Physician Brain Drain: Does Health Expenditure Matter?

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ABSTRACT. Although previous research on migration has documented skilled migrants' cross-border activities very few empirical studies have examined physician migration. In recent years, the migration of physicians from developing to developed countries has received a great deal of attention and raised much concern. In this study, a gravity model and the Poisson pseudo-maximum-likelihood (PPML) estimator was used to examine the impact of various health expenditure variables on physician migration to the United States. The empirical results show that inadequate total expenditure on health, as well as inadequate government and private expenditure on health, encourage physicians from developing countries to migrate to the United States. (F2; F22)

I. Introduction

This study contributes to previous literature on physician "brain drain" by examining the role health expenditure plays in encouraging physician emigration from developing countries. While much of the analysis on the impact of health expenditure focuses on health outcomes (Nixon and Ulmann 2006; Anyanwu and Erhijakpor 2009; Novignon et al. 2012; Kim and Lane 2013; Farag et al. 2013), to my knowledge, no study has examined the impact of various health expenditure variables on physician migration. According to the World Health Organization (WHO 2006), health financing is a critical component of health systems. The number of resources devoted to health care directly affects the quality of medical care, funding for medical research and development, and the provision of medical equipment. Moreover, health systems with robust financing have well-maintained medical facilities and a well-trained and adequately paid work force.[1] For instance, of the $2.6 trillion dollars spent on health care in the United States in 2010, 20.04% was spent on medical services provided by physicians.[2] In fact, the Association of American Medical College factbook notes that the average starting salary for physicians in the United States ranges from $132,500 (infectious disease specialist) to $520,000 (surgery/neurological specialist). It is therefore not surprising that insufficient health spending at home may encourage physician emigration from developing countries.

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According to Xu et al. (2011), health expenditure is well over $3,000 per capita in high-income countries compared to only $30 per capita in resource-poor countries. An examination of the number of resources devoted to health care shows that health-care expenditure differs across countries. In the United States, for example, total health expenditure comprised 17.6% of the GDP in 2010 (Canada 11.4%, France 11.7%, Germany 11.5%, and the United Kingdom 9.6%) compared to 3.7% in Bangladesh, 6.5% in Colombia, 4.4% in Malaysia, 5.4% in Nigeria, and 5.3% in Venezuela (WHO, 2013). A similar examination using health expenditure per capita resulted in the same conclusion: Developed countries spend more than developing countries on health care (WHO, 2013). Schieber and Maeda (1999) note that high-income countries accounted for 89% of the $2.3 trillion spent on health care in 1994, while the amount spent on health care in developing countries accounted for only 11%. According to Schieber and Maeda (1999), this difference translates into large disparities in health infrastructure and outcomes.[3] Consequently, given the lack of investment and insufficient funding in the health sector at home, physicians in developing countries may be forced to migrate.

Stewart et al. (2007) argue that foreign medical doctors constitute a substantial proportion of the physician workforce in developed countries. While many of these physician migrants originate from Africa, the Caribbean, South Asia, and Southeast Asia, their preferred destinations are mainly those countries belonging to the Organization for Economic Cooperation and Development (OECD; Hamilton and Yau, 2004). More than 34% of physicians practicing in New Zealand are foreign-born, compared to 30.4% in the United Kingdom, 26.4% in the United States, 21.4% in Australia, and 21.4% in Canada (Forcier et al., 2004; Stewart et al., 2007). Hussey (2007) notes that health is important to economic development and that for many developing countries, physician migration is a barrier to achieving that goal.[4] According to the International Organization for Migration (IOM), insufficient human resources for health care limits the progress of the "3 by 5" initiative developed by UNAIDS and WHO, as well as that of the United Nations Millennium Development Goals (MDGs). Moreover, medical schools are highly subsidized in many developing countries, and the emigration of health workers represents a huge loss to both the private and public sectors of these economies (Parsi, 2008). In financial terms, developing countries lose, on average, approximately $500 million per year due to physician emigration (Hamilton and Yau, 2004).

This study focuses on foreign physicians who resided and practiced

in the United States from 1995 to 2004.[5] The United States was chosen as a destination country for two reasons. First, compared to other OECD countries, the United States receives the highest number of foreign physicians (Dumont and Zurn, 2007). Between 2001 and 2008, the number of foreign-educated medical doctors passing the final stage of the United States Medical Licensing Examination (USMLE) increased by 70% compared to 40% in Canada during the same period (Khadria, 2010). Moreover, in 2010, there were 188,402 actively licensed international medical graduates (IMGs) in the United States compared to 196,573 in 2012 (a 4.3% increase).[6] Roughly 23% of the actively licensed IMGs graduated from schools in India, followed by the Philippines (8%), Pakistan (5% in 2010 and 6% in 2012), and Mexico (5%).[6] The second reason the United States was chosen for the present study is that it is currently experiencing a severe physician shortage, which makes the country more likely to rely on foreign-trained physicians.

The Association of American Medical Colleges (2015) projects an overall shortage of between 46,100 and 90,400 physicians by 2025. The demand for physician specialists experienced in such areas as general surgery, ophthalmology, orthopedics, urology, psychiatry, and radiology is expected to exceed the supply by the year 2020 (Dill and Salsberg, 2008). Increasing physician demand in the U.S. has been attributed to several factors including the aging U.S. population (Stryker, 2011), aging U.S. physician population (Salsberg and Grover 2006) and the affordable care act, implemented among other things to provide insurance coverage to 32 million uninsured Americans (American Hospital Association factsheet).[7] In the present study, an examination of this issue via the use of a gravity model framework revealed that inadequate government health expenditure, total expenditure, and private expenditure on health care encourage physician emigration. The results also indicate that migrant networks, origin-physician population per capita, and the medium of instruction used in medical training are additional important factors that lead to physician emigration.

II. Data and Methodology

This study employed a modified gravity model of trade and panel data related to physician immigrants from 130 developing countries who practiced in the United States during the period 1995 to 2004 to examine the role of various health expenditures on physician migration.[8] Although gravity models have been widely used in studies described in the trade

literature to predict FDI and trade flows, such models have also been used to predict migration flows (Lewer and Van den Berg, 2008; Karemera et al., 2000). Immigration, like international trade, is determined by the attractive force between immigrant origin and destination countries and is deterred by the costs of moving between countries (Lewer and Van den Berg, 2008). The gravity model of immigration is given as follows:

$$M_{ij} = F[(POP_i^{\beta_1} POP_j^{\beta_2}) DIST_{ij}^{\phi}] \tag{1}$$

The log-linearized augmented gravity model is given in equation (2).

$$\ln M_{ijt} = \beta_1 \ln POP_{it} + \beta_2 \ln POP_{jt} - \theta \ln DIST_{ij} + \delta \ln X_{it} + \varepsilon_{ijt} \tag{2}$$

Santos and Tenreyro (2006) argue that traditional methods used to estimate empirical gravity equation are inappropriate. According to Santos and Tenreyro (2006), log-linearization of the empirical gravity model in the presence of heteroskedasticity leads to inconsistent estimates. Moreover, log-linearized gravity models are incompatible with the existence of zeros in the data which leads to unsatisfactory solutions, such as truncation of the sample. Following Santos and Tenreyro (2006), I estimate the following gravity model.

$$M_{ijt} = \beta_1 \ln POP_{it} + \beta_2 \ln POP_{jt} - \theta \ln DIST_{ij} + \delta \ln X_{it} + \varepsilon_{ijt} \tag{3}$$

where the dependent variable M_{ijt} is defined as the number of foreign physicians in the United States at time t. The dependent variable M_{ijt} for some countries contains 0 for the whole sample period, while several countries have 0 migrating physicians for certain years. The descriptive statistics are displayed in Table 1.

TABLE 1–Descriptive Statistics

Variable	Mean	Minimum	Maximum
Number of Emigrating Physicians	821.458	0	19149
Origin Physician Population	37257.7	14.4	2116162
U.S. Physician Population	804624	700424	872430
U.S. GDP	37621.02	3327.22	40906.35
Home Country GDP	4685.07	153.44	19721.72
Distance	9160.725	1467	16370.82
External resources for health as a percentage of total expenditure on health	9.8	0	98.2
Total expenditure on health as a percentage of gross domestic product	6.35	0.8	39
General government expenditure on health as a percentage of total government expenditure	11.14	0.1	55.5
Private expenditure on health as a percentage of total expenditure on health	42.30	0	100
Political Right	3.949	1	7
Freedom from Corruption	28.5	4	79.4
English as a medium of Instruction	0.440	0	1
Trade Volume	2.966	0	380.162
Migrant Network	1.644	0	53.488
Persons obtaining Legal Permanent Resident Status By Country of Birth	5134	3	218822
Prevalence of HIV, total (% of population ages 15-49)	2.69	0.1	27.3
Mobile Cellular subscriptions	2147685	0	334824000
Inflation, consumer prices (annual %)	25.06	-16.12	4145.11

List of countries included in the study: Afghanistan, Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi Cambodia, Cameroon, Cape Verde, Central African Rep. Chad, Chile, China, Colombia, Comoros, Congo, Dem. Congo Rep., Costa Rica, Cote d'Ivoire, Cuba, Djibouti, Dominica, Dominican Rep., Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, Gabon, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kyrgyzstan, Laos, Lebanon, Lesotho, Liberia, Libya, Lithuania, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Micronesia Fed., Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Romania, Russia, Rwanda, Saint Kitts , Saint Lucia, Saint Vincent , Samoa, Sao Tome & Principe, Senegal, Serbia and Montenegro, Seychelles, Sierra Leone, Solomon Islands, Somalia, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syria, Tajikistan, Tanzania, Thailand, Togo, Tonga, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, Uruguay, Uzbekistan, Vanuatu, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe

The main right-hand-side variables of interest include total expenditure on health as a percentage of gross domestic product (GDP), general government expenditure on health as a percentage of total expenditure on health, private expenditure on health as a percentage of total expenditure on health, and external resources for health as a percentage of total expenditure on health. These data were obtained from WHO's Global Health Observatory Data Repository. Total expenditure on health provides information on the level of resources channeled to health relative to a country's wealth and is measured as the sum of all financing agents managing funds to purchase health goods and services. General government expenditure on health includes resources channeled through government budgets, as well as expenditure on health by parastatals, extra-budgetary entities, and, notably, the compulsory health insurance. This indicator contributes to an understanding of the burden of public spending on health within the total value of public sector operations. Private expenditure on health includes expenditure from pooled resources with no government control, such as voluntary health insurance, and the direct payments for health by corporations (profit, not-for-profit, and non-governmental) and households. Finally, external resources for health-measures financing flow from external sources that provide funds to public and private financing agents. These resources include in-kind and in-cash funding provided as loans and grants. Higher health expenditure financing, all other things equal, will help retain physicians in the origin country and therefore should be negatively related to physician emigration.

The data for total population, U.S. physician population, and origin-physician population were compiled by Frederic Docquier. Using these data, I calculated the physician population per capita variable for the United States and the different origin countries as the ratio of total physician population to total population. Physician population per capita is indicative of the availability of physicians in the United States and in the origin countries. Therefore, physician emigration is a positive function of physician population per capita in the origin country and a negative function of physician population size in the destination country. If the United States is really experiencing a physician shortage, we should expect a negative relationship between U.S. physician population per capita and the number of physician emigrants. Distance is measured using the great-circle distance between capital cities. Distance affects migration through two channels: First, transportation costs impede migration such

that the further the distance, the less likely it is to emigrate. Secondly, migration involves leaving behind families and friends while one "seeks greener pastures." The further the distance, the less people are willing to migrate due to the need to leave friends and families behind. The distance variable data were compiled by Bruce Blonigen.

TABLE 2–List of Variables and source

Name	**Source**
Origin Physician Population	Frederic Docquier website[a]
U.S. Physician Population	Frederic Docquier website
Total number of physician emigrants	Frederic Docquier website
Physician population per capita	Constructed by author
Real GDP Per Capita	World Penn Table
Distance	Compiled by Blonigen[b]
Healthcare Expenditures	World Health Organization[c]
Persons Obtaining Legal Permanent Resident Status By Country of Birth	U.S. Department of Homeland Security[d]
Inflation, consumer prices (annual %)	World Development Indicator
Prevalence of HIV, total (% of population ages 15-49)	World Development Indicator
Mobile cellular subscriptions	World Development Indicator
Political rights	Freedom House rating of political system[e]
Freedom from Corruption	The Heritage Foundation[f]
Bilateral Trade	Correlate of War database[g]
Dummy variable for Medium of Instruction	World Health Organization[h]

[a]http://perso.uclouvain.be/frederic.docquier/oxlight.htm
[b]http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html
[c]http://apps.who.int/gho/data/node.main.75?lang=en
[d]http://www.dhs.gov/yearbook-immigration-statistics
[e]http://www.freedomhouse.org/template.cfm?page=439
[f]http://www.heritage.org/index/explore
[g]http://www.correlatesofwar.org/datasets.htm
[h]http://www.who.int/hrh/wdms/en/

Given the difficulties in obtaining reliable income data for physicians in developing countries, real GDP per capita data from the Penn World Tables were used as a proxy for physician income. Classic migration

literature argues that migrants move out of areas with low income or move into areas with higher levels of income. For that reason, I calculated differences in real GDP per capita to capture income differentials between destination and origin countries. Data on migrant networks were obtained from the U.S. Department of Homeland Security and were defined as the number of persons, based on country of birth, who obtained legal permanent resident status. In other words, this variable measures the number of immigrants from origin country *i* residing in the United States legally. Migrant networks make it easier for recent immigrants to adjust to their new environments. Moreover, the migration process involves collecting a great deal of information about the destination country, which could be costly and time-consuming. Existing migrant networks in the destination country provide useful information to potential migrants at a lower cost.

The Political Rights and Freedom from Corruption indexes were used in the present study to capture level of political freedom and corruption in the origin countries. Greater political stability in a country generally reflects more political autonomy, thus ensuring such rights as an individual's freedom of expression, as well as the right to vote and to participate in the political process.[9] Corruption, on the other hand, erodes economic freedom by introducing insecurity and uncertainty into economic relationships.[10] The Political Rights and Freedom from Corruption indexes are published by the Freedom House and the Heritage Foundation, respectively. The Political Rights Index is measured on a scale of 1–7: Countries with a rating of 1 enjoy a wide range of political rights, including free and fair elections, and countries with a rating of 7 have few or no political rights due to severe government oppression. The Freedom from Corruption Index is measured on a scale of 0–100, with 0 representing a very corrupt government and 100 representing very little corruption. I expected to find lower physician emigration rates in countries with good political stability and minimal corruption. Bilateral trade data, which measure economic ties, were obtained from the Correlate of War database and are defined as the sum of bilateral trade flows between the United States and the origin country. The greater the volume of trade between two countries, the stronger are the economic (business and trade) ties. As the economies of the United States and the origin countries become more integrated, labor mobility and migration will become important aspects of the economic relationship. As a result, the stronger the economic ties between the United States and the origin

country, greater are the number of physicians migrating to the United States.

A dummy variable was used to capture the language of medical school instruction. Physicians from countries in which English is used as a medium of instruction are more likely to migrate to the United States than physicians from countries that use a language other than English. The Consumer Price Index (CPI), a key macroeconomic variable that gauges the state or health of an economy, was used to measure cost of living. All other factors being constant, physicians tend to emigrate if the cost of living is high in the origin country relative to that of the United States. The numbers of mobile cellular subscriptions proxy for infrastructure development in the origin countries. Well-functioning infrastructures, important for the growth and development of a community or society, are believed to reduce physician emigration. Finally, HIV and AIDS continue to be major public health issues in many developing countries. Given that several developing countries are overwhelmed by these diseases, many physicians might want to leave their home countries to avoid exposure to them.[11] Data on CPI, on mobile cellular subscriptions, and on HIV and AIDS were obtained from the World Development Indicator.

III. Results and Discussion

Since the dependent variable is count data and contains 0 observations for several countries, ordinary least squares (OLS) is not the appropriate technique to utilize in this framework. Rather, the Poisson pseudo-maximum-likelihood (PPML), recommended by Santos and Tenreyro (2006), was used as the estimation model. The PPML provides consistent estimators in the presence of heteroskedasticity and is also good at handling 0 observations in the dependent variable. I first performed a heteroskedasticity-robust RESET test (Ramsey, 1969), which, essentially, is a test for the correct specification of the conditional expectation.[12] The *p*-values are provided at the bottom of Table 3. The null hypothesis that the model(s) has no omitted variables cannot be rejected at 5% significance level. This essentially confirms that the gravity model was specified correctly. One interesting observation that is particularly noteworthy, shown in Table 3, is that the results vary before and after controlling for fixed effects. Controlling for fixed effects helps to eliminate potential omitted variable bias. In my discussion of the

study results, I largely focus on the fixed effects columns and occasionally refer to the no-fixed effect columns when appropriate.

A. BASE RESULT

The benchmark model, columns (1) and (2), presents the estimation results prior to controlling for the health expenditure variables. Specifically, columns (1) provide the PPML result prior to controlling for fixed effects, while (2) controls for both time and country fixed effects. As noted in the data section, physician population per capita is indicative of the availability of physicians in the United States and in origin countries. If the United States is actually experiencing a physician shortage, the coefficient of the U.S. physician population per capita should be negative, while the coefficient of the origin-physician population per capita should be positive. In other words, a shortage of physicians in the United States should attract foreign physicians from countries with larger physician pools. The results across the different specifications show that origin-physician population per capita affects physician migration to the United States positively, while the U.S. physician population per capita has no impact on physician immigration. Although the physician population per capita has a negative effect on physician immigration in column (1), controlling for fixed effects, however, changed the coefficient sign and rendered the estimated coefficients insignificant. The table benchmark also confirms the widely known theory that the geographic distance between origin and destination countries is inversely related to emigration and should have a negative coefficient sign. In addition to representing physical distance, distances serve as proxies for travel and psychological costs. Physicians from countries that are farther from the United States find it less attractive to migrate to the United States (Hamilton and Yau, 2004).

Other factors affecting physician emigration include medium of instruction, bilateral trade volume, migrant networks, inflation, political rights, HIV prevalence, and mobile cellular subscriptions. Conventional wisdom suggests that migration occurs between countries that share a common language. Even though English may not be the national language in several countries, what really matters is the medium of instruction used in medical schools.

TABLE 3–Gravity Model Fixed Effect Estimation of Physician Migration

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Origin Physician Population per Capita	0.314*** (0.081)	0.049*** (0.012)	0.439*** (0.081)	0.058*** (0.012)	0.306*** (0.082)	0.054*** (0.012)	0.252*** (0.084)	0.051*** (0.012)	0.295*** (0.086)	0.060*** (0.012)	0.056*** (0.012)	0.066*** (0.012)
US Physician Population per Capita	-2.595*** (0.530)	0.047 (0.076)	-2.675*** (0.543)	0.023 (0.077)	-2.560*** (0.531)	0.091 (0.077)	-2.601*** (0.520)	-0.019 (0.077)	-2.400*** (0.537)	-0.109 (0.086)	0.031 (0.077)	-0.052 (0.087)
Log (Distance)	-0.316** (0.130)		-0.541*** (0.155)		-0.326*** (0.155)		-0.334*** (0.127)		-0.207*** (0.130)			
log GDP Difference	3.738*** (0.910)	-0.010 (0.124)	3.547*** (0.944)	-0.025 (0.125)	3.757*** (0.915)	-0.099 (0.127)	3.080*** (0.959)	0.070 (0.125)	4.507*** (0.940)	0.214 (0.140)	-0.092 (0.127)	-0.014 (0.144)
log Inflation	-0.001** (0.0004)	-0.000*** (0.000)	-0.001* (0.0007)	-0.0004** (0.00005)	-0.001 (0.0005)	-0.0003 (0.00005)	-0.001* (0.0003)	-0.0004*** (0.00005)	-0.002* (0.001)	-0.0003*** (0.00005)	-0.0004*** (0.00005)	-0.0003*** (0.00005)
Political Rights	0.020 (0.036)	0.018*** (0.002)	0.024 (0.035)	0.017 (0.002)	0.018** (0.036)	0.019*** (0.002)	-0.013 (0.035)	0.023*** (0.002)	0.026 (0.035)	0.017*** (0.002)	0.024*** (0.002)	0.020*** (0.002)
Medium of instruction	1.191*** (0.113)		1.089*** (0.119)		1.185*** (0.120)		1.154*** (0.113)		1.091*** (0.113)			
log Freedom From Corruption	-0.482*** (0.169)	0.005 (0.006)	-0.511*** (0.178)	0.002 (0.006)	-0.486*** (0.169)	0.006 (0.006)	-0.375** (0.170)	-0.001 (0.006)	-0.512** (0.172)	0.014** (0.006)	-0.005 (0.006)	-0.003 (0.006)
Bilateral Trade Volume	0.531*** (0.077)	0.014** (0.006)	0.475*** (0.082)	0.019*** (0.006)	0.529*** (0.078)	0.019*** (0.006)	0.474*** (0.080)	0.013** (0.006)	0.600*** (0.077)	0.011** (0.006)	0.019** (0.006)	0.016*** (0.006)
lag Migrant Network	0.010 (0.016)	0.010*** (0.016)	0.005 (0.019)	0.011*** (0.001)	0.010*** (0.017)	0.011*** (0.001)	0.018 (0.016)	0.011*** (0.001)	0.015 (0.015)	0.010*** (0.001)	0.011*** (0.001)	0.011*** (0.001)
HIV Prevalence	-0.263*** (0.055)	0.065*** (0.010)	-0.201*** (0.045)	0.113*** (0.012)	-0.294*** (0.058)	0.106*** (0.013)	-0.279*** (0.054)	0.125*** (0.012)	-0.276*** (0.058)	0.111*** (0.013)	0.115*** (0.013)	0.102*** (0.013)
log Mobile	0.203** (0.065)	0.047** (0.003)	0.240*** (0.070)	0.050*** (0.003)	0.198** (0.067)	0.047*** (0.003)	0.234*** (0.067)	0.049*** (0.003)	0.131*** (0.064)	0.049*** (0.003)	0.051*** (0.003)	0.052*** (0.003)

TABLE 3–Gravity Model Fixed Effect Estimation of Physician Migration (continued)

Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Total Health Expenditure			-0.184*** (0.042)	-0.013** (0.003)								
General Government Health Expenditure					-0.001 (0.016)	-0.005*** (0.001)					-.007*** (0.001)	-0.009*** (0.001)
Private Expenditure							0.014*** (0.005)	-0.003*** (0.0004)			-0.004*** (0.0004)	-0.003*** (0.0004)
External Resource on Health									-0.035*** (0.020)	0.006*** (0.007)		0.005*** (0.0007)
Reset test p-values	0.306		0.232		0.159		0.105		0.052		0.101	0.199
Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Observations	673	673	673	673	673	673	673	673	673	673	673	673
Average VIF	1.77		1.85		1.77		1.79		1.79		1.83	1.88

Standard errors are in Parenthesis. *Significance at the 0.10 level; **Significance at the 0.05 level; ***significance at the 0.01 level. P-values are in square brackets. Similar results are obtained when zero values of physician emigration were excluded from the data. The VIF alues indicate how much the variances of the estimated coefficients are inflated by multicolinearity. VIF > 10 indicates harmful collinearity (Kennedy, 2003). Note, the VIFs for the individual explanatory variables in each model are strictly less than 4. The variables ln_distance and language were dropped in the fixed effect estimates because they are constant within groups.

The results of the present study indicate that countries with medical instruction presented in English experience higher physician emigration to the United States than countries that use other mediums of instruction. The USMLE requires a certain amount of English proficiency, and physicians from countries in which the medium of instruction in medical schools is not presented in the English language finds it difficult to pass the test.

Consistent with previous studies (Zawodny, 1997; Hamilton and Yau, 2004; Salsberg and Grover, 2006), migrant networks have a positive impact on physician emigration. The presence of natives in the destination country helps to reduce the cost of physicians' adaptation to the new environment (Salsberg and Grover, 2006). Thus, countries with greater numbers of migration networks experience more physician emigration. Similarly, the level of economic ties between the United States and the origin country facilitates physician emigration immigration. As the trade volume between the origin countries and the United States increases, the economic ties improve, and the volume of physician emigration increases. Similarly, political rights positively affect physician emigration. Note that political rights are measured on a scale of 1–7: Countries with a rating of 1 enjoy a wide range of political rights, while a rating of 7 implies few or no political rights. Therefore, a lower political rating (better political rights) should lead to a decreased volume of physician emigration. One other reason for this result is that more political freedom generally implies a peaceful and conducive work environment.

While most of the estimates in column 2 are consistent with theory, the coefficient sign on infrastructure development (number of mobile cellular subscriptions) is inconsistent with economic theory and hence presents an apparent puzzle. As shown in column (2), better infrastructure development drives up physician emigration, contrary to the expectation. One possible explanation could be the nature of the proxy variable. The mobile cellular subscriptions variable captures overall infrastructure development in a country but not necessarily hospital infrastructure development. As a result, a country with a good road network and constant electricity and water supplies may still experience physician emigration if it lacks modern hospital buildings and equipment. Similar to infrastructure development, inflation rate, the measure of cost of living has a negative coefficient sign that is inconsistent with the expectation.

B. HEALTH EXPENDITURE RESULT

An important but often ignored variable in physician migration studies is the issue of health financing. Health financing provides the resources and economic incentives for the operation of health systems and is a key determinant of health-system performance in terms of equity, efficiency, and health outcomes (Schieber et al., 2006). Moreover, disparities in health spending across countries can help explain the current pattern of physician emigration. Table 3 presents the results for the health expenditure variables. The health expenditure variables employed in this study are derived from four broad sources: the public sector (expenditures financed from general revenues and social insurance contributions), the private sector (expenditures financed out-of-pocket and by private insurance), external sources (grants or loans from international funding agencies), and total health expenditure.

Column 4 of Table 3 provides the estimation result when total health expenditure is included with fixed effects in the base model. The result clearly shows that physician emigration seemed to decrease as total health expenditure increased. Specifically, a 1% increase in total health expenditure results in an approximate 0.013% reduction in physician emigration. Strictly speaking, countries investing fewer resources in health care tend to experience significant physician emigration compared to countries that invest more resources in health care. This result somewhat echoes Stilwell et al.'s (2004) argument that health-care systems in developing countries are suffering from years of under-investment, and for health-care workers, this has resulted in low wages, poor working conditions, a lack of leadership, and few incentives of any kind. As a result, physicians in developing countries find it worthwhile to migrate to developed countries such as the United States, where investment in health-care expenditure is relatively high. Note that the coefficient of total health expenditure is consistently significant with the expected coefficient sign before and after controlling for fixed effects.

Results from the disaggregated total health expenditure variable are shown in column (6) for general government expenditure on health, and column (8) illustrates results from private expenditure on health. Similar to total health expenditure, the coefficients of general government expenditure on health and private expenditure on health after controlling for fixed effects are negative and highly significant, suggesting that government and private expenditure on health independently affect

physician emigration. A 1% increase in the growth of public-sector funding for health and in private-sector funding for health results in 0.005% and 0.003% reductions in physician emigration, respectively. A closer look at the coefficients, however, reveals that government expenditure on health plays a slightly better role than private expenditure on health in deterring physician migration in developing countries. This may be due to the fact that government funding for health care is, for the most part, spent on providing health care infrastructure, purchasing medical equipment, and financing research and development, an investment too cumbersome for private health-care expenditure to achieve in developing countries.

The evidence notwithstanding, the results still suggest that higher government expenditure and private expenditure on health care help discourage physician emigration. Increasing the amount of resources devoted to financing government and private health care in developing countries will reduce physician emigration. The coefficient of external resources on health (column 10), although significant, has a rather puzzling unexpected coefficient sign, given WHO's argument that external resources are becoming a major source of health funding in low-income countries.[13] Novignon et al. (2012) however, argue that external resources are not only unsustainable but also inadequate, considering the enormous health-care burden in the region. Furthermore, the effectiveness of external resources on health also depends on how these external funds are channeled and used. Ehrenfeld (2004) explains that donor countries are to be blamed for the unproductive outcome of aid in most receiving countries, as aid-tying practices and conditionality have redirected aid in such a way as to benefit the lenders. All these taken together could explain why an increase in external resources on health has a positive impact on physician emigration.

The last two columns of Table 3 provide the estimation results for government health expenditure and private health expenditure (column 11), government health expenditure, private health expenditure, and external resources for health (column 12). The results remain unchanged, thereby reinforcing the conclusion that an increase in government and private expenditures on health care deter physician migration, while external resources for health encourage physician migration.

IV. Conclusion

During the past decade, several developed countries have experienced severe physician shortages due to an increasing aging population, among other factors. In an effort to keep up with rising demands for physicians, many developed countries rely on foreign physicians. This in turn affects the quality of the health-care services provided in these developing countries. This study used a gravity model and applied the PPML estimator to examine the role of various health expenditure variables on physician migration to the United States. Health-care expenditures in many developing countries are significantly low compared to those in developed countries. As a result, physicians in developing countries might be forced to emigrate due to insufficient, or a lack of, investment in the health sector.

The results show that repelling forces in origin countries play a significant role in encouraging physician emigration. I found that a declining total expenditure on health, inadequate government and private expenditure on health, economic ties, and migrant networks are among the key factors that pressure physicians from developing countries to migrate to the United States. Given that government plays a huge role in most of these developing economies, increased government health-care expenditures would help to reduce physician migration. Expenditures to be considered could include new and well-maintained hospitals and clinics, better hospital infrastructures, medical-research grants, seminars, and conferences.

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Endnotes

1. See "Health sector development." http://www.wpro.who.int/laos/areas/health_systems/en/
2. See "The facts about rising healthcare costs." http://www.aetna.com/health-reform-connection/aetnas-vision/facts-about-costs.html
3. Much of the analysis on the impact of health expenditures on health outcomes is mixed (Burnside and Dollar 1998; Anyanwu and Erhijakpor 2009; Farag et al. 2012; Novignon et al. 2012). It is important to note that higher health financing does not necessarily imply better health outcomes. Despite the fact that the U.S. has the highest health care spending among OECD countries, the country still lacks behind on many measure of health outcomes. Particularly, in 2012, health spending accounted for 16.9% of GDP in the U.S., 7.5 percentage points above the OECD average of 9.3%, yet life expectancy at birth was 78.7 years compared to OECD average of 80.2 years. (See http://www.oecd.org/unitedstates/Briefing-Note-

UNITED-STATES-2014.pdf). A report published by the commonwealth Fund titled "Mirror, Mirror on the Wall-2014 Update" show that the U.S. ranks behind most OECD countries on many measure of health outcomes, quality and efficiency despite having the most expensive health care system in the world. (see http://www.commonwealthfund.org/publications/fund-reports/2014/jun/mirror-mirror).

4. While it seems most reasonable to expect that physician migration affects economic development, it is entirely possible that causality runs the other direction: economic development may actually affect physician migration. For instance, a well-developed economy with abundant wealth may allocate more resource to health care. If the resources are used efficiently, it will improve health outcomes and may even discourage physician emigration.
5. Physician emigration between developed countries do exist but is beyond the scope of this study.
6. See Young A, Chaudhry HJ, Rhyne J et al. 2011 and 2013
7. See American Hospital Association. Fact Sheet: Medicare Graduate Medical Education. http://www.aha.org/content/12/12factsheet-gme.pdf
8. Data on the stock of foreign physicians in the United States compiled by Bhargava, Docquier and Moullan (2010) is available online at http://perso.uclouvain.be/frederic.docquier/oxlight.htm.
9. See Freedom House methodology. https://freedomhouse.org/report/freedom-world-2012/methodology#.VaGF9vlVikd
10. See Freedom from corruption description. http://www.heritage.org/index/freedom-from-corruption
11. Due to lots of missing observations for HIV/AIDS, we chose to use TB prevalence.
12. According to Silva and Tenreyro (2006), the test checks the significance of an additional regressor constructed as (x`b)2.
13. See http://www.who.int/whosis/whostat/EN_WHS09_Table7.pdf. World Health Statistics 2009.