$$

However, the ultimate impact of FDI on growth would depend on the interaction between FDI and domestic investments in the host country. As stated by De Mello:

> *"Although FDI is expected to boost long-run growth in the recipient economy via technological upgrading and knowledge spillovers, it is shown that the extent to which FDI is growth-enhancing depends on the degree of complementarity and substitution between FDI and domestic investment."*
>
> (De Mello, 1999)

If FDI has an impact on domestic investment (DI), the total factor productivity or state of technology, *A*, will be affected either positively or negatively depending on whether FDI crowds out or complements domestic investment (DI). The study models two scenarios: when FDI complements domestic investment and when it substitutes domestic investment.

$$A = h\ (FDI * DI) \quad [3]$$

Suh that, $\frac{\partial A}{\partial FDI*DI} > 0$ if FDI complement DI and $\frac{\partial A}{\partial FDI*DI} < 0$ if FDI crow-out DI.

According to Kinoshita (1998) and Sjöholm (1999), FDI can complement DI through technological diffusion or spillovers which may happen through imitation, competition, linkages, and training. However, Khan (2007) and Makki & Somwaru (2004) argued that FDI might crowd out domestic investment when the technology transfer from FDI quickly accelerates the technological obsolescence of traditional domestic technologies used in developing countries. This does not only make traditional domestic technology outdated and crowd out domestic investment, but it also reduces domestic savings. This can momentarily lower the economic growth of the host country.

If equation (2) and (3) are substituted into equation (1), we have an equation that shows the impact of FDI on economic growth through the cost of R&D and the productivity level as in equation (4):

$$g = \frac{1}{\theta}\left[\ (L.f(FDI)^{-1}).\ h(FDI * DI)^{1/(1-\alpha)}\ .\ \left(\frac{1-\alpha}{\alpha}\right).\ \alpha^{2/(1-\alpha)} - \rho\right] \qquad [4]$$

Equation (4) shows that FDI lowers the cost of R&D in the host country because the inflow of FDI into the host country allows domestic firms to imitate foreign technology, and imitation is cheaper than innovation. The higher the inflow of FDI in the host country, the higher the chance of imitation, and this leads to technological diffusion in the host country and ultimately enhances growth. However, the net impact of FDI inflows on economic growth depends on how foreign investment also affects domestic investments. If FDI has no impact on local firms, FDI would unambiguously have a positive impact on economic growth by lowering the cost of R&D. However, if FDI has an impact on domestic firms, FDI could complement or substitute DI. If it complements DI, economic growth will unambiguously increase. If it substituted it, the impact of FDI on economic growth would not be clear cut.

2.2 Empirical Literature

There have been many studies that investigated the relationship between the inflow of FDI and the income of the host country and the findings are mixed. The results of the studies seem to depend on the type of FDI used (stock or flow) and the methodology employed. However, few studies have been conducted on The Gambia, Ghana, and Senegal, especially on The Gambia. Table 1 shows the empirical studies that have been conducted in The Gambia, Ghana, and Senegal.

Table 1. The nexus between FDI and growth

Study	Sample; Period	Result
Adeniyi and Omisakin (2012)	Ivory Coast, Gambia, Ghana, Nigeria, and Sierra Leone for the period 1970 – 2005.	FDI has an impact on growth in the Gambia, Ghana, and Sierra Leone depending on the type of variable used as a proxy for financial development. The relationship between growth and FDI in Nigeria is not affected by the level of financial development.
Gibba and Mark (2016)	Gambia; 1970 -2013	FDI has a positive impact on growth but not significant
Esso (2010)	Senegal and Ghana and eight other Sub-Saharan African countries: 1970 -2007	The study found a positive long-run relationship between growth and FDI in Senegal and GDP significantly impacts FDI in Senegal. The author could not find results for Ghana
Keho (2015)	Senegal, Ghana and ten other Sub-Saharan African countries; 1970 - 2013	FDI and GDP are positively related in the long run in Ghana. In the short run, there is a bidirectional causality between FDI and growth in Ghana. In the long run, GDP causes FDI in Senegal, and the relationship is positive.
Tekin (2012)	Gambia, Senegal and 16 other African countries; 1970 – 2009	GDP growth-causing FDI in Gambia. Export granger-causing FDI and GDP sever as an auxiliary variable in Senegal
Touray (2020)	The Gambia; 1980 to 2013	The findings indicated that in the immediate term, foreign direct investment (FDI) inflows displaced domestic investment, resulting in a detrimental effect on income. Additionally, the results demonstrated that in the long term, FDI inflows supplemented domestic investment, leading to a favourable impact on overall income. This study concludes that the overall influence of FDI inflows on The Gambia's aggregate income relies on the level of complementarity and substitution between FDI inflows and domestic investment.

The conclusion one can draw from the literature is that the impact of FDI on the economy of the host country works through many channels and whether it has a negative or positive impact on the economy of the host country would depend on whether positive channels dominate the negative channels (OECD, 2002; Moura & Forte, 2010). To extend the FDI-economic growth literature, the paper frames the following hypotheses:

H_1: The FDI has an impact on economic growth in The Gambia, Ghana, and Senegal.

H_2. The interaction between domestic investment and FDI plays a crucial mediating role in the nexus between FDI and economic growth in The Gambia, Ghana, and Senegal.

3. Methodology and Data

Most of the previous empirical studies on the link between FDI inflows and income were examined in the time domain. These methods assume that the relationships between the variables are constant over time. However, Clive Granger who won the Nobel Prize in economics in 2003 stated that there is no reason to assume that the relationship between time series is constant at different frequencies, that is, the degree of nexus between variables may change over time (Ramsey, 2002). To capture the evolution of the nexus between time series, the Fourier Transform (FT) was introduced to capture the nexus at frequency level. FT analysis captures nexus at frequency level only, thus, the time dimension is completely lost in the analysis. Moreover, FT analysis assumes that the series are stationary, this is another drawback. To have a measurement that examines nexus in both time and frequency dimensions with the assumption of nonstationarity of the time series, wavelet analysis was introduced. Wavelet analysis combined both time and frequency analysis, that is, the nexus is examined in both time and frequency domain. According to Ramsey (2002), wavelet acts as a lens that helps to reveal a nexus that was unobservable before.

Since wavelet transforms a series from the time domain to the time-frequency domain, it can detect problems such as structural break, nonstationarity and outliers which have affected the previous empirical results. Time series having such features is better evaluated via wavelet than traditional econometric methods. Wavelet can deal with such complex time series by decomposing aggregate data into time-scale, this reveals more information about the series or the nexus (Ramsey, 2002). Ramsey & Camille (1998a) argued that our understanding of economic variables could be enhanced when we examine the dynamic relationship between economic variables in time-frequency space.

The first step in the calculation of wavelet coherence is to transform the two series from their time domain series into a time-frequency domain. The transformed series is now called continuous wavelet transform(CWT). Given a time series *x (t)*, its continuous wavelet transform (CWT) with respect to $\psi(t)$, is given in equation (5).

$$W_x(\tau, s) = \int_{+\infty}^{-\infty} X(t)\, \psi_{\tau,s}{}^{*}(t)\, dt \qquad [5]$$

In equation (5), the sign $*$ denotes the complex conjugate. $\psi_{\tau,s}(t)$ is a daughter wavelet derived from the mother wavelet, $\psi\,(t)$, through dilation and translation (Percival & Andrew T, 2006). In a nutshell, equation (5) shows how a time series is transformed from a time domain into a time-frequency domain. CWT breaks down a time series into wavelet daughters through dilation and translation by using a mother wavelet. The link between the mother wavelet, $\psi\,(t)$, and the daughter wavelet, $\psi_{\tau,s}(t)$, is given in equation (6);

$$\psi_{\tau,s}(t) = \frac{1}{\sqrt{s}}\, \psi\left(\frac{t-\tau}{s}\right) \qquad [6]$$

Where τ denotes the time position or translation parameter, s denotes the scale or dilation parameter, which is inversely related to frequency, and $\frac{1}{\sqrt{s}}$ is a normalization factor that makes sure that wavelet transform can be compared throughout scales and time. Equation (6) clearly shows that daughter wavelets are derived from mother wavelets. The translation parameter,τ, shows us the position of the window while parameter s dilates (if $|s| > 1$) or compress (if $|s| < 1$) the length of the mother wavelet to extract the frequency information from the time series. The mother wavelet is dilated or compressed to show different cycles of the frequencies. In the process of dilating or compressing the mother wavelet, daughter wavelets are generated from the mother wavelet which are used to analyse the time series. Continuous wavelet transforms, $W_x(\tau, s)$, has both real part (R$\{W_x\}$) and the imaginary part (I$\{W_x\}$). There are many types of mother wavelets, but this study uses Morlet wavelet. According to Heisenberg uncertainty principles, there is a trade-off between localization in frequency and in time. Thus, the rule is to find a mother wavelet that gives a good balance between the two localization, Morlet wavelet provides this good balance, thus, the reason it is chosen (Grinsted & Svetlana, 2004). Equation (7) gives Morlet wavelet.

$$\psi(t) = \frac{1}{\pi^{1/4}} e^{-i\omega_o t} e^{-t^2/t} \quad [7]$$

In equation (7), ω_o is the central frequency of the Morlet wavelet. Morlet wavelet has a complex sine wave within a gaussian (Addison, 2002). To get better frequency localization, ω_o can be increased but at the cost of good time localization. To get a balanced localization in both time and frequency, this study follows Rua and Nunes (2009) by selecting $\omega_o = 6$, this gives a good balance, and it is what is frequently used in economics and financial empirical research (Grinsted & Svetlana, 2004).

Since wavelet Coherence (WTC) is a local[1] correlation coefficient, thus, to compute WTC between two series requires the calculation of wavelet power spectrum or local variance (WPS) and cross-wavelet transform or local covariance (XWT). WPS for time series $x(t)$ is given in Equation (8).

$$WPS_x(\tau, s) = |W_x(\tau, s)|^2 \quad [8]$$

To find the bivariate nexus between time series $x(t)$ and $y(t)$ in the time-frequency domain, XWT can be used. XWT measures the local covariance between two series (Aguiar-Conraria & Soares, 2011). Given two variables, $x(t)$ and $y(t)$, and their wavelet transforms, $W_x(\tau, s)$ and $W_y(\tau, s)$, respectively. The XWT of the two-time series is defined in equation (9).

$$\mathrm{XWT} = W_{xy}(\tau, s) = W_x(\tau, s)\, W_y^{*}(\tau, s) \quad [9]$$

This study follows Torrence & Webster (1998) by defining WTC between two series as;

$$WTC = R_{xy}{}^2(\tau, s) = \frac{|S(s^{-1}W_{xy}(\tau, s)|^2}{S(s^{-1}|W_x(\tau, s)|^2) \quad S(s^{-1}\left|W_y(\tau, s)\right|^2)} \quad [10]$$

In equation (9), S indicates a smoothing operator in both time and frequency (Aguiar-Conraria & Soares, 2010). Smoothing is necessary to avoid WTC being equalled to one in all frequencies or scales (Priestley, 1981). Equations (8) and (9) are combined to compute WTC between series $x(t)$ and $y(t)$ in equation (10). The definition of WTC in equation (10) bears a resemblance to the traditional correlation coefficient, however, WTC is a localized correlation coefficient in time-frequency space. The value of squared wavelet ranges between 0 and $1 (0 \leq R_{xy}{}^2(\tau, s) \leq 1)$. The closer the value of squared wavelet coherence to one, the stronger the nexus between the two series and vice-versa. Since WTC has no theoretical distribution, Monte Carlo methods are used to determine the 5% significant level of WTC. Since the coefficient value of WTC ranges between zero and one, it cannot give the direction of the correlation from the coefficient, that is, whether the series are positively related or negatively related. However, phase difference approximations can show whether the two series are positively related (in-phase) or negatively related (out-of-phase or anti-phase) (Soares, 2011).

Moreover, one of the most debated areas in the FDI literature is the direction of causality between FDI and growth in the host country, the phase difference can also be used to determine the direction of causality, that is, it can determine the lead-lag relationship between two series at a specific scale (Aguiar-Conraria & Soares, 2010). Phase difference, $\emptyset_{xy}(\tau, s)$, is computed in this study by following Torrence and Webster (1998) as in equation (11);

$$\emptyset_{xy}(\tau, s) = \tan^{-1}\left(\frac{\Im(W_{xy}(\tau, s))}{\Re(W_{xy}(\tau, s))}\right) \; with \quad \emptyset_{xy} \in [-\pi, \pi] \quad [11]$$

Where $\Im$ is the imaginary part and $\Re$ is the real part of the cross wavelet transform. The advantage of phase difference over the traditional methods of determining the direction of causality is that phase difference can show the evolution of the direction of causality over different scales or frequencies. The results of the phase difference are stated in radians and its likely values range between $-\pi \; and \; \pi$. Table 2 shows the interpretation of the result of phase difference. The results of the phase difference are also shown in the WTC diagram by arrows. When arrows point to the left it means the two series are out-of-phase (anti-phase or negatively related) while arrows pointing to the right mean the two series are in-phase (positively related). The arrows pointing up or down determine the direction of causality between the two series.

[1] The word local here means variance, covariance and correlation coefficient are calculated at both time and frequency domain unlike the other traditional variance, covariance and correlation coefficients which are computed at time domain only.

Table 2. Interpretation of Lead-Lag (Causality) of Phase Difference

Phase Difference $\emptyset_{xy}(\tau, s)$	Phase	Causality
$\emptyset_{xy} \in [\ \mathbf{0}, \frac{\boldsymbol{\pi}}{\mathbf{2}}]$	In-Phase	$x \leftarrow y$
$\emptyset_{xy} \in [-\frac{\boldsymbol{\pi}}{\mathbf{2}}, \mathbf{0}\ ]$	In-Phase	$y \leftarrow x$
$\emptyset_{xy} \in [\frac{\boldsymbol{\pi}}{\mathbf{2}}, \boldsymbol{\pi}]$	Out-of-Phase	$y \leftarrow x$
$\emptyset_{xy} \in [\ -\boldsymbol{\pi}, -\frac{\boldsymbol{\pi}}{\mathbf{2}}]$	Out-of-Phase	$x \leftarrow y$

Note: If the phase difference is equalled to zero, the two series move together at a particular scale or frequency.

The data is taken from two different sources. The data for per capita income growth and gross fixed capital formation was taken from world development indicators of the World Bank (World Bank, 2016) while data for per stock of FDI inflows and the total stock of FDI inflows was taken from UNCTAD (2015). Gross fixed capital formation is used as a proxy for domestic investment. The data is a time series that ranges from 1980 to 2015.

4. Empirical Results

The empirical results for The Gambia, Senegal and Ghana are in Figures 1, 2, and 3, respectively. In the figures, the focus is on the 5% significance areas shown by the thick black contour within the cone. The color codes show the strength of the relationship between the two series. The color codes range from blue (weak relationship) to red (strong relationship). The interpretation of each of the figures falls under one or more of the following cases;

Case 1: The arrows point to the right & up within the 5% significance area in the cone. This means per stock of FDI inflows and per capita income growth is in phase with per capita income growth lagging, that is, causality runs from per stock of FDI inflows to per capita income growth.

Case 2*:* The arrows point to the right & down within the 5% significance area in the cone. This means per stock of FDI inflows & per capita income growth is in-phase with per capita income growth leading, that is, causality runs from per capita income to per stock of FDI inflows.

Case 3: The arrows point to the left & up within the 5% significance area in the cone. This means per stock of FDI inflows & per capita income growth is out-of-phase with per stock of FDI inflows lagging, that is, causality runs from per capita income growth to per stock of FDI inflows.

Case 4: The arrows point to the left & down within the 5% significance area in the cone. This means per stock of FDI inflows and per capita income growth are out-of-phase with per stock of FDI inflows leading, that is, causality runs from per stock of FDI inflows to per capita income growth.

Case 5: The arrows point to the right and straight within the 5% significance areas in the cone. This means per stock of FDI inflows and per capita income growth is in-phase and per stock of FDI inflows and per capita income growth move together.

Case 6: The arrows point to the left and straight within the 5% significance areas in the cone. This means per stock of FDI inflows and per capita income growth are out-of-phase and per stock of FDI inflow and per capita income growth move together.

Figure 1 shows that within the cone there is only one strong significant nexus between per stock of FDI inflows and per capita income growth in The Gambia.

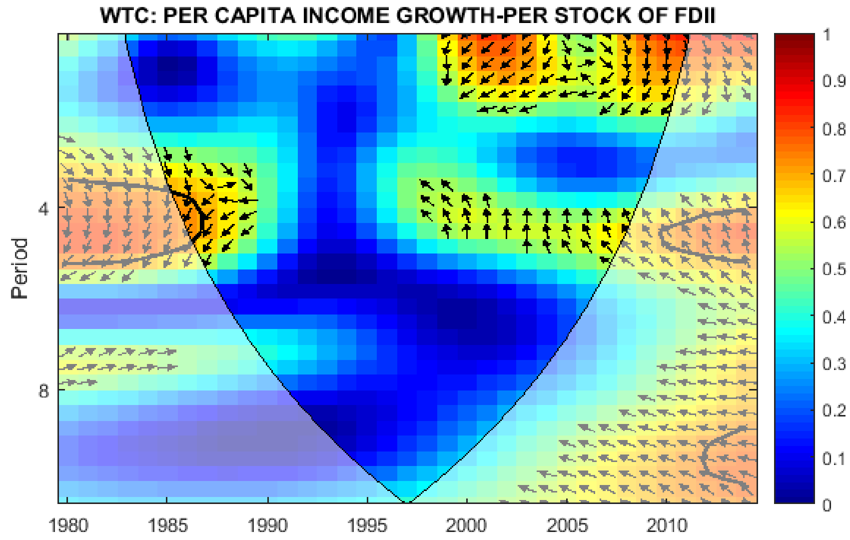

Figure 1. Per Capita Income Growth and Per Stock of FDI Inflows, The Gambia

In Figure 1, a significant relationship occurred between 1986 and 1987 at a scale of 4 years. The interpretation of this significance nexus in Figure 1 falls under case 4. That is, per stock of FDI inflows in The Gambia have a very small negative impact on the Gambian economy and the causality runs from FDI to growth. Table 3 summarizes the information in Figure 1.

Table 3. Per Capita Income Growth and Per Stock of FDI Inflows, The Gambia

Country	Figure	Case	Time-Frequency		NEXUS	
			Year	Scale	Phase	Causality
The Gambia	1	4	1986-1987	4	Out-of-Phase	$Growth \leftarrow FDI$

Note: Frequency is negatively related to scale. $X \leftarrow Y$ means causality runs from Y to X.

Figure 2 shows that there are three significant nexuses between per stock of FDI inflows and per capita income growth in Senegal. The first significance relationship occurred between 1985 and 1986 at a scale of 1-3 years, the interpretation of this significance nexus in Figure 3.2 falls under case 5. The second significance nexus occurred between 1996 and 2010 at a scale of 3-6 years, the interpretation of this significance nexus in Figure 2 falls under case 1. The last significance nexus happened between the years 2001 and 2005 at a scale of 7-8 years, and the interpretation of this significance nexus in Figure 2 falls under case 5. The information in Figure 2 is summarized in Table 4 below. The empirical results show that the impact of FDI inflows on per growth in Senegal is large and strong.

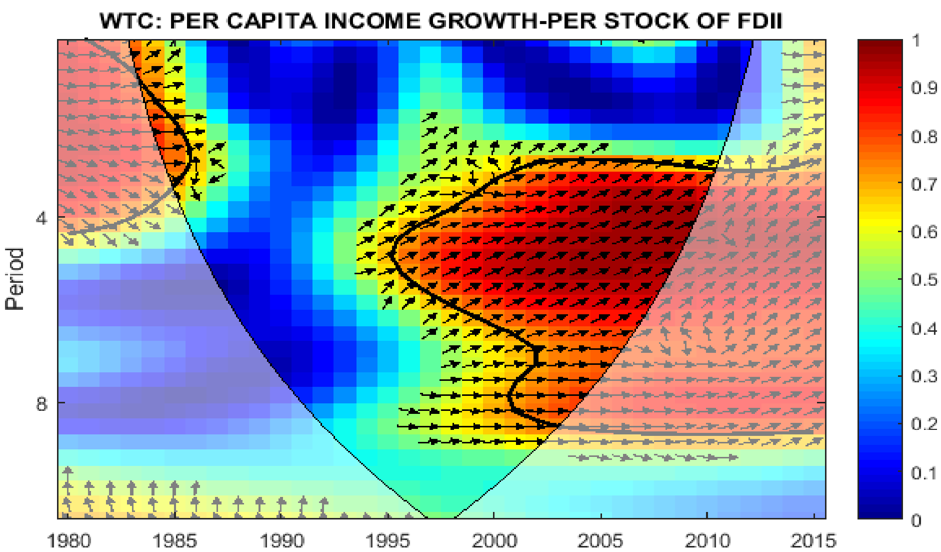

Figure 2. Per Capita Income Growth and Per Stock of FDI Inflow, Senegal

Table 4. Per Capita Income Growth and Per Stock of FDI Inflows, Senegal

Country	Figure	Case	Time-Frequency		NEXUS	
			Year	Scale	Phase	Causality
Senegal	3.2	5	1985 -1986	1~3	In-Phase	Move together
Senegal	3.2	1	1996 - 2010	3~6	In-Phase	Growth ← FDI
Senegal	3.2	5	2001 - 2005	7~8	In-Phase	Move together

Note: Frequency is negatively related to scale. $X \leftarrow Y$, means causality runs from Y to X.

Figure 3 shows that there is only one significant nexus between per stock of FDI inflows and per capita income growth in Ghana. This significant relationship occurred between 1989 and 1991 at a scale of 6-7 years. The interpretation of this significance nexus in Figure 3 falls under case 1 and is summarized in Table 5 below.

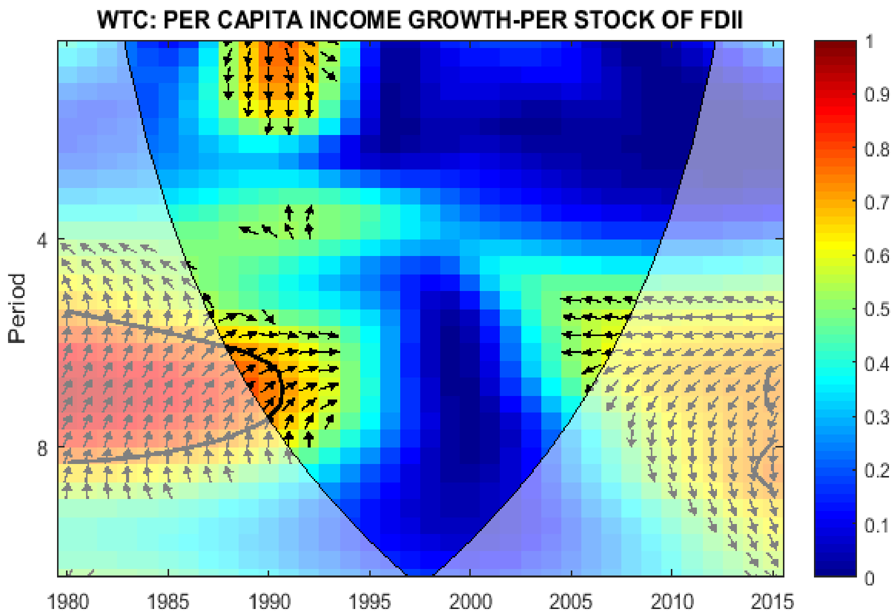

Figure 3. Per Capita Income Growth and Per Stock of FDI Inflow, Ghana

Table 5. Per Capita Income Growth and per Stock of FDI Inflows, Ghana

Country	Figure	Case	Time-Frequency		NEXUS	
			Year	Scale	Phase	Causality
Ghana	3.3	1	1989-1991	1	In-Phase	$growth \leftarrow FDI$

Note: Frequency is negatively related to scale. $X \leftarrow Y$, means causality runs from Y to X. In-Phase means the series are positively related.

From the empirical results, Senegal benefits more from FDI inflows than any other country then followed by Ghana. FDI hurts economic growth in The Gambia. The natural question is why Senegal benefits more from FDI inflows than Ghana and The Gambia. In the FDI literature, it is claimed that the ultimate impact of FDI inflows on the economy of the host country depends mainly on the interaction between foreign firms and local firms. This interaction was emphasized by De Mello (1999) who stated that.

"... Although FDI is expected to boost long-run growth in the recipient economy via technological upgrading and knowledge spillovers, it is shown that the extent to which FDI is growth-enhancing depends on the degree of complementarity and substitution between FDI and domestic investment…"

(De Mello, 1999: 133).

Thus, this study empirically examined how the interaction of stock of FDI inflows and domestic investments (interaction variable) affects per growth in each country. The interaction variable is an indicator of the linkage between foreign direct investors and local firms. Interaction variables are defined in equation (12) below.

$$\text{Interaction variable} = (\text{total stock of FDI inflows}) * (\text{Domestic Investments}) \qquad [12]$$

Figures 4, 5, and 6 show how the interaction variable affects per growth in The Gambia, Senegal, and Ghana respectively. In a nutshell, the figures show how the linkage between foreign and domestic firms affects per growth. The interpretation of each of the figures falls under one or more of the following cases;

Case A: The arrows point to the right & up within the 5% significance area in the cone. This means the interaction variable & per growth are in-phase with per growth lagging, that is, causality runs from the interaction variable to per growth. The in-phase nexus means FDI inflows complement domestic investment in enhancing per growth.

Case B: The arrows point to the right & down within the 5% significance area in the cone. This means the interaction variable & per growth are in-phase with per growth leading, that is, causality runs from per capita income to the interaction variable. The in-phase nexus means FDI inflows complement domestic investment in enhancing per growth.

Case C: The arrows point to the left & up within the 5% significance area in the cone. This means the interaction variable & per growth are out-of-phase with the interaction variable lagging, that is, causality runs from per capita income growth to the interaction variable. The out-of-phase nexus means FDI inflows substitute domestic investment in enhancing per growth.

Case D: The arrows point to the left & down within the 5% significance area in the cone. This means the interaction variable and per capita income growth are out-of-phase with per stock of FDI inflows leading, that is, causality runs from interaction variable to per capita income growth. The out-of-phase nexus means FDI inflows substitute domestic investment in enhancing per growth.

Case E: The arrows point to the right and straight within the 5% significance areas in the cone. This means the interaction variable and per capita income growth are in-phase and they move together. The in-phase nexus means FDI inflows complement domestic investment in enhancing per growth.

Case F: The arrows point to the left and straight within the 5% significance areas in the cone. This means the interaction variable and per capita income growth are out-of-phase and interaction variable and per capita income growth move together. The out-of-phase nexus means FDI inflows substitute domestic investment in enhancing per growth.

Case G: There is no significant nexus between the interaction term and the per capita income growth. This means FDI inflows have no impact on domestic investment.

Figure 4 below shows that in The Gambia there is only one period where a significant nexus between interaction variable and stock of FDI inflows occurred. This significance nexus in Figure 4 falls under case F and happened from 2009 to 2010 at a scale of 1-2 years. This result shows that FDI in enhancing per growth substituted domestic investment and this caused FDI to have a net negative impact on per growth in The Gambia. The information in Figure 4 is summarized in Table 6.

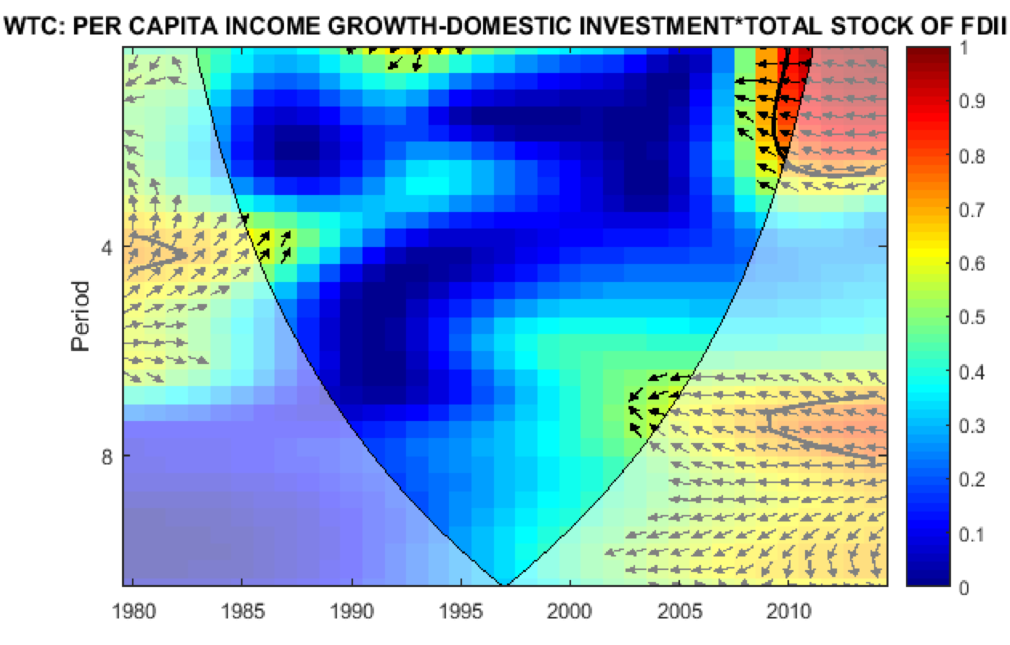

Figure 4. The Impact of Interaction Variable on Per Growth in The Gambia

Table 6. The Nexus between Interaction Variable and Per Capita Growth, Gambia

Country	Figure	Case	Time-Frequency		FDI in enhancing per-growth
			Year	Scale	
Gambia	3.4	F	2009-2010	1~2	FDI crowded out domestic investment

Figure 5 below shows that in Senegal there are four periods where a significant nexus occurred between the interaction variable and per growth and these significant nexus in Figure 5 fall under case B, A and E. The year and the scale at which this significant nexus occurred are shown in Table 7 below. This result shows that FDI inflows complemented domestic investment in the process of enhancing per growth and this causes FDI to have an even larger positive impact on per growth in Senegal. The information in Figure 5 is summarized in Table 7.

Table 7. The Nexus between Interaction Variable and Per Capita Growth, Senegal

Country	Figure	Case	Time-Frequency		FDI in enhancing per growth,
			Year	Scale	
Senegal	3.5	B	1985-1988	1~3	FDI complements domestic investment
Senegal	3.5	B	1990-1991	1	FDI complements domestic investment
Senegal	3.5	A	1998-2005	2~6	FDI complements domestic investment
Senegal	3.5	E	2000-2006	7~9	FDI complements domestic investment

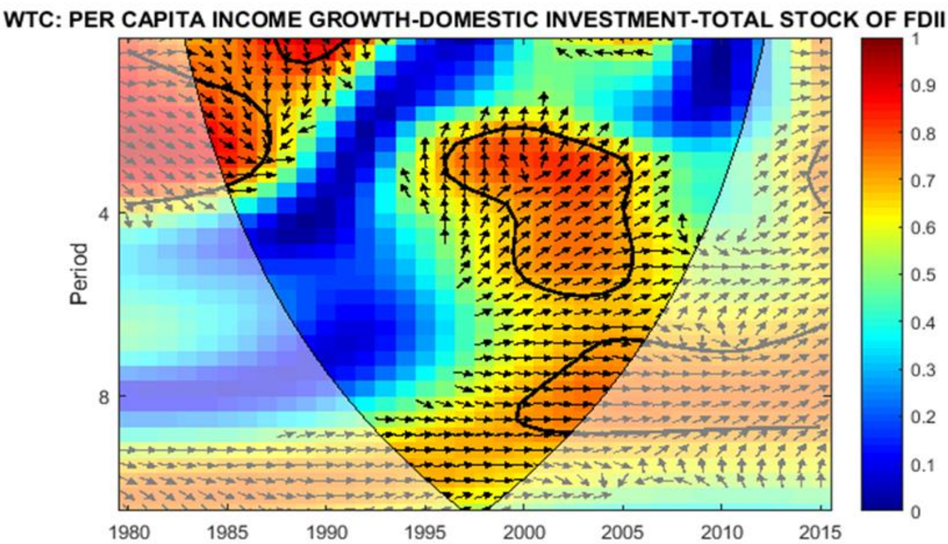

Figure 5. The Impact of Interaction Variable on Per Growth in Senegal

Figure 6 below shows that in Ghana there is no period where a significant nexus between interaction variable and stock of FDI inflows occurred, thus, Figure 6 falls under case G. This result shows FDI inflows do not have any impact on domestic investment in the process of enhancing per growth and this cause FDI not to have a larger positive impact on per growth in Ghana. The information in Figure 6 is summarized in Table 8.

Table 8. The Nexus between Interaction Variable and Per Capita Growth, Ghana

Country	Figure	Case	Time-Frequency		FDI In enhancing per growth,
			Year	Scale	
Ghana	3.6	G	-	-	FDI has no impact on domestic investment

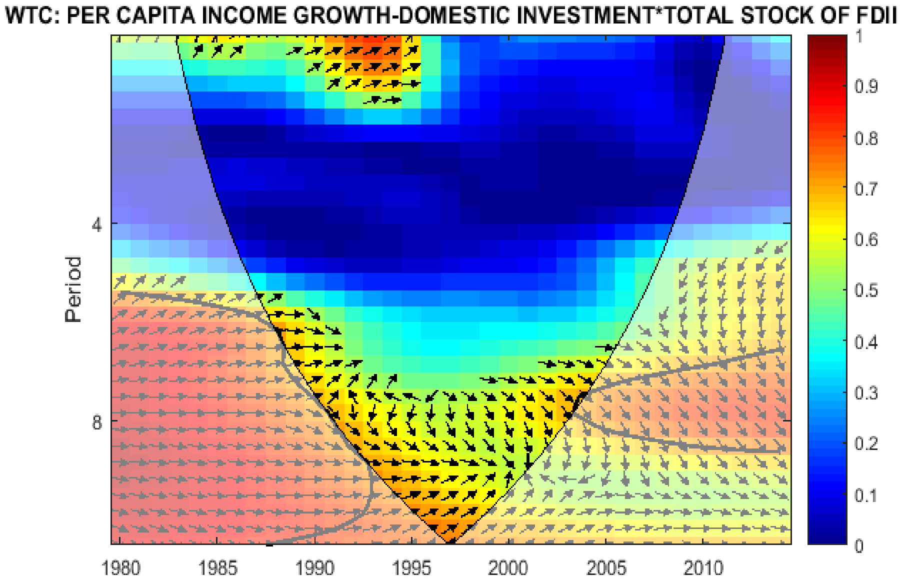

Figure 6. The Impact of Interaction Variable on Per Growth in Ghana

5. Discussion

The empirical results show that the extent to which FDI inflows are enhanced in the host country depends on the degree of complementarity and substitution between FDI inflows and domestic investment as stated by De Mello (1999). The reason why Senegal derived the most benefit from FDI inflows is because FDI in enhancing growth also complemented domestic investment, which led to FDI inflows to even have a larger impact on per growth. However, in The Gambia where FDI is enhancing per growth, it substituted domestic investment, causing the net impact of FDI on per growth to be negative. Ghana could not derive large benefits from FDI inflows because FDI in enhancing growth does not have any impact on domestic investment. The result of this study is in line with Touray (2020) where it is concluded that the net effect of FDI inflows on the aggregate income in The Gambia is contingent on the degree of complementarity and substitution between FDI inflows and domestic investment. Moreover, Keho (2015) also confirmed that FDI and GDP have a positive nexus in the long run in Ghana, and the direction of the causality is bidirectional. In Snegeal the impact of FDI on the economy is positive. Adeniyi and Omisakin (2012) stated that FDI has an impact on growth in the Gambia, Ghana, and Sierra Leone depending on the type of variable used as a proxy for financial development. In conclusion, the reason why Senegal derives more benefit from FDI inflows than Ghana, and why Ghana derives more benefit than The Gambia is because there are more significant positive linkages between local firms and foreign direct investors in Senegal than in Ghana and The Gambia.

6. Conclusion

In conclusion, the impact of FDI inflows on the economy of the host country depends on the linkage between foreign direct investors and local firms. In a situation where the local firms and foreign firms establish a positive linkage, the host country derives more benefit from FDI inflows this is because the local firms serve as agents of technological transfer and knowledge spillover in the host country. However, when the linkage between foreign firms and local firms is negative or FDI inflows substitute domestic investment, the host country would not be able to derive maximum benefits from FDI inflows and in the worst-case scenario FDI inflows could hurt per growth as in The Gambia.

The policy implication of this is that policymakers should implement policies to ensure that the overall impact of FDI inflows remains positive when endeavouring to attract such investments. Encouraging partnerships between local and external firms by providing incentives is one such policy. For the host country to derive maximum benefit from FDI inflows, the governments of the host countries should encourage voluntary joint ventures between foreign direct investors and domestic firms. This voluntary joint venture can be promoted by giving incentives to foreign firms that formed joint ventures with domestic firms, this would ensure that foreign technologies are transferred and diffused in the host country. By fostering cooperation between domestic and foreign companies, local firms can avoid being displaced in the resident market. Furthermore, as domestic corporations learn from their foreign counterparts, they can expand their operations in the future. This expansion will result in the hiring and training of resident individuals in current foreign manufacturing practices, leading to technological improvements and expertise spillovers within the local economy. Eventually, local foreign partnerships can facilitate the transfer of technology between foreign investors and the local economy.

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