

Measuring the Efficiency of China's Foreign Direct Investment in Ghana

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Abstract

This research examines the efficiency and influencing aspects of China's Foreign Direct Investment to Ghana using quarterly time series data from 2003 to 2020. To achieve the objectives of the study, a stochastic frontier model in which technical inefficiency impacts are specified to be a function of Economic Index variables is estimated using the generalized maximum likelihood approach. The mean technical efficiency of the Chinese FDI to Ghana is 0.80. The correlation analysis reveals apart from GDP per capita of China and Ghana, all other variables correlate positively with Chinese FDI to Ghana. The results from stochastic estimates show all frontier determinant factors are significant influencing factors of China's FDI to Ghana except Ghana's GDP per capita. However, Ghana's GDP, and China's GDP per capita had negative influence on China's FDI to Ghana while China's GDP, natural resource rents to GDP and Ghana's GDP per capita had positive impacts on China's FDI to Ghana. The analysis reveals that China's overall performance to Ghana is semi-highly efficient. The study suggests expansion and attractive pricing policies, and natural resource conservation program be put in place by the Ghanaian and Chinese government to attract more Foreign Direct Investment while preserving natural resources.

Keywords

Efficiency, Foreign Direct Investment, Stochastic Frontier, Influencing Factors

1. Introduction

Gunawardhana and Damayanthi (2020) mentioned that most economies in this present globalized economic environment are integrated with the rest of the world either through investments or trade. Foreign Direct Investment (FDI) is a

long-term relationship investment that indicates a resident entity's long-term interest and influence in another economy. Global economic integration has accelerated in recent years, resulting in increased foreign direct investment and flows in global trade. Interestingly, FDI destinations are the developing countries and global organizations such as, International Monetary Fund (IMF), United Nations (UN) and World Bank are strongly motivating these developing countries to engage in activities that will attract more FDI inflows. With this at hand, policies and activities aimed at attracting more inflows of FDI have been engaged by most developing countries (Yakubu & Mikhail, 2019).

Investing in China's expanding economy has been a prominent international feature since the mid-1980s. The key reasons FDI is attractive include China's pursuit of market-oriented reforms, as well as a big internal market and low manufacturing costs. The recent boom of Chinese investment, particularly in Africa, has piqued the interest of scholars and policymakers who want to know if it's due to any cause. The economy of Africa has seen progress with FDI from China to Africa, even though it has attracted a lot of attention due to Western concerns. By the end of 2018, China has collected US\$143 billion in overseas direct investment, making it the world's second largest. Among developing nations, China is the greatest in terms of both stocks and flows of FDI (Chen, Zhai, & Zhang, 2020).

The fact that one of Ghana's development goals is to push the country to become a higher middle income earning country brings the motivation behind this study. This aim can be achieved if the country achieves a high and sustained rate of growth of more than 8% per year, through the aid of FDI. China placed second in terms of FDI to Ghana in 2020. The study examines the performance of Chinese FDI in Ghana in order to accelerate the country's growth. China's main commercial partners at first were the European Union and United States. This has altered in recent years with China making significant investments in Africa, particularly Ghana. The rising entry of FDI from China into Ghana has sparked a lot of interest in researching China's FDI in Ghana, particularly the factors that influence it. Although research on the drivers of FDI in Ghana has been undertaken, there have been few papers on the determinants of China's FDI to Ghana and, to a greater degree, the effectiveness of the investments (Asiamah, Afful, & Ofori, 2019; Yeboah & Antwi, 2019; Tang & Gyasi, 2012; Boakye-Gyasi & Li, 2017; Boakye-Gyasi & Li, 2016). To contribute and broaden the studies on the determinants of China's FDI in Ghana, this study explores the determinants of China's FDI in Ghana and how efficient it has been to the Ghanaian economy.

The rest of the paper is structured as: the second section delves into China's FDI looking at the trend of China's FDI in Ghana, characteristics of China's FDI in Ghana and a theoretical synthesis model describing China's FDI in Ghana. The third section describes the methodology employed in this study with the fourth section discussing the results of the estimations. The last section of this

paper presents conclusions and recommendations.

2. Literature Review on China's FDI in Ghana

2.1. Trend of China's FDI in Ghana

Ghana has attracted investments into the country with factors such as stable political environment, improvement in institutions and policy environment, openness of the economy, resource, investment environment among others. Apart from Ghana, several African nations have seen considerable investment. Infrastructure development, mining, education, and agriculture are all sources of Chinese foreign direct investment in Ghana. The relationship between Ghana and China is characterized by frequent visits, cultural or educational exchanges, commercial collaboration, and the provision of development aid (Boakye-Gyasi & Li, 2017; Asiamah, Afful, & Ofori, 2019). China's initial FDI flow to Ghana in 2003 was US\$2.89 million. After this investment in Ghana, China's FDI flows were decreasing and increasing until 2008 when it increased to US\$10.9 million. Since then, China's FDI flow to Ghana has been on an increasing rate. From 2014 to 2016, the total FDI flows from China to Ghana increased from US\$72.9 million to US\$490.61 million. However, the Chinese Foreign direct investment flows to Ghana in 2017 saw a sharp decline to US\$44.2 million which increased to US\$142.25 million in 2018 and declined to US\$29.41 in 2019 and -6.71 in 2020 (Figure 1). This explains the significant expenditures in critical infrastructure and support services, which are critical to increasing productivity and decreasing poverty. However, China's FDI stock in 2003 was US\$6.63 million. This initial investment rose to US\$41.87 in 2007 and since then, China's FDI stock to Ghana has been increasing. In the year 2016, the Chinese FDI stock to Ghana

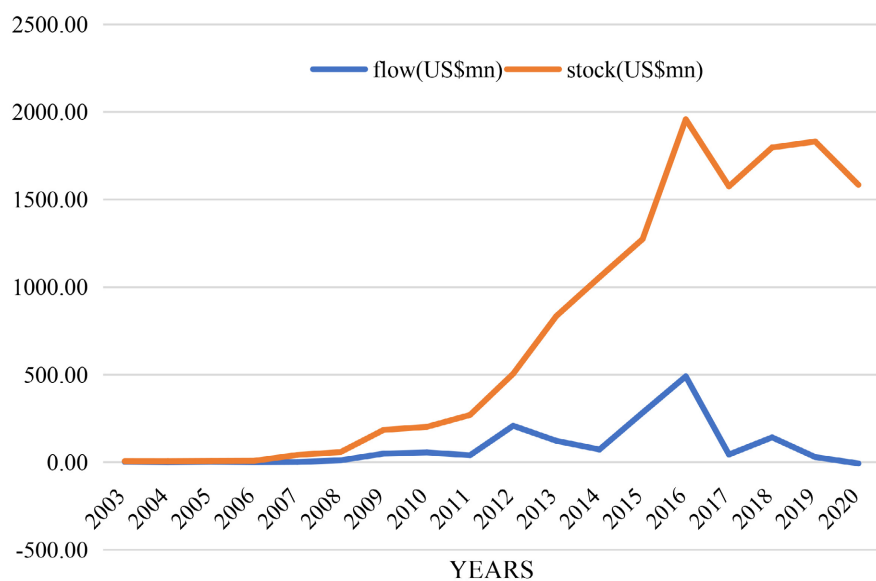


Figure 1. China-Ghana FDI flow versus stock (2003-2020). Source: Author's illustrations with data from China-Africa Research Initiative.

rose to US\$1958.27 million but decreased to US\$1575.36 million in 2017. The year 2018 recorded US\$1797.47 million of China's FDI stock while US\$1831.29 and US\$1584.03 in millions were recorded in 2019 and 2020 respectively (**Figure 1**).

From 2003 through 2020, the flow and stock of Chinese FDI into Ghana are depicted in **Figure 1**. Comparatively, the FDI flows and stock initially started in low sums but that of stock is higher than flow. From 2008, both China's FDI flow and stock saw an increase but the increase of stock was comparatively higher than that of flow. From **Figure 1**, it can be observed that the margin between China's FDI to Ghana from 2016 to 2020 is very high with FDI stock recording the highest within these years in 2016 while FDI flow recorded its highest value also in 2016.

2.2. Characteristics of China's FDI in Ghana

Market-seeking, asset-hunting, resource-searching, and efficiency-hunting are the four main reasons for investing overseas (Chen, Zhai, & Zhang, 2020). According to Habyarimana and Wu (2017), efficiency-seeking objectives do not play a significant role in Chinese enterprises expanding global because China has a low-cost manufacturing edge. However, one of the ultimate ways considered by most investors of becoming more productive is by efficiency seeking. This enables global specialization in which organizations seek to benefit from product difference and variegate risk in factor price. Using cultures, institutional arrangements, diverse factor endowments, economic systems and regulations, and market structures, foreign enterprises concentrate output in a restricted number of places to service various markets in searching for efficiency (Habyarimana & Wu, 2017; Yeboah & Antwi, 2019). Market searching is another primary motivation for investors looking to invest internationally. Investors looking for a good deal will be lured to a state with a huge and growing domestic market. Investors look at population size, wealth, and purchasing power in addition to these considerations. Ghana's participation in the Economic Community of West African States (ECOWAS) provide access to the West African sub region's joint market for Chinese investors. Most Ghanaians have developed a great desire in made-in-China products such as smartphones and other industrial goods, which has had an influence on Chinese investment in the Ghanaian economy. As a consequence, Chinese investors were given permission to establish a branch in Ghana to service their clients (Habyarimana & Wu, 2017; Yeboah & Antwi, 2019).

Habyarimana and Wu (2017) mentioned that market searching and resource hunting remain the major reasons of China's investment worldwide. The resource-seeking motive is to supply commodities that are needed as the country is advantaged to have state-owned companies with considerable reserves for investment. Ghana on the other side with vast stock of resources but insufficient capital base to develop however allows Chinese investors with the considerable reserves to invest. Chinese and other developed nations, on the other hand, in-

invest in Ghana in order to find and secure natural resources such as gold, diamonds, bauxite, and aluminum, as well as raw materials and lower labor costs (Yeboah & Antwi, 2019). When investors attempt to acquire existing firms or assets in order to safeguard a certain superiority, this is referred to as asset-seeking. Key domestic established enterprises, market expertise and pre-market entry by rivals, and local skills are among the acquisitions targeted at strengthening its international competition's stance (Yeboah & Antwi, 2019). Many West African countries prefer FDI coming from China and these countries have enjoyed streams of FDI because of China's fast-growing economy and prior FDI experience. Many international corporations, particularly Chinese firms, have expanded their activities in Ghana as a result of the country's stable political climate (Yakubu & Mikhail, 2019). So, what are the advantages of China investing in Ghana? Ghana's economy has grown as a result of increased Chinese investment, which has increased earnings and helped to relieve poverty (Boakye-Gyasi & Li, 2017; Boakye-Gyasi & Li, 2016). Yeboah and Antwi (2019) also indicated that Ghana has benefited from the FDI from China ranging from technical and development assistance to trade investment. They said that among the other investing nations, China ranks first in terms of recorded operations in the Ghanaian economy.

China's investments in many public sectors have boosted Ghana's economy. Teaching, communication, energy and farming, fishing, and training are just a few of the advantages. Ghanaians have had access to Chinese government scholarships, municipal and local government scholarships, and university scholarships as part of their educational benefits. Aside from this, academic activities for technical assistance involve labor, equipment, and training to aid in the progress of a variety of sectors. China and Ghana are collaborating on a number of projects, including the Bui Hydro-electric Power Dam in the power sector and the Afire rice initiative in the Volta Region (Yeboah & Antwi, 2019). With Chinese assistance in the building and construction business, several key state sector undertakings in Ghana's growth have been completed. The US\$15 million office block for the Ministry of Foreign Affairs and Regional Integration, the US\$622 million development of the Bui Hydro-electric Power Dam, the US\$28 million construction of the 17-kilometer Ofankor-Nsawam road network, and the US\$6 billion Ghana Railway Project are examples of such projects (Boakye-Gyasi & Li, 2016). The US\$2 billion bauxite barter agreement between China and Ghana would fund facilities in Ghana, including residences, rail services, health-care, bridges, roads, and rural power, among other things (Yeboah & Antwi, 2019).

2.3. Theoretical Synthesis Model of China's FDI in Ghana

The theoretical synthesis model below (Figure 2) illustrates a system process about the main scope of this study, key themes, and issues that this study sought to address, data acquisition for some key variables, coupled with some data

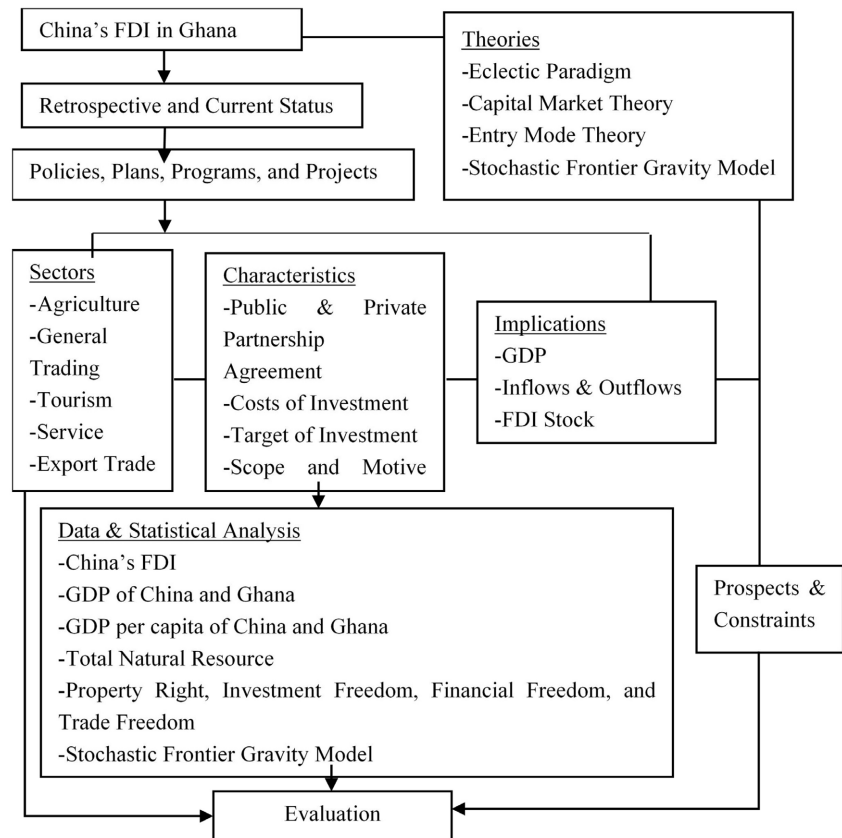


Figure 2. A theoretical synthesis model based on China's FDI in Ghana. Source: Author's illustration.

analysis techniques, and standardized theories anchoring the current study. The model gives a retrospective account of the systematic process, employed to accentuate the efficiency and influencing factors of China's FDI in some key sectors in Ghana. These forms of investments are projected in the form of policies, plans, programs, and projects (PPPPs) based on some key characteristics (nature or scope of the project, target, costs, and means of operation, among others). These PPPPs are enshrined in China's "win-win" foreign policy with the countries it engages. Hence, have major prospects and constraints during the formulation, implementation and monitoring or feedback process. To ensure a balanced understanding of the complex link between FDI, China's FDI in Ghana, and Stochastic Frontier Gravity Model, a thorough account of the trend and characteristics of China's FDI in Ghana. The remaining sections of the paper empirically examine the efficiency and influencing factors of China's FDI in Ghana employing the Stochastic Frontier Gravity Model and the Generalized Maximum Likelihood Approach.

3. Research Methodology

3.1. Source of Data

China's FDI is the coefficient of determination, which uses quarterly data from

the China Africa Research Institute from 2003 through 2020. Data on the other variables of the frontier determinant which are GDP of China and Ghana in constant 2015 US\$, GDP per capita of China and Ghana in constant 2015 US\$, and total natural resource levels were sourced from the World Bank. From the Economic Freedom Index, data on variables of index such as property right, investment freedom, financial freedom, and trade freedom were sourced. These variables are employed based on related literature on the estimation of efficiency and determinants (Fan et al., 2016; Asiamah, Afful, & Ofori, 2019).

3.2. Description of Variables

3.2.1. Determinants of Frontier

The dependent variable and the independent variable used in estimating the efficiency scores of Chinese FDI in Ghana defines the determinants of the frontier. A set of independent variables together with a dependent variable is needed when generating an output-oriented efficiency where the independent variables represent the inputs while the dependent variable denotes the output (Fan et al., 2016). The foreign direct investment of China to Ghana in this study combines both the stock and flow from China to Ghana. In this study FDI_t is the indicator. Following Fan et al. (2016), the study employs both FDI stock and flow as its output since there can be irregularities which can disturb the gravity law. This is because FDI flows are vulnerable to single events and FDI stocks are inadequate variables for output of one-year value only. The GDP of China and Ghana are indicated as $GDP_{ch,t}$ and $GDP_{gh,t}$, respectively in the study.

In both China and Ghana, the GDPs are used as a measure of their size of market which often have its coefficients signed positive as it is believed that large size of market by host country encourage the participation of more inward and outward FDI (Fan et al., 2016; Song, 2018). The positive signed coefficient can also be related to the fact that greater opportunities of investments in host country can be linked with having a relatively bigger size of market as indicated by various Chinese investors (Shan et al., 2018; Mele & Quarto, 2017; Jiang & Liu, 2018). $PGDP_{ch,t}$ and $PGDP_{gh,t}$ in this study are indicators for GDPs per capita for China and Ghana. The development level in both China and Ghana in terms of the economy measures the $PGDP_{ch,t}$ and $PGDP_{gh,t}$, respectively. Badayi (2018) and Dai (2021) explain that feature by a unique and intertemporal nexus with the development level of an economy proxy as the GDP per capita birth the overall FDI using the hypothesis of investment development path. Birthing the overall FDI leads to the accumulation of firm-specific asset enabling companies to participate in FDI defining a positively signed coefficient of GDP per capita (Badayi, 2018; Dai, 2021). The proportion of overall natural resource rents to GDP derived as log of China's level of natural resource minus log of Ghana's level of natural resource is used to generate an indicator for the level of natural resource in China and Ghana, DNR_t . Armstrong (2011) mentioned that the coefficient of DNR_t due to China's motive of investment being natural resource seeking is

supposed to be negatively signed.

3.2.2. Determinants of Inefficiency

Any impediment to Foreign Direct Investment which can be political factors or any man-made restrictions that can affect the score of efficiency are what describes the determinants of inefficiency (Armstrong, 2011; Fan et al., 2016; Mourao, 2018). INV_{Fgh_t} an indicator for index of Investment Freedom of Ghana explains the rate at which investment capital flow within and across China and Ghana without any difficulty. Fan et al. (2016) indicated that the barriers to investment of FDI in Ghana measures the Investment Freedom Index which has its coefficient signed as negative. $PROR_{Igh_t}$ is an indicator for Property Right index of Ghana. This indicator is ambiguous because Ghana's intellectual property protection stimulates inward FDI by reducing the advantages associated with multinational industry internalization, but it can also stifle the progress of strategic asset seeking FDI, which is said to be one of the principal elements driving China's FDI. It is measured using the intellectual property protection of Ghana and describes how people are able to acquire properties privately with clear laws which are secured (Fan et al., 2016).

FIN_{Fgh_t} represents the Financial Freedom index of Ghana. How efficient the banking sector is as well as how independent the financial sector is from government control is what this indicator describes. Financial Freedom index of Ghana measures the barriers to finance of FDI and its often expected to be negative due to the influence the local financial system of Ghana has on the operations of foreign industries from China (Fan et al., 2016; Ramasamy, Yeung, & Laforet, 2012). $TRAF_{gh_t}$ stands for the Trade Freedom Index of Ghana. According to Stack et al. (2015), the impediments to trading globally such as price, investment and restrictions of the government explains the Trade Freedom Index measured by policy barriers with an expected sign being ambiguous.

3.3. Model Specification

The paper examines the causes and effectiveness of China's Foreign Direct Investment in Ghana using quarterly data from 2003 to 2020. It is based on Fan et al. (2016) with minor adjustments. The empirical model may be described as follows:

$$\ln FDI_t = \beta_0 + \beta_1 \ln GDP_{ch_t} + \beta_2 \ln GDP_{gh_t} + \beta_3 \ln PGDP_{ch_t} + \beta_4 \ln PGDP_{gh_t} + \beta_5 \ln DNR_t + v_t - u_t \quad (1)$$

The indexes, ch , gh , t corresponds to the variables of home nation (China), host economy (Ghana) and period respectively. FDI_t is FDI from China to Ghana in terms of both flow and stock over time t . GDP_{ch_t} and GDP_{gh_t} are China's and Ghana's GDPs throughout time t (in constant 2015 US dollars). China's and Ghana's GDP per capita throughout time t are shown by $PGDP_{ch_t}$ and $PGDP_{gh_t}$. DNR_t describes the relative endowment of natural resource between China and Ghana proxied by log of China's level minus log of Ghana's level. $v_t - u_t$ stands

for the two-sided error value and the one-sided inefficiency component respectively. To be able to know the resistances that go against the Chinese foreign direct investment to Ghana, the inefficiency frontier model is employed which is described below:

$$u_t = \delta_0 + \delta_1 \text{INVFgh}_t + \delta_3 \text{PRORIGH}_t + \delta_4 \text{FINFgh}_t + \delta_5 \text{TRAFgh}_t + \varepsilon_t \quad (2)$$

INVFgh_t denotes the index of Investments Freedom of Ghana. PRORIGH_t denotes the Property Right index of Ghana. FINFgh_t represents the Financial Freedom index of Ghana. TRAFgh_t represents the Trade Freedom Index of Ghana. ε_t is an error term describing any noise affecting the normal distribution.

Overtime, the technical efficiency (TE) of China's FDI to Ghana will be:

$$\text{TE}_t = \frac{\text{FDI}_t}{\text{FDI}_t^*} = \exp(-u_t) \quad (3)$$

3.4. Generalized Maximum Likelihood Approach

To investigate the technical efficiency hypothesis, this study used a generalized maximum likelihood technique. In the areas of applied economics, production function estimation has gain popularity. In estimating the model of interest, least squares are usually employed according to the disturbance in the assumption of normally distribution in the model. However, the maximum output achieved using the levels of inputs given defines what a production function is. With this, the techniques which will be used in their estimations should account for the attainable maximum output when the input levels are given. This has birthed the maximum likelihood approach in frontier regressions. In this study, the generalized maximum likelihood estimate is used employing likelihood ratio tests that enables only one-sided residuals (Greene, 1980). The formula for the generalized maximum likelihood test is as follows:

$$\text{Likelihood Ratio (LR)} = -2[L(H0) - L(H1)] \quad (4)$$

The outcome of the log likelihood function for the frontier model under the null hypothesis is $L(H0)$. Under the alternative hypothesis $L(H1)$, the magnitude of the log likelihood function for the frontier model is represented by $L(H1)$. For generalized likelihood ratios, the chi square distribution is estimated. We reject $H0$ using a degree of freedom at a 1 percent, 5 percent, or 10 percent significance level when the computed chi square is larger than the critical chi square, which is the number of parameters equal to zero (0) at the null hypothesis. The degree of freedom is defined as the number of parameters constrained that are equal to the difference between the estimated parameters of $H1$ and $H0$ when the null hypothesis is true. As a result, when the chi square value is smaller than the table value, $H0$ is approved (Asefa, 2011; David & Okoye, 2016).

4. Discussion of Results

The empirical results of the study are discussed in this section. The section be-

gins by discussing the descriptive statistics of the study. The empirical results include the estimates of generalized maximum likelihood, correlation analysis, and estimates of the stochastic frontier gravity model also discussed. The section also discusses the performance of China's FDI in Ghana.

4.1. Descriptive Statistics

Table 1 shows the descriptive information for the parameters used in this investigation. As presented in **Table 1**, the average FDI from China to Ghana is 204.92 with the maximum value of 612.22 and the minimum value of 1.66. This also shows a wide separation when it comes to the maximum and minimum values of FDI observations. China's GDP recorded a mean of $2.18e+12$ with a maximum value of $3.57e+12$ and a minimum value of $9.01e+11$. Ghana's GDP on the other hand had an average of $9.91e+09$ with maximum and minimum values of $1.50e+10$ and $5.51e+09$ respectively. The GDP per capita for China had its maximum value as 3.41 and a minimum value of 1.39 with an average of 2.16. Ghana's GDP per capita with an average of 0.97 had minimum and maximum values of -0.04 and 2.82 respectively. Total natural resources between China and Ghana had a mean score of 2.18 with a maximum value of 9.66. The average score for property right was 12.53 with a minimum value of 12.22. Trade freedom had a mean of 16.10 with its maximum value as 16.95. Investment freedom and financial freedom had their average scores as 15.42 and 13.89 respectively.

Correlation values are usually between +1 and -1 . Correlation values lesser than or equal to 0.5 are classified as weak correlation with values greater than 0.5 as strong correlation. Moderate correlation occurs when the value is between 0.5 to 0.6. The results of **Table 2** revealed that Chinese FDI and Ghana's GDP had a strong positive association ($r = 0.92$). The findings suggest that large size of Ghana's market encourage the participation of more inward Chinese FDI. China's FDI and the GDP of China recorded a strong positive correlation ($r = 0.92$).

Table 1. Descriptive statistics of variables used in the study.

Variable	Observation	Mean	Std. Dev.	Min	Max
FDI	72	204.92	202.02	1.66	612.22
GDPch	72	$2.18e+12$	$8.64e+11$	$9.01e+11$	$3.57e+12$
GDPgh	72	$9.91e+09$	$3.10e+09$	$5.51e+09$	$1.50e+10$
PGDPch	72	2.16	0.55	1.39	3.41
PGDPgh	72	0.97	0.65	-0.04	2.82
DNR	72	2.18	1.72	-0.13	9.66
PRORIGH	72	12.53	0.19	12.22	13.12
TRAFgh	72	16.10	0.68	13.85	16.95
INVFgh	72	15.42	2.18	12.5	17.5
FINFgh	72	13.89	1.92	7.5	15

Source: Author's illustration.

Table 2. Correlation coefficients of the variables used in the study.

	FDI	GDPch	GDPgh	PGDPch	PGDPgh	DNR	PRORIgh	TRAFgh	INVFgh	FINFgh
FDI	1									
GDPch	0.92***	1								
GDPgh	0.92***	0.99***	1							
PGDPch	-0.73***	-0.68***	-0.70***	1						
PGDPgh	-0.23**	-0.02	0.00	0.01	1					
DNR	0.36***	0.41***	0.43***	-0.07	-0.09	1				
PRORIgh	0.09	0.17	0.16	0.23*	0.03	0.67***	1			
TRAFgh	0.22*	0.26**	0.29**	-0.44**	0.31**	0.19	-0.007	1		
INVFgh	0.67***	0.83***	0.85***	-0.66***	0.15	0.42***	0.15	0.46***	1	
FINFgh	0.58***	0.69***	0.68***	-0.54***	0.11	0.25**	0.09	0.21*	0.79***	1

Note: *, ** and *** means significant at 1%, 5% and 10%. Source: Author's illustration.

The relationship between Chinese FDI and Property rights of Ghana showed a weak positive correlation ($r = 0.09$). The results indicate that between Chinese FDI and GDP per capita of China and Ghana indicated a negative correlation (-0.73 and -0.23 respectively) which are both weak. Between total natural resources and China's FDI, there is a weak positive association ($r = 0.36$). Between Chinese FDI and trade freedom of Ghana exists a positive weak correlation ($r = 0.22$). The relationship between China's FDI and Investment freedom of Ghana has a strong positive correlation ($r = 0.67$). A moderate association ($r = 0.58$) exists between Chinese FDI and Ghana's financial independence. **Table 2** shows the correlation coefficients for the study's explanatory factors.

4.2. Analysis of the Estimates of the Stochastic Frontier Gravity Model

The determinants of the frontier given in Equation (1) and the determinants of the inefficiency model reported in Equation (2) are both assessed concurrently using Stata software in a one-step procedure. **Table 3** shows the results of the maximum likelihood estimates as well as the results of the inefficiency model. The Likelihood Ratio test findings' estimated chi square is 19.35, which is bigger and significantly different from zero. Therefore, we assert that probability $> \chi^2$ of 0.0002 is significant at 1%. We reject the null, $\text{Insig2u} = 0$, in favor of the alternative, $\text{Insig2u} > 0$, at a 1% significance level. One-sided residual likelihood ratio tests prefer the model's FDI estimate, which explains why one-sided residual likelihood ratio tests favor the model's FDI estimate. At 10%, the Insig2v of -2.51 is significant. In measuring the FDI, the Insig2v has a value of -2.51 , which is statistically significant at the 10% level, meaning that there is -2.51 times the random error in the degree of inefficiency.

With a coefficient of 10.81 and a significance of 10%, China's market size has

Table 3. Stochastic frontier gravity model estimation.

lnFDI	Coeff.	Std. Err.	z-value
lnFDI			
lnGDPch	10.81***	1.16	9.30
lnGDPgh	-9.19***	1.74	-5.27
lnPGDPch	-1.36***	0.41	-3.34
lnPGDPgh	0.12	0.12	0.95
lnDNR	0.79***	0.14	5.75
_cons	-90.84***	9.21	-9.87
lnsig2v_cons	-2.51***	0.21	-11.68
lnsig2u			
lnINVFgh	35.07***	12.48	2.81
lnPRORlgh	51.49***	18.27	2.82
lnFINFgh	-20.12***	7.43	-2.71
lnTRAFgh	-64.27***	21.13	-3.04
lnsig2u_cons	-9.63*	377.29	-0.03
sigma_v	0.29	0.03	
LR chi2(3) = 19.35			
Prob > chi2 = 0.0002			
log likelihood = -17.78			

Note: *, ** and *** means significant at 1%, 5% and 10%. Source: Author's illustration.

a positive and significant influence on China's FDI, confirming the gravity model's prediction that big nations engage in more outward FDI. On the same note, Ghana's market size negatively affects the China's FDI with coefficient value of -9.19 and is significant at 10% significance level. The GDP per capita of Ghana describing the level of development of the country positively affects China's FDI but is statistically not significant. Ghana can be said to have high production costs as high GDP per capita implies a higher production cost. The development level of Ghana is therefore positively signed. China's market size has positive impacts on its FDI to Ghana at 10% significance level and this corresponds with the expectation that states that are bigger usually involve in more outward FDI. These results can be related to the fact that the study combined both FDI flow and stock in its estimations preventing irregularities that disturb the gravity law when only FDI flows are used. This result supports the research by [Fan et al. \(2016\)](#) who had a positive coefficient of China's market size for FDI stock and negative China's market size for FDI flows. The GDP per capita of China describing the development level of China negatively affects the FDI of China to Ghana with coefficient value of -1.36 and is significant at 10%. This result can be the fact that the study employed both FDI stock and flow and FDI stock con-

sists of cumulative data which are not up to more often for independent variables with only quarterly values affecting the results to have a negatively signed coefficient for China's development level. This can be supported with the results of [Fan et al. \(2016\)](#) who showed that the level of development of China was negatively signed in regards to FDI stocks but positively signed with FDI flows. The natural resource rents to GDP in this study are positively affecting the Chinese FDI to Ghana and have a significance level of 10%. It has a coefficient value of 0.79 and is significant at 10%. This result contradicts the findings of [Habyarimana and Wu \(2017\)](#) who observed that China's motive of FDI is to seek natural resources. With these results, it can be said that apart from the GDP per capita of Ghana which is not significant as a driver of China's FDI to Ghana, all the other frontier determinant variables are significant.

The results of the coefficient of investment freedom of Ghana variable positively affects the level of inefficiency by increasing technical inefficiency and is significant at 10%. This result shows how investments that come to Ghana are affected with barriers to investments inflows. Intellectual property rights index of Ghana in this estimation affects the inefficiency level of China's FDI positively with a coefficient value of 51.49 and is significant at 10%. The results imply that Ghana in its way of protecting the rights on properties largely increases the man-made impediments to foreign investments. Trade freedom index of Ghana variable negatively affects inefficiency, indicating that as trade freedom index of Ghana increases, technical inefficiency declines. With a coefficient value of -64.27 and a 10% significance level, the trade freedom index is said to reduce inefficiency and is significant. This result implies that in the absence of trade barriers, China's FDI to Ghana can be encouraged. The coefficient of financial freedom index of Ghana has a negative sign for Chinese FDI. This indicates that financial freedom reduces the level of inefficiency and is significant at 10%. This can be explained by Ghana's local banking sector rules, which limit China's FDI to Ghana. All the variables discussed in the inefficiency drivers' variables are substantial and, as a result, have an influence on China's FDI in Ghana.

4.3. The Performance of China's Foreign Direct Investment in Ghana

The ratio of actual FDI to anticipated FDI is used to calculate China's FDI efficiency score ([Song, 2018](#)). In order to analyze how China's FDI performs in Ghana, the study estimated the efficiency scores of China's FDI using both stock and flow data from 2003 to 2020. Efficiency scores usually ranges from 0 to 1 where by the actual FDI is said to lie on the frontier FDI when efficiency score has a value of 1. Higher performance of FDI is usually associated with higher scores of efficiencies in which the inefficiency factors less affect the performance. However, higher performance of the FDI is more often associated with lower room of potential as a higher performance of FDI is said to be close to full potential ([Armstrong, 2011](#); [Song, 2018](#)). [Fan et al. \(2016\)](#) also highlighted that a

lesser chance of improvement is the result of having a higher FDI performance as its associated with a level of FDI potential that is lesser in the future. In this study, equation (3) which is $TE_t = \frac{FDI_t}{FDI_t^*} = \exp(-u_t)$ used to calculate the performance of China's FDI to Ghana. The results of the estimation are presented in **Table 4**. The study in explaining the features of the results make use of the efficiency score benchmark of **Gulati (2011)** to describe the scores of efficiencies.

Efficiency Score less than 0.5 ranks 7 meaning inefficiency. Low efficiency is represented by scores from 0.5 and less than 0.6. Efficiency scores greater or equal to 0.6 and less than 0.7 corresponds to semi-low efficiency ranking 5. Medium, Semi-high, high, and full efficiency are represented by scores $0.7 \leq E < 0.8$, $0.8 \leq E < 0.9$, $0.9 \leq E < 1$ and $E = 1$ respectively.

The Performance of China's FDI to Ghana as illustrated by **Table 4** has some features that need to be highlighted. China's overall FDI performance to Ghana from 2003 to 2020 has a mean value of 0.80. This explains that China's FDI to Ghana overall performance falls under rank 3 which is $0.8 \leq 0.80 < 0.9$ implying a semi high efficiency. This result implies that the potential level of China's FDI

Table 4. China's foreign direct investment to Ghana efficiency scores.

Year	Q1	Q2	Q3	Q4	Mean
2003	0.99	0.99	0.99	0.99	0.99
2004	0.99	0.99	0.99	0.99	0.99
2005	0.71	0.71	0.71	0.71	0.71
2006	0.49	0.49	0.49	0.49	0.49
2007	0.99	0.99	0.99	0.99	0.99
2008	0.99	0.99	0.99	0.99	0.99
2009	0.99	0.99	0.99	0.99	0.99
2010	0.92	0.92	0.92	0.92	0.92
2011	0.97	0.97	0.97	0.97	0.97
2012	0.97	0.97	0.97	0.97	0.97
2013	0.92	0.92	0.92	0.92	0.92
2014	0.83	0.83	0.83	0.83	0.83
2015	0.87	0.87	0.87	0.87	0.87
2016	0.97	0.97	0.97	0.97	0.97
2017	0.48	0.48	0.48	0.48	0.48
2018	0.53	0.53	0.53	0.53	0.53
2019	0.35	0.35	0.35	0.35	0.35
2020	0.35	0.35	0.35	0.35	0.35
Mean	0.80	0.80	0.80	0.80	0.80

Source: Author's illustration.

to improve is low as it has a lower potential level of FDI outflow in the future with its semi high efficiency score as explained by Song (2018). On the other hand, having a semi high efficiency score indicates that there is a semi high performance of China's FDI (Armstrong, 2011). The study highlights a widely separated minimum and maximum efficiency scores of China's FDI during the period of 2003 to 2020 in Ghana. In Ghana, the maximum efficiency score for China's FDI is 0.99 with a minimum efficiency score of 0.35. Due to this widely separated minimum and maximum efficiency scores, China's FDI to Ghana performance can be said to have an uneven pattern. According to the efficiency score benchmark of Gulati (2011), in the year 2003, China's FDI to Ghana received an average score of 0.99, placing it in the second position ($0.9 \leq 0.99 < 1$). As a result, China's FDI performance in 2003 was classed as high efficiency, signifying that China's FDI performance was high in 2003 and had a lower potential level, implying that there was a smaller likelihood of progress or advancement. The year 2004 also had same efficiency score like that of 2003 with its score being 0.99 which is also in rank 3 and can be described as a high efficiency score. Therefore, in both 2003 and 2004, China's performance in terms of FDI to Ghana was high having a lower potential of FDI in the future. With an efficiency score of 0.71, China's performance in the year 2005 can be described as medium efficiency ranking 4. This shows that China's FDI performance to Ghana reduced to a medium efficiency in 2005 from a high efficiency rank in 2003 and 2004. However, in the year 2006, China's overall performance in terms of FDI to Ghana had efficiency score of 0.49 which ranks 7 said to be the level of inefficiency. From a level of high performance, China's FDI dropped to inefficiency level in 2006 implying a higher chance of improvement in the future. This can be said to be true as China's FDI to Ghana performance has since then improved until 2016. The performance of China's FDI to Ghana from 2007 to 2013 all recorded efficiency scores that ranked 2 which is high efficiency. The average performance scores from 2007 to 2013 are 0.99, 0.99, 0.99, 0.92, 0.97, 0.97 and 0.92.

2014 and 2015 however, recorded average performance scores of 0.83 and 0.87 respectively ranking 3 which is semi high efficiency. In the year 2016, the performance of China's FDI improved from a semi high efficiency to a high efficiency rank of 2 with efficiency score of 0.97. Meanwhile, China's FDI to Ghana performance from 2017 to 2019 saw a decrease in their efficiency scores. Within these three years, 2019 and 2020 had the least efficiency performance with a score of 0.35 which ranks 7 and is inefficient while 2018 had the highest efficiency score of 0.53 which ranks 6 meaning a low efficiency score. China's FDI to Ghana performance in 2017 also had an inefficient score of 0.48 which is lesser than 0.5, the benchmark score for inefficiency.

5. Conclusions and Recommendations

5.1. Conclusions

Ghana's market size had a negative impact on China's FDI, which was substan-

tial at 10%. Ghana's per capita GDP had a beneficial impact on Chinese FDI; however, it was not a substantial effect. At the 10% significance level, China's market size has a positive influence on its foreign direct investment to Ghana, corroborating the idea that big nations invest more in the world. This finding backs up [Fan et al. \(2016\)](#), who found China's market size to be positive for FDI stock and negative for FDI flows in their analysis. The external FDI from China to Ghana is negatively affected by China's per capita GDP, which describes the country's development level, and this effect is considerable at a significance level of 10%. In this study, the natural resource rents of GDP have a favorable impact on Chinese FDI to Ghana and are statistically significant at the 10% significance level. This conclusion however, contradicts [Habyarimana and Wu \(2017\)](#) who claim that China's FDI is driven by a need for natural resources. The study also concludes that China's entire performance in terms of FDI to Ghana is similarly semi-highly efficient ($E = 0.80$), according to the assessment.

5.2. Recommendations

The following policies are suggested to be implemented using the findings as a basic.

First, the government of Ghana should promote market development strategies in order to enhance the size of the Ghanaian market which in this study is a significant determinant of Chinese FDI to Ghana but has negative effects. Market development strategies such as geographical expansion (reaching out to Ghanaians and foreigners to promote made in Ghana products) and attractive pricing can be adopted by the Ghanaian government. Through "buy made in Ghana" at affordable price policy, the government can promote made in Ghana products to foreigners as well as Ghanaians abroad and in other regions of Ghana.

Also, natural resources rent to GDP in the study had a significant impact on China's FDI to Ghana. Therefore, natural resource conservation program should be put in place by the Ghanaian government. This will complement the already existing Mining and Mineral Policy to preserve the natural reserves of the country. The Chinese government also should enforce cooperation on contracts for exchange of the sale of "made in Ghana" products in China for natural resources. This is suggested as Ghana needs to improve its market size while China needs to maintain its natural resource levels. When this is done, it will attract more Chinese FDI to Ghana and help enhance their cooperation.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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