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CORRUPTION AND EMIGRATION OF PHYSICIANS FROM AFRICA

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Medical brain drain remains a major challenge for African countries mostly characterized by poor economic, political and health institutions. This paper seeks to determine how corruption in the home country affects physician emigration from Africa. Econometric estimations are implemented on a panel of 50 African countries over the period 1995-2004, using both the dynamic panel data approach and the count data analysis. Our results suggest that: first, corruption promotes physician emigration from Africa. The most corrupt countries experience higher physician emigration rates. Second, income level, especially the returns to education, is one of the channels through which corruption promotes physician emigration. To ensure retention of African health-care professionals and ultimate reduction in medical brain drain, the fight against corruption must be one of the essential measures.

Keywords: Medical Brain Drain, Physician Emigration, Corruption, Africa
JEL classification: D73, F22, J61, O55

1. INTRODUCTION

Physician emigration remains one of the challenges of developing countries and gives rise to controversial debates in economic literature. Some views tend to support the beneficial effects of emigration of highly educated labor forces, especially, medical brain drain (Stark *et al*., 1998; Clemens, 2007; Beine *et al*., 2008; Benie *et al*., 2011). However, this phenomenon is supposed to lower indicators of human development in the source countries significantly (Bhargava *et al*., 2011; Capuano and Marfouk, 2013) by: imposing negative externalities on those who do not migrate (Clemens, 2014), predicting higher mortality rate (Bhargava and Docquier, 2008; Bhargava *et al*., 2011), causing severe medical personnel shortages and higher disease prevalence, and making countries unable to manage epidemic diseases. The incapacity of Liberia, Guinea, and Sierra-Leone to manage and limit the spread of the 2014 Ebola virus disease in record time is

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partly attributed to medical personnel shortages, which is exacerbated by higher physician emigration (Torrey, 2014).

Physician migration from African countries to rich countries is an old phenomenon; it has been started in some parts of the continent (West Africa) since the first medical doctors were trained in the middle of the 20th century (Hagopian *et al*., 2005). Despite national and international policy responses to reduce this phenomenon, physician brain drain rates as well as the total number of physician emigrants have drastically increased in African countries. The analysis of the revised panel data set on physician emigration (1991-2004) constructed by Bhargava, Docquier and Moullan in 2010 (Bhargava *et al*., 2011)[1] reveals that about 21716 physicians emigrated from Africa in 1991. This number has quadrupled in 14 years to reach about 95220 in 2004 (Figure 1). The top affected countries were South Africa (16433), Egypt (8515), Nigeria (5499), Algeria (1387), and Sudan (1235). While the rate of physician emigration, defined as the total number of physician emigrants from a given source country divided by the sum of the migrant and resident physician population in the same source country, is high in Liberia (51.2 percent),[2] Zimbabwe (45.4 percent), Ghana (37.8 percent), Uganda (34.3 percent) and South Africa (34.1 percent).The preferred destinations of migrants from 52 African countries in 2004 were United Kingdom (38964), United States of America (29847), and Canada (5983). However, Tankwanchi *et al*. (2014) showed that migration trends among Sub-Saharan Africa-trained physicians increased from 2002 to 2011 for most of the African countries. They identified 10,819 physicians born or trained in 28 sub-Saharan African countries who currently practice in the United States.[3] They concluded that the high emigration trends will persist, and the United States will remain one of the leading destinations for Sub-Saharan Africa (SSA) physicians emigrating from the continent of greatest need for physicians.[4]

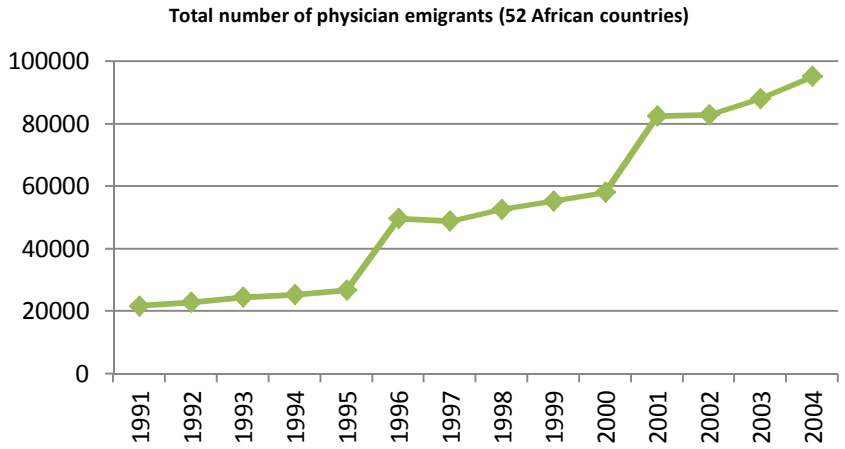
Most of the reasons that have been highlighted to explain the flight of physicians include lower wages, poor working conditions, lack of resources in the health system, limited career opportunities insufficient post-graduate training opportunities, general political and economic conditions, family ties and culture (Hagopian *et al*., 2005). However, recent studies pointed out poor economic and political institutions (Bertocchi and Strozzi, 2008; Yakovlev and Steinkopf, 2014) especially corruption as a major push factor of (high skilled) migration (Dimnat *et al*., 2013; Ariu and Squicciarini, 2013a; Ariu and Squicciarini, 2013b; Cooray and Schneider, 2014; Poprawe, 2015). Therefore, it is important to investigate whether corruption in African countries is a major driver of medical brain drain.

[1] http://siteresources.worldbank.org/INTRES/Resources/DataSetDocquierBhargava_Medical_BD100306.xls.

[2] Recently, the total number of Liberian doctors in America is about two-thirds the total now working in their homeland (Torrey, 2014), 77 percent of its estimated 226 physicians were in the 2011 American Medical Association Physician Masterfile (Tankwanchi *et al*., 2014).

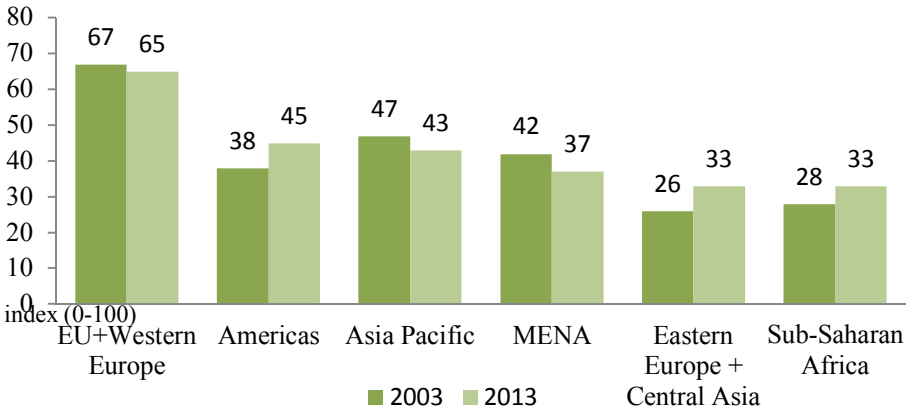
[3] They have exploited data from the 2011 American Medical Association Physician Masterfile.

[4] Scheffler *et al*. (2009) estimated that thirty-one African countries will experience in 2015 shortage of approximately 792,000 health care professionals includes 240,000 doctors and 551,000 nurses and midwives.



Source: Using data constructed by Bhargava, Docquier and Moullan in 2010.

Figure 1. Trend in Total Number of Physician Emigrants from 52 African Countries between 1991 and 2004



Source: Using data from Transparency International.

Note: CPI is scaled from 0 (high corrupt) to 100 (high clean).

Figure 2. Regional Average Score of Corruption Perception Index (CPI)

Figure 2 presents regional average scores of Corruption Perception Index (CPI) in 2003 and 2013. It shows that Sub-Saharan Africa experiences low scores (about less than the half of the score of the Europe Union and Western Europe areas) implying that this region is one of the most corrupt in the world. An analysis of the control of

corruption index of the Worldwide Governance indicators reveals that African countries experience negative scores meaning that most African countries are among the most corrupt. According to Transparency International (2013), 10 Africans countries[5] were ranked among the top 20 corrupt countries out of 177 countries and territories. In this context, understanding the role of corruption in the flight of high-skilled workers particularly physicians from Africa is important for the success of the variety of policy responses proposed to tackle the phenomenon, as well as the improvement of public health care among African countries.

It appears from the economic literature that corruption may affect emigration through several channels mainly, the returns to education and the domestic cost and the time of the emigration process. Firstly, corruption tends to lower the returns to education. Given the irreversibility of human capital investment, corruption may make it more attractive to migrate to recoup one's individual education investment (Dimnat *et al*., 2013). Secondly, corruption could affect the domestic cost and time of the emigration process. On one hand, by compassing the ill-functioning of institutions and rigid, over centralized and dishonest bureaucracy, corruption through bribery is supposed to lessen the time spent in queues, give bureaucrats an incentive to speed up the (migration) process in a sluggish administration, and help to surmount a tedious bureaucratic regulation and tight immigration policies (Méon and Sekkat, 2005; Bertocchi and Strozzi, 2008). On the other hand, corrupt civil servants may cause delays in the migration process just to get the opportunity to extract bribes; however such bribes could increase the cost of emigration and discourage potential migrants.

The main objective of this paper is to determine direct and indirect effects that corruption in the home country may exert on physician emigration from African countries. The first hypothesis tested is that higher corruption promotes physician emigration. The second states that income level, especially returns to education is a channel through which corruption triggers physician emigration. We estimate the effect of corruption on both the number of physician emigrants and the rate of physician emigration from 50 African countries over the period 1995-2004, using dynamic panel data method. Migration data used are from revised panel data set on physician emigration constructed by Bhargava, Docquier and Moullan in 2010 (Bhargava *et al*., 2011). Three indicators of corruption are used: (i) the corruption index of the International Country Risk Guide (ICRG), (ii) The control of corruption indicator from the Worldwide Governance Indicators and (iii) Freedom from Corruption Index of Heritage foundation. System GMM estimators developed by Arellano and Bover (1995) and Blundell and Bond (1998) were used for estimating the rate of physician emigration model, to overcome possible endogeneity problems while appropriate count data model (negative binomial model) was used to estimate the number of physician emigrants model.

[5] Somalia, Sudan, South Sudan, Libya, Guinea Bissau, Equatorial Guinea, Chad, Eritrea, Zimbabwe and Burundi.

This study fills some gaps in the literature on the possible linkage between medical brain drain and corruption in several ways. Previous studies have analyzed the determinants of medical brain drain (Yakovlev and Steinkopf, 2014; Tankwanchi *et al*., 2014; Kizhakethalackal *et al*., 2015) but leaving behind corruption as a significant factor. Papers have analyzed the effect of corruption on high-skilled emigration in general but not focus on the specific case of physician emigration. Moreover, apart from Kizhakethalackal *et al*. (2015), many of the studies that explore this issue do not adopt the dynamic approach. This study adopts a dynamic approach and shows that corruption in African countries significantly promotes physicians' flight. Besides, our results show that income level is a significant channel through which corruption affects medical brain drain.

The remainder of the paper is organized as follows: Section 2 presents the literature review. Section 3 looks into the theoretical model while Section 4 provides the method of empirical analysis and the data. The results and interpretations are given in Section 5, followed by the conclusion in Section 6.

2. LITERATURE REVIEW

In this section, we review some previous studies on determinants of medical brain drain, especially the controversial effects that corruption may have on physician emigration, in order to expose the current state of the literature and highlight the gaps in this literature.

Many studies have found that lower wages (Bhargava and Docquier, 2008), poor working conditions, lack of resources in the health sector, limited career opportunities, insufficient post-graduate training opportunities, general political and economic conditions, family ties and culture (Hagopian *et al*., 2005), demographic characteristics, residency institutions, primary specialty, structural adjustment programs and immigration policies (Tankwanchi *et al*., 2014)[6] increase medical brain drain. Others found that institutional factors such as governance and colonial history (Kizhakethalackal *et al*., 2015), democracy (Bertocchi and Strozzi, 2008), economic freedom (Yakovlev and Steinkopf, 2014), corruption (Dimnat *et al*., 2013; Ariu and Squicciarini, 2013a; Ariu and Squicciarini, 2013b; Cooray and Schneider, 2014; Poprawe, 2015) may determine cost of migration, wages and returns to education of potential migrating skilled workers. However, these studies do not explicitly discuss the possibility of the effect of corruption in the specific case of physician emigration.

Studies on the effect of corruption on emigration, most of the time, adopts empirical approach but the theory behind these analyses is that: first, corruption tends to affect the

[6] Tankwanchi *et al*. (2014) suggests that the physician brain drain from Sub-Saharan Africa to the United States began in earnest in the mid-1980s and accelerated in the 1990s during the implementation years of the Structural Adjustment Programs (SAPs).

returns to education and the domestic cost and time of emigration process. Corruption tends to lower the returns to education. As wage is one component of returns to education, an increase in corruption will decrease the wage rate (Lin and Zhang, 2009). Given the irreversibility of human capital investment, corruption may make it more attractive to migrate to recoup one's individual education investment (Dimnat *et al*., 2013). Second, corruption through family ties, money or political affiliations determines access to the job market and makes it unfair and less attractive (Ariu and Squicciarini, 2013a). In this case, jobs are granted on the basis of political connections rather than merit, this could also demotivate those with high levels of educational attainment. These highly skilled workers respond by migrating in order to pursuit what they describe as "greener pastures", fair labor market, better-working conditions, better pay, better training and research opportunities, and less corrupted environment (Hagopian *et al*., 2005).

Contradictory views emerge in the literature and show that corruption does not always promote physician emigration. Cooray and Schneider (2014) highlighted that under some circumstances (such as increased inequality), corruption may decrease emigration rate. The idea is that if living conditions continue to deteriorate as corruption increases, the increased inequality generated by corruption can increase liquidity constraints, particularly among those with medium and low levels of educational attainment, reducing their ability to emigrate. Furthermore, corruption through bribes is a tax (Shleifer and Vishny, 1993) that may increase the cost of migration or reduce the ability of potential migrant to afford emigration cost. Kizhakethalackal *et al*. (2015) analyze physician emigration from Developing Countries using count data analysis and find that control-of-corruption index has negative effects on the physician outflow; however, this effect is not significant at 5% level.

In light of this literature review, some issues can be highlighted. The first is the lack of sector-focused studies. Even though medical brain drain is perhaps the most important type of brain drain because of the wide variety of people who are affected by it (Yakovlev and Steinkopf, 2014), the current state of research on the effect of corruption on medical brain drain is scarce in comparison with the overall brain drain literature. The second issue is the lack of the dynamic aspect of the approach. The reviewed studies on the association between emigration and corruption do not adopt dynamic analysis (Dimnat *et al*., 2013). The analysis of Poprawe (2015) used only one year (2000) data. Cooray and Schneider (2014) use dynamic approach but their data on emigration rates are five-year intervals. The lack of regional and focused study is the third issue. To the best of our knowledge, there is no study that focuses solely on African countries. Several studies use a sample of heterogeneous countries that include African countries (Kizhakethalackal *et al*., 2015). By doing so, the results and policy recommendations may not correspond to the specificities of African economies. The fourth issue concerns the indicator of corruption. Due to the lack and structure of data, some of the studies focused on the use of only one indicator of corruption. However, it is of a paramount importance to test the robustness of results by using many indicators of corruption. This

paper attempts to fill these gaps in the literature.

3. THEORETICAL FRAMEWORK: A MODEL OF MIGRATION CHOICE FACING CORRUPTION IN THE SOURCE COUNTRY

This section discusses the channels through which corruption in the source country can affect physician's decision to emigrate, in order to derive testable hypotheses and motivate our empirical analysis. We follow Bertocchi and Strozzi (2008) but focus on medical brain drain because it is the type of skilled brain drain that can lower economic and health outcomes in both the short and long term (Yakovlev and Steinkopf, 2014). We consider a dynamic model with bequests where each individual (physician) lives for a single period and gives birth to a single child, to whom he leaves a bequest. Each physician has a choice between remaining in his/her home country, H and migrating into a foreign country, F. All physicians are identical. Each individual's preferences at time t are given by

$$u_t = (1-\theta)\log x_t + \theta \log b_{t+1}, \tag{1}$$

where x_t is the physician level of consumption, b_{t+1} is a bequest left to the physician's child, and θ is a preference parameter, such that $0 < \theta < 1$. Each physician maximizes her utility u_t subject to the following budget constraint:

$$x_t + b_{t+1} \leq y_t, \tag{2}$$

where y_t is physician income. The solution to the optimization problem is given by the following consumption and bequest functions:

$$x_t = (1-\theta)y_t, \tag{3a}$$

$$b_{t+1} = \theta y_t. \tag{3b}$$

We can derive the indirect utility function from these results as

$$v_t = \log y_t + (1-\theta)\log(1-\theta) + \theta \log\theta. \tag{4}$$

It follows that the level of utility an individual can achieve depends on her income level. We can now analyze how the latter is determined. We assume that individuals are simply endowed with a unit of labor which they supply inelastically to receive a wage income, which depends on location. The migration choice affects individual income as follows:

$y_t^H = w_t^H + \delta\pi_t^H$ is the income level if the individual remains in the home country,

where w_t^H is the level of the home wage (especially wage returns to education),[7] π_t^H is the institutional quality[8] of the home country, and, δ is a positive parameter. Similarly, $y_t^F = w_t^F + \delta\pi_t^F - c$ is the income level if the individual migrates to the foreign country, where w_t^F is the level of the foreign wage, π_t^F is the institutional quality of the foreign country, and c is the cost of migration.

We assume that the level of institutional quality generates direct or indirect material gains, and can, therefore, be included among the determinants of the income level, weighted by the parameter δ. It follows that an individual decides to migrate if and only if $y_t^F > y_t^H$, that is if and only if $w_t^F + \delta\pi_t^F - c > w_t^H + \delta\pi_t^H$. The gain from migration is positive when the sum of the wage gap, $w_t^F - w_t^H$, and the weighted gap in the quality of institutions $\delta(\pi_t^F - \pi_t^H)$ is larger than the cost of migration. In other words, the decision to migrate, m_t can be formalized as

$$m_t = (w_t^F - w_t^H) + \delta(\pi_t^F - \pi_t^H) - c > 0. \quad (5)$$

Aggregating over individuals, the migration rate will be higher for countries with higher wages relative to the rest of the world and for countries with more attractive institutions. Corruption may affect the three components of the decision to migrate in different ways. Thus introducing corruption in Equation (5) yields,

$$m_t = [w_t^F - w_t^H(1-\phi_t)] + \delta[\pi_t^F - \pi_t^H(1-\phi_t)] - c(1+\phi_t), \quad (6)$$

where ϕ_t is the level of corruption in the home country at time t. It may be measured as follows: if we consider the wage differential component $[w_t^F - w_t^H(1-\phi_t)]$, ϕ_t is the proportion of the physician wage rate (wage returns to education) stolen by the government official or lost by the physician through corruption. It is proved that an increase in corruption will decrease the wage rate (Lin and Zhang, 2009) and consequently the wage returns to education (Dimnat *et al.*, 2013); that is $\frac{\partial w_t^H(1-\phi_t)}{\partial \phi_t} < 0$. An increase in the level of corruption at home leads to an increase in the wage differential and the rate of emigration.

Considering the cost of emigration component $c(1+\phi_t)$, ϕ_t refer to the level of

[7] Wages are formed of a fixed component, for example, corresponding to the minimum wage, and a variable component that depends on the returns to education and the skill level of each individual (Péridy, 2010).

[8] For simplicity, π especially reflects the quality of formal institutions such as: (i) political institutions, which capture how a country fares in terms of political rights and democracy, (ii) migration institutions includes information on the kind of citizenship laws, land distribution policy, public education policy, and immigration policy attitudes (Bertocchi and Strozzi, 2008) as well as (iii) the legal system. π as an indicator of the quality of formal institutions thus excludes corruption that is an informal institution (Lavallée *et al.*, 2008; Rothstein, 2011).

bribes paid to government officials to speed up the migration process of a physician. The cost of migration will increase if the level of corruption (bribes) increases, $\frac{\partial c(1+\phi_t)}{\partial \phi_t} > 0$. The increase in the cost of migration may reduce the probability of emigrating (Méon and Sekkat, 2005). However, in the institutional gap component $\delta[\pi_t^F - \pi_t^H(1-\phi_t)]$, ϕ_t is institutional especially bureaucratic rigidities that may be removed by paying bribes. This may weaken domestic institutions, increase institutional gap $\left(\frac{\partial \delta[\pi_t^F - \pi_t^H(1-\phi_t)]}{\partial \phi_t} > 0\right)$ and the rate of emigration (Rowlands, 1999). In the emigration decision, the corruption effect in the institutional gap equates (and is neutralized by) the corruption effect in the cost of emigration, that is $\frac{\partial \delta[\pi_t^F - \pi_t^H(1-\phi_t)]}{\partial \phi_t} = \frac{\partial c(1+\phi_t)}{\partial \phi_t}$. An explanation is that the bribes (costs) are the counterpart of removing institutional (bureaucratic) rigidities. Corruption is seen as an informal institution that helps the functioning of public services (Méon and Sekkat, 2005; Lavallée *et al.*, 2008).

In sum, the intuition is that the decision to emigrate depends on the sum of the wage gap, the weighted gap in the quality of institutions and the cost of migration. The net effect of corruption on emigration decision refers mostly to the effect in the wage gap component. Thus, as corruption increases, the rate of emigration (or probability of emigrating) increases; that is $\frac{dm_t}{d\phi_t} > 0$.

The model shows that corruption affects physician emigration by (i) lessening the wage returns to education, (ii) increasing emigration cost and (iii) weakening the quality of the country's public and migration administrations. An increase in the rate of corruption rate will increase the probability of emigration in individual level and the rate of emigration at the national level. Two major testable hypotheses are derived from the theoretical framework. First, corruption promotes medical brain drain. In other words, the most corrupt countries experience higher physician emigration rates. Second, income level is the channel through which corruption increase physician emigration.[9] This theoretical framework also allows as deriving an empirical model of medical brain drain with corruption as the key explanatory variable.

[9] One would think that brain drain is most common shortly after graduation when individuals do not yet have sufficient income. However, we suppose that, even though individuals do not yet have sufficient income in this early stage, it is easy for them to borrow from their elders (abroad or in the home country) in order to afford immigration costs and bribes, since people will think that (with their skill and graduation) they could be able to reimburse once they migrate.

4. EMPIRICAL ANALYSIS

Equipped with the intuition given by the theoretical framework developed above, we test empirically our hypothesis using econometric estimations with data from 50 African countries of origin (sending) to 18 developed countries of destination (receiving) over the period 1994-2004. Migration data are from revised panel data set on physician emigration (1991-2004) constructed by Bhargava, Docquier and Moullan in 2010 (Bhargava *et al*., 2011). Three indicators of corruption are used: (i) the corruption index of the International Country Risk Guide (ICRG) (ii) The control of corruption indicator from the Worldwide Governance Indicators and (iii) Freedom from Corruption Index of Heritage foundation.

4.1. Empirical Model

In order to evaluate the effect of corruption on physician migration, our empirical equation is given by:

$$PEM_{it} = \alpha_0 + \alpha_1 PEM_{it-1} + \alpha_2 CORRUPT_{it} + \alpha_2 INCOME_{it} + \beta' X_{it} + u_{it}, \qquad (7)$$

where PEM_{it}, $CORRUPT_{it}$, $INCOME_{it}$ and X_{it} denote the physician emigration from African country i in the period (year) t, the level of corruption, income (returns to education reflected by standard-of-living) and the vector of other control variables (democracy (*PolityII*), health spending (*Expenses*) , the population density (*Density*), Labor force (*Labour_Force*), Trade openness (*Trade*) and colonial origin (*British*)) respectively and u is the error term.

The dependent variable, physician emigration (PEM) is captured by the rate of physician emigration. Our primary interest focuses on the statistical significance and the sign of the parameter α_2. However, to measure $CORRUPT$, (our variable of interest), we use three different indexes:

(i) The corruption index of the International Country Risk Guide (ICRG). It is the index of perceived corruption based on the assessments by country experts. Here, corruption is captured via "actual or potential corruption in the form of excessive patronage, nepotism, job reservations, 'favour-for-favours', secret party funding and suspiciously close ties between politics and business". The index is scaled from 0 to 6, with higher values denoting less corruption. In order to facilitate interpretation of the statistical results, the index is rescaled from a scale of 0, implying low corruption, to a scale of 6 implying high corruption, ($CORRUPT = -(index - 6)$).

(ii) The control of corruption indicator from the Worldwide Governance Indicators, ranging originally from -2.5 (weak) to 2.5 (strong) governance performance.[10] This

[10] Originally, this index is centered on 0 in each year (i.e., the World average is 0 for each year) and is aggregated from surveys of households and firms, NGOs, public sector organizations, and commercial

index "reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests". It is rescaled from 0 (strong) to 5 (weak) governance performance, $CORRUPT = -((index + 2.5) - 5))$.

(iii) Freedom from Corruption Index of Heritage foundation. It is scaled from 0 to 100.The higher the level of corruption, the lower a country's score.[11] For reasons of convenience and harmony, we rescaled this variable so that higher values correspond to higher corruption levels. That is $CORRUPT = -(index - 100)$, this changes only the sign of the coefficient associated with this variable because the scale becomes 0 (lower level of corruption) to 100 (higher level of corruption).

The coefficient on the variable $CORRUPT$ is expected to be negative (that is $\alpha_2 > 0$). It is shown that the higher corruption is in the source country the higher emigration rate of skilled workers (Dimnat *et al*., 2013; Ariu and Squicciarini, 2013a; Ariu and Squicciarini, 2013b; Cooray and Schneider, 2014; Poprawe, 2015).

To measure physician returns to education, we use the level of per capita income (*GNI*). It is a proxy of job satisfaction conditions, especially returns to education, of physicians. In this study the returns to education are captured by the standard of living because the appropriate data series on the returns to education are not available for the sample countries; however it is showed that returns to education are one of the components of individual income (Péridy, 2010). Higher returns and, therefore, higher wages may retain skilled workers. The coefficient on this variable is supposed to be negative. The lagged dependent variable (PEM_{it-1}) captures the dynamic effect ("diaspora effect") that past migration may have on current migration. By helping the next wave of migrants to overcome the cost of migration, the existing stock of migrants, the diaspora, increase migration mainly because it lowers the cost of migration (Collier and Hoeffler, 2014). Kizhakethalackal *et al*. (2015) mention that countries with a well-established culture of emigration make it easier to emigrate (in macroeconomic approach); also, new emigrants may get support from their past peers (in microeconomic approach). Moreover, emigration is facilitated by network effects, established through

business information providers (http://info.worldbank.org/governance/wgi/pdf/WGI.pdf). It is based on perceptions.

[11] The score for this component is derived primarily from Transparency International's Corruption Perceptions Index (CPI). The CPI is based on a 10-point scale in which a score of 10 indicates very little corruption and a score of 0 indicates a very corrupt government. In scoring freedom from corruption, the Index converts the raw CPI data to a scale of 0 to 100 by multiplying the CPI score by 10. For countries that are not covered in the CPI, the freedom from corruption score is determined by using the qualitative information from internationally recognized and reliable sources. The *Index* relies on the following sources for information on informal market activities, in order of priority: Transparency International, *Corruption Perceptions Index*; U.S. Department of Commerce, *Country Commercial Guide*; Economist Intelligence Unit, *Country Commerce*; Office of the U.S. Trade Representative, *National Trade Estimate Report on Foreign Trade Barriers*; and official government publications of each country, (http://www.heritage.org/index/freedom-from-corruption).

the stock of previous migrants, which can be captured by a reduction of the direct cost of migration (Bertocchi and Strozzi, 2008). The coefficient on the lagged dependent variable is expected to have a positive sign.

The knowledge of the direct effect of corruption on PEM is interesting; however, it does not provide information about the transmission mechanism through which corruption operates. Previous studies have stated that corruption affects emigration by increasing income inequality (Cooray and Schneider, 2014) or lowering returns to education (Dimnat *et al*., 2013). In this study, we test returns to education channel by introducing an interaction term between corruption and returns to education ($CORRUPT$x$INCOME$). Its coefficient is supposed to be positive ($\alpha_4 > 0$) implying that by lowering returns to education corruption increases physician emigration from African countries. The following equation is estimated,

$$PEM_{it} = \alpha_0 + \alpha_1 PEM_{it-1} + \alpha_2 CORRUPT_{it} + \alpha_3 INCOME_{it} + \alpha_4 (CORRUPT\text{x}INCOME)_{it} + \beta' X_{it} + u_{it}. \quad (8)$$

Explanatory variables contained in the vector X include the following factors: (i) Democracy (*PolityII*), we use democracy index Polity2 from PolityIV database. It is a combined index of democracy and autocracy, ranging from -10 (strongly autocratic) to +10 (strongly democratic). The expected sign of its coefficient is positive. Democracy is associated with more out-migration of scientists (Weinberg, 2011). (ii) Health spending (*Expenses*): total (public and private) health spending as a percentage of GDP is used. A greater health spending may offer physicians better benefits and discourages medical migration. (iii) Population density (*Density*): population density (people per sq. km of land area) in logarithm is used. (iv) Labor force (*Labour_Force*): Labor force participation rate, total (percentage of total population ages 15-64) is used. Cooray and Schneider (2014) found that increased labor force participation reduces emigration. (v) Trade openness (*Trade*): Trade openness, as the proxy of economic networks, may foster emigration (Péridy, 2010). (vi) Colonial origin (*British*): We use dummy variable which takes the value of 1 if the country is a former British colony and 0 if not. The expected sign of this variable is positive assuming that former British colonies achieve higher physician emigration than other former colonies (Kizhakethalackal *et al*., 2015).

4.2. Data and Estimation Method

The empirical model is estimated using a dynamic approach rather than a static one. It is based on annual data on African countries and different indicators of corruption. Panel data covering the period 1995-2004 for 50 African countries[12] is used. Our data consist of annual observations for the period 1995-2004. Data sources and descriptive statistics of variables are presented in Table A2 (in the appendix). Data on Physician

[12] Countries sample is contained in Table A1 (in appendix).

emigration are from the revised panel data set on physician emigration constructed by Bhargava *et al*. (2010) (http://go.worldbank.org/9Y0NKDQK60). According to this database, 95220 physicians emigrated in 2004 from Africa to 18 developed countries. Other data are from World Development Indicators database. The ideal is to use data on returns to education of physicians, but due to unavailability of this type of data series for African countries, we use the level of per capita income. In fact, returns to education are one of the components of individual income (Péridy, 2010).

Due to possible endogeneity of regressors, OLS estimates might be inconsistent. For example, some of the variables such as corruption and per capita income may be endogenous. However, we use system GMM estimators developed by Arellano and Bover (1995) and Blundell and Bond (1998). The system GMM estimator allows us to address this endogeneity problem. This estimation method is also suitable for the study because it takes into account the dynamic specification. The dynamic specification of migration model enables the "Diaspora effect" (Collier and Hoeffler, 2014) to be captured. We use lagged variables as instruments. To check the robustness of the results, a different method of estimation is conducted besides the use of the number of physician emigrant as an alternative measure of physician emigration. One may suggest the use of gravity model, but gravity models seem not to be suitable for our analysis since we do not focus on the bilateral flows of migrants between origin and destination countries.

5. ESTIMATION RESULTS

5.1. The Main Results

Table 1 reports system GMM estimation for the direct effect of corruption on physician emigration from African countries (Equation (7)). AR tests and Hansen tests suggest that our instruments are valid. Our econometric estimates indicate that the coefficient on the lagged dependent variable (*L.PEM*) is positive and statistically significant. These results do not only support the choice of the dynamic GMM approach used but also, confirm the idea that Diasporas increases migration by reducing the cost of migration (Collier and Hoeffler, 2014).

The estimated coefficient on our independent variable of interest, corruption, is positive as expected and statistically significant for each indicator of corruption. The results are similar when we use corruption index of the International Country Risk Guide (column 1.1), control of corruption indicator from the Worldwide Governance Indicators (column 1.2) and Freedom from Corruption Index of Heritage foundation (column 1.3). These results are suggestive of a positive causal effect of corruption on the rate of physician emigration from African countries. The most corrupt countries experience higher physician emigration rates. These provide support for our first hypothesis that corruption "greases the wheels" of the flight of African physicians. One explanation of these results in the African context is that physicians are sensitive to the level and the

effect of corruption in their home countries; and as the level increases, they prefer to leave the country.

Table 1. Direct Effect of Corruption on Emigration of Physicians from Africa (Dependent Variable: Rate of Physician Emigration)

	1.1	1.2	1.3
L.PEM	0.940***	0.868***	0.990***
	(44.18)	(31.68)	(117.45)
ICRG_Corruption	1.959***		
	(7.46)		
WGI_Corruption		5.796***	
		(6.49)	
EFI_Corruption			0.017**
			(2.28)
PolityII	0.097***	0.227***	0.050***
	(2.60)	(4.03)	(2.66)
GNI	-1.898***	-1.200***	-1.636***
	(4.26)	(4.10)	(5.71)
Expenses	-3.559***	0.608	-1.529***
	(3.04)	(1.00)	(9.15)
Density	0.322	0.131	0.038
	(1.34)	(0.40)	(0.40)
Trade	1.683**	1.172***	1.019***
	(2.36)	(3.90)	(4.30)
Labour_Force	-0.083***	-0.073**	-0.068***
	(2.59)	(2.49)	(4.79)
British	1.595***	2.802***	0.885***
	(2.92)	(2.94)	(4.94)
_cons	8.441***	-11.290***	11.820***
	(2.65)	(2.81)	(5.51)
N	350	441	460
countries	35	49	46
Instruments	31	32	42
AR(1) (p-value)	0.018	0.033	0.014
AR(2) (p-value)	0.673	0.908	0.975
Hansen (p-value)	0.314	0.475	0.290

Notes: The estimation method is two-step system GMM. The rate of physician emigration is defined as the total number of physician emigrants from a given source country divided by the sum of the migrant and resident physician population in the same source country. *L.PEM* is the lagged dependent variable. Absolute value of z-statistics in parentheses. The null hypothesis of the AR tests is that the errors exhibit no second order serial correlation.***, ** and * denote significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Our results are in line with previous studies that pointed out corruption in the source country as one of the push factors of skilled migration (Dimnat *et al*., 2013; Ariu and Squicciarini, 2013a; Ariu and Squicciarini, 2013b; Cooray and Schneider, 2014; Poprawe, 2015), however, our study focuses on the specific case of physician emigration. Even though corruption may increase the cost of migration, physicians are not discouraged by this cost because they are skilled workers and can easily afford it. However, they are more sensitive to institutional weaknesses generated by rent seeking of civil servants. Corruption is, therefore, one of the institutional causes of frustration and demotivation among skilled workers especially physicians in developing countries in general and African countries in particular. By causing a loss of national financial resources, it leads to poor public (health) infrastructures. Frustrated human resources tend to migrate to rich countries. As showed in Figure 1, European Union, Western Europe and Americas regions are on average relatively less corrupt than the Africa region. The high level of corruption among African countries demotivate those with high levels of educational attainment especially physicians, encouraging them to emigrate towards countries that are less corrupt.

Results in Table 1 also show that other variables such as trade openness, democracy and being a former British colony seem to increase the rate of physician emigration while the level of per capita national income, health expenditure and labor force negatively affect it. The coefficient on income (*GNI*) is negative and significant suggesting that increases in the per capita income decrease the rate of physician emigration. Another explanation is that countries with the highest per capita incomes, experience lower rates of physician emigration. Trade is positively related to the rate of physician emigration suggesting that more open countries have higher rates of physician emigration. Democracy is also positively related to the rate of physician emigration. A similar result was found by Weinberg (2011). The coefficient on the dummy variable *British* is positive and significant suggesting that former British colonies experience higher rates of emigration compared to other former colonies in Africa.

This direct and positive effect of corruption in the home country on physician emigration is significant and interesting but it does not provide any insight about the transmission channel through which corruption works. The effect of corruption may not be only linear or direct. In this study we test the indirect effect, through the level of per capita income, to understand the validity of the returns to education channel. Table 2 reports estimation results for the indirect effect of corruption in the home country on physician emigration (Equation (8)). The results show that the coefficient on our independent variable of interest (the interaction between corruption and income, *Corrupt*×*income*) is positive as expected and statistically significant for each indicator of corruption. It appears from these results that income level especially returns to education is one of the channels through which corruption promotes physician emigration. This confirms our second hypothesis that corruption promotes physician emigration by lowering their returns to investment in education.

Table 2. Indirect Effect of Corruption on Emigration of Physicians from Africa through Income (Dependent Variable: Rate of Physician Emigration)

	2.1	2.2	2.3
L.PEM	1.009***	1.004***	0.283***
	(39.07)	(240.75)	(3.99)
ICRG_Corruption	-12.577***		
	(2.58)		
GNI×ICRG_Corruption	2.065**		
	(2.42)		
WGI_Corruption		-1.439**	
		(2.26)	
GNI×WGI_Corruption		0.254***	
		(2.67)	
EFI_Corruption			-1.682***
			(5.78)
GNI×EFI_Corruption			0.238***
			(5.25)
PolityII	0.217***	0.047*	0.472***
	(2.59)	(1.95)	(2.88)
GNI	-8.382***	-0.726**	-18.775***
	(2.67)	(2.13)	(5.10)
Expenses	-6.247***	1.426***	14.294***
	(3.00)	(5.14)	(6.51)
Density	0.613**	0.012	-1.654
	(1.96)	(0.20)	(1.51)
Trade	-0.503	0.407***	-1.582
	(0.80)	(4.11)	(0.85)
Labour_Force	-0.052	0.005	0.062
	(1.12)	(0.52)	(0.59)
British	1.304	-0.060	27.557***
	(1.54)	(0.34)	(8.15)
_cons	64.690***	0.058	114.509***
	(2.76)	(0.02)	(4.28)
N	350	441	460
countries	35	49	46
Instruments	31	32	32
AR(1) (p-value)	0.049	0.006	0.046
AR(2) (p-value)	0.938	0.623	0.489
Hansen (p-value)	0.266	0.534	0.783

Notes: The estimation method is two-step system GMM. The rate of physician emigration is defined as the total number of physician emigrants from a given source country divided by the sum of the migrant and resident physician population in the same source country. *L.PEM* is the lagged dependent variable. Absolute value of z-statistics in parentheses. The null hypothesis of the AR tests is that the errors exhibit no second order serial correlation.***, ** and * denote significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Similar results have been highlighted by Lin and Zhang (2009) who showed that when corruption in the labor market increases, the after-bribery wage rate will decrease. Through simulations, these authors showed that an increase in corruption in the labor market will reduce the labor supply domestically. However, the labor market for healthcare professionals is the specific market explored in this paper. Results are consistent with the prediction of our theoretical framework and confirm the view of Dimnat *et al*. (2013) that corruption tends to diminish returns to education of high-skilled workers who find it more profitable to migrate to richer countries. Wages of health workers are lower in African countries compared to other regions of the world; in Ghana, for example, annual salary of a physician in 2003 was 33,145 US dollars (purchasing power parity), lower than the annual salaries of 100,901 US dollars in the United Kingdom and 142,636 US dollars in the United States (Appiah-Denkyira *et al*., 2013). It is not surprising that corruption in this context of low wages increases physician emigration.

However, these results do not exclude the fact that some doctors are involved in corruption in Africa to reduce the gap between real income in Africa and the rich countries, especially in public hospitals. Moreover, medical qualifications from African universities are not always recognized as equivalent to their fair value by the host countries. This could reduce migrant's returns to education (wages) abroad.

5.2. Robustness

In order to check the robustness of results above, we use the number of physician emigrants, as the independent variable, and apply negative binomial model as another estimation technic. Table 3 reports the estimation results using the logarithm of 1+ number of physician emigrants as dependent variable while Table 4 reports results of the number of physicians using negative binomial model.

First, we estimate the number of physician emigrants with a log-linear model using dynamic GMM approach (Table 3). Results remain unchanged when the logarithm of 1+number of physician emigrants is used as indicators of physician emigration. Considering the direct effect, the estimated coefficient on the dependent variable of interest is positive and statistically significant at 1 percent level (column 3.1 to 3.3). The results confirm those found above and suggest that countries with higher level of corruption experience a higher number of physician emigration. Considering indirect effect, the interaction terms have positive signs and are statistically significant (column 3.4 to 3.6) confirming the results above that income especially returns to education is one of the channels through which corruption promotes physician emigration.

Table 3. Effect of Corruption on Emigration of Physicians from Africa
(Dependent Variable: ln(1+number of Physician Emigrants))

	3.1	3.2	3.3	3.4	3.5	3.6
L.physemig_Log	1.000***	0.969***	1.022***	1.004***	1.005***	0.995***
	(226.96)	(45.24)	(57.82)	(205.70)	(256.14)	(49.99)
ICRG_Corruption	0.028***			-0.737***		
	(4.31)			(3.94)		
WGI_Corruption		0.536***			-0.162*	
		(4.62)			(1.67)	
EFI_Corruption			0.016**			-0.032***
			(2.31)			(2.86)
GNI×ICRG_Corruption				0.121***		
				(3.97)		
GNI×WGI_Corruption					0.031**	
					(2.10)	
GNI×EFI_Corruption						0.005***
						(2.80)
GNI	-0.026	-0.239***	-0.192***	-0.533***	-0.084	-0.394***
	(1.45)	(5.17)	(3.12)	(4.12)	(1.62)	(2.95)
Expenses	-0.081***	-0.142***	-0.217**	0.053***	-0.052*	-0.018
	(3.15)	(2.98)	(2.35)	(2.77)	(1.90)	(0.34)
Trade	0.051	0.248***	0.187**	0.064*	0.000	0.004
	(1.57)	(3.80)	(2.25)	(1.77)	(0.01)	(0.08)
British	-0.016	0.049	0.169	0.066***	-0.048*	0.043
	(0.74)	(0.49)	(1.63)	(2.95)	(1.91)	(0.39)
PolityII	0.020***	0.013	0.013	-0.006***	0.020***	-0.009*
	(6.94)	(1.05)	(0.90)	(2.62)	(5.69)	(1.91)
Density	0.037***	0.063*	0.014	-0.041***	0.023***	0.003
	(3.89)	(1.72)	(0.52)	(3.29)	(3.32)	(0.13)
Labour_Force	-0.003***	-0.011**	-0.015***	-0.003**	-0.002*	-0.003
	(2.82)	(2.45)	(3.05)	(2.53)	(1.81)	(1.10)
_cons	0.120	-0.375	0.538	3.267***	0.601	2.883***
	(0.64)	(0.71)	(0.84)	(3.86)	(1.58)	(2.76)
N	315	392	414	315	441	414
countries	35	49	46	35	49	46
Instruments	32	33	20	32	34	29
AR(1) (p-value)	0.009	0.018	0.010	0.026	0.004	0.004
AR(2) (p-value)	0.673	0.218	0.060	0.089	0.179	0.397
Hansen (p-value)	0.625	0.456	0.175	0.189	0.255	0.236

Notes: The estimation method is two-step system GMM. *L.physemig_Log* is the lagged dependent variable. Absolute value of z-statistics in parentheses. The null hypothesis of the AR tests is that the errors exhibit no second order serial correlation.***, ** and * denote significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Table 4. Effect of Corruption on Emigration of Physicians from Africa
(Dependent Variable: Number of Physician Emigrants)

	4.1	4.2	4.3	4.4	4.5	4.6
L.physemig	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(27.34)	(31.43)	(35.81)	(24.57)	(34.20)	(30.65)
ICRG_Corruption	0.103***			-0.877***		
	(5.63)			(10.96)		
WGI_Corruption		0.211***			-0.924***	
		(4.48)			(3.92)	
EFI_Corruption			0.004**			-0.035***
			(2.55)			(2.86)
GNI×ICRG_Corruption				0.163***		
				(12.96)		
GNI×WGI_Corruption					0.177***	
					(4.86)	
GNI×EFI_Corruption						0.006***
						(2.97)
PolityII	-0.023***	-0.016***	-0.019***	-0.023***	-0.013***	-0.025***
	(4.90)	(3.63)	(4.72)	(6.32)	(3.48)	(4.57)
Expenses	-0.132	-0.145**	-0.081	-0.218***	-0.197***	-0.051
	(1.60)	(2.25)	(1.24)	(3.38)	(3.43)	(0.57)
Density	1.116***	1.259***	0.916***	1.290***	1.126***	0.876***
	(9.51)	(13.90)	(10.41)	(13.02)	(13.13)	(8.87)
Labour_Force	-0.014*	-0.007	0.028***	-0.009	0.001	-0.043***
	(1.77)	(1.08)	(4.44)	(1.37)	(0.15)	(5.43)
GNI	0.003	0.033	0.055	-0.688***	-0.503***	-0.451***
	(0.04)	(0.68)	(1.21)	(10.80)	(3.83)	(2.71)
Trade	-0.023	-0.076	-0.026	-0.151***	0.031	-0.264***
	(0.34)	(1.34)	(0.47)	(2.88)	(0.61)	(3.64)
British	0.238	0.345	0.343	0.175	0.249	-0.286
	(0.69)	(1.14)	(1.12)	(0.52)	(0.82)	(0.94)
_cons	1.647**	0.142	-1.233*	5.765***	3.080***	8.706***
	(2.05)	(0.20)	(1.86)	(8.36)	(3.06)	(6.54)
N	350	441	460	350	441	460

Notes: The estimation method is Negative binomial model estimation. *L.physemig* is the lagged dependent variable. Absolute value of z-statistics in parentheses.***, ** and * denote significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Second, as the number of physician emigrants seems to be count data, the appropriate count data model especially negative binomial model is used (Table 4). Once again, the coefficients on indicators of corruption (column 4.1 to 4.3) and

interaction terms (column 4.3 to 4.3) are statistically significant and exhibit expected sign suggesting that corruption promotes, directly and indirectly, physician emigration from Africa. The main findings are confirmed by also using the number of physician emigrants as an alternative measure of physician emigration and applying different estimation technics.

6. CONCLUSION

Medical brain drain has drastically increased in Africa and remains one of the challenges of African countries. Before developing policy mechanisms to encourage retention of health care professionals in resource-limited countries, it would be necessary to understand the factors that promote emigration of this specific group. This paper focuses on the possible role that corruption plays in the physician emigration from African countries. The effect of corruption on both the number of physician emigrants and the rate of physician emigration from 50 African countries over the period 1995-2004 were estimated using dynamic panel data method with revised panel data set on physician emigration constructed by Bhargava, Docquier and Moullan in 2010 (Bhargava *et al*., 2011). Results showed that corruption promotes physician emigration. It causes distortions on the labor market of health professionals by diminishing the returns to education. Some consistent findings emerge.

First, on average, countries with higher levels of corruption experience higher rates of physician emigration, supporting our first hypothesis. An interpretation is that frustration and demotivation caused by high level of corruption in terms of poor public health infrastructures, lead skilled workers especially physicians to emigrate. Costs of corruption in previous studies are limited to low tax revenue that reduces public spending on education and health (Antonaka *et al*., 2013; Gupta, 2007), inefficient allocation of public resources (Haque and Kneller, 2008), capital flight (Swaleheen, 2008), inflation and growth (Al-Marhubi, 2006; Blackburn and Powell, 2011), obstacle to Foreign Direct Investment (Zhao *et al*., 2003), weak agricultural development (Slagen *et al*., 2004; Onoma, 2008) and deforestation (Koyuncu and Yilmaz, 2009). Our results highlight the relevance of the cost of higher corruption prevailing in African countries, in terms of loss of talented workers in general and medical personnel shortages in particular.

Second, income level is one of the channels through which corruption promotes physician emigration. It appears that high levels of corruption in African countries "greases the wheels" of physician flights by lowering per capita income especially the returns to investment in education. This confirms our second hypothesis that corruption promotes physician emigration by lowering their returns to investment in education. Our explanation is that in order to compensate income loses due to corruption, physicians decide to migrate to rich countries where income may be higher than domestic country despite the level of corruption in that country. Our results are in line with Lin and Zhang

(2009) and Dimnat *et al*. (2013).

In sum, the results showed that corruption promotes physician emigration. It causes distortions on the labor market of health professionals by diminishing the returns to education. In addition to previous measures proposed such as improving incentives to stay, creating barriers to flight, recouping financial investment losses from those who leave, use of substitutes in the workforce, encouraging return of talent and appealing to receiving countries for compensation (Hagopian *et al*., 2005), fighting corruption and mitigating its effect on income especially returns to education can help to reduce medical brain drain and ensure retention of health care professionals in African countries. Since most of the African anti-corruption commissions are inefficient and unsuccessful (Economic Commission for Africa, 2010), state governments must be tougher in the applicability of anti-corruption measures. Although African countries have some common characteristics, they are different in some respects and a singular policy may not be sufficient. Appropriate anti-corruption measures must be implemented, taking into account the specificities of each country. Income level is the channel primarily examined in the paper; however, deep theoretical and quantitative analysis of other additional channels (formal institutions) through which corruption may affect physicians' decision to emigrate with appropriate data is an important avenue of future research.

APPENDIX

Table A1. Countries Sample

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African , Chad, Comoros, Congo RDC, Congo Republic, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

Table A2. Data Description a Data Sources

Variable	Definition	Source		
PEM	Rate of physician emigration (Medical Brain Drain) is defined as the total number of physician emigrants from a given source country divided by the sum of the migrant and resident physician population in the same source country	Revised panel data set on physician emigration: Bhargava *et al*. (2010)	Obs Mean Std. Dev. Min Max	500 8.4 11.6 0.0 51.2

physemig	Total number of physician emigrants	Revised panel data set on physician emigration: Bhargava *et al*. (2010)	Obs Mean Std. Dev. Min Max	500 617.4 2101.5 0.0 16433.2
physemig_Log	Logarithm of 1+Total number of physician emigrants	Revised panel data set on physician emigration: Bhargava *et al*. (2010)	Obs Mean Std. Dev. Min Max	500 3.3 2.7 0.0 9.7
ICRG_Corruption	The corruption index of the International Country Risk Guide (ICRG) from a scale of 0, implying low corruption, to a scale of 6 implying high corruption	International Country Risk Guide (ICRG)	Obs Mean Std. Dev. Min Max	350 3.6 0.9 1.0 6.0
WGI_Corruption	The control of corruption indicator from the Worldwide Governance Indicators indicator rescaled from 0 (strong) to 5 (weak) governance performance.	The Worldwide Governance Indicators, www.govindicators.org	Obs Mean Std. Dev. Min Max	450 3.1 0.6 1.3 4.6
EFI_Corruption	Freedom from Corruption Index of Heritage foundation (lower level of corruption) to 100 (higher level of corruption).	Heritage foundation	Obs Mean Std. Dev. Min Max	460 72.3 15.5 30.0 93.1
GNI	The GNI (gross national income) per capita, using the World Bank Atlas method, divided by the midyear population. (Current U.S. dollar) in logarithm	World Development Indicators	Obs Mean Std. Dev. Min Max	500 6.2 1.0 4.2 9.1
Expenses	Total (public and private) health spending as percentage of GDP in logarithm	World Development Indicators	Obs Mean Std. Dev. Min Max	500 1.6 0.3 0.4 2.9
Trade	Trade openness: the sum of exports and imports of goods and services measured as a share of gross domestic product in logarithm	World Development Indicators	Obs Mean Std. Dev. Min Max	500 4.2 0.5 2.7 6.3

PolityII	polity2 is a combined index of democracy and autocracy of POLITY IV project, ranged from -10 (strongly autocratic) to +10 (strongly democratic)	Polity IV	Obs Mean Std. Dev. Min Max	490 0.2 5.3 -9.0 10.0
Density	Population density (people per sq. km of land area) in logarithm	World Development Indicators	Obs Mean Std. Dev. Min Max	500 3.6 1.3 0.7 6.4
Labour_Force	Labor force participation rate, total (percentage of total population ages 15-64)	World Development Indicators	Obs Mean Std. Dev. Min Max	490 69.8 12.3 45.4 90.8
British	Dummy variable which takes the value of 1 if the country is former British colony and 0 if not		Obs Mean Std. Dev. Min Max	500 0.3 0.5 0.0 1.0

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