

Why Foreign Direct Investment Goes Towards Central Africa¹?

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Abstract

This article examines the determinants of foreign direct investment in Central Africa. We use a theory based on the OLI paradigm of Dunning (1980). The estimation technique is panel data. We obtained the following main results: (i) high rates of GDP growth attract foreign investment, (ii) oil production, human capital and trade openness also promotes the entry of FDI in Central Africa (iii) the study also show that the amplifier FDI effect would be greater if a real national investment policy is implemented. The economic policy recommendations of the study are: (i) the authorities must intensify the fight against corruption and reduce inflation; (ii) encourage private investment and (iii) modernizing infrastructure to facilitate transactions and transport of products.

Keywords: Foreign Direct Investment, traditional determinants, institutional determinants, territorial attractiveness, panel data.

JEL Classification: F2; F21; F23; F35

1. Introduction

Over the past three decades, foreign direct investment (FDI) has known an unprecedented evolution. It is increasingly playing a prominent role in the growth and development process of states. For external financial flows, FDI accounts for 64%, portfolio Investment (IPF) 29.2%, and 6.8 % for Official Development Assistance (ODA) (WDI, 2011). Moreover, between the GDP and trade opening measures, FDI is having a remarkable growth rate. From 1980 to 2010 the average growth rate of global FDI was 15%; GDP and trade opening measures recorded 5% and 2.3% respectively (UNCTAD, 2011).

Despite this strong representation, FDI is experiencing significant variability. In 2007, they decreased by 20%. This drop was greatly marked by the decrease in the attractiveness of developed countries due to the global financial crisis. Developing countries as well as countries in transition have maintained their up-trend. Since 2007, these countries have attracted more than half of inflows (UNCTAD, 2011).

Moreover, after a slight shudder between 2004 and 2006, Central Africa has returned with a strong attraction for FDI though relatively low when compared to the volume of FDI in Africa. Central Africa alone represents 18.81% of FDI to Africa (UNCTAD, 2011).

In light of this evolution, the main question of this article is centred on providing reasons for the increasing attractiveness of developing countries in general and those of Central Africa in particular. The authors have analysed the new dynamics of FDI which are increasingly concentrated in developing countries. The rest of the paper presents a brief review of the literature used (section 2). This is precisely in section 3 enabled us to analyse facts while focusing on the sources and destinations of FDI in Central Africa. In Section 4, we specify, estimate the chosen model and interpret our results. The conclusion is done in the section 5.

2. Literature review

2.1. Theoretical framework

The study of the determinants of foreign direct investment has two approaches which are largely complementary. An approach based on Industrial theory and a second one based on the theory of international trade.

Observed through the prism of the industrial economy, the main explanatory theory is the "product life cycle" theory by Vernon (1966): *"a firm that innovates in the" North " gets a comparative advantage, enabling it to*

¹ Central Africa regroups all the countries of the Economic Community of Central African States (ECCAS), created in 1983, and is considered as the integration milieu chosen by the African Union. It includes Angola, Burundi, Cameroon, Congo, Gabon, Equatorial Guinea, the Central African Republic, the Democratic Republic of Congo, Sao-Tome and Chad.

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export to the markets of other countries (the "South"). Gradually, however, this advantage disappears because the same innovation is also done in the South. When the product loses value in the North, the firm prefers to relocate its production to the South, where demand is higher, cost of production is lower and production technology is well mastered". In this industrial dynamics, the multinational firm is at the centre of foreign investment. This rather eclectic theory or O.L.I. paradigm propounded by Dunning (1980) presents three advantages of multi-nationalisation: (1) the specific advantage of the firm (Ownership advantages), (2) the benefit to the location abroad or the comparative advantage of the host country (Location advantages) and (3) the benefit to internalization (Internalization advantages). In the same logic, Mucchielli (1985) comes up with the synthetic approach in which the incentive for a firm to export or be relocated depends on a comparison of its comparative internal advantages (organizational innovation) in relation to the comparative advantages of Home countries (costs factor and market size).

The business logic of private capital flows is defended for the first time by Mundell (1957) within the context of international trade. According to this author, foreign investment serve as substitutes for trade given that, with the existence of customs barriers, firms will prefer to relocate their production before export: investment therefore has a negative impact on trade. In this sense, FDI countries are usually from countries having an abundance of resources to those having less. But the facts show otherwise. Investment between countries of equal standing is more than that between countries of different economic standing (assuming the new theories of international trade). In addition, foreign investments are born by firms and not by the country as alleged by the traditional theory of international trade. So, Brainard (1993), Markusen (1995) and, Markusen and Venables (1999) incorporate elements such as imperfect competition, product differentiation and economies of scale to justify the investment made by foreign multinationals. Moreover, Brainard (1997) believes there is some sort of correlation between the concentration of production and proximity to the market in the choice between export strategies and direct investment by U.S. firms. She uses indicators of economies of scale referring to the firm on the one hand and to the production side on the other. It is on this basis that the comparison between cost and profit has been analysed in the model of economic geography which derives its main assumptions from the theory of trade under monopolistic competition. Krugman (1979, 1980 and 1991) publicise the model. The choice of the location of firms depends on the profit made (or expected) which is negatively influenced by the applicable cost of production in the country and positively correlated with market potential.

2.2. Empirical review

In addition to the theoretical presentation, empirical studies on the determinants of FDI vary and generally depend on the countries concerned.

Anyanwu (2012) studies the determinants of FDI in an article entitled "Why Does Foreign Direct Investment Go Where It Goes: New Evidence From African Countries." The author considers 53 African countries over the period 1996 to 2008 and includes a number of factors explaining FDI. Using ordinary least squares and generalized least squares, he concluded that the rate of GDP growth positively influences the attractiveness of FDI. According to Anyanwu (2012) the growth rate higher and higher in Africa encourages the entry of foreign investors looking for higher returns on their capital.

Also, Asiedu (2006) leads to the same result with a positive significance at 5% of GDP on FDI. His study covers 22 countries in sub-Saharan Africa between 1984 and 2000. It uses the technique of generalized least squares and the flow of FDI to GDP as dependent variable. In addition to the generic result say, the author shows that large sample countries (South Africa, Nigeria and Angola) that have significant growth, attracting more FDI and positive significance is 1 %.

In general, human capital, whatever its extent, confirms the expected sign. If Lucas (1988) was the first to stress the impact of human capital in FDI attractiveness, this was a real critical analysis with renewed Borensztein et al. (1998). These authors, in a study of 69 developing countries between 1970 and 1989, found that the positive effect of FDI on growth stems from human capital (transmission channel). A minimum of human capital is necessary for this purpose.

In terms of physical infrastructure, in a cross-sectional study by Loree and Guisinger (1995) between 1977 and 1982, shows that country with more developed infrastructure attracts more FDI from the United States. Asiedu (2002) find for African countries, a positive and significant relationship at 5% between FDI and infrastructure. Indeed, they consider the number of telephone lines per 1000 inhabitants (measure widely used) to designate infrastructure. Bamou and Khan (2006) use the ratio of paved roads and electricity infrastructure as measures in a study on the determinants of FDI in Cameroon. They found a positive and highly significant impact of infrastructure in the attraction of FDI in Cameroon.

Bissoon (2012) examines the impact of institutional quality on the attractiveness of FDI in 45 developing region Africa, Latin America and Asia over the period 1996-2005. Institutional indicators used are the control of corruption, the role of law, regulatory quality, political stability and freedom of expression. Based on the technique of ordinary and generalized least squares, he obtained the following main results: the controls of

corruption, regulatory quality and political stability have a positive and significant impact on the investment attractiveness. Indeed, the author agrees with Du and Tao (2008) that better institutions reduce the cost of implementing investors and improves the investment climate.

For Dupuch and Milan (2005), the determinants of FDI in developed countries revolve around cost factors and are mostly vertical or relocative FDI in search of cheaper production factors. Djaowe (2009), Benassy-Quere et al. (2007) and Asiedu (2002) greatly consider institutional determinants. They characterized the attractiveness of developing countries. Stein and Daude (2007) confirm that institutional and political factors are important determinants in the location of FDI in developing countries. Wei (2000) finds that corruption has a significant adverse effect on the location of FDI. This result is robust through the use of different measures of corruption.

In addition to institutional factors, FDI in the direction of Central African countries is largely influenced by natural resources, especially oil. In a research carried out in countries of sub-Saharan Africa, Fotso Deffo (2003) argues that the exploitation of oil is an important factor of attractiveness for foreign investors.

However, alongside the institutional factors and natural resources, traditional determinants however remain relevant. Anwar and Nguyen (2010) distinguish human capital, GDP, infrastructure, inflation, trade openness and exchange rates. Hattari and Rajan (2011) based their analysis on distance. In all scenarios of the research, distance negatively affects the attraction of FDI.

One of the most successful studies on the effect of natural resources is one of Asiedu (2006). It analyzes the role of natural resources, market size, government policy, institutions and political instability on the entry of FDI in Africa. The author considers 22 African countries over the period 1984-2000. Using the technique of generalized least squares; it is only 2.7% of FDI directed towards the African countries in the sample when oil production increases by one percent.

3. The analysis of stylized facts

Until very recently, European countries such as France, Germany, Portugal and Belgium were the main investors in Central Africa. The United States and emerging countries have become significant actors in foreign direct investment (Table 1).

Table 1: Sources of FDI to Central African States

Host Countries	Country of origin in percentage of investment								
	US A	Franc e	Portug al	German y	Belgiu m	Norwa y	The Netherland	Malaysi a	Chin a
Angola	35		45			20			
Burundi		55	35						10
Cameroon	35	45		25					5
Central Africa		60			35				5
Chad		45						35	25
Congo	15	35					45		
Dem. Rep. Of Congo	35			5	25				35
Equatorial Guinea	35	45							20
Gabon		55		35					10

Source: Author's construction from the World Investment Directory (2008).

On average, we realise that countries which had been colonial masters remain among the first foreigners to have invested in the sub-region. This can be explained by treaties, trade agreements and the sharing of a common language which is also a significant factor. If the sources of FDI abide to the historical or colonial logic, their interest to invest will be driven by the search for markets but more especially for natural resources.

Also, countries with high oil productivity, minerals and timber attracted more than half of FDI in the sub-region. Between the year 2000 and 2010, the average stock of FDI in Central Africa totalled to 63.265 MDUS; unevenly distributed between the countries.

Angola remains the largest oil producer in the sub-region. Over the period 2000-2009, it produced an average of 941.92 thousand barrels daily. In 2008, it reached the milestone of one million barrels per day (1,875 million barrel day). Thus, there is a strong relationship between the level of oil production and the attractiveness of FDI in the country. The discovery of new oilfields and the diversity of partner countries have helped Gabon to maintain its daily oil production despite the slight decline between 2000 and 2009. On average, the country produces about 300,000 barrels per day. Congo could also be said to produce at this rate. Cameroon is among the oil-producing countries in Central Africa which had a continuous decline in its production. With only

100,000 barrels per day on average over the period 2000-2009, the country began its production in 1977 following the discovery of deposits in Limbe; an area found in the South West Region of the country, in 1975 and the construction of the SONARA (Société Nationale de Raffinerie – National Oil Refinery Company). Given this reduction, and in order to remain attractive, the government envisaged to diversify production into other economic sectors and gradually improving the business climate, plagued by corruption in all its forms.

At concern institutional quality, Transparency International notes that Cameroon is still among the most corrupt countries in the world. In 2009, the agency gave her a rating of 2.2 on a scale of 10. It is not however the most corrupt country in central Africa. Angola, Burundi, Chad and Equatorial Guinea recorded 1.9, 1.8, 1.6 and 1.8 respectively, on the perception index. Gabon, with its score of 2.9 in 2009 is top of the class.

The risk of existing corruption in countries does not discourage investors in search of raw materials and mineral resources.

In relation to the oil industry, there is a slight contrast as concerns the attractiveness of countries (Table 2).

Table 2: Performance and percentage index of FDI attractiveness in Central Africa

Country	average performance index (1980-2010)	Percentage of attractiveness
Equatorial Guinea	12.480	36.54
Angola	7.6913	22.52
Congo	4.4644	13.07
Chad	3.7112	10.86
Burundi	2.9551	8.654
Dem. Rep. of Congo	1.4391	4.214
Cameroon	0.7723	2.261
The Republic of Central Africa	0.5243	1.535
Gabon	0.1093	0.320

Source: Author's construction from UNCTAD data, 2011.

Equatorial Guinea is the leading country in terms of FDI performance index³ and attractiveness followed by Angola, whereas the latter remains the largest oil producer in the sub-region. In addition, among the five most attractive countries, Burundi occupies the fifth position ahead of Gabon and Cameroon. Two plausible explanations can be made: (1) the decline in oil production was heavy on Cameroon (-12.8%) in 2008-2009, it stood at 4.9%, 12.3% and 2.6 % in Angola, Equatorial Guinea and Gabon respectively, (2) this confirms the hypothesis that there are other determinants of foreign direct investment that would influence, either individually or collectively, countries of the Central African Region.

The second reason is supported by Dupuch and Milan (2005), Assiedu (2002), Benassy-Quere et al. (2007) and Djaowe (2009) who think that there are several determinants to FDI and these revolve around strategies adopted by firms as well as the characteristics of the receiving country.

4. Methodology

4.1. Economic model

The adopted model is inspired by the works of Anyanwu (2012), Bloningen and Peg (2011) and Asiedu (2002). Its specification is as follows:

$$(FDI / GDP) = \beta_0 + \beta_1 GDP_{it} + \beta_2 HC_{it} + \beta_3 INV_{it} + \beta_4 Inf_{it} + \beta_5 Open_{it} + \beta_6 Infrast_{it} + \beta_7 Petrol_{it} + \beta_8 Corrupt_{it} + \beta_9 HC * INV_{it} + \beta_{10} Open * Infrast_{it} + \varepsilon_{it} \quad (1)$$

Where, $\varepsilon_{it} = u_i + v_t + \eta_{it}$

Interactive variables $HC*INV$ and $Open*Infrast$ enable us to outline the impact of FDI transmission channels in the sub-region.

4.2. Variables, data and estimation method

In our study, we laid emphasis on eight variables widely discussed in literature pertaining to this domain. The

³ Hatem (2004) presents the formalization of the performance index calculation. Its formula is

$$PI = \frac{FDI_{country} / FDI_{world}}{GDP_{country} / GDP_{world}}$$

where PI is the performance or attractiveness index of the country.

dependent variable is FDI flows (FDI/GDP). The explanatory variables are grouped into three categories: (1) traditional variables of attractiveness [growth of GDP (GDP), Human Capital (HC), Private Investment (INV), infrastructure (Infras), inflation (Infl) and trade openness (Open)], (2) an institutional variable [Corruption (Corrup)] and (3) a natural resource variable [oil production (Petrol)]. Appendix 1 provides a detailed explanation of the variables.

The number of general observations is 279 or 9×31 . The sample consists of 9 countries (Angola, Burundi, Cameroon, Congo, Gabon, Equatorial Guinea, The Central African Republic, The Democratic Republic of Congo and Chad). The lack of data obliged us to remove Sao Tome et Principe from the sample list. The time frame is from 1980 to 2010; say 31 years.

Three different data sources were used: (1) World Development Indicator (2011) for the traditional variables, (2) Transparency International's corruption index and (3) The Statistical Review of World Energy (2010) for oil production.

Our findings based on the random-effects models are summarized in Table 4. In general a regression model of panel data is as follows: we make Fischer Test to choose between panel data and OLS method and the Hausman test permits to choose between fixed and random effects.

Table 4: Choosing between Panel data and OLS (Using Fischer-test) and choosing between Fixed and Random effects (Using Hausman-test)

Tests	Probability	Degree of freedom	Statistics
Fischer-test	0.0000	(7 ; 279)	72.816
Hausman test	0.0271	8	38.792
Breusch-Pagan test	0.0000	1	24.153

Source: Author's construction

Building on the procedure for the estimation of panel data, the results of the general model suggests the technique of generalized least squares (GLS). Indeed, Fisher's exact test shows that $F(7, 279) = 72,816$ and is higher than the probability of F ($\text{Prob} > F = 0.0000$), but less than 5%. This leads to the adoption of panel data estimation. The presence of random effects is confirmed by the Breusch-Pagan test so the probability is less than 5%. The Hausman test highlights the lack of correlation between the individual effects and the explanatory variables. His statistics ($\text{Chi}^2(8) = 38.792$) is greater than the probability ($\text{Prob} > \text{chi}^2 = 0.0271$). We prefer the random effects model and the estimator of the MCG.

Descriptive statistics are compiled in Table 3 below.

Table 3: Some descriptive statistics

Descriptive statistics of main regression variables (Excluding interactive variables), 1980-2010

Variables	Means	Std. Dev.	Min	Max	Obs
FDI/GDP	58.59	0.84	-0.34	4.23	277
GDP	6.16	1.84	0	10.92	279
HC	23.88	15.97	2.49	71.52	173
INV	17.83	2.73	0	10.12	279
Corrupt	-2.09	0.4	1.4	3.3	126
Inf	58.12	1584.82	-100	3.51	244
Open	66.45	2.79	0	9.65	279
Infrast	34.65	16.21	0	106.94	275
Petrol	373.97	7.35	-0.951	8.342	266

Source: Author's construction

In general, the variables used have a low fluctuation rate. The stock of foreign direct investment greatly differs from one country to another, but linearization enables us to align the sizes (Bloningen and Peg, 2011; Eaton and Tamura, 1994; Wei, 2000). The observations on the corruption variable are few because Transparency International, the official measurement index of corruption, only began its activities in 1995. The first African countries listed were only included in 1998. The high variation of data on inflation is due to the heterogeneity of the country. Six of the nine sample countries have the same currency⁴. Angola and the Democratic Republic of

⁴ Central Africa has an economic zone: the Economic Community of Central African States (ECCAS) and a monetary zone: The Economic and Monetary Community of Central Africa (CEMAC) which comprises Cameroon, Congo, Gabon,

Congo have very high inflation rates because they print their money and take decisions on the instruments of their monetary policy.

4.3. Results and discussion

Table 4: Results of the regression

The dependent variable is 100*FDI/GDP : Random effects Model				
	Model 1	Model 2	Model 3	Model 4
GDP	1.101* (0.22)	2.049* (0.52)	1.035** (0.40)	2.026*** (0.32)
HC	0.914 (4.07)	1.122*** (4.39)	0.431 (4.52)	2.142*** (3.38)
INV	0.036 (0.49)	-0.004 (-0.74)	0.047 (-0.69)	0.824* (0.79)
Corrup	-3.288* (-0.38)	-1.921 (-1.43)	-0.044 (-0.64)	-5.211*** (-1.00)
Inf	-0.0009** (-2.40)	0.0002 (0.61)	-0.00079 (-2.23)	-0.0021** (-0.74)
Open	4.189*** (11.07)	2.104** (4.34)	-1.081 (-1.32)	3.142*** (0.33)
Infrast	0.024*** (4.85)	-0.912 (-1.49)	0.01228** (4.93)	0.0712** (1.69)
Petrol	12.425*** (10.29)	7.158** (4.61)	15.26* (11.08)	17.515** (4.59)
HC*INV		1.234** (3.63)		1.234 (2.69)
Open*Infras			5.172* (2.28)	1.241* (0.92)
Cons	2.014** (2.26)	2.281* (3.18)	2.202 (2.68)	2.320** (3.21)
Nber of Obs.	276	268	268	279
Nber of groups	0.5490	0.7244	0.6424	0.7371
Wald Chi2 (8)	0.9953	0.9966	0.9963	0.9968
Prob>Chi2	0.0000	0.0000	0.0000	0.0000

Source: Author's construction from Stata 11.0 Software.

***, **, *: Significance at 1%, 5% and 10%; the robust z of the random effects model in parentheses.

In the table of results above, Model 1 shows the results of the interactive effects without incorporating simple variables of the research. Model 2 shows the influence of specific human capital and private investment which is related to an input FDI channel. Model 3 does same with trade openness and infrastructures. This scenario allows us to compare the relative influences of different FDI input channels (Ayala et al. 2009). Model 4 takes into account simple and interactive variables.

GDP appears to be very significant in four models: the strong growth experienced in recent years the countries of Central Africa more attractive to foreign investors. A percentage point increase in the growth rate leads to an increase of 2.06%. Also, efforts are being made by the authorities to diversify economies and gradually increase economic activities.

Human capital (HC) is positive and highly significant. This result confirms the progress in the diversification of education and vocational training. However, this is a result of human potential decay in Central Africa.

With regard to private investment, the business climate is improving at a very slow pace. National Trust encourages foreign investors who are motivated up to 0.82%. Several problems still hamper private initiative:

Equatorial Guinea, Central African Republic and Chad. Compliance with the convergence criteria requires an inflation rate below 3%.

corruption, administrative procedures to start a business, political unrest and taxation.

Corruption despite the many initiatives taken by the authorities is a real problem that discourages up to 5.21% entry of FDI in Central Africa. It increases the cost of investment and reduces the expected profits for investors. The institutional recurrent problems remain in Central Africa (Avom, 2007).

Similarly, inflation decreases the competitiveness of enterprises, the purchasing power of consumers, distorts competition. Its low impact (-0.0021%) still reflects the efforts made by the countries of Central Africa in particular those of the CEMAC.

The effects of FDI openings to Central Africa are positive and significant in two of the four models. Most often described as an economically slow region, the macroeconomic reforms implemented since 1994 helps in strengthening economic exchanges. Reductions in custom taxes levied on companies that invest in the area, encourage foreign investment. This result confirms that which was obtained by Paniki and Wunnava (2004), and Kahai (2011): FDI are complementary to trade and central Africa is used by multinational Companies as an exportation platform; they use a vertical strategy.

The contribution of infrastructure (Infra) represented by the number of mobile phone subscribers (Appendix 1) is a widely used variable in related literature. It is positive and significant for both the single variable model (model 1) than models of interactive variables. This result is also obtained by Bloningen and Peg (2011). Averagely, 1.71% of FDI came into the sub-region because the infrastructure therein is improving, roads; a means of integration, are constructed and new technologies are globally being used; with quite glaring examples such as the installation of the optical fibre on all of Cameroon's national territory.

Oil production (Petrol) is positive and significant for all models, proving that oil is a resource very much sought by multinational firms: the sector is currently experiencing a very high variation of investing partners. French firms which were dominant in oil-producing countries of the CEMAC zone, as the case may be, are now being replaced by American and Chinese firms. Today, a greater number of multinationals are now taking over oil exploitation in this region⁵. Averagely, almost 17.51% of FDI in Central Africa are attracted by oil exploitation. This result is largely obtained as most research carried out (Mina, 2007; Fotso Deffo, 2003).

Interactive variables *CH*INV* and *Open*Infras* indicate the channels through which FDI can enter the sub-region. This method is used by Alaya et al. (2009); Assiedu (2002) and Borenztein et al. (1998). The results are consistent with the studies cited. High technology provided by the engineers of multinationals is transmitted to local personnel who stand to benefit. This reduces costs destined for the creation of human capital. The model adopted by Romer (1990), *Learning by doing* is further confirmed. Human capital, private investment, openness trade and infrastructures respectively influence the entry of FDI in the Central African zone to 1.234% (model 2) and to 5.172% (model 3).

5. Conclusion and policies implications

Central Africa is gradually progressing in its FDI attractiveness. This observation is justified by economic and institutional factors, as well as the presence of natural resources. Central Africa alone represents 18.81% of FDI to Africa (UNCTAD, 2011).

This article has sought to provide an answer to the main question "why foreign investment goes live: towards Central Africa?". To achieve this, we used a panel data model by the method of generalized least squares. Our main results show that FDI will in Central Africa because of the high oil production, trade openness, growth rates become higher, human capital and infrastructure, though still low level.

However, the study calls for several economic policy recommendations: (i) the authorities must intensify the fight against corruption and inflation so as to reduce them, (ii) encourage private investment and (iii) modernizing infrastructure to facilitate transactions and transporting products.

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⁵ For example, we can cite TRADEX, SOCAEPE in Cameroon and the Congolese Refinery in Congo.

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Appendices

Appendix 1: Description of variables and data sources

Variables (label)	Description	Sources
Foreign Direct Investment (FDI/PIB)	Annual foreign direct investment in flow, 1980-2010	UNCTAD, 2011
Market size (GDP)	Growth of GDP	World Bank data, 2011
Human capital (HC)	Gross enrolment ratio in secondary schools.	World Bank data, 2011
Private Investment (INV)	Gross fixed capital creation	World Bank data, 2011
Corruption (Corrup)	Corruption Perception Index	Transparency International, 2010
Inflation (Inf)	Index of consumer prices	World Bank data, 2011
Trade openness (Open)	Sum of imports and exports in relation to the GDP	World Bank data, 2011
Infrastructure (Infras)	mobile phone subscribers (per 100 people)	World Bank data, 2011
Oil production (Petrol)	Million barrel production	Statistical Review of World Energy, 2010.

Source: Author's construction

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