Infrastructure and Foreign Direct Investment Inflows: Evidence from Ghana

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Abstract
The main objective of the study is to examine the impact of economic and social infrastructure on FDI in flows in Ghana using the Two Stage Least Squares (2SLS) estimation technique and quarterly time series data from 1975 to 2012. The results indicate a positive and statistically significant effects of economic and social infrastructure on net FDI inflows in Ghana. While market size, trade openness and agglomeration exerted a positive and statistically significant effect on FDI inflows, inflation and external debt stocks revealed a negative effect on FDI inflows. In order to attract more FDI inflows, the study recommends an increase investment in electricity generation and educational facilities respectively to enhance economic and social infrastructure.

Keywords: Economic Infrastructure, Social Infrastructure, FDI, 2SLS, Ghana.

JEL Classification: E00, F30, H00, H54

Introduction

Background to the study

The connection between infrastructure and foreign direct investment (FDI) inflows is well known in the development literature (Anyanwu, 2012; Asiedu, 2002; Cheng & Kwan, 2000; Coughlin, Terza, & Arromdee, 1991; Globerman & Shapiro, 2003; Kang & Lee, 2007; Khadaroo & Seetanah, 2007; LICHAO, 2011; Wheeler & Mody, 1992). Infrastructure improve the business investment environment for FDI by subsidising the cost associated with total investment by foreign investors and thus raising the rate of return from the investment. Thus, availability of infrastructure such as electricity generation and human capital resources directly influence the productivity and thereby attract higher levels of FDI.

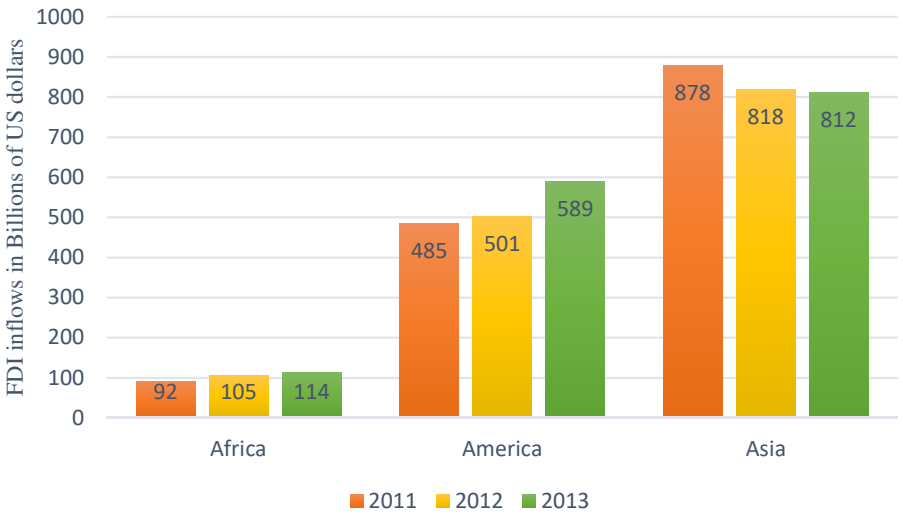
Over the past decades, there has been a substantial increase in FDI inflows to developing countries. The role of FDI as a source of private external finance to developing countries has become increasingly important. It helps to transfer knowledge and to invest in technology and infrastructure development in host countries (Dupasquier and Osakwe, 2006; Anyanwu, 2012). More so, FDI inflows bridges the gap between the desired and the actual level of capital stock, especially when domestic savings and investment are not enough to push the actual capital stock up to the desired level. In view of this, many international development agencies, such as the World Bank, consider FDI as one of the most effective tools in the global fight against poverty, and therefore actively encourage poor countries to pursue policies that will encourage FDI inflows.

Empirical evidence on developing countries tends to suggest that the availability and quality of economic and social infrastructure may attract FDI inflows into these countries.

Economic infrastructure in this context may include investment in electricity, roads, railways, air transport, ports and harbours and telecommunications whereas social infrastructure also includes expenditure on education, health, water supply and environmental sanitation. Foreign investors prefer to invest in economies with a well-developed network of roads, airports, water supply, environmental sanitation, uninterrupted power supply, telephones and Internet access. As indicated by Jordaan (2008) and Wheeler and Mody (1992), countries with good and well-developed infrastructure tend to increase the productivity of investments and therefore stimulates FDI flows towards the country.

Multinational corporations (MNCs) are in fact profit-seeking entities that seek to minimise the costs of doing business. If moving to a developing economy to take advantage of lower costs of doing business means higher transactional and operational costs due to inadequate and unreliable economic and social infrastructure, then these corporations will not choose to do business in a host country with poor infrastructure. Thus, both economic and social infrastructure contribute to firms cost structures and hence should be included in a model that explains the multinationals as well as the host government's decision for investment.

Despite the growing importance of FDI inflows as indicated above, Africa has never been a major recipient of FDI inflows and still lags that of other developing economies (see Figure 1). Moreover, on an annual average basis, the region's share of global FDI inflows was 2.6 percent in the period 1980-89; 1.9 percent in the period 1990-1999 and 3.2 percent in the period 2000-2009. During the same periods, the Asian region for example received FDI inflows averaging 14.2 percent, 19.1 percent, and 19.1 percent of total global inflows, respectively (Anyanwu, 2012).



Developing economics in Africa, America and Asia

Figure 1: FDI inflows to developing economies, by major regions, 2011–2013 (Billions of US dollars). Source: (UNCTAD, 2014).

In addition, until the mid-1990s, Sub-Saharan Africa (SSA) received only a small share of FDI relative to other developing regions of the world. Official lending to most developing countries particularly to SSA has reduced substantially over the years (Asiedu, 2002).

Furthermore, World Bank (2006) report indicate that foreign aid and official assistant per capita to the region declined from an average of $35 billion over 1989-92 to about $28 billion over 1993-97 and even further down in the 21st century (UNCTAD, 2006). In view of this, developing countries find it very essential to attract and increase their share of FDI in order to make up for the decline in official lending reaching $238 billion in 2005 (UNCTAD, 2006).

Among various key factors that influence FDI inflows, economic and social infrastructure development are widely considered as crucial factors influencing the desirability of investment location. The examination of the role of these infrastructure components is important particularly for middle income economies, such as Ghana, since developing both economic and social infrastructure is one of the main processes to attract foreign investments.

Infrastructure in most African countries and particularly in Ghana is underdeveloped. Although the country has gone far in terms of economic and political stability she is considered as infrastructure deficient in almost all sectors of the economy. According to Ghana Statistical Service (2014), although the country recorded Gross domestic product (GDP) growth rate averaging 6.9 percent in 2014, this seemingly impressive growth has however not translated into the provision of needed economic and social infrastructure that will play the crucial role of attracting FDI inflows. For example, poor road networks, schools under trees, intermittent and unreliable power supply and water crisis emerge as some of the most limiting factors negatively weighing foreign investment. Thus, both economic and social infrastructure constraint in Ghana presents a major threat to foreign investment and international competitiveness given the close link between the availability of these infrastructure components and net FDI inflows.

Similarly, FDI trends over the past years for Ghana have not been sustained and perhaps one plausible reason for such a decline in FDI inflows has been due to inadequate and poor economic and social infrastructure development. Ghana has not been able to realise the benefits that a more stable inflows of investments could bring (UNCTAD, 2006). FDI flows to Ghana can at best be described as erratic and at worst insignificant to stimulate and sustain economic growth. Between 1993 and 2005, annual FDI inflows fluctuated between US $50 million and US $250 million (UNCTAD, 2006). Also, FDI inflows as a percentage of gross fixed capital formation (GFCF) to Ghana stood at 56.6 percent in 2009, declining to 36.0 percent in year 2010. It decreased further to 31.7 percent in 2011 and then to 30.9 percent in 2012 (UNCTAD, 2013). The declining trend in net FDI inflows coupled with huge economic and social infrastructural gap in Ghana calls for the need to critically analyse the relationship between these infrastructure components and net FDI inflows.

Statement of the problem

Ghana currently ranks far behind the best performing countries in Africa in terms of quality of infrastructure (African Development Bank, 2012). A recent study carried out by the Ministry of Finance (2014) to address Ghana's infrastructure deficit shows the country requires sustained spending of at least USD 1.5 billion per annum over the decade to plug economic and social infrastructure gap that exit in the country. Another report by the Africa Infrastructure Country Diagnostic (2010) shows that though the country is doing quite well economically, there remain serious shortfalls in the provision of both economic and social infrastructure. Total government expenditure in terms of acquiring new infrastructure and maintaining existing infrastructure stock has not been encouraging for some time. For instance, African Economic Outlook (2014) report indicates that Ghana's recurrent expenditure account for about 80 percent of the country's public expenditure while spending on infrastructure ranks the least at around 5

percent. Even when huge government budget is allocated to provide and develop infrastructure, there is also lack of proper maintenance culture. That is, we allow infrastructure to deteriorate before they are repaired.

The net FDI inflow to Ghana in recent times continues to show declining trend. For example, FDI inflows to Ghana declined during the first half of 2013 when compared to the same period in 2012. The country's FDI inflow decreased to 1.2 billion dollars in 2013, slightly lower than last 1.6 billion dollars in 2012 (GIPC, 2013). More so, the latest Global investment trends monitored by the UNCTAD indicated that net FDI inflow to Ghana has also declined by 11 percent in 2013. Meanwhile, FDI flows to Africa decreased by 5 percent in the first half of 2013, compared to the same period in 2012. One plausible reason for such a decline in FDI inflows perhaps may be due to inadequate and poor infrastructure situation in the country. A recent World Bank Enterprise Survey (2013) in Ghana has also revealed that infrastructure is one of the dominant barriers to foreign investors and development.

Economic and social infrastructure constraint in Ghana presents a major threat to foreign investment and international competitiveness given the close link between the availability of these infrastructure components and net FDI inflow. In adequate infrastructure situation in Ghana therefore undermine foreign investment that is required to harness growth, diversify the economy and to create employment opportunities. The devastating effect of Ghana's inadequate and poor economic and social infrastructure has led to declining FDI inflows, reduction in export performance, increased imports, high price levels, balance of payment problems, increased unemployment and increased poverty levels.

A lot of empirical studies have put much emphasis on the role of infrastructure in attracting FDI to SSA, emerging and developed economies. Furthermore, most of these studies have shown the clear evidence supporting that highly developed infrastructure would play a crucial role in attracting FDI inflows (Cheng & Kwan; 2000, LICHAO; 2011, Wheeler & Mody; 1992, Asiedu; 2002, Khadaroo & Seetanah; 2007). Almost all these studies seem to focus much on the contribution of transport, road and communication infrastructure in attracting FDI. All these measurement focus on the economic aspect of infrastructure. But very little is known about the contribution of social infrastructure in driving FDI inflows. Furthermore, given the fact that recently net FDI inflows to Ghana is declining amid huge economic and social infrastructure deficit calls for the need to examine the impact of both economic and social infrastructure on FDI inflows in Ghana.

Objectives of the study

The borad objective of this study was to investigate the effects of infrastructure on FDI inflow to Ghana.

Specifically, the study sought to:

- Examine the effects of economic infrastructure on FDI inflows in Ghana.
- Examine the effects of social infrastructure on FDI inflows in Ghana.
- Determine the differential effects of both economic and social infrastructure on FDI inflows.

Hypotheses of the study

The study sought to test the following hypotheses in line with the outlined objectives:

- H_0: There is no positive relationship between economic infrastructure and FDI inflows.

H_A: There is a positive relationship between economic infrastructure and FDI inflows

- H_0: There is no positive relationship between social infrastructure and FDI inflows.
  H_A: There is a positive relationship between social infrastructure and FDI inflows.
- H_0: There are no differential effects of both economic and social infrastructure on FDI inflows.
- H_A: There are differential effects of both economic and social infrastructure on FDI inflows.

Significance of the study

The significance of this study cannot be overemphasised when in recent times Ghana is faced with the problem of FDI decline and infrastructure deficit. This study contributes to empirical literature because it is the first study examine the impact of both economic and social infrastructure on FDI inflows in Ghana. Policy makers and budget analyst could use the outcome of this study to make informed decisions. Also, the study can also serve as a basis for further research.

Review of empirical literature

A lot of researchers have examined the infrastructure-FDI nexus for cross country, developed countries and developing economies using varying estimation approaches. However, there are few widely agreed on results. This section therefore reviewed several empirical literatures specifically on the relationship between infrastructure and FDI.

To begin with, the first comprehensive study on the relationship between infrastructure and foreign direct investment was conducted by Cheng and Kwan (2000) using a self-reinforcing model of FDI, these researchers employed a dynamic model of foreign investment and used a Generalised Method of Moment (GMM) estimator to examine the impact of infrastructure on the stock of FDI. They selected 29 Chinese regions from the period of 1985 to 1995. Their findings support that good infrastructure (density of roads) had a positive effect on location attractiveness and leads to higher FDI inflows. They concluded that quality of the roads, however, did not seem to matter much, that is, high-grade paved roads did not perform any better than all roads in determining which regions hosted the most FDI. They also concluded that differences in transport and communications infrastructure affect the location decisions of MNCs at both country and intra-country levels.

More so, Khadaroo and Seetanah (2007) conducted a study on the role of transport infrastructure in attracting FDI in 25 African economies. Their study innovatively addressed the hypothesised link in a dynamic panel data framework using the Generalised Method of Moments (GMM) methodology and crucially testing for panel unit root. They also used the length of paved roads per square kilometre of area to measure transport infrastructure. The results from the analysis shows that transportation capital has been an important ingredient in making the countries attractive to foreign direct investors in both the short and long run.

Moreover, Anyanwu (2012) considers whether infrastructure play a role as FDI force in some selected African countries. The data set for the empirical analysis consist of annual data from 1996 to 2008 for 53 Africa countries. Fixed telephone lines and mobile phones subscribers (per 1000 people) were used as a measure for infrastructure. With regards to the estimation the study performed different empirical techniques to strengthen their empirical results. First, he

performed robust pooled ordinary least squares (OLS). Second, feasible generalised least squares (FGLS) was conducted for the cross-sectional time series linear model. Lastly, two-step (IV) efficient generalised method of moments (GMM) was also adopted to deal with any possible endogeneity problem. The conclusion from the study was that infrastructure has positive and statistically significant effect in attracting FDI for East and Southern Africa sub regions.

Although the above studies (Anyanwu; 2012, Cheng & Kwan; 2000, Khadaroo & Seetanah; 2007) have examined the effects infrastructure on FDI, their measurement of infrastructure only measure economic or physical infrastructure. These studies did not adequately address the contribution of social infrastructure and how its impact on FDI.

Another study by Fung, Garcia-Herrero, Iizaka and Siu (2005) examined whether hard infrastructure, in the form of more highways and railroads, or soft infrastructure, in the form of more transparent institutions and deeper reforms, leads to more FDI. Their data on FDI were sourced from the United States, Japan, Korea, Hong Kong, and Taiwan to regions of China. They found that soft infrastructure is a more important determinant of FDI than hard infrastructure.

In considering the catalysts and barriers to foreign direct investment in Ghana, Aveh and Krah (2013) tried to investigate the factors influencing FDI in the Ghanaian economy. Further, their study administered questionnaire to twenty-two Chief Executive officers of Multinational Companies operating in banking, telecommunication, mining, oil and gas sectors of the Ghanaian economy. The result from the study indicates that several factors influence or inhibit FDI in the economy and these factors include, among others, poor ICT infrastructure, lack of reliable supply of water and energy, and poor road network as the very important factors that inhibit inflows of FDI into Ghana.

In addition to the above, a study by Alavinasab (2013) aims at examining the relationship between infrastructure and FDI inflows in Iran for the period of 1991-2009. Simple econometric model and least squares technique were used to determine the effect of infrastructure on FDI inflows. The study also used paved roads as a measure of infrastructure. Result found indicates the positive significant effects of infrastructure on FDI. The positive significant relationship between infrastructure and FDI implies that development of infrastructure promotes FDI inflows to the country. In addition, FDI investors normally looking for a location that is available and convenient in infrastructure such as road, telecommunication, transportation. Thus, if a location is well-developed, investors can reduce their production cost and then increase their profits. Although the study by Alavinsaab (2013) engender interesting result, the study suffers from endogeneity problems because OLS estimation failed to address this problem. In addition, the data coverage of 19 years used for the study was small and could affect the results of the study.

Another study by Rehman, Ilyas, Alam and Akram (2011) also analyses the impact of infrastructure on Foreign Direct Investment in Pakistan. The study employs autoregressive distributed lag (ARDL) approach to cointegration and an error correction model based on ARDL approach using time series data for the period 1975-2008 in case of Pakistan. In addition, their study reveals a strong positive impact of infrastructure in attracting foreign direct investment both in the short and long run in the case of Pakistan.

Further Zeb and Muhammad (2014) also conducted a study on the relationship between communication infrastructure and foreign direct investment (FDI) in Pakistan. The study basically explored the role of infrastructure availability, particularly with respect to telecommunication in stimulating FDI inflows in Pakistan. Mobile cellular subscription was used as a proxy variable for communication infrastructure. Again, the study covers the time period from 1990 to 2012 since mobile cellular service was introduced in 1990s in Pakistan for the first

time. In addition, Johansen test of Co-integration was used to check for the long run relationship between the variables and then ordinary least square technique was applied to estimate the coefficients of all the variables. The results of empirical analysis indicated that there is long run relationship and positive significant effect of infrastructure in attracting FDI to Pakistan. That is, one percent increase in infrastructure increases the level of FDI by almost 57 percent in Pakistan. This also confirms the importance of Infrastructure in attracting Foreign Direct Investment in Pakistan.

In their influential paper, Wheeler and Mody (1992) employed a translog specification and uses a panel of 42 countries for the period 1982-1988 to analyse the determinants of FDI. They interestingly reported that infrastructure quality (quality of transport, communications, energy infrastructure and degree of industrialisation) exhibit a high degree of statistical significance and thus have large, positive impacts (1.57 to 2.54) on investment. They concluded that high quality infrastructure is not a necessary condition for initial investment, but infrastructure improvements are required to encourage further FDI inflows. Thus, good infrastructure is a performance-related determinant for FDI and an expected feature in developed economies such as USA.

More so, a study by Suh and Boggs (2011) examined the effects of communications infrastructure on net investment inflows into developed versus emerging markets. Hypotheses were developed and tested empirically using auto-regression analysis. Data used for the study covered 38 countries (19 developing and 19 developed) over a ten-year period (1995-2004). Findings are consistent with the view that research models of the drivers of investment inflows should consider infrastructure development, different time frames. Communications infrastructure influences a country's ability to attract foreign investment. The study also concluded that managers should carefully examine the information and communications technology (ICT) infrastructure before investing in foreign countries to determine suitability to supporting achievement of company objectives. That is, policy makers that wish to attract foreign investment should strengthen country ICT capacity and, especially for emerging economies, complementary capabilities and telecommunications utilisation.

A study by Nunnenkamp and Stracke (2007) also examined foreign direct investment in Post-Reform India. Their study looked at the correlation between FDI and infrastructure. Length of roads and electricity supply (KWh) were used as the proxies for transport infrastructure and electricity infrastructure respectively in the study. In line with the bivariate correlations, FDI is more strongly correlated with transport infrastructure than with the supply of electricity. More so, the coefficient of roads is significant in all the three estimations at the 10 percent level or better with an elasticity of 0.6 – 0.7. Though coefficient for electricity supply was weak, it was also significant at 10 percent level.

Furthermore, studies investigating the role of infrastructure in attracting net FDI inflows in the African context have been very scarce and among the rare one features Asiedu (2002) who analysed 34 countries Africa over the period 1980-2000. Using the number of telephones per 1000 population to measure infrastructure development and controlling for classical FDI determinants she came out with the conclusion that countries that improved their infrastructure were “rewarded” with more investments. Specifically, the study suggested that a one unit increase in infrastructure was estimated to lead to a 1.12 percent increase in FDI/GDP in the 1980s. However, the use of telephones per 1000 population as a proxy of infrastructure was admitted having its own limitations. First, the use of telephones per 1000 people does not always accurately reflects degree of telecommunications. There are other indicators of

telecommunication developments such as data network subscribers. Secondly, fixed lines on a country level does not indicate the breakdown of the distribution of lines into business, residential, urban and rural although this disaggregated information is available for some countries. Thus, the indicator provides no measure of the quality or reliability of the telephone service

In addition, drawing on the empirical literature on the determinants of FDI, Asiedu and Lien (2004), provides an explanation for the deterioration in SSA's global (relative) FDI position. Asiedu argues that SSA's share of FDI to developing countries has declined over time, because of the less attractiveness of SSA for FDI over time, relative to other developing regions. The study focuses on good infrastructure as FDI determinant. Telephone lines per 1000 people was adopted as a measure of infrastructure. Also, system Generalised Method of Moments (GMM) was employed as the estimation technique for the study. Since one of the objectives of this paper is to prescribe policies that will enhance SSA's global FDI position over the 1980-99 period. The main finding shows a strong positive relationship between infrastructure and FDI. Thus, from 1980-89 to 1990-99, although SSA had improved their infrastructure and this had impacted positively on FDI inflows into the region, compared with other developing regions, the degree of changes in FDI into SSA had been meagre.

Furthermore, Dupasquier and Osakwe (2006) summarise the reasons for Africa's poor FDI record, based on an overview of the empirical determinants of FDI to Africa. The aim of the paper was to identify concrete actions or strategies that need to be adopted at the national, regional and international level to enhance FDI flows to Africa. Briefly, these include among others supporting existing investors through infrastructure development. Initiating and encouraging infrastructure development projects at the regional level. They also concluded that it would be desirable for African countries to make more efforts to reduce the cost of investing in the region by investing in infrastructure

Behname (2012) conducted a study to show the relationship between FDI and urban infrastructure in Southern Asia. Panel data model was adopted to estimate the parameters for southern Asia countries. Also, before he proceeded to estimate panel data, he carried out unit root tests to examine whether the variables are stationary. The data set used covers southern Asia countries over the period 1980-2009. The study also used the number of telephones per 1,000 people as the indicator of urban infrastructure. He concluded from the study that urban infrastructure in the form of electricity, roads, phones and ports has a positive effect on FDI and therefore, governments in these zones should pay attention in this variable for FDI attraction.

Government infrastructure is an important determinant of both FDI inflows and outflows. Not only does government infrastructure attract FDI, but the proper conditions can also stimulate the creation of home-grown MNEs that invest abroad. The study by Globerman and Shapiro (2003) examine the effect of government infrastructure on both the probability that a country receives FDI and separately on the amount of FDI received (for countries receiving any FDI). They find that countries failing to achieve a minimum threshold of effective governance are unlikely to receive any US FDI. Thus, ineffective governments that failed to promote transparent markets and whose legal systems are not rooted in English law are apt to be excluded from FDI.

In addition, Gholami, Tom Lee and Heshmati (2006) uses a sample of 23 developed and developing countries observed for the period 1976 to 1999 based on ICT data availability to show that in developed countries, existing ICT infrastructure attracts FDI; a higher level of ICT investment leads to a higher level of FDI inflows but in developing countries the direction of causality goes instead from FDI to ICT.

In order to achieve a better understanding of how Middle East and North Africa (MENA) economies may attract FDI, Kozlova and Smajlovic, (2008) examined whether infrastructure have significant effect in attracting foreign direct investment (FDI) inflows in the MENA region. Eighteen countries were sampled for the period 1996-2006. The analysis of the study was done using OLS regression method. Also, the examined empirical model of the study was based on the eclectic theory developed by John Dunning and the previous empirical studies. The results of the regression analysis show that physical infrastructure is significant in attraction of FDI in the MENA countries.

Broadman and Sun (1997) used 882 Chinese provincial data to also examine the relationship between Social infrastructure and FDI inflows. The objective of their study was to examine what infrastructural factors can effectively contribute to more FDI flows to the Chinese hinterland. That is, will the economic infrastructure dominate the game or the social infrastructure factors can also contribute to the FDI flows? Their methods of estimation were pooled OLS and random effect generalised least squares. Also, in their study, they used the number of students enrolled in third level education per 10 thousand people to measure social infrastructure. The results from the study confirmed that provincial illiteracy was found to be a statistically significant negative determinant of FDI.

The empirical work by Anwar and Nguyen (2010) examined the relationship between infrastructure and foreign direct investment in Vietnam. They sent 300 foreign investors in many provinces in Vietnam to study which factors in addition to infrastructure drives more foreign investors into Vietnam. Out of the 300, 258 foreign investors responded. The result from their survey showed that infrastructure is the most important factor which attracts FDI. It accounted for 47.8%. Other determining factors of FDI accounted for the remaining.

A study by Tsen (2005) investigated the location theory of FDI particularly the relationship between infrastructure and FDI in the manufacturing industry of Malaysia using time series data from 1980 to 2002. The cointegration analysis was adopted to investigate the long run relationship between FDI and infrastructure. The study finds a positive relationship between infrastructure and FDI. The study concluded that an increase in infrastructure leads to an increase in FDI flows in Malaysia. The time series data coverage used for study even though generated good results, it is still limited because the data coverage of 23 years is small and could decrease the robustness of the estimation.

LICHAO (2011) also conducted a regional analysis study on the role of transport infrastructure in attracting FDI in China. The objective of the study was to investigate the relative importance of transport infrastructure in attracting FDI to three different regions in China based on 28 Chinese provincial economies from 1995 to 2008. Using fixed effect panel data approach, transport infrastructure was seen to have contributed to the relative attractiveness of the provinces, especially in west and middle regions, while the effect is not significant in the east region. More so, the impact of other forms of infrastructure, such as telecommunication infrastructure, seems to exhibit similar positive impact, though to a lesser extent. The study also concluded that the extent and presence of good transport infrastructure in neighbouring provinces have a significantly positive impact on local FDI decision.

More so, Kinoshita and Campos (2003), using survey data to study the locational determinants of foreign direct investment (FDI) by Japanese manufacturing firms in seven Asian countries, subsequently reported that infrastructure encourage firms to invest in a certain country with a reported regression coefficient of 0.2. The study further employed the Generalised

Method of Moments (GMM) Instrumental Variable estimator for dynamic panels. The study used the number of main telephone lines (TELEPHON) as the infrastructure variable.

Not only this but also, as indicated by Kumar (2001), using a composite index of infrastructure availability for the case of 66 countries, came out with the conclusion that multinational enterprises decision making pertaining to location of product mandates for global or regional markets sourcing is significantly influenced from infrastructure availability (with an infrastructure coefficient varying between 0.6 and 1.5) considerations and that infrastructure development should become an integral part of the strategy to attract FDI inflows in general. Even though the conclusion from the study is quite interesting however, the use of composite index analysis failed to explicitly come out which components of infrastructure that should be developed to increase FDI.

Another study by Kingsley (2012) examined the role infrastructural development in addition to other variables on FDI inflows into Nigerian economy for the period of 1986 to 2009. Expenditure on economic services was used as a proxy for infrastructural development. In addition, Ordinary Least Square (OLS) multiple regression, unit root, cointegration, and Granger causality test were used to analyse the data. The results showed that infrastructure have positive effect on FDI although their effects are not statistically significant. The granger causality test shows that there is uni-directional relationship between infrastructure and FDI in Nigeria. It was found that infrastructural development in Nigeria granger causes foreign direct investment. Also, effort should be made to improve the state of infrastructure in Nigeria via judicious utilisation of expenditure on public services in order to guarantee desired and optimal FDI inflows into Nigeria. Even though the study produced interesting result for the Nigeria economy, it is limited in terms of data coverage. Using a time series of data of 24 years is not adequate and this can affect the robustness of the estimates. Employing the cointegration estimation is quite good for long run analysis however, employing the OLS is fraught with the endogeneity problem between infrastructure and FDI and hence can adversely affect the results.

Sekkat and Veganzones-Varoudakis (2004) estimated a correlation coefficient for infrastructure of 0.45 for the case of Middle East and North African (MENA) countries the 1990s with a lower correlation coefficient of 0.21 for the case of the manufacturing sector. They reported that in the 1990s, if the MENA countries had increased their infrastructures to the level of the East Asian economies, FDI flows could have reached 2.5 percent of GDP (compared to 1.2 percent). The methodology of the study is limited to some extent because the use of correlation does not tell the exact marginal effect that infrastructure should be infrastructure be increased to attract some percentage of FDI inflows. The study should have employed the GMM which is superior to the ordinary correlation analysis.

While most studies found the importance of infrastructure for FDI, there are also other studies which failed to validate the hypothesis. For instance, Quazi (2007), on the other hand, could not established positive and significant relationship between infrastructure (measured as the number of telephones per 1,000 people) and FDI using panel data from 1995-2000 for a sample of seven Latin American countries. The authors however admitted that ‘it is plausible that their proxy variables - the natural log of the number of telephones available per 1,000 people and the adult literacy rates, respectively, perhaps inadequately capture their true effects on FDI’.

In conclusion, most of the studies reviewed above concentrated on cross country study on developed and developing countries (Wheeler & Mody 1992, Asiedu 2002, Khadaroo & Seetanah 2007, Anyanwu 2012, Cheng & Kwan, 2000, Fung et al 2005). Almost all these studies use telephone lines per 1000 people, road density, transport to measure infrastructure. These

measurement focus much on economic aspect of infrastructure and not measure the social aspect of infrastructure. To the best of my knowledge, there is no particular study in Ghana that helps to investigate the role infrastructure in attracting FDI inflows and the very little studies in the literature that were country-specific used either the OLS or ARDL estimation technique and also employed small sample size for the estimation. The use of OLS is deficient because of its inability to solve the endogeneity problem between infrastructure and FDI. This current study fills these gaps in the literature by employing a new estimation technique (2SLS) and a larger sample size to examine the effect both economic and social infrastructure on FDI.

Methodology

Introduction

This chapter is to present the methodological framework suitable for carrying out this study. Specifically, the chapter presents a detailed description of the theoretical and empirical specification of the model, definition, measurement and justification of the variables in the model, data source, estimation technique and data analysis.

Research design

It is crucial to come out with the research design in a study. It influences the perspective of researchers about the selection of research problems and generally results in the choice of methods to accomplish the research purpose (Saunders, Lewis & Thornhill, 1997).The study is situated within the context and assumptions of positivist philosophy which support the use of quantitative method. The positivist philosophy basically assumes that objective knowledge systematically pursued by researchers is based on general causal laws. The positivist philosophy also assumes that as knowledge is externally objective, researchers take strictly neutral and detached positions towards the phenomenon under investigation. It ensures that personal biases of the researcher do not influence outcome of the study.

The study seeks to examine the effects of both economic and social infrastructure on FDI inflows and to investigate the differential effects of both economic and social infrastructure on FDI inflows in Ghana. Based on both quantitative and econometric methods, hypotheses of study were either rejected or confirmed. According to the positivistic philosophical approach, results of this study therefore are objective to explain the relationship for Ghana. The external validity of the study is the degree to which study accurately answers the question it was intended to answer (i.e. to determine whether infrastructure affect FDI inflows in Ghana). Internal validity is achieved when the study produces a single, unambiguous explanation for the relationship between infrastructure and FDI inflows indicators used in the study. External validity is also concerned with whether the study's findings can be generalised to a comparable unit of analysis or other developing countries.

Theoretical model specification

The choice of location for investment depends on the stream of returns in the long run which is largely determined by location specific potential to convert the investment into returns. This means that, in order to derive the theoretical model on the determinants of FDI inflows, it is important to define an appropriate functional form of conversion of investment into returns.

Following Griffiths and Webster (2004), let us define the expected return from investment (R_t) as,

$$R_t = \varphi_t \left[\tau_t \, ln \, (FDI_t) + \gamma\right] \quad (1)$$

Here, FDI_t is the amount of FDI inflows into Ghana, φ_t is the return per unit of realised output from FDI in Ghana and τ_t represents Ghana's potential to convert FDI into output, t represent years, given γ as the threshold output which is constant across all the regions in Ghana. Therefore, the present value of expected return from investment PVR_t will be;

$$PVR_t = \frac{\varphi_t \left[\tau_t \; ln \, (FDI_t) + \gamma\right]}{(X_t + r)} \quad (2)$$

Here, X_t stands for the risks of investing in Ghana and r for the rate of discount constant for all regions in Ghana. Similarly, the present value of the recurring expenses of investment will be:

$$C_t = \frac{\mu FDI_t}{(X_t + r)} \quad (3)$$

Here, μ stands for the proportional factor and it is assumed to be constant across all regions in Ghana. If the investors decide to make investment to the maximum amount of FDI_0 in Ghana, then the actual investment will be FDI_t will be either less than or equal to FDI_0, i.e.

$$FDI_0 \geq FDI_t \; or \; FDI_0 - FDI_t \geq 0$$

Therefore, the objective of the investors is to decide FDI_t so that the net expected return (NER) at time t becomes:

$$NER_t = \frac{\varphi_t \left[\tau_t \; ln \, (FDI_t) + \gamma\right]}{(X_t + r)} - \frac{\mu FDI_t}{(X_t + r)}$$

The objective of the investor is to maximise NER_t subject to $FDI_0 - FDI_t \geq 0$, Hence, the problem of the potential investor can be written in Lagrange expression as follows:

$$L = \frac{\varphi_t \left[\tau_t \, ln \, (FDI_t) + \gamma\right]}{(X_t + r)} - \frac{\mu FDI_t}{(X_t + r)} + \lambda(\, FDI_0 - FDI_t) \quad (4)$$

By applying Kuhn-Tucker conditions the constrained optimisation becomes,

$$FDI_t = \frac{\varphi_t \tau_t}{[\mu + \lambda(x_t + r)]} \quad (5)$$

If the rate of discount 'r' is uniform across all regions, (5) can be expressed as the following functional relationship,

$$FDI_t = f(\tau_t, \varphi_t, x_t) \quad (6)$$

$$\frac{\partial FDI_t}{\partial \tau_t} > 0, \frac{\partial FDI_t}{\partial \varphi_t} > 0, \; and \; \frac{\partial FDI_t}{\partial x_t} < 0$$

This means that the optimum investment in Ghana varies directly with the country's potential to convert FDI into output, return per unit of realised output, but inversely with the risks of investment in Ghana. Ghana's ability to convert FDI into returns is likely to depend on availability of economic and social infrastructure, the scope for investment therein and the technology frontier. Economic and social infrastructure in this study are captured in the τ_t since

well-developed infrastructure in Ghana will not only serve as catalyst for attracting FDI but will also ensure increases in output of the investor. Again, a well-developed market size and trade openness are expected to impact positively on FDI therefore these variables are also captured in τ_t.

Empirical model specification

Therefore, from equation (6) τ_t becomes;

$$\begin{aligned}\tau_t &= \emptyset(Econinfra_t, Socinfra_t, Size_t, Opn_t) \\ &= \emptyset\,(Econinfra_t^{\beta_1}\, Socinfra_t^{\beta_2}\, Size_t^{\beta_3}\; OPN_t^{\beta_4}) \end{aligned} \qquad (7)$$

To further augment the model, the study assume that inflation (Inf_t) and external debt stocks (Ex_debt_t) are considered as risk to the investing environment and hence were captured in x_t. Therefore, by adding Inf_t and Ex_debt_t to those variables contained in τ_t and also by adapting equation (6), a new expression is obtained for FDI in equation (8);

$$FDI_t = f(Econinfra_t^{\beta_1}\; Socinfra_t^{\beta_2}\, Size_t^{\beta_3}\; Opn_t^{\beta_4}\, Inf_t^{\beta_5}\, Ex\_debt_t^{\beta_6}) \qquad (8)$$

By taking log of equation (8) and including both first and second lags of FDI inflows equation (9) is obtained. Again, if we further assume that there exists linearity in the relationships, the above functional relationship can be rewritten as;

$$\begin{aligned} ln\, FDI_t = {} & \beta_0 + \beta_1 lnEcoinfra_t + \beta_2 lnSocinfra_t + \beta_3 lnSize_t + \beta_4 Opn_t + \\ & \beta_5 Inf_t + \beta_6 lnEx\_debt_t + \beta_7 lnFDI_{t-1} + \beta_8 lnFDI_{t-2} + \varepsilon_t \end{aligned} \qquad (9)$$

Where FDI represents foreign direct investment inflows, *Econinfra* is the economic infrastructure, *Socinfra* measures social infrastructure, Size measures market size, Opn measures trade openness, *Inf* measures inflation, Ex_debt measures external debt, FDI_{t-1} and FDI_{t-2} are the first and second lags of foreign direct investment respectively. The inclusion of the lagged values of FDI helps to determine how previous FDI inflows impacts on current FDI inflows and this is what Anyanwu (2012) termed as the agglomeration effects. Also, inclusion of the lagged dependent variable in the regression model helps to avoid misspecification and serial correlation Baltagi, Jung and Song (2010).
Also ln represents natural logarithm, t denotes time and ε_t stands for the random disturbance term. The slope coefficients $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7\ and\ \beta_8$ measures the elasticities and β_0, is the intercepts parameter.

Empirical research has shown that both economic and social infrastructure act as prerequisite for the establishment of FDI projects (Asiedu 2002; Cheng & Kwan 2000; Khadaroo & Setenaah, 2007). That is, a good and available infrastructure have positive effect on attracting FDI inflows. Other researchers (Kirkpatrick, Parker & Zhang, 2006; World Bank 2006) have shown that FDI inflows can also have significant effect in developing country's infrastructure. Therefore, one can conclude that there exists a bi-causal relationship between infrastructure and FDI inflows. This leads to an endogeneity problem in the structural equation (9). Hence, if

equation (9) is estimated by the traditional Ordinary Least Squares (OLS) approach, a biased and inconsistent estimates will be obtained due to the likely correlation between the stochastic explanatory variables $Ecoinfra_t$ and $Socinfra_t$ and the stochastic disturbance term ε_t.

Because OLS estimation of equation (9) cannot resolve the possible endogeneity problem, the study employs a more appropriate estimation technique, the Two Stage Least Squares (2SLS) developed independently by Theil (1953) and Basmann (1957) yields a consistent estimates than the OLS does. Therefore, from the structural equation (9), both economic and social infrastructure are considered as an endogenous explanatory variable in the FDI regression and external instruments are therefore needed to correct for this endogeneity problem using two-stage estimation procedure.

The first stage of 2SLS

In the first stage of 2SLS, both economic and social infrastructure are regressed on a set of exogenous and predetermined variables including the external instrumental variables that affect infrastructure, but do not directly affect FDI. With regards to the choice of instruments, the study observed the conditions underlying the choice of an instrument (i.e. instrument validity and relevance) and came out with appropriate instrument for both economic and social infrastructure. Since the study proxied economic infrastructure by electricity production (kWh), therefore the study followed the literature such as Jaramillo, Griffin and Matthews (2007) and used world natural gas production as an instrument for electricity production (economic infrastructure) in the first stage equation. The use natural gas is seen as a good source of electricity supply for several economic, operational and environmental reasons: it is low-risk (technically and financially) and lower-carbon relative to other fossil fuels. Electric power generation remains the main driver behind global natural gas demand growth and the growth in natural gas is expected to occur in every region and is most concentrated in developing countries, where demand increases more than twice as fast as in developed countries. Furthermore, natural gas is expected to be the world's fastest growing fossil fuel, with consumption increasing at an average rate of 1.5 percent per year to 2040. In view of the above, using world natural gas production to measure electricity generation is justified (International Energy Agency, 2013).

Also, with regards to social infrastructure, the study used secondary school enrolment (number of students) to measure social infrastructure. Hence to get a good instruments for social infrastructure, the study reviewed the work by Ahiakpor, Nunoo and Alnaa (2014) and used fertility rate per woman to measure social infrastructure. Whiles increase in fertility is expected to have positive effect on enrolment, it can also have negative effect on schooling. That is, increase in the number of children in each household is expected to lead to an increase in household expenditure which makes it difficult for households to have excess to money to spend on children's education and therefore leading to low school enrolment. Similarly, as indicated by Child Trends Databank (2015) sustained high fertility rates lead to disproportionately large populations of young dependents, driving demand for supports for young families and for an adequate number of schools. As a result, the use of fertility rate to measure schooling in this study is also justified in the literature. Based on the structural equation (9), the first stage equations (or the reduced form equation) for both economic and social infrastructure in the 2SLS are specified below:

$$lnEcoinfra_t = \alpha_0 + \alpha_1 lnSize_t + \alpha_2 Opn_t + \alpha_3 Inf_t + \alpha_4 lnEx\_debt_t + \alpha_5 lnfdi_{t-1} + \alpha_6 lnfdi_{t-2} + \alpha_7 lnWNGP_t + \alpha_8 fert_t + \nu_t \quad (10)$$

$$lnSocinfra_t = \eta_0 + \eta_1 lnSize_t + \eta_2 Opn_t + \eta_3 lnf_t + \eta_4 lnEx\_debt_t + \eta_5 lnfdi_{t-1} + \alpha_6 lnfdi_{t-2} + \eta_6 lnWNGP_t + \eta_9 fert_t + \upsilon_t \quad (11)$$

Where $WNGP$ indicates world natural gas production which act as external instrument for economic infrastructure, $fert$ indicate fertility rate per woman respectively which also act as external instruments for social infrastructure, ν_t and υ_t are the error terms from the first stage regression. All other variables have been defined already. Also according to Wooldridge (2005), instruments should satisfy the following assumptions: (1) the instruments in the equation (10) and (11) must be uncorrelated with ε_t. (2) $WNGP$ must correlate with economic infrastructure and $fert$ must also correlate with social infrastructure. To ensure that these conditions are satisfied, the study regress both economic and social infrastructure on only their instrument and the control variables which were assumed to be exogenous.

The second-stage equation

In the second stage, the predicted values of both economic and social infrastructure enter equation (9) as one of the regressors (exogenous) variables of the FDI inflows.

$$ln\ FDI_t = \pi_0 + \pi_1 lnEcon\widehat{infra}_t + \pi_2 lnSoc\widehat{infra}_t + \pi_3 lnSize_t + \pi_4 Opn_t + \pi_5 Inf_t + \pi_6 lnEx\_debt_t + \pi_7 lnFDI_{t-1} + \pi_8 lnFDI_{t-2} + \varepsilon_t \quad (12)$$

Where $Econ\widehat{infra}_t$ and $Soc\widehat{infra}_t$ are the predicted values for economic and social infrastructure respectively at time t from the first stage OLS estimation. The following are the a priori expected signs of the variables in equation (12); $\pi_1 > 0,\ \pi_2 > 0,\ \pi_3 > 0, \pi_4 >$ or $< 0,$ $\pi_5 < 0\ or > 0,\ \pi_6 < 0, \pi_7 > 0, \pi_8 > 0$

Definition, measurement and justification of variables

Economic infrastructure *(Econinfra)*

Economic infrastructure is defined as internal facilities of a country that promote economic or business activity such as electricity production, roads network, ports, communication and financial institutions. Economic infrastructure is one of the variable central to this study. Although there are different ways for measuring economic infrastructure, this study used electricity production (kWh) to capture for economic infrastructure. Using electricity production as a proxy for measuring economic infrastructure is vital to nearly all long-term capital development projects (Amaro & Miles, 2006; Wheeler & Mody, 1992). The measure of economic infrastructure used in the study is an aggregation of all national source of electricity production. Again, the measure is justified in the sense that alternative infrastructure metrics fail to define the quality of such factors. For instance, a measure of road network in terms of mileage fails to define whether the road system is congested or limited to single or multi-lane thoroughfares, regardless of road surface quality. Therefore, this measure of economic infrastructure used for the study is an aggregate of all-source electricity production (includes hydro, nuclear, coal, crude oil and fossil fuel) measured in kilowatt-hours. Access to sufficient and consistent electricity supply, intuitively, are of importance to foreign investors, particularly when considering plant and factory demands placed up on the national electric grid (Wheeler and

Mody, 1992). Availability of economic infrastructure in addition to other infrastructural variables is instrumental for bringing in private investment whereas shortage of it is likely to restrict investment inflows (Archana & Basu, 2014; De & Ghosh, 2005). The coefficient of economic infrastructure is expected to be positively related to FDI inflows.

Social infrastructure *(Socinfra)*

Social infrastructure are facilities in the community such as schools, libraries, health facilities, cultural and religious facilities, open spaces and recreation. Social infrastructure also covers more on providing basic well-being facilities for the society. For instance, expenditure on social (schooling and hospital) infrastructure generates positive externalities by creating a healthy and educated populace which are needed to convert foreign investment into returns. The study used the secondary school enrolment in terms of the number of students as a proxy for measuring social infrastructure (Feenstra & Hanson, 1997; Noorbakhsh, Paloni & Youssef, 2001). The reason for using secondary school enrolment is that a more educated labour force can learn and adopt to new technology faster, conduct research and is generally considered to be more productive. Higher levels of social infrastructure measured by secondary enrolment are a good sign of the availability of skilled workers, which tends to boost the locational specific advantages of a country in terms of attracting FDI. The empirical studies by Moosa (2009), Root and Ahmed (1979), Schneider and Frey (1985), Borensztein, De Gregorio and Lee (1998), Noorbakhsh et al. (2001) and Aseidu (2002) found that the level of human capital is a significant determinant of the locational advantage of a host country and plays a crucial role in attracting FDI. Therefore, the study expects a positive relationship between social infrastructure and FDI inflows. That is, high levels of social infrastructure development all other things held constant, will lead to attraction of FDI inflows.

Market size *(Size)*

Another variable of interest in this study is market size. The size of the host country's market, which also indicates the host country's economic conditions and the potential demand for output play a significant role in FDI decision-makings. The empirical work by Scaperlanda and Mauer (1969) argued that FDI responds positively to the market size once it reaches a threshold level that is large enough to allow economies of scale and efficient utilisation of resources. The importance of the market size in driving FDI inflows has also been confirmed in many previous empirical studies (Kravis & Lipsey, 1982; Lipsey, 2004; Loree & Guisinger, 1995; Schneider & Frey, 1985; Wei, 2003; Wheeler & Mody, 1992). To get a good proxy for market size, the study reviewed the empirical literature and use real GDP per capita. The study expects a positive relationship between market size and FDI inflows. This implies that an improvement in the host country's market size is expected to increase FDI inflows.

Inflation *(Inf)*

Inflation basically is defined as the continuous and persistence rise in the general price levels. It does not imply an increase in price levels but rather the rate of change of the general price levels in the country. Economic theory postulates that inflation decreases the purchasing power of investors. Changes in the inflation expectation therefore affect the purchasing power of the foreign investor, hence it is expected that inflation will have effect on FDI inflows. More so, high inflation represents greater instability in many countries

(Buckley et al, 2007). That is, a volatile and unpredictable inflation rate in the host market creates uncertainty and discourages MNCs' FDI activities. Further high inflation rate devalues domestic currency and reduces the real return on investment as a result. On the other hand, a stable inflation is a measure of stable macroeconomic environment which also promotes FDI by showing less investment risk. As a result, the effect of inflation on FDI can either positive or negative. While Udoh and Egwaikhide (2008) found a statistically significant positive relationship between inflation and FDI, Djokoto and Dzeha (2012) also found a negative relationship among inflation and FDI to the agricultural sector but a positive relationship among inflation and total FDI inflows. The study used consumer price index as a measure for inflation. The coefficient of inflation in this study is expected to be positive or negative.

Trade openness (*Opn)*

Trade openness in this study followed the traditional definition that is, the ratio of the sum of exports and imports of goods and services to gross domestic product. Multinational companies prefer to locate in a country with more open investment environment (Chakrabarti, 2001). These firms assumed that imperfections of local market, for example, trade protection, will lead to rising transaction costs, which can be meliorated when the level of openness is going up. High level of trade openness also leads to more economic relations of the host countries with other foreign countries. Openness makes domestic countries have access to international markets and prepares suitable conditions for multiple countries to invest in those countries. For instance, whiles Chakrabarti (2001) and Morisset (2000) found a positive relationship between trade openness and FDI flows, De and Ghosh (2005) found an inverse relationship between trade openness and FDI. Trade openness attracts export-oriented FDI, whiles trade restriction on the other hand attracts tariff-jumping FDI whose primary interest is to take advantage of the domestic market (Onyeiwu, 2003). Trade openness in this study is expected to be either positively or negatively related to FDI.

External debts *(Ex_debt)*

From economic point of view, external debt is defined as the portion of a country's debt that was borrowed from foreign lenders including commercial banks, governments or international financial institutions. These loans, including interest, must usually be paid in the currency in which the loan was made. In other words, external debt or foreign debt is the amount of money owed by domestic government to the rest of the world. The reason for using this variable in this study is to determine the impact macroeconomic performance on FDI inflows in Ghana. A lot researchers have argued that too much dependence on external debt can negatively affect FDI inflows (Banga, 2003; Udo & Obiora, 2006). Too much external debt accumulation can negatively affect economic growth through the crowding out effect or by affecting the composition of private investment. In addition, an increasing debt service may increase the government's interest bill and the budget deficit and consequently, because the long-term interest rate to rise or simply crowd out credit available for private investment. Therefore, the coefficient of external debt is expected to carry negative sign. To capture for external debt the study used total external debts stock, concessional (DOD, Current US$).

Agglomeration effects *(fdi_{t_1}, fdi_{t_2})*

Agglomeration economies may exist given that foreign investors may be attracted to countries with more existing foreign investment. In order to test for agglomeration effects, it is

believed that the country which has FDI inflow is better in attracting new FDI inflow (Gichamo, 2012). A lot of empirical researches present evidence on the presence and importance of such a self-reinforcing effect of foreign investment. Interestingly, FDI is found to agglomerate more often than ordinary financial investment partly because FDI is a long-term capital investment that is irreversible in a short run. For example, Head, Ries and Swenson (1995) find that industry level agglomeration benefits play a significant role in the location choice of Japanese manufacturing plants in the US. More recently, Cheng and Kwan (2000) in the study of the determinants of FDI in Chinese regions also report the positive feedback effect of FDI. If there is a positive feedback effect, once the initial flow of FDI sets in, it should perpetuate itself and attract further FDI. Another study by Anyanwu (2012) found a positive relationship between current FDI inflows and previous FDI inflows among African countries. To capture for agglomeration effect, the study relates current FDI inflows to past FDI inflows. This is proxied by the first and second lagged values of FDI. The study expects the coefficient of both first and second lagged FDI variables to be positive.

Table 1: Summary of variables, sources and measurement

Variable	Measurement	Source	Sign
lnFDI	Log of Foreign direct investment, net inflows (BOP, Current US$)	WDI	
lnEconinfra	Log of Economic infrastructure measured by electricity production (kWh)	WDI	+
lnSocinfra	Log of Social infrastructure measured by secondary school enrolment (number of pupil)	WDI	+
lnSize	Log of Market size measured by GDP, (current US$)	WDI	+
Inf	Inflation measured by consumer price index	IFS	+/-
Opn	Trade openness measured by the ratio of import plus export to GDP. All values in current US$	WDI	+/-
lnEx_debt	Log of external debt measured by external debt stocks, concessional (DOD, Current US$)	WDI	+/-
$lnfdi_{t-1}$	Log of first lagged values of FDI	Author	+
$lnfdi_{t-1}$	Log of second lagged values of FDI	Author	+
lnWNGP	Log of World natural gas production (Billion Cubic Metres) used as an instrument for economic infrastructure (electricity production).	BP-Statistical Review	+
fert	Fertility rate per woman used as an instrument for social infrastructure (secondary school enrolment)	WDI	-/+

Source: Author's construct.

Type and sources of data

The study made use of quarterly data for all the variables used for the study from the period 1975:4 to 2012:4. All the data series were obtained as annually except consumer price index (2010=100) which was obtained as quarterly. A brief summary of the variables is presented in Table 1. As a result, the Gandolfo (1981) algorithm was used to interpolate the annual series into quarterly series. All variables are expressed as natural logarithms, except for inflation, trade openness and fertility rate per woman which are already in a preferred measure. The data was obtained from World Bank, IMF-International Financial Statistics and British Petroleum Statistical Review.

Estimation procedures

To test the relationship between both economic and social infrastructure and foreign direct investment inflows and to determine the differential effects of the infrastructure components on FDI inflows in Ghana, the study applied the instrumental variable (two stage least squares) estimation. The estimation procedure involves

1. First, testing the time series properties of the data by using the Augmented Dickey-Fuller (ADF) and the Phillip-Perron (PP) test. This was done by carrying out the unit root test to determine whether the variables are stationary.
2. The second step was to estimate the structural equation using OLS approach and then proceed to estimate both the first stage and second equations using the two –stage least squares (2SLS) approach.
3. Thirdly, the test of differences in coefficients was conducted to examine the differential effects of the infrastructure components on FDI.
4. Thirdly, the diagnostic test statistics of both the OLS and 2SLS model are examined to ensure the reliability and the goodness of fit of the model.

Unit roots test

Confirming the order of integration is a pre-requisite for almost all time series analysis. Time series data are mostly nonstationary in level forms and that regression involving non-stationary time series often result in the problem of spurious regression. The issue of spurious regression occurs when the regression results reveal a high and statistically significant relationship among variables when in actual sense, no relationship exist. When a time series is said to be stationary, its mean, variance and autocovariances are independent of time but because of data generating process, time series data is rarely stationary.

To test for the presence of Unit root, the study adopts both the Phillip- Perron (PP) and the Augmented Dickey- Fuller (ADF) statistic. The PP and ADF are used to determine the order of integration. This was done to ensure reliable results for the test of the stationarity as a result of the inherent individual weaknesses of the techniques. According to Cheung and Lai (1993), these two tests are similar except that they differ with respect to the way they correct for autocorrelation in the residuals and also the ADF test has low power in small sample so the study employed the PP unit roots test to check the robustness of the estimation results. The PP nonparametric test generalises the ADF procedure, allowing for less restrictive assumptions for the time series in question.

The null hypothesis that the variable under investigation has a unit root against the alternative that it does not. In each case, the lag-length is chosen using the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) for both the ADF and PP test. Both the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) or Schwarz Information Criterion (SIC) have the common objective of selecting a model that produces errors that approach a white noise process.

The ADF test does not take into consideration heteroscedasticity and non-normality and unable to discriminate between stationary and non- stationary series which are associated with high degree of autocorrelation. As a result, the PP test is adopted to deal with this problem. More so, the PP test is considered superior to the ADF test in situations where the time series variables exhibit serial correlation and structural breaks. The Phillip-Perron (PP) unit root tests differ from the ADF tests mainly in how they resolve serial correlation and heteroscedasticity in the errors. While the ADF tests use a parametric autoregressive to approximate the Autoregressive Moving Average (ARMA) structure of the errors in the test regression, the PP tests ignore any serial correlation in the test regression. Hence, the PP test can be considered as nonparametric. Further, whereas the ADF assumes the error terms are independent with a constant variance, the PP test also assumes the error terms are weakly dependent and distributed heterogeneously and thus provides robust estimates over the ADF.

The null hypothesis tested is that the series contain unit root against the alternative hypothesis that it does contain unit roots. That is, if the series has a unit root it shows that they are non-stationary and implies stationary if it does not contain any unit root. The decision rule is that, if the ADF and PP statistics in absolute terms are higher than the critical values, we fail to accept the null hypothesis and conclude that the series contains no unit root implying stationary. On the other hand, if the ADF and PP statistics are less negative than the critical values, we fail to reject the null hypothesis and conclude that the series contain unit root and is thus non-stationary.

Rank and order condition

Given that there exist G number of equations or endogenous variables and K number of exogenous variables and that the i-th equation has M variables, the order condition requires that

- If $K - M < G - 1$, then equation is underidentified and hence cannot be estimated.
- If $K - M > G - 1$, then the equation is overidentified. This equation can be estimated and may have multiples solutions
- If $K - M = G - 1$, then the equation is exactly identified and may be estimated with a unique solution.

Thus according to Wooldridge (2005), the order condition is a necessary but is backed by the rank condition, which is the sufficient condition. The rank condition requires that given a system of G equations or endogenous variables, the i-th equation is identified if it is possible to construct a one non-zero determinant from the coefficients of the variables excluded from the i-th equation.

The 2SLS model setup

The study considers a more general regression model with the scalar dependent variable y_1, which depends on the m endogenous variable, denoted by y_2 and K_1 exogenous variables (

including an intercept), also denoted by x_1. This model is specified below and it is called the structural equation:

$$y_{1t} = y'_{2t}\beta_1 + x'_{1t}\beta_2 + \epsilon_t \quad (13)$$

The error term ϵ_t is assumed to be uncorrelated with x_{1t} but are correlated with y_{2t}.This correlation leads to the OLS estimator being inconsistent for β. To obtain a consistent estimator, the study assumes the existence of at least m instrumental variables (x_2) for y_2 that satisfy the assumption that $E(\epsilon_t/x_{2t})=0$.

The instruments x_2 need to be correlated with y_2 so that they provide some information on the variables being instrumented. One way to encourage this is to assume that each component y_{2j} of y_2 satisfies the first-stage equation (i.e. the reduced-form model)

$$y_{2jt} = x'_{1t}\pi_{1j} + x'_{2t}\pi_{2j} + \epsilon_{jt}, \qquad j= 1,\ldots, m \quad (14)$$

The first -stage equations have only exogenous variables as the independent variables. The exogenous regressors x_1 in equation (13) can serve as instruments for themselves. Generally, with m number of endogenous regressors, the study needs at least m additional instruments x_2.This sometimes can be difficult in the sense that x_2 needs to be a variable that can be legitimately excluded from the structural model (13) for y_1. By simplifying equation (13), we obtain equation (15):

$$y_t = x'_t\beta + \epsilon_t \quad (15)$$

Where the regressors' vector $x'_t = [y'_{2t}\ x'_{1t}\ ]$ includes endogenous and exogenous variables and the dependent variable is denoted by y_t. Similarly, a set of instruments is combined for these variables. The vector of instrument becomes $z'_t=[x'_{1t}\ x'_{2t}]$, here the variable x_1 serves as an ideal instrument for itself and x_2 is the instrument for the endogenous variables y_2 and the instruments z satisfy the conditional moment restriction $E(\epsilon_t/z_t)=0$. In summary, we regress y_t on x_t using instrument z (Cameron & Travedi, 2010)

Estimating the 2SLS estimator

From the assumption that $E(\epsilon_t/z_t)=0$ and hence the moment condition or the population zero-correlation condition, the study obtain expression below,

$$E\{z'_t(y_t - x'_t\beta)\} = 0$$

According to Cameron & Travedi (2010) in a just-identified case, where the number of instruments exactly equals the number of endogenous regressors and by substituting the vectors x'_t into the matrix X, the scalars y_t into the vector y and the vectors z'_t into the matrix Z, the study obtain $Z'(y - X\beta) = 0$. Solving for the parameter, the study obtains β, for the IV estimator:

$$\widehat{\beta_{IV}} = (Z'X)^{-1}Z'y$$

The second situation is where the model is said to be unidentified or underidentified. Here, the number of instruments is less than the number of endogenous regressors and hence IV estimators cannot be estimated. A third situation is called the overidentified situation where the number of instruments used are more than the number of endogenous regressors. This situation normally occurs when economic theory result in a clear omission of variables from the equation of interest. In this case, the solution for β cannot be obtained from the expression $\mathrm{Z}'(\mathrm{y} - \mathrm{X}\beta) = 0$. One possible way deal with the situation is to arbitrarily drop instruments to get to the just-identified case.

More so, other more efficient estimators such as the two-stage least (2SLS) can be explored to obtain consistent and efficient estimate for β. Mathematically, the 2SLS is expressed below:

$$\widehat{\beta_{2SLS}} = \{\mathrm{X}'\mathrm{Z}(\mathrm{Z}'\mathrm{Z})^{-1}\mathrm{Z}'\mathrm{X}\}^{-1}\mathrm{X}'\mathrm{Z}(\mathrm{Z}'\mathrm{Z})^{-1}\mathrm{Z}'\mathrm{y} \qquad (16)$$

The 2SLS estimator from equation (16) is most efficient estimator if the error terms ϵ_t are independent and homoscedastic. In the just-identified case the estimated beta from the 2SLS ($\widehat{\beta_{2SLS}}$) equal to the estimated beta from the IV ($\widehat{\beta_{IV}}$) (Cameron & Travedi, 2010)

Model diagnostic test (2SLS)

To ensure that external instruments used in this study are both internally and externally valid and to evaluate the reliability, adequacy and the goodness of fit of the model, the following diagnostic test was carried out after running the 2SLS estimation:

Underidentification test

The underidentification test is the first diagnostic tool the study employed for assessing the strength of identification based on a Langrange-Multiplier (LM) test for underidentification using the Kleibergen and Paap (2006) rk statistic. This is a post estimation test that allows us to determine whether the minimal established correlation between the endogenous variables and their external instruments are statistically different from zero. The null hypothesis of the test is that the model under consideration is underidentified as against the alternative hypothesis that the model is identified. Under the null, the test statistic is distributed as chi-square (χ^2) with (L − K + 1) degrees of freedom, so that it may be calculated even for an exactly identified equation. The decision rule is that if the P-value is statistically significant, the study fails to accept the null hypothesis that equation under consideration is underidentified. The study then conclude that the model is identified. The underidentification test is also effective in testing whether the rank condition is satisfied therefore amounts to testing the rank of a matrix. Rejection of the null also implies full rank and failure to reject the null implies the matrix is rank-deficient.

Weak identification test

The problem of weak instruments can occur even when the correlation between the endogenous explanatory variables and the excluded instruments are nonzero but small. Empirical econometrics literature by Bound, Jaeger and Baker (1995) and Stock and Yogo (2005) have shown that the weak-instruments problem can arise even when the correlations between endogenous regressors and instruments are significant at conventional levels (5 percent or 1 percent) and the researcher is using a large sample. According to Stock, Wright, and Yogo (2002) and Dufour (2003), rejecting the null of underidentification at even conventional

significance levels is not enough; the researcher must call for other methods. One approach that has been advanced by Stock and Yogo (2005) is to test for the presence of weak instruments. With the weak–instrument test the critical values are different for different estimators because the estimators are not affected to the same degree by weak instruments. The test statistic proposed by Stock and Yogo (2005) is the F-statistic form of the Cragg and Donald (1993) statistic. The null hypothesis being tested is that the estimator is weakly identified in the sense that it is subject to bias that the study finds unacceptably large. The weak-instruments test statistic is a Wald F statistic based on the Kleibergen–Paap *rk* statistic. Since the study adopted *rk* statistic to test for weak identification, the critical values approach compiled by Stock and Yogo (2005) or the older "rule of thumb" which says that the *F* statistic should be at least 10 for weak identification not to be considered a problem.

Test for overidentifying restriction

The validity of the instruments is vital when employing the 2SLS estimation. This is because as already has been emphasised, the instrument chosen for the study must satistisfy two key requirements. First, the instrument must not be correlated with the error term (exogeneity). Second, it must be highly correlated with the endogenous explanatory variable (relevance). Albeit the validity of an instrument cannot be tested when working with a just-identified model, it is possible to test the validity of overidentifying instruments in an overidentified model provided that the parameters of the model are estimated using the 2SLS (Wooldridge, 2005).

Testing for endogeneity

Once there is a suspicion that there exist bicausality or endogeneity between the dependent variable and the endogenous explanatory variables, the next thing is to conduct a test to see if really endogeneity is a problem. The 2SLS estimator performs poorly than OLS when the explanatory variables are exogenous. This is because 2SLS estimates can have large standard errors hence, it is vital to have endogeneity test of an explanatory variable that shows if 2SLS is even needed. The Hausman test provides a way to test whether an explanatory variable is endogenous. The decision rule for the Hausman test is that if there is a little difference between OLS and 2SLS estimators, then there is no need to instrument and hence the study concludes that the regressor was exogenous. That is, both OLS and 2SLS are consistent if all variables are exogenous. On the other hand, if there is a significant difference between the OLS and 2SLS estimators, then we needed to instrument and the regressor is endogenous, Cameron and Travedi (2010). It is therefore prudent to compute both OLS and 2SLS to determine if the estimates are practically different. To find out whether the differences are statistically significant it is easier to employ a simple regression test. To carry out this test the study adopts the structural and the reduce form equation (15) and (16) respectively:

$$y_{1t} = y'_{2t}\beta_1 + x'_{1t}\beta_2 + \epsilon_t$$

$$y_{2jt} = x'_{1t}\pi_{1j} + x'_{2t}\pi_{2j} + \epsilon_{jt}, \qquad j = 1,\ldots, m$$

Now the study test that if both x'_{1t} and x'_{2t} are uncorrelated with ϵ_t, y_{2jt} is uncorrelated with ϵ_t if, and only if, ϵ_{jt} is uncorrelated with ϵ_t. If $\epsilon_t = \delta_1\epsilon_{jt} + e_t$, where e_t is uncorrelated with ϵ_{jt} and has zero mean. Then, ϵ_t and ϵ_{jt} is uncorrelated if, and only if, $\delta_1 = 0$. The easiest way to conduct this test is to include ϵ_{jt} as an additional explanatory variable in equation (15) and to

conduct a t test. The only one problem involved in carrying out this test is that the error term ϵ_{jt} is not observed in equation (16). Since the study can estimate the reduced form for y_{2jt} by OLS, it can obtain the reduced form residuals, $\widehat{\epsilon_{jt}}$. Therefore, equation (15) can be estimated by OLS and test $H_0: \delta_1 = 0$ using a t statistic. This is presented in equation (17)

$$y_{1t} = y'_{2t}\beta_1 + x'_{1t}\beta_2 + \widehat{\epsilon_{jt}}\delta_1 + \epsilon_t \qquad (17)$$

The decision rule is that if we reject H_0 at a small significant level, we conclude that y_{2t} is endogenous because ϵ_{jt} and ϵ_t are correlated. Also, in testing for endogeneity, the study tested the null hypothesis that the regressors are exogenous against the alternative hypothesis that the regressors are endogenous. The test statistic is distributed as chi-square (χ^2) with degrees of freedom equal to the number of regressors tested. If the P-value is statistically significant say at 5 percent alpha level, the study rejects the null hypothesis that the regressors are exogenous at 5 percent alpha level and conclude that the regressors are endogenous and therefore there is need for 2SLS estimation.

Results and Discussion

The objectives of this study are to examine effects of both economic and social infrastructure on FDI inflows as well as to determine the differential effects of these infrastructure components on FDI. This section presents and discusses the results from the study.

Descriptive statistics

Table 3 report the summary statistics of all the variables that were used in the study. Over the period under study, foreign direct investment inflows ($lnFdi$) into Ghana on the average was 4.599. Economic infrastructure ($lnEconinfra$) on the average was 4.139 whiles the mean value of social infrastructure ($lnSocinfra$) was 3.441. Market size ($lnSize$) measured by GDP (current US$) averaged 4.926. Most of the variables show signs of positive skeweness. The Jarque-Bera statistic show that the null hypothesis that the series are drawn from normally distributed random process can be rejected for all the variables since their probability values are statistically significant except for market size.

Table 2: Summary statistics

	LnFDI	lnEconinfra	lnSocinfra	lnSize	inf
Mean	4.599630	5.616828	3.441867	4.926160	8.671086
Median	4.026160	5.326864	3.210745	4.553460	6.351443
Maximum	5.896068	6.694577	4.263230	7.137318	38.02739
Minimum	3.233814	4.139967	2.639785	3.289003	1.655264
Std. Dev.	0.436073	0.194857	0.146328	0.882470	7.701107
Skewness	0.186502	1.03833	1.215403	0.09891	1.950894
Kurtosis	3.936267	32.05214	17.64692	2.213318	6.617555
Jarque-Bera	6.432948	5372.816	1396.127	4.167322	179.3008
Probability	0.040096	0.000000	0.000000	0.124474	0.000000
Sum	699.1438	853.7579	523.1638	748.7763	1318.005
Sum Sq. Dev.	28.71405	5.733376	3.233183	117.5918	8955.364
Observations	150	150	150	150	150

Note: Std. Dev. Represents Standard Deviation while Sum sq. Dev. Represents Sum of Squared Deviation. Source: World Bank (2015) and British Petroleum Statistical Review (2014).

Table 3 continuation

	Opn	lnEx_debt	lnFdi_1	LnWNGP	fert
Mean	0.141475	5.354612	3.599630	1.906814	1.338345
Median	0.113050	5.179520	3.202616	1.006652	1.207973
Maximum	0.301303	6.422117	4.896068	2.361909	1.705705
Minimum	0.014208	3.975400	2.233814	1.460274	0.749718
Std. Dev.	0.076784	0.256973	0.436073	0.096510	0.227225
Skewness	0.137477	0.36283	0.186502	0.530969	0.11919
Jarque-Bera	7.667847	255.3235	6.432948	256.2520	9.72897
Probability	0.021625	0.000000	0.040096	0.000000	0.00772
Sum	21.50422	813.9010	547.1438	289.8357	203.4285
Sum Sq. Dev.	0.890266	9.971285	28.71405	1.406439	7.796297
Observations	150	150	150	150	150

Note: Std. Dev. Represents Standard Deviation while Sum sq. Dev. Represents Sum of Squared Deviation. Source: World Bank (2015) and British Petroleum Statistical Review (2014).

Correlation Analysis

A two-way scatter plot showing the correlation between economic infrastructure (lnEconinfra) proxied by electricity production and its external instrument measured by world natural gas production (lnWNGP) is presented in Figure 8.

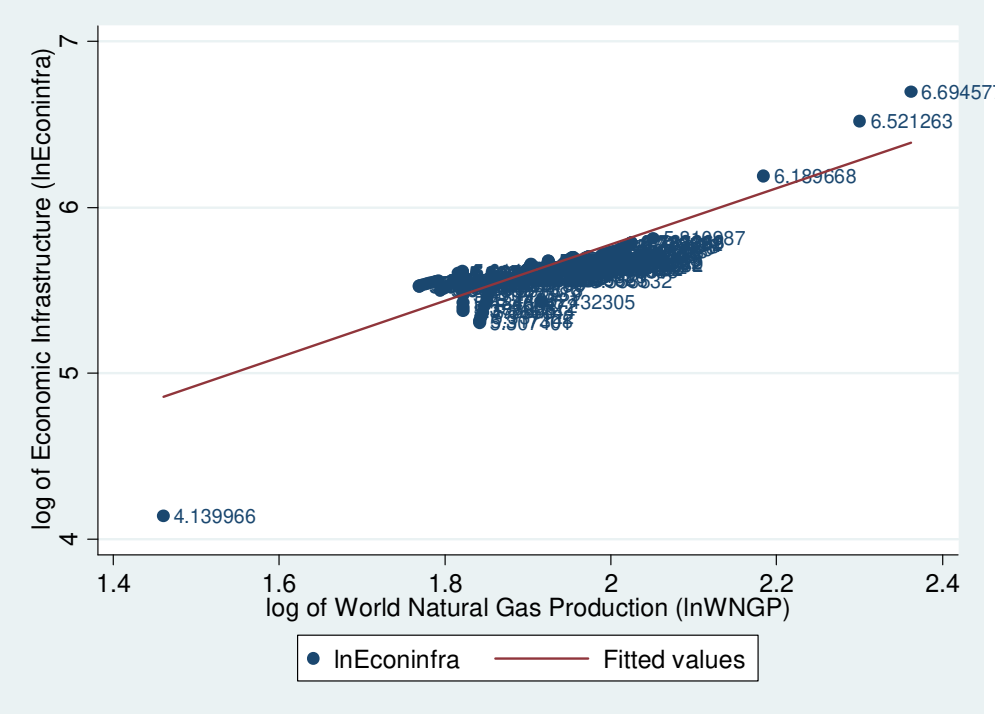


Figure 8: Scatter plot showing the relationship between Economic infrastructure and world natural gas production in Ghana

Source: STATA output from World Bank (2015) and British Petroleum Statistical Review (2014).

The upward sloping of the fitted line in Figure 8 depicts a positive correlation between economic infrastructure (lnEconinfra) measured by electricity production and its external instruments measured by natural gas production (lnWNGP). Intuitively, an increase in the production of natural gas leads to increase in economic infrastructure (i.e. electricity production) (Jaramillo et al., 2007; International Energy Agency, 2013). This correlation analysis gives a fair idea about the relevance and exogeneity of the external instruments. Figure 9 also depicts a two-way scatter plot that shows the correlation between social infrastructure (lnSocinfra) measured

by secondary school enrolment and its external instrument measured by fertility rate per woman (fert).

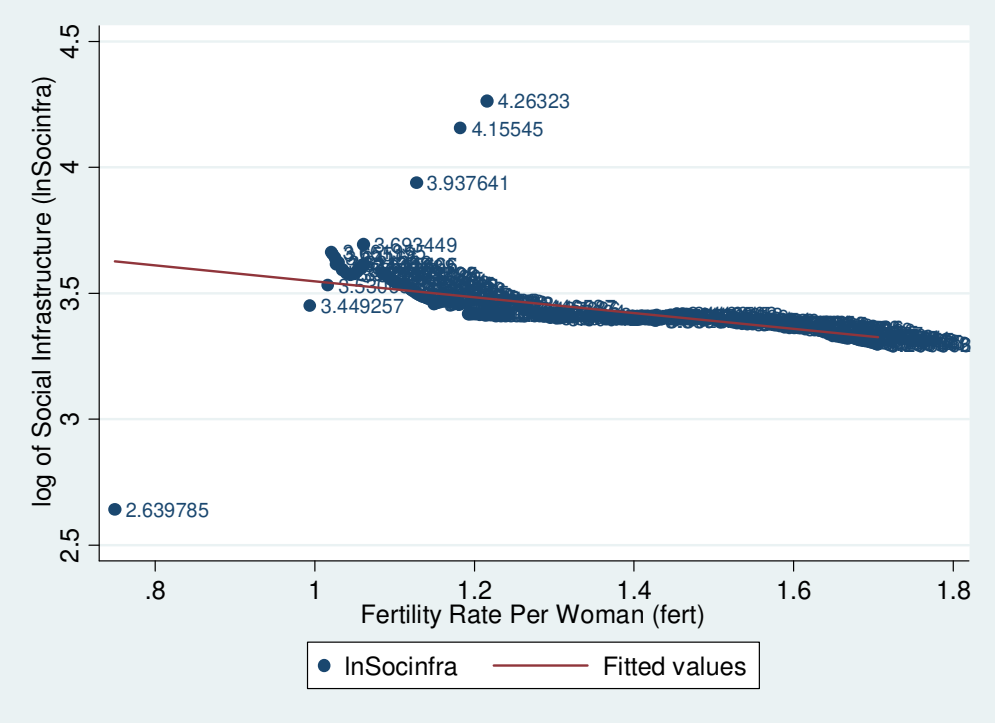


Figure 9: Scatter plot showing the relationship between Social infrastructure and fertility rate per woman in Ghana
Source: STATA output from World Bank (2015)

The fitted line depicts a negative correlation between lnSocinfra and fert. Furthermore, the scatter plot is consistent with theory and intuition. That is, intuitively, it is expected that social infrastructure proxied by secondary school enrolment declines as fertility rate per woman increases. This is also consistent with a study by Ahiakpor et al. (2014) and Child Trends Databank (2015) who also reported a negative relationship among the variables. This correlation gives a brief idea about the relevance and exogeneity of the instrument and suggest that the two measures are related meaning they are important in the study.

The study presents the first stage results for both economic and social infrastructure for the two-stage least squares model in Table 4. These two main variables have been the central endogenous explanatory variables and according to the literature the study instrumented economic infrastructure by world natural gas production and social infrastructure by fertility rate per woman. The rationale for presenting the results was to determine whether the instrument is relevant in explaining these infrastructure components.

Table 4: Results of First Stage Regression of Economic and Social Infrastructure

Dep Var: ***lnEconinfra; lnSocinfra***		
Explanatory Variables	*lnEconinfra*	*lnSocinfra*
lnSize	-0.538***	0.023
	(0.073)	(0.026)
Inf	0.001	0.001***
	(0.001)	(0.0002)
lnEx_debt	0.116**	-0.181***
	(0.046)	(0.026)
Opn	-0.378***	0.096
	(0.135)	(0.057)
$lnfdi_{t-1}$	-0.015	0.003***
	(0.024)	(0.018)
$lnfdi_{t-2}$	0.016	0.045
	(0.021)	(0.017)
lnWNGP	4.602***	2.058***
	(0.318)	(0.149)
fert	-0.840***	-0.296***
	(0.208)	(0.077)
Constant	-0.112	-0.234
	(0.150)	(0.094)
Observations	150	
Diagnostic Tests (First Stage)		
Underidentification test:		
Kleibergen-Paap rk LM stat	21.27	0.000***
Weak identification test:		
Crag-Donald Wald F stat	15.72	-
Kleibergen-Paap Wald rk F- stat	13.09	-
Weak instrument test:		
Anderson-Rubin Wald F test	9.85	0.000***
Anderson- Rubin Wald chi test	20.95	0.000***
Stock-Wright LM S stat	16.15	0.000***

Robust standard errors in bracket, * significant at 10%; ** significant at 5%; *** significant at 1%. Notes: Statistics robust to heteroskedasticity and autocorrelation. Source: Author's construct

It can be observed from Table 4 that there exist a positive and one percent statistically significant relationship between natural gas production *(lnWNGP)* and economic infrastructure *(lnEconinfra).* That is, the coefficient of 4.602 indicates that a percent increase in world natural gas production leads to 4.602 percent increase in economic infrastructure in Ghana. This result implies that world natural gas production is directly related to economic infrastructure development (i.e. electricity production) in Ghana. This result is in line with Jaramillo et al. (2007) and International Energy Agency (2013) who also found that natural gas production positively impacts economic infrastructure (electricity production). This result also confirms the

hypothesis of a positive correlation between economic infrastructure and world natural gas production as depicted by the scatter plot shown in Figure 8.

In addition, the study used fertility rate per woman *(fert)* as an external instrument for social infrastructure (i.e. secondary school enrolment). It can be observed from Table 4 that the coefficient of 0.296 indicates that one percent increase in fertility per woman leads to 0.296 percent decrease in social infrastructure in Ghana. The negative sign of this coefficient indicates the damaging effect of fertility rate per woman on school enrolment. High level of fertility is found to hinder school enrolment in Ghana. This reality commensurate with the fact that increases in the fertility rate increase the number of pupils in each household. The increase in the number of children in each household leads to an increase in household heads expenditure which makes it difficult for them to have excess money to spend on children's education hence leading to low school enrolment. This relationship between fertility rate per woman and school enrolment was confirmed in the work of Ahiakpor et al. (2014) and Child Trends Databank (2015). This is also consistent with the hypothesis of a negative correlation between social infrastructure and fertility rate per woman as depicted by the scatter plot shown in Figure 9.

The study presents the results of the OLS and IV (2SLS) estimation of the relationship between infrastructure and FDI in Ghana in Table 6. Since the OLS results are fraught with the problem of endogeneity bias, the study discussed on the IV (2SLS) estimation which can address the problem of endogeneity.

Table 5: Results of OLS and IV (2SLS) estimation of the relationship between Infrastructure and FDI inflows

Dependent variable: *lnFDI*		
Explanatory Variables	OLS	IV (2SLS)
lnEconinfra	0.066	0.823***
	(0.076)	(0.295)
lnSocinfra	0.014	0.241***
	(0.056)	(0.069)
lnSize	0.134***	0.264***
	(0.037)	(0.057)
Inf	-0.002**	-0.003***
	(0.001)	(0.001)
lnEx_debt	-0.221**	-0.418***
	(0.086)	(0.157)
Opn	-0.114	0.324*
	(0.191)	(0.182)
$lnfdi_{t-1}$	1.471***	1.408***
	(0.115)	(0.120)

$lnfdi_{t-2}$	-0.625***	-0.570***
	(0.121)	(0.122)
Constant	1.244**	1.357***
	(0.537)	(0.556)
Observations	150	150
Diagnostic Tests (OLS)		
Autocorrelation:		
Durbin Watson d-stat (9,150)	1.875	
Heteroskedasticity:		
Breusch-Paap/Cook-Weinberg- test	49.85	0.0000***
Diagnostic Tests (2SLS)		
Underidentification test:		
Kleibergen-Paap rk LM stat	21.718	0.0000***
Weak identification test:		
Crag-Donald Wald F stat	15.721	
Kleibergen-Paap Wald rk F stat	13.089	
Overidentification test		
Hansen J Statistic		0.0000***
Equation exactly identified		
Endogeneity test	11.432	

Robust standard errors in bracket, * significant at 10%; ** significant at 5%; *** significant at 1%. Notes: Statistics robust to heteroskedasticity and autocorrelation. Source: Author's construct

Results of the 2SLS model

From Table 5, holding the influence of all variables in the model constant, the positive and statistically significant constant term shows that the FDI into the Ghanaian economy will increase by approximately 1.357 percent due to the influence of all other variables that were not captured in the model.

The results from the 2SLS regression indicate that at one percent level of significance, a percentage increase in economic infrastructure in Ghana will lead to 0.823 percent increase in FDI inflows. This positive sign implies that economic infrastructure plays a crucial role in attracting FDI inflows into Ghana. It is clear from Figure 3 that Ghana attract more FDI inflows into services, manufacturing, general trading and liaison. FDI into these sectors of the economy requires quality and well-developed economic infrastructure to operate efficiently hence if the country develops its economic infrastructure in terms of generating more power by say 100 percentage point it will attract about 82.3 percent FDI inflows into these sectors. The result also confirms the upward trends of both FDI inflows and electricity production given by Figure 2 and 6 respectively. This result is consistent with Anyanwu (2012) who conducted infrastructure- FDI study for 53 African countries and found that infrastructure has positive and statistically significant effect in attracting FDI for East and Southern Africa sub regions. Similarly, it confirms the result by Asiedu (2002) who also suggested that infrastructure development is vital for attracting FDI inflows in SSA. The outcome not only supports empirical

literature but also confirms the location factor theory that emphasises the positive link between infrastructure development and FDI inflows.

Social infrastructure exerted one percent statistically significant effect in attracting FDI in the 2SLS estimation. The results of the 2SLS indicate a one percentage point increase in social infrastructure leads to an increase in FDI inflows by 0.241 percent. This positive sign implies that when all other factors are held constant, social infrastructure plays a critical role in attracting FDI inflows into Ghana. As indicated by Figure 3, FDI projects are predominant in manufacturing, services, general trading and liaison and these sectors of the economy require quality social infrastructure in terms quality human resources to operate efficiently. Again, social infrastructure investment should not be limited to the cities, but it should be developed across all the regions of Ghana especially the three Northern Regions, Brong Ahafo and Volta Region to increase FDI inflows in these regions. This is consistent with studies (Broadman & Sun, 1997; Feenstra & Hanson, 1997; Noorbakhsh et al., 2001) which have all acknowledged that increase in social infrastructure development have positive effect in attracting FDI inflows. The result is also in line with theoretical literature that a country with well-developed social infrastructure in terms human capital development attract more FDI. In addition, the variation in the OLS and 2SLS in terms of size of the coefficient and the statistical significance of this variable might also be due to endogeneity that exist in the OLS.

From the 2SLS results, the coefficient of variable $size$ implies that FDI inflows increases by 0.264 percent as Ghana's market size increases by one percent. This result confirms the hypothesised positive correlation between FDI inflows and Ghana's market size. That is, countries with well- developed market size attracts more FDI. This result is true for an emerging economy like Ghana because as indicated by Figure 3, the sectoral distribution of FDI projects into the country are predominantly in services, manufacturing, selling and retailing. These sectors require large market size to operate efficiently therefore if Ghana can develop its domestic market size by implication more market seeking FDI will be attracted into the country. Empirically this result is also in line with results obtained by these researchers (Asiedu, 2002; Kravis & Lipsey, 1988; Lipsey, 2004; Loree & Guisinger, 1995; Schneider & Frey, 1985; Tsai, 1994; Tsikata, Asante, & Gyasi, 2000; Wei, 2003; Wheeler & Mody, 1992) who also noted a positive relationship between market size and total FDI inflows.

Furthermore, the negative sign of inflation (*Inf*) signifies macroeconomic instability meaning high inflation impact negatively on real purchasing power hence increasing the cost of living and reducing spending. High cost of living not only reduces spending but also discourages market seeking FDI. The coefficient of variable *Inf* implies that FDI decreases by 0.003 percent for everyone cedi rise in the general price level. The P-value shows that the inflation is statistically significant at the 1 percent level. The result for inflation is consistent with Djokoto and Dzeha (2012) who also found a negative effect of inflation on overall FDI into Ghana but found a positive relationship between inflation and FDI in flows to the agricultural sector.

Moreover, the coefficient of variable *Ex_debt* implies that FDI decreases by 0.418 percent for every one percent increase in Ghana's external debt stocks. The negative relationship between external debts stock and FDI is statistically significant at one percent level meaning too much accumulation of external debts serves as threat to both potential and existing multinational firms in Ghana. High accumulation of external debts is also an indication of poor macroeconomic management and low economic growth. This situation then sends a signal to foreign investors that the country is not performing well in terms of economic growth hence decreasing FDI inflows. The negative relationship between external debt stocks and FDI as

indicated by the result is in line with Figure 9 where debts generally showed upward trend. The result is consistent with the empirical results of these researchers (Banga, 2003; Eli A. Udo et al., 2006) who found a negative relationship between external debts stock and FDI inflows.

The results from the 2SLS on the other side indicate a positive and ten percent statistically significant level relationship between openness and FDI. The coefficient of openness *(Opn)* implies that Ghana is more likely to increase FDI inflows by 0.324 percent for any additional attempt by the country to open for international trade. This implies that there is the tendency for the country to attract more export oriented FDI whose prime motive is to increase the export base of a country. As indicated in Figure 5, India, China and Lebanon appears to be Ghana's major trading partners in terms of registered projects. The positive relationship between openness and FDI from this study suggest that Ghana can attract more foreign projects from these countries by providing them with conducive and attractive business environment. This finding is also consistent with the FDI theory that openness is an indicator of the host country's ease of access to the world market for material inputs. It also implies that countries in which trade is important also have relatively higher FDI for instance countries that pursue policies that are more attractive to foreign investors. Thus, implementation of more liberal economic policies would certainly attract more foreign investments. This confirms findings of studies (Chakrabarti, 2001; Morisset, 2000; Nahidi & Badri, 2014; Tsikata, Asante, & Gyasi, 2000) that found a positive relationship between openness and FDI flows.

Interestingly, whiles last year's stock of FDI *(fdi_{t-1})* has 1 percent statistically significant positive relationship with FDI inflows within the study period, last two years stock of FDI *(fdi_{t-2})* on the other hand, shows a negative sign and one percent statistical relationship with FDI inflows within the study period. That is, the significant coefficient of *(fdi_{t-1})* from the 2SLS results shows that last year's stock of FDI contributed positively towards the current level of FDI, implying there is a self-reinforcing effect of FDI on itself and suggest that foreign investors' incremental knowledge about investment opportunities in host countries are important as well. It is clear from the results that FDI within the study period increases by 1.408 percent for any percentage increase in last year's FDI inflows. The result is consistent with the sensitivity of analysis that was performed by the study to assess the consistency of the lag of FDI on current FDI shown by Appendix H. This results is also in line with Anyanwu (2012), who found a positive relationship between the first lagged of FDI and FDI within the study period among some selected African economies. Kinoshita and Campos (2003) also found similar result for Central and Eastern European and former Soviet Union countries.

Model diagnostic test (2SLS)

Conducting various diagnostic tests is a crucial step in time series modelling. The test assisted in assessing the adequacy, reliability and the robustness of the estimates and the model in general. In view of this, the study presented the results of the diagnostic test at the bottom of Table 5.

After estimating the 2SLS regression model, the study conducted a series of tests to establish endogeneity of both economic and social infrastructure variables and test the validity of the instruments. To test for the endogeneity the study used STATA 12 command of ivreg2 with "endog" option, finding that the test statistic chi-square P-value equals to 0.0033. The test result thus rejects the null hypothesis of exogeneity meaning at 1 percent significant level, the study has enough information to conclude that both economic and social infrastructure are endogenous

and therefore there is the need for 2SLS estimation which gives more robust estimates than the OLS.

In addition, the study conducted underidentification tests to determine whether the minimal recognised correlation between the endogenous variables and the instruments is statistically different from zero and to test whether the rank condition is satisfied. The underidentification tests basically test the null hypothesis that the model is underidentified against the alternative hypothesis that the model is exactly identified. The test statistic chi-square P-value of 0.0000 indicates that at 1 percent level of significant, the study has enough information to reject the null hypothesis of underidentified model implying the model under consideration is exactly identified and has a full rank.

Moreover, weak instrument test was conducted to test for the strength of the instruments in the study. This test was conducted to evaluate the efficiency of the instrumental variable by measuring the relative bias of 2SLS coefficients comparing to the bias of OLS regression (Stock & Yogo, 2002). The Kleibergen–Paap *rk* LM statistic assumes "rule of thumb" which says that the LM statistic should be at least 10 for weak identification not to be considered a problem. The LM statistic of 21.718 which is greater than 10 also attest to the fact the weak instrument is not a problem in this study hence study finds no reason to accept the null hypothesis of weak identification of the estimators**.**

Results of test of differences in coefficients for economic and social infrastructure

The study presents results of the test of differences in coefficients of both economic and social infrastructure. The rationale for conducting this test was to determine which infrastructure components have higher differential effect on FDI inflows in Ghana (i.e. is it economic or social infrastructure?). Because from the 2SLS regression results presented in Table 5, it came out that economic infrastructure has higher marginal effect on FDI inflows than social infrastructure in Ghana. This could be deceiving because it may happen that differences in coefficients between these infrastructure components might be zero. In that case one can conclude that both economic and social infrastructure have the same marginal effect or impact on FDI inflows. The result that emanated from the test was presented below:

H_0: lnEconinfra-lnSocinfra=0

H_A: lnEconinfra-lnSocinfra≠0

Chi2(1)=10.35

Prob> Chi2=0.0013

The test basically tested the null hypothesis (H_0) that difference in coefficients of the infrastructure components is zero against the alternative hypothesis (H_A) that difference in coefficients of the infrastructure components is not equal to zero. Since the Chi2 (1) value (10.35) generated from the test was statistically significant it gives enough evidence to reject the claim that difference in coefficients is zero hence accepting the alternative hypothesis at one percent significance level that difference in coefficients is not zero but positive. The results also confirm that the coefficient of economic infrastructure from the 2SLS is larger than the coefficient of social infrastructure. This implies that economic infrastructure in this study drives more FDI inflows than social infrastructure in Ghana.

Summary, Conclusions and Recommendations.

Summary of the study

The study aimed at achieving three main objectives. First, to examine the effects of economic infrastructure on FDI inflows. The second is to examine the effects of social infrastructure on FDI and lastly, to determine the differential effects of economic and social infrastructure on FDI in Ghana using quarterly time series data covering the period of 1975 to 2012. Because of the inability of OLS to address the endogeneity in infrastructure and FDI, the study employed the 2SLS estimation to achieve the first and the second objectives. The study finally conducted two-tailed differences in coefficients test to achieve its third objective.

In addition, all the variables used in the study were first subjected to ADF and PP tests in order to find out their stationarity properties. The ADF revealed that all variables except market size and inflation were integrated of order one. Further, the PP test revealed that apart from the inflation which has order of integration of zero, all the other variables were integrated of order one. After performing the unit root tests, the study then continued to examine the relationships between infrastructure and FDI. The diagnostic tests results show that the model passes underidentification test, endogeneity test, and weak instrument test.

Findings:

The first stage regression analysis revealed a positive and one percent statistically significant relationship between economic infrastructure proxied by electricity production (kWh) and its external instrument (i.e. world natural gas production). Similarly, social infrastructure proxied by secondary school enrolment showed a negative relationship with its external instrument (i.e. fertility rate per woman). The 2SLS results also revealed that one percent increase in economic infrastructure in Ghana leads to 0.823 percent increase in FDI inflows. The study also reemphasise the significant role economic infrastructure plays in attracting FDI inflows into Ghana.

Moreover, the results from the 2SLS regressions also show that social infrastructure has a positive effect on FDI inflows. The 2SLS regression analysis revealed that FDI inflows into the Ghanaian economy increase by 0.241 percent for any one percent point increase in social infrastructure.

As anticipated, the 2SLS revealed a positive and one percent statistically significant relationship between market size and FDI inflows. That is, FDI inflows increases by 0.264 percent as Ghana's market size increases by one percent. This implies that increase in market size attract more market seeking FDI into the country.

Again, inflation came out as having a negative impact on FDI inflows in Ghana. FDI decreases by 0.003 percent for everyone cedi rise in the general price level in Ghana. The negative sign of inflation decreases real purchasing power and increases the cost of living in Ghana. High cost of living therefore discourages private investment.

In addition, external debts stock negatively impacted significantly on FDI inflows. It was revealed that, FDI inflows decreases by 0.418 percent for every one percent increase in Ghana's external debts stock. This is an indication that too much accumulation of external debts hinders both potential and existing multinational firms in Ghana. Huge external debt stocks can negatively affect growth through the crowding out effect or by affecting the composition of private investment. In addition, an increasing debt service may increase the government's

interest bill and the budget deficit and consequently, causes the long-term interest rate to rise or simply crowd out credit available for private investment.

Expectedly, the 2SLS results revealed a positive and ten percent statistically significant level relationship between trade openness and FDI. Thus, FDI inflows in Ghana increases by 0.324 percent for any extra attempt the country makes in relating to the rest of the world in terms of international trade.

Furthermore, agglomeration effects exerted a positive statistically significant effect on FDI. The results therefore suggest that foreign investors' incremental knowledge about investment opportunities in host countries are important as well.

The Chi(2) test of differences in coefficients also revealed that economic infrastructure has higher marginal effects on FDI than social infrastructure. Thus, the test suggests that economic infrastructure drives more FDI than social infrastructure in Ghana.

Conclusions

The following conclusions were made based on the findings of the study:
From the results, the first and second objectives that sought to examine the effects of economic and social infrastructure on FDI inflows were accomplished. Thus, from the 2SLS estimation it was revealed that both economic and social infrastructure are drivers of FDI inflows to Ghana. These findings show that there are benefits from both economic and social infrastructure as revealed in the literature.

Moreover, the last objective that sought to determine the differential effects of economic and social infrastructure on FDI inflows was also accomplished. The Chi(2) test of differences in coefficients conducted confirmed that economic infrastructure derives more FDI inflows than social infrastructure in Ghana.

Again, in line with empirical evidence, market size, trade openness and agglomeration effects all serve as important determinants of FDI inflows in Ghana. This finding suggests that market size, trade openness and agglomeration effects are also critical in attracting more FDI inflows into the Ghanaian economy. In addition, the study found negative effects of inflation and external debts stock on FDI inflows. This means inflation and external debts stock are inimical to FDI inflows.

Policy recommendations

Having considered the findings and conclusions of this study, the following recommendations are advocated:

- The study recommends that the Ministry of Power and the Ministry of Energy should increase investment in electricity generation to enhance the economic infrastructure of the country.
- The study also recommends that the Ministry of Education should increase investment in educational facilities to encourage a lot of people to enrol in schools in order to boost social infrastructure of the country.
- Government should focus on economic infrastructure (electricity generation) more than social infrastructure (schooling) since economic infrastructure drives more FDI inflows than social infrastructure in Ghana.
- The government should maintain macroeconomic stability and promote activities that will enhance economic growth.

Limitations of the study

- The main limitation of the study had to do with the quality and limited availability of annual data of some key variables used in the study. To produce highly reliable estimates especially with 2SLS estimation, long span of annual time series data of all the variables was needed. As a result of the inadequate annual series, quarterly series were generated through interpolation for the purpose of estimation. However, there is no gain in the power of these tests by switching from low frequency to high frequency and merely increasing the number of observations over short time period (Campbell & Perron, 1991; Hakkio & Rush, 1991). However, the use of interpolated quarterly series did not, pose danger to the reliability of the results because other authors including Komuves and Ramirez (2013) have employed similar approach and arrived at reliable results.
- The study also admits non-inclusion of natural resource in the model as a limitation since it is known that FDI comes to developing countries and particularly Ghana to extract these natural resources.

Direction for future research

Taking cognisance of the findings, conclusions and limitations of this study, the following suggestions are made for future studies:

- The study used electricity generation and secondary school enrolment to measure economic and social infrastructure respectively. Future researchers can generate an index for economic and social infrastructure. For example, road network, transport system, telecommunication and electricity generation can be used in generating an index for economic infrastructure. Similarly, health expenditure, education expenditure, life expectancy, HIV prevalence rate and sanitation can also be used in constructing an index for social infrastructure.
- Future research can also disaggregate investment in Ghana into both domestic and foreign and then examine how infrastructure impact on these investment components.
- Since Ghana resource abundant economy, future researchers can include natural resource as one of the control variables.

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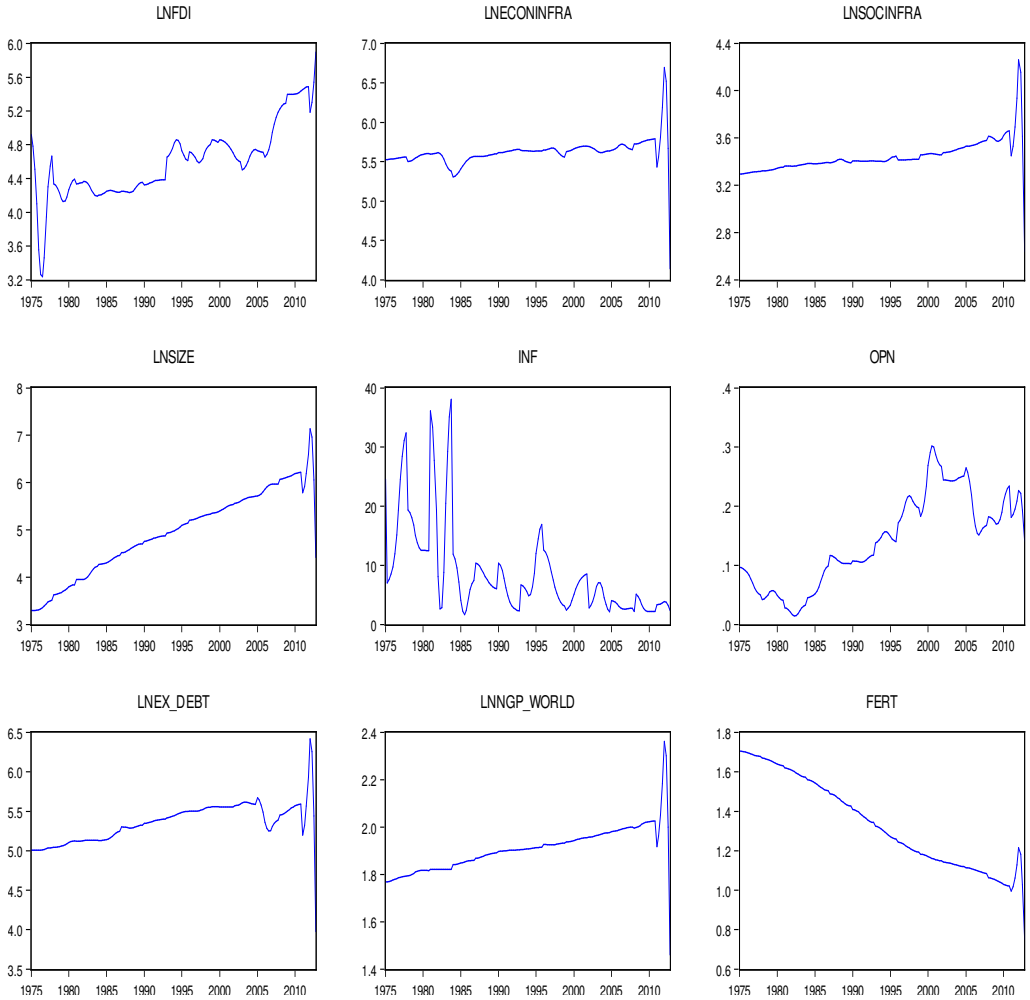
APPENDICES

Appendix A

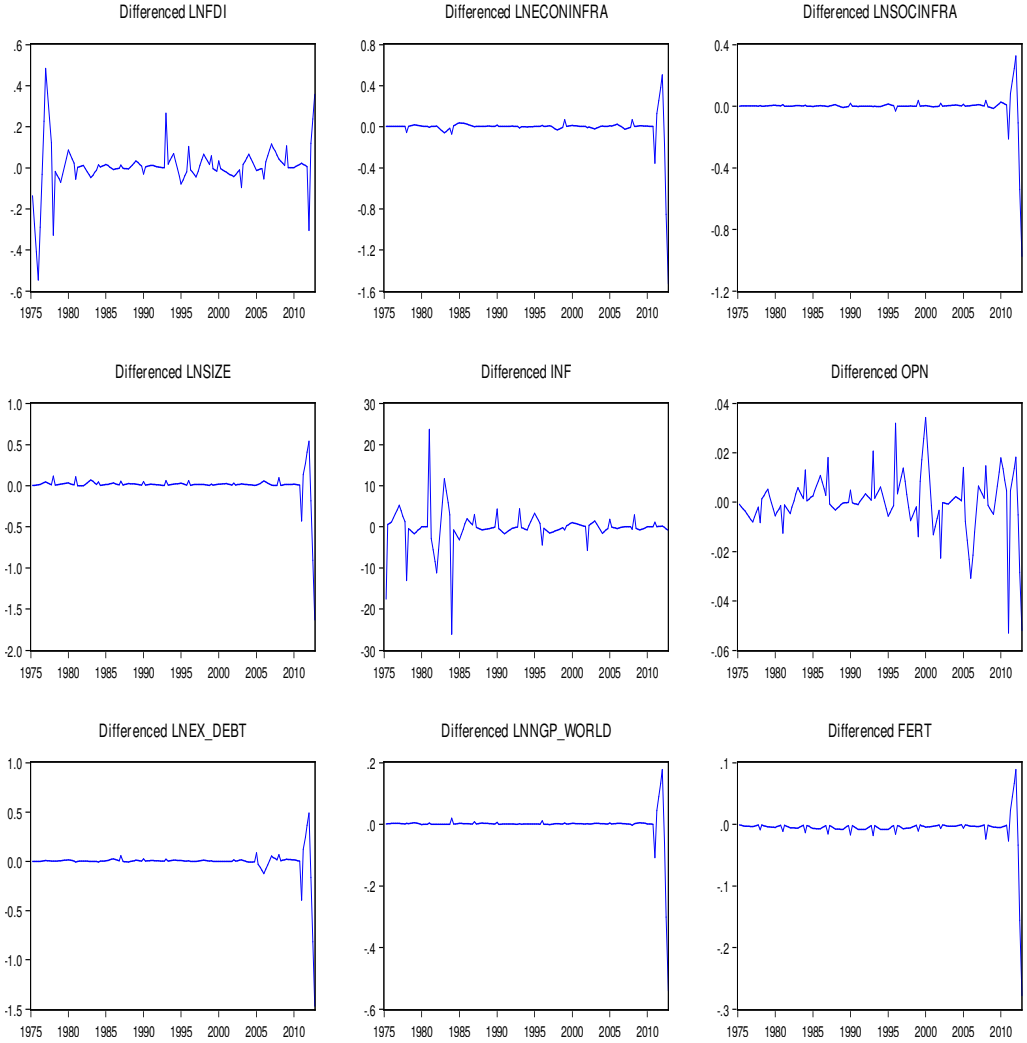
Plots of Variables in Levels



Source: Author's construct.

Appendix B

Plots of Variables in First Difference



Source: Author's construct

Appendix C

Test for the Order of integration (ADF): Levels and first difference with intercept only

Levels(Intercept)				First Difference(Intercept)				
Var	ADF-Statistic	P-Value	Lag	Var	ADF-Statistic	P-Value	Lag	OI
lnFDI	-2.033	0.272	1	DlnFDI	-5.224	0.000	0	I(1)
lnEconinfra	-2.265	0.185	7	DlnEconinfra	-4.612	0.000	7	I(1)
lnSocinfra	3.657	1.000	12	DlnSocinfra	-3.405	0.012	6	I(1)
lnSize	-3.128	0.027	7	DlnSize	-4.893	0.000	6	I(0)
Inf	-1.709	0.004	13	DInf	-5.142	0.000	12	I(0)
lnEx_debt	-1.595	0.483	8	DlnEx_debt	-5.19	0.000	7	I(1)
Opn	-1.638	0.461	1	Dopn	-5.865	0.000	0	I(1)
lnWNGP	0.061	0.962	6	DlnWNGP	-12.691	0.000	5	I(1)
fert	-1.924	0.321	13	Dfert	-0.933	0.083	11	I(1)

OI represents the order of integration

Source: Author's construct

Appendix D

Test for the Order of integration (ADF): Levels and first difference with intercept and trend

Levels (Intercept)				First Difference (Intercept)				
Var	ADF-Statistic	P-Value	Lag	Var	ADF-Statistic	P-Value	Lag	OI
lnFDI	-6.069	0.000	1	DlnFDI	-5.331	0.000	0	I(0)
lnEconinfra	-4.289	0.000	7	DlnEconinfra	-4.63	0.000	7	I(0)
lnSocinfra	2.365	1.000	12	DlnSocinfra	-3.891	0.015	12	I(1)
lnSize	-2.372	0.393	7	DlnSize	-5.771	0.000	6	I(1)
Inf	-2.357	0.001	13	DInf	-5.164	0.000	12	I(0)
lnEx_debt	-1.738	0.729	8	DlnEx_debt	-5.248	0.000	7	I(1)
Opn	-1.638	0.461	1	Dopn	-5.865	0.000	0	I(1)
lnWNGP	-1.988	0.603	6	DlnWNGP	-12.63	0.000	5	I(1)
fert	0.553	0.999	13	Dfert	-3.03	0.013	11	I(1)

OI represents the order of integration

Source: Author's construct.

Appendix E

Test for the Order of integration (PP): Levels and first difference with intercept only

Levels (Intercept)				First Difference (Intercept)				
Var	ADF-Statistic	P-Value	Bwd	Var	ADF-Statistic	P-Value	Bwd	OI
lnFDI	-1.348	0.606	3	DlnFDI	-3.426	0.000	0.011	I(1)
lnEconinfra	-0.142	0.942	26	DlnEconinfra	-5.051	0.000	12	I(1)
lnSocinfra	-1.884	0.339	22	DlnSocinfra	-4.477	0.000	13	I(1)
lnSize	-1.838	0.361	18	DlnSize	-5.973	0.000	11	I(1)
Inf	-3.576	0.007	8	DInf	-13.70	0.000	22	I(0)
lnEx_debt	-1.551	0.505	20	DlnEx_debt	-5.644	0.000	12	I(1)
Opn	-1.241	0.656	2	D0pn	-5.220	0.000	9	I(1)
lnWNGP	-1.874	0.344	19	DlnWNGP	-1.874	0.000	12	I(1)
Fert	-2.086	0.551	16	Dfert	-4.150	0.007	7	I(1)

OI represents the order of integration. Bwd represents bandwidth

Source: Author's construct

Appendix F

Test for the Order of integration (PP): Levels and first difference with intercept and trend

Levels (Intercept)				First Difference (Intercept)				
Var	ADF-Statistic	P-Value	Bwd	Var	ADF-Statistic	P-Value	Bwd	OI
lnFDI	-4.072	0.009	1	DlnFDI	-3.472	0.038	20	I(0)
lnEconinfra	1.661	1.000	27	DlnEconinfra	-5.194	0.000	12	I(1)
lnSocinfra	3.455	1.000	35	DlnSocinfra	-4.848	0.001	13	I(1)
lnSize	0.224	0.998	19	DlnSize	-6.125	0.000	11	I(1)
Inf	-4.160	0.007	9	DInf	-13.535	0.000	22	I(0)
lnEx_debt	-0.198	0.993	20	DlnEx_debt	-5.786	0.000	12	I(1)
Opn	-1.638	0.461	1	D0pn	-5.865	0.000	9	I(1)
lnWNGP	3.020	1.000	31	DlnWNGP	-4.390	0.000	12	I(1)
fert	-2.083	0.551	16	Dfert	-4.150	0.007	7	I(1)

Bwd represents bandwidth

Source: Author's construct

Appendix H

Sensitivity analysis showing the effect of lag of FDI on FDI

lnfdi	Coef	Std.Err	t	P>t	95%Conf.	Interval
L1	1.6386180	0.078445	20.89	0.000	1.483557	1.79368
L2	-0.5575688	0.153249	-3.64	0.000	-.8604948	-.2546428
L3	-0.4237083	0.1532119	-2.77	0.006	-.726561	-.1208556
L4	0.3345709	0.0789461	4.24	0.000	.1785188	.4906231
Constant	0.0450244	0.0717105	0.63	0.531	.0967252	.1867739

Source: Author's Construct