EVALUATING THE IMPACTS OF MEDICAL BRAIN DRAIN ON HEALTH OUTCOMES IN LATIN AMERICA: AN INSTRUMENTAL VARIABLE APPROACH

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Abstract. The paper attempted to investigate the relationship between medical brain drain and health outcomes and to evaluate the causal impacts of the former on three health indicators (life expectancy, child mortality and prevalence of HIV). A panel dataset of Bhargova and Docquier (2010) for the period of 1991-2004 consisting of 18 Latin American developing countries was given main focus as a primary data and OLS regression model, fixed-effects panelregression model and instrumental variable approach under two-stage least squares (2SLS) regression analysis were utilized. In order to overcome the problem of endogeneity between medical brain drain and health outcome, "American Competitiveness and Workforce Improvement Act" (ACWIA) was applied as an instrument for medical brain drain. The final outcome of the analysis revealed that increase in medical brain drain leads to decrease in life expectancy, increase in number of child deaths, and an acceleration of HIV prevalence among population. Therefore, future policy recommendations and further research are required to reduce the negative impacts of medical brain drain on healthcare condition.

Index terms: medical brain drain, health outcome, instrumental variable, Latin America JEL classification: C33, F22, I18, J11, O54

1. INTRODUCTION

"To this day we continue to lose the best among ourselves because the lights in the developed world shine brighter.
Nelson Mandela

The statement of Nelson Mandela on emigration succinctly expresses his concerns about the problem in developing countries in the era of globalization, where severe competition exists not only for material resources but also for human resources.

Although a myriad of various descriptions exists for the term of brain drain, this term is commonly referred as a migration of skilled personnel from developing countries to more advanced economies for a better condition of living. The term brain drain gained its wide usage in late 1960s, when the migration of skilled individuals increased substantially (Commander et al., 2004). The number of well-educated immigrants living in OECD countries has risen by 70 percent during 1990s and specifically two-thirds of this rise belongs to developing nations (Docquier *et al.*, 2008). Plenty of studies have been conducted to explain the root causes of this movement and several factors such as political instability, lack of educational facilities, poor standard of living, deficiency of job facilities are considered to be the major concerns of it. As Klein and Sauer (2008) emphasize, brain drain significantly impacts the economic development of a country, while if this movement occurs in medical sectors, it will affect not only economic welfare but also health condition as well.

In fact, one of the alarming direction of the brain drain – medical brain drain (MBD) refers to the migration of skilled health personnel from developing nations to more advanced economies. Sinnott (2013) explains that migration of skilled health personnel is usually associated with extremely low physician density, and the leakage of those high-qualified, best-performing doctors may affect negatively on health quality in the region. Because, there is possibility that less-educated and lower performing doctors will remain in the country. There are several channels, such as maternal mortality, infant and child mortality, life expectancy, prevalence of HIV and AIDS[1] etc., through which medical brain drain can affect health condition. Theoretically, high rate of medical brain drain in particular country is associated with a decrease in life expectancy rate, an increase in HIV prevalence, a rise in child and maternal mortality, which contradicts current United Nations Sustainable Development Goals. Therefore, the topic under discussion is no doubt controversial and it is of high importance to analyze and evaluate the impacts of medical brain drain on a country`s healthcare potential. Although sufficient amount of studies has been conducted to analyze the impacts of brain drain, only limited number of them were specialized in medical direction. Unfortunately, no research has been analyzed so far in order to assess the deteriorating effects of medical brain drain in Latin America, while this region is one the most heavily impacted.

For this reason, fulfilling this research gap, I aim to investigate the causal impacts of medical brain drain on health outcomes in Latin American region. Hence, the following research question is identified:

To what extent does the medical brain drain impact the health outcomes in Latin America?

Considering this, the project pursues numerous research objectives:

- To analyze the relationship between medical brain drain and health outcomes;
- To evaluate the impacts of movement of skilled health personnel on health outcome through the channels of life expectancy, child mortality and HIV prevalence;
- To provide some policy recommendations based on empirical findings.

This paper is structured as follows. Section 2 reviews various discussing theories and debates around this topic and describes how medical brain drain is linked to several health indicators. Section 3 describes the data used in the analysis and explains the models that has been applied to investigate the relationship mentioned above. Subsequently, empirical results are presented, interpreting and comparing the outcomes of selected models. The subsequent sections summarize the outcomes and provide policy proposals based on research findings, and the last section discusses some limitations of the research.

II. LITERATURE REVIEW

Recent years have witnessed considerable emergence of controversial ideas between researchers and policymakers about the relationship of the brain drain, especially medical brain drain and health indicators. As this literature review reveals, the ideas about the impact of movement of skilled health personnel on health outcomes and economic indicators are categorized into two subgroups - proponents and critics. The former considers the influence of medical brain drain as positive, whereas the latter contradicts to those ideas and claims that it has deteriorating effects. Therefore, it is crucial to investigate whether the issue of brain drain in medical sector in developing countries cause poor health conditions, and if so, what kind of policies can be implemented to alleviate this.

In his research, Hagopian et sl., (2004) studied the impacts of physician migration in case of African countries and identified that higher rates of medical brain drain are negatively associated with African doctor-to-population ratios. This ratio has also been proven to affect child immunization and vaccination rates as well, which is considered to be one of the important measures of health standards. Moreover, this research also reveals that medical brain drain in African countries has also been inherently linked with increasing rates of HIV deaths.

One of the most popular studies on this topic has been conducted by Bhargova and Docquier (2011), who recorded the actual rates of medical brain drain. They established a new panel data set for the period of 1991-2004 and tabulated the number of physicians who were initially trained in their country of origin, in developing countries, then emigrated abroad. According to their analysis, among all developing countries in the dataset, the most heavily affected by physician migration from 1991 to 2004 were located in sub-Saharan Africa and Latin America. In order to cope with the problem of endogeneity, they utilized a time-lagged variable of medical brain drain as an instrumental variable and the results revealed that infant and child mortality as well as vaccination rates were negatively correlated with the number of doctors available per capita. Additionally, their estimations of brain gain, positive aspects of migration magnitudes on increased medical training in sending countries, were statistically insignificant.

Different research has been conducted by the same authors (Bhargova and Docquier, 2010) in order to investigate the causal relationship between medical brain drain and health indicators, specifically the number of deaths due to HIV and life expectancy. Launching random effects model, they obtained that lower wages and high prevalence of HIV were the main determinants, driving forces of migration in medical sector of sub- Saharan African countries. Moreover, it was estimated that a doubling of the medical brain drain rate led to 20% increase in the number of deaths from HIV. However, they identified no relationship between physician migration and life expectancy rate and summarized that life expectancy is a function of economic development rather than the availability of doctors.

In contrast with Bhargova and Docquier`s dataset, Clemens and Pettersson (2006) utilized different approach and specification in order to build doctors migration dataset, tracking the number of doctors who were originally from Africa but practicing abroad. Thus, they obtained that almost one-fifth of African-born doctors were performing their medical activities abroad. Additionally, it was determined that not only some of the least developed countries but also advanced economies had the lowest rates of emigration. They attributed this with limited resources and few medical schools in those suffering regions, while the availability of employment opportunities and political, economic and financial stability caused less incentive to emigrate in developed countries. Considering these two findings, the authors summarized that middle countries, in terms of income levels and size of the economy, were suffered hard by medical brain drain.

Regarding measures to tackle the problem under discussion, several scholars provided various policy recommendations to improve the situation in developing countries. For instance, Plotnikova (2012) claims that the roles of international bodies such as the United Nations, World Health Organization, are crucial in resolving this issue and special regulatory policies and schemes should be established which controls the operations of recruitment agencies of advanced nations and oblige them to attract less doctors from poor developing countries or even restrict for particular period of time.

Apart from these, some scholars (Vujicic *et al*., 2004; Mackey and Liang, 2013) suggest “return of talent” programs as motivation which can encourage those emigrated to return to their home country. This program has already been practicing in Ghana, Zimbabwe and providing some positive results. The idea is to provide higher remuneration, special bonuses and opportunities for workers who returned back to their country. However, Packer *et al*., (2010) strongly contradicts to this view stating that those professionals who are loyal to their country usually stay behind and they are ignored by the authorities, while the main work burden was on their shoulders during shortage of workforce in particular areas. Additionally, Frehywot *et al*., (2010) also recommend that making compulsory service, at least for short period of time, as graduating requirement of the higher education degree should stop graduates of medical school from emigrating. In some countries, this requirement can be waived if special tax burden obligation is met by those graduates. In contrast, both types of these requirements raise several issues from an ethical perspective and human rights point of view. Wolffers *et al*., (2003) highlights that those obligations can be regarded as a severe verdict which violates the autonomy, freedom of movement, individual and professional choice of health workers.

III. METHODOLOGY

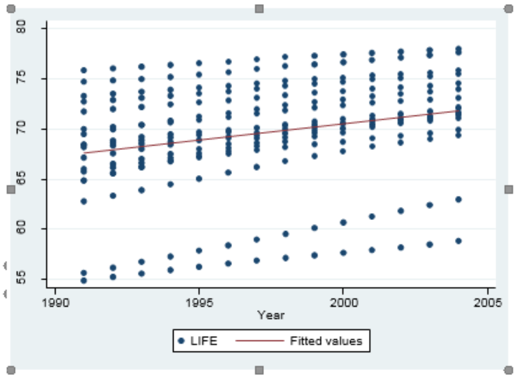
a) Data description

The panel data was utilized in this project spanning 14 years (1991-2004) and including 18 developing Latin American countries (Argentina, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela). In my analysis, I concentrated on investigating the impacts of medical brain drain on health outcomes in developing countries. Therefore, Chile and Mexico were excluded from the dataset in order to avoid the outlier effect, since these countries are the members of OECD and considered to be one of the developed countries in Latin American region. Medical brain drain rate was given the main focus as a variable of interest in the analysis, while life expectancy, child mortality and prevalence of HIV are considered to be the determinants of health outcome and utilized in the analysis as dependent variables. Moreover, the panel contains GDP per capita, the quantity of population, the number of children living with HIV, the percent of population having access to water sources and physician's density as control variables. These indicators are obtained from the databases of two organizations such as the World Bank and World Health Organization. Additional sources such as official website of OECD, UNESCO, UNAIDS and several publications are also utilized in order to reduce the number of missed observations and improve the value of the research.

b) Measure of health outcome (Dependent variable)

One of the most utilized measure of health outcome is the **life expectancy rate** which is commonly applied in various cross-country analysis. According to Cohen (2011) 'life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life'. The units of this variable are measured in years and it was observed that throughout of 14-year time period, countries in Latin America experienced an upward trend in life expectancy (Figure 1). The dataset for life expectancy was collected from the World Bank database (2017) for the period of 1991-2004.

Figure 1. Life expectancy in 18 Latin American countries for the period of 1991-2004.



Another important health indicator is **the child mortality** or the number of under-five deaths which describes the number of children dying before reaching age five. Several scholars utilized this variable in their regression analysis and (El Arifeen, 2008) defines child mortality as the death of children who are under the age of five or between the age of one month to four years. Moreover, as Azarnert (2012) highlights, child death is not only health issue but also economic problem in developing countries which has severe consequences. The dataset for this dependent variable was collected from the World Health Organization (WHO) database for the period of 1991-2004.

The third important heath determinant adopted to our model was **prevalence of the Human Immunodeficiency Virus (HIV)** which refers to the percentage of people ages 15-49 who are infected with HIV. Additionally, Letamo (2003) considers that prevalence of HIV, being a global issue, is an effective estimator of health condition in particular country. The dataset for this dependent variable was collected from the United Nations (UNAIDS) database for the period of 1991-2004.

c) Medical brain drain (Variable of interest)

Even though limited number of research has been conducted in order to identify the causal impacts of medical brain drain, this term is widely utilized in several studies. For instance, Serour (2009) in his paper "*Healthcare Workers and the Brain Drain*" defines medical brain drain as the movement of skilled health personnel from country of origin seeking better facilities, opportunities and favorable environment. Panel dataset on physician emigration was created by Docquier and Bhargava in 2006 with the purpose of estimating the impacts of medical brain drain on Sub-Saharan African countries. They revised this dataset in 2010, including more countries and modeling the effects of physician emigration on human development for the period of 1991-2004. Thus, this database was utilized in my analysis and it includes the population of each country, the number of physicians trained in each Latin American countries, the total quantity of physicians emigrated from particular country, the number of health staff per 1000 people and the number of medical personnel that emigrated to each 16 OECD destination countries. Being a key variable, medical brain drain rate was obtained by dividing the quantity of doctors emigrating from the country of origin by the total number of doctors trained in that country in a certain year. Among all Latin American countries in the data set, Haiti and Dominican Republic were the most suffered compared to others (see figure 2 in appendix).

d) Control variables

In order to strengthen our empirical results and to reduce potential omitted variable bias, various control variables were included into the model. The investigation of available literature revealed that there were several other essential factors which contributes to health outcomes (life expectancy, child mortality, prevalence of HIV) as well. Bhargava (2017), Bradby (2014) and Carrion-i-Silvestre (2005) included **GDP per capita** and the number of **population** in their estimations and obtained significant results in terms of relationship between GDP per capita and life expectancy rate. To capture these effects, we also included GDP per capita (in constant 2010 US dollars) and each country`s population in our estimations and the World Bank`s "World Development Indicators" database (2017) was helpful in obtaining relevant data for the time-span of 1991-2004.

Moreover, as Villamor *et al.*, (2005) suggest, the increasing number of **children living with HIV** is one of the concerns rising awareness of countries in African continent and this issue is associated with child mortality and the distribution of HIV diseases across regions. For this reason, the number of children who are infected with HIV between the age of 0-14 were included into the model as an independent variable. Appropriate information was obtained from the United Nations database (UNAIDS, 2017).

Furthermore, several other factors such as improved sanitation and water supply facilities also play crucial role in enhancing healthcare system of particular country, having significant association with life expectancy, child mortality and HIV prevalence as well (Chauvet, Gubert and Mesplé-Somps, 2013). Therefore, **access to an improved water sources**, which refers to the percentage of the population using an improved drinking water source[2], was implemented as a control variable.

Lastly, I decided to include the number of **physicians per 1000 people** into the model, which is considered to be a proxy for doctor density in the region. According to Hagopian *et al.*, (2004) physician density is an essential indicator of healthcare quality in the area, emphasizing that the fewer doctors are available to public, the poorer the quality of healthcare.

Descriptive statistics							
Variable	**Obs**	**Mean**	**SD**	**Min**	**Max**	**Skewness**	**Kurtosis**
Life expectancy	252	69.70	5.19	54.91	77.97	-1.04	3.87
Child mortality	252	9.13	1.30	6.67	12.33	-0.07	2.68
Prevalence of HIV	252	0.62	0.80	0.10	4.00	2.63	9.59
Medical brain drain	252	8.30	11.69	0.60	66.63	2.94	11.51
GDP per capita	252	8.15	0.72	6.47	9.48	-0.28	2.49
Population	252	16.18	1.02	14.74	19.03	1.04	3.74
Children living with HIV	252	6.43	1.43	4.61	9.39	0.27	2.13
Access to water sources	252	83.52	9.77	55.20	97.70	-0.72	2.95
Physician per 1000	252	1.60	1.21	0.08	5.91	1.84	6.35

The table above displays the descriptive statistics on the set of all variables utilized in the basic OLS, fixed-effects regression and 2SLS instrumental variable models.

IV. EMPIRICAL MODELS

In order to investigate the causal impacts of medical brain drain on health outcome, the following linear equations were established, considering life expectancy, child mortality and HIV prevalence as dependent variables and determinants of health outcome.

$$LIFE_{i,t} = \beta_0 + \beta_1 MBD_{i,t} + \beta_2 lnGDPc_{i,t} + \beta_3 lnPOP_{i,t} + \beta_4 lnCHILD\_HIV_{i,t} + \beta_5 WATER_{i,t} + \beta_6 PHYSICIAN1000_{i,t} + \mu_{i,t}$$

$$lnCHILD\text{-}MOR_{i,t} = \beta_0 + \beta_1 MBD_{i,t} + \beta_2 lnGDPc_{i,t} + \beta_3 lnPOP_{i,t} + \beta_4 lnCHILD\_HIV_{i,t} + \beta_5 WATER_{i,t} + \beta_6 PHYSICIAN1000_{i,t} + \mu_{i,t}$$

$$HIV\_PREV_{i,t} = \beta_0 + \beta_1 MBD_{i,t} + \beta_2 lnGDPc_{i,t} + \beta_3 lnPOP_{i,t} + \beta_4 lnCHILD\_HIV_{i,t} + \beta_5 WATER_{i,t} + \beta_6 PHYSICIAN1000_{i,t} + \mu_{i,t}$$

In this model:

LIFE – is life expectancy rate at birth,

lnCHILD_MOR – is the natural logarithm of the number of children deaths aging 0-5,

HIV_PREV – is the prevalence of HIV referring to percentage of population ages 15- 49, who are infected with HIV,

MBD – is the medical brain drain rate,

lnGDPc – is the natural logarithm of GDP per capita,

lnPOP – is the natural logarithm of the number of population,

lnCHILD_HIV – is the natural logarithm of the number of children living with HIV, ***WATER*** – is the percentage of population who have access to water sources,

PHYSICIAN1000 – is the number of doctors available per 1000 people,

β0 – is the intercept, ***βi*** – are the coefficients of regressors,

μi,t – is the error term.

a) Basic OLS and Fixed-effects models

Initially, the OLS method, which minimizes the sum of squared residuals, was implemented in order to investigate the relationship between medical brain drain and health outcomes. Hence, results revealed that medical brain drain was significantly correlated with all three health indicators. However, let us to consider a scenario in which movement of skilled health personnel is inherently linked to health outcome. As Sinnott (2013) suggests doctors are probably leaving their country of origin due to struggling health care system, and a suffering system will likely to provide poor health outcomes. Therefore, I am unable to estimate accurately the causal effects of medical brain drain on health outcomes relying to basic OLS model, since the essential assumption of unbiased estimator, Cov(MBD_{it}, μ_{it}) = 0, may not hold.

Continuing further, the results of Hausman specification test (see in appendix) revealed that the difference in coefficients in our model is systematic, thus it was suggested to adopt fixed-effects model rather than random. One of the dominant characteristics of fixed-effects regression model is that it eliminates individual heterogeneity and separately examines both country and time effects (Gujarati, 2003). Nevertheless, there are several limitations of the model as well. Firstly, fixed-effects regression model does not capture the time-invariant and country-specific factors, because those are usually indicated as dummies (Borenstein *et al.*, 2009). Secondly, the problem of autocorrelation and heteroscedasticity, which mislead the estimates, are usually observable in panel with large set of countries and time frame. Moreover, the violation of assumption, that regressors should be independent from error term, is the important limitation of the model (Wooldrigde, 2008). However, in our model medical brain drain is considered to be an endogenous variable and the reversal causality of it with the health outcomes induce us to adopt another model which can cope with this issue.

b) The instrumental variable model

In order to overcome the problem of endogeneity, I utilized an instrumental variable two-stage least squares (2SLS) model to identify the effects of medical brain drain on health outcomes. In this approach, one exogenous variable (Z_{it}) determines one endogenous independent variable. In fact, sufficient amount of research (Newey and Powell, 2003; Baiocchi *et al.*, 2014; Imbens, 2014) conducted on the nature of instrumental variable model suggested that this instrument (Z_{it}) should be uncorrelated with the error term but strongly correlated with endogenous independent variable. It can be represented in the following equations:

$$(1) \quad MBD_{it}^* = \beta_0 + \beta_1 Z_{it} + \beta_2 X_{it} + \varepsilon_{it}$$

$$(2) \quad Y_{it} = \beta_0 + \beta_1 MBD_{it}^* + \beta_2 X_{it} + \mu_{it}$$

In those equations, X_{it} describes the set of all exogenous control variables, while MBD_{it}^* is the estimation of medical brain drain rate from variation in the instrument for country i and year t. This instrumented estimation of medical brain drain rate was utilized in the second stage of equation as an explanatory variable.

Analyzing 16 OECD destination countries, I determined that the United States of America (henceforth USA) was dominant in attracting foreign doctors and this considered to be a driving factor in increasing medical brain drain in developing Latin American countries. There were several reasons for such movement. One of them is the attractive immigration policy of USA in terms of recruiting skilled foreign labor force and benefits provided to those immigrants. In 1996, implementation of Illegal Immigration Reform and Immigrant Responsibility Act (IIRIRA) influenced negatively on immigration rate to USA as whole. It increased the number of border patrol agencies, introduced new controlling measures, decreased state benefits to immigrants, thus reducing the number of migrants. However, an important election occurred in 1997 in USA which was followed by structural and ideological changes in governmental authorities. In 1998, crucial policy The American Competitiveness and Workforce Improvement Act (henceforth ACWIA) was adopted by US government, which opened US doors to skilled immigration (Hahm, 2000). In fact, this policy was designed to encourage high-skilled immigration to USA through H-1B visa[3], the quota of which was increased from 65000 to 115000 each year. Moreover, the law increased the benefits provided for potential immigrants, relaxed restrictions on family reunification visas, and increased the accessibility of visas for foreign scholars and professors. Additionally, taking into account close geographical and continental location between Latin American countries and USA, these immigration policies created a strong incentive for foreign physicians to migrate. Most importantly, those attractive immigration policies are strongly correlated with the movement of skilled health personnel but uncorrelated with the health condition in Latin American nations from 1991-2004.

Therefore, in order to deal with the problem of endogeneity, I applied those findings and created an instrumental variable for ACWIA which is a dummy variable.

Table 2

	ACWIA
Before policy change (1991-1997)	0
After policy change (1998-2004)	1

According to table 2, the dummy variable takes the value of 1 after 1998, when USA adopted ACWIA act and thus created favorable immigration policy, otherwise it takes the value 0.

Finally, adopting this instrument I attempted to overcome the issue of reversal causality between dependent and key independent variables and to achieve the results with unbiased estimates.

I. Empirical results

This section exhibits the estimations of the linear equation which was conducted using three various models, namely OLS regression model, fixed effects panel regression model and instrumental variable approach using 2SLS regression analysis. The estimation of OLS model revealed that an increase in medical brain drain is negatively correlated with life expectancy, and positively with child mortality and prevalence of HIV. Although the results were as expected, OLS method was far from accuracy. Conversely, a fixed effect panel regression model depicted insignificant results which also confirmed the existence of reversal causality or endogeneity problem between medical brain drain and health outcome. As we discussed earlier, this issue forced us to deal with instrumental variable approach utilizing 2SLS regression analysis, which, finally, described that increase in medical brain drain is associated with a decrease in life expectancy, an increase in number of child deaths, and with an acceleration of HIV prevalence among population. The variations of estimated results of three different approaches are given below in details.

a) The basic OLS model

Firstly, I estimated OLS model for three health determinants, considering medical brain drain as a key independent variable. According to results provided in table 3, medical brain drain is statistically significant and correlated with all three health indicators, highlighting that 1% increase in medical brain drain reduce the life expectancy rate by 0,158 years. Following this, 1% increase in the key variable leads to a rise in number of child deaths by 0,011%, and increase the prevalence of HIV among population by 0,04%. Although majority of variables experienced statistically significant results, there were observed some exceptions such as GDP per capita, which was insignificant in terms of correlation with prevalence of HIV. Apart from this, some priori signs of control variables, specifically, GDP per capita, the number of children living with HIV were not as expected as well. Additionally, OLS model ignores the problem of endogeneity, which refers to the reversal causality between medical brain drain and health outcome and thus, reveals the inaccuracy of that approach.

Table 3. OLS estimations of medical brain drain effects on health indicators

	LIFE	lnCHILD_MOR	HIV_PREV
MBD	-0.158	0.011	0.040
	(9.79)***	(5.11)***	(12.97)***
lnGDPc	2.426	-0.215	0.011
	(5.43)***	(4.22)***	(0.39)
lnPOP	-2.621	1.191	-0.283
	(10.33)***	(35.54)***	(14.79)***
lnCHILD_HIV	1.134	-0.067	0.334
	(4.90)***	(2.16)**	(17.10)***
WATER	0.163	-0.024	-0.006
	(4.39)***	(4.65)***	(2.18)**
PHYSICIAN1000	1.341	-0.401	0.089
	(6.93)***	(12.54)***	(7.79)***
_cons	70.605	-5.431	2.966
	(29.35)***	(14.79)***	(8.77)***
R^2	0.77	0.93	0.94
N	252	252	252

Note: t stats in parenthesis * p<0.1; ** p<0.05; *** p<0.01

b) Fixed-effects regression model

As we discussed earlier, the outcomes of the Hausman specification test revealed that difference in coefficients in the model was systematic. Hence, it was suggested to adopt fixed effect regression model in our analysis. According to results displayed in table 4, medical brain drain showed insignificant correlation with the life expectancy and child mortality, describing that increase in the movement of skilled health personnel causes decrease in the number of child death who ages from 0-5. This contradicts our expectations, since theoretically decrease of skilled doctors in the country is associated with lower health quality, thus leading to increased number of child mortality (Chauvet et al., 2013). Additionally, the priori signs of some control variables such as the number of children living with HIV and physician density depicted unexpected and illogical outcomes. The R^2 of the regressions (0,87; 0,78; 0,5) describes that model is fit well and Gujarati (2003) claims that compared to cross-sectional and time-series data, R^2 of panel regressions is relatively lower. In fact, one of the concepts of Durbin-Wu-Hausman test is to detect endogenous regressors in a regression model. Hence, as other studies (Hahn *et al.*, 2011), (Amini *et al.*, 2012) also suggest rejecting null hypothesis in the test predicts that fixed effect model is preferred, which simultaneously confirms that there is a correlation between errors and the regressors in the model. Thus, it was required to conduct further analysis in order to overcome the problem of endogeneity between medical brain drain and health outcomes.

Table 4. Fixed-effects model estimations of medical brain drain effects on health indicators

	LIFE	lnCHILD_MOR	HIV_PREV
New_MBD	-0.014	-0.001	0.033
	(1.17)	(0.24)	(9.82)***
lnGDPc	2.311	-0.451	0.605
	(4.53)***	(4.80)***	(4.36)***
lnPOP	9.568	-1.022	-1.154
	(9.41)***	(5.46)***	(4.18)***
lnCHILD_HIV	0.714	-0.019	0.257
	(5.70)***	(0.81)	(7.57)***
WATER	0.061	-0.013	-0.000
	(3.18)***	(3.60)***	(0.01)
PHYSICIAN1000	0.576	-0.239	0.240
	(3.50)***	(7.88)***	(5.38)***
_cons	-114.463	30.907	12.052
	(7.65)***	(11.23)***	(2.97)***
R^2	0.87	0.78	0.50
N	252	252	252

Note: t stats in parenthesis * p<0.1; ** p<0.05; *** p<0.01

c) 2SLS Model: instrumental variable approach

Utilizing "American Competitiveness and Workforce Improvement Act" (ACWIA) asan instrument for medical brain drain in order to overcome the problem of endogeneity, estimated the causal impacts of medical brain drain on three health indicators, namely life expectancy, child mortality and HIV prevalence. As it was given in table 5, empirical results revealed that movement of skilled health staff significantly influences the health outcomes. It was estimated that 1% increase in medical brain drain rate leads to the reduction of life expectancy among population by 0,23 years. This result contradicts to the estimations conducted by Bhargava and Docquier (2008) who found no significant correlation between these two variables. At the same time, a percentage increase in the key variable is associated with an increase in child mortality and HIV prevalence as well (0,044% and 0,048% respectively). Likewise, similar results was observed in the studies of Serour (2009), who identified positive relationship with an increase of medical brain drain and HIV spreadness. In order to check the strength of the implemented instrument, I have conducted the first stage test (see in appendix), the large F-value (21,27) described that selected instrument is strong enough for instrumental variable approach. The value of R^2 ranging from 0,76 to 0,93 suggests that the model is fit well. Regarding to coefficients of control variables, comparing three different models, we can state that there were noticeable changes. For instance, the magnitude of MBD`s effect on life expectancy depicted a rise throughout the models (0,158 in OLS and 0,230 in 2SLS). The identical increasing magnitude occurred with other two health indicators as well and MBD reached its highest coefficients in instrumental variable method (0,044 and 0,048 respectively). Nonetheless, the coefficient of GDP per capita, when it was regressed with life expectancy, decreased from 2,426 in OLS to 2,146 in instrumental variable approach. Similarly, the slope of the variable - children living with HIV, with respect to Prevalence of HIV, reduced slightly from 0,334 in OLS to 0,257 in Fixed effects model and to 0,288 in 2SLS model. In contrast, the variable called "physician per 1000 people" experienced a gradual rise from 1,341 in OLS to 1,458 in instrumental variable regression model, when it was considered as a control variable for life expectancy. Summarizing the analysis, we can state that the instrumental variable method provides more accurate and reliable results compared to other models used in the research, since it described statistically significant outcomes with 1% significance level in almost all variables. Moreover, magnitudes of variables increased significantly throughout of three model estimations and signs of the majority of regressors were as theoretically expected. Finally, the instrumental variable approach managed to deal with the problem of endogeneity between medical brain drain and health outcome and the first stage test confirmed the strength of implemented instrument in the model.

Table 5. 2SLS estimations of medical brain drain effects on health indicators

	LIFE	*lnCHILD_MOR*	*HIV_PREV*
MBD	-0.230	0.044	0.048
	(3.61)***	(3.81)***	(7.66)***
lnGDPc	2.146	-0.085	0.041
	(4.12)***	(1.19)	(1.57)
lnPOP	-2.994	1.364	-0.242
	(8.15)***	(21.35)***	(8.05)***
lnCHILD_HIV	1.553	-0.260	0.288
	(3.98)***	(4.04)***	(8.40)***
WATER	0.152	-0.019	-0.005
	(3.93)***	(3.12)***	(1.44)
PHYSICIAN1000	1.458	-0.456	0.076
	(6.96)***	(11.74)***	(4.48)***
_cons	77.515	-8.618	2.210
	(12.22)***	(8.08)***	(3.98)***
R^2	0.76	0.89	0.93
N	252	252	252
F(1, 245)	21,27	21,27	21,27

Note: t stats in parenthesis * $p<0.1$; ** $p<0.05$; *** $p<0.01$

II. CONCLUSION

This paper attempted to investigate the relationship between medical brain drain and health outcomes and to evaluate the causal impacts of the former on several health indicators. Analyzing a compendium of academic literature, it was decided to conduct three different econometric models, namely OLS regression model, fixed-effects panel regression model and instrumental variable approach using two-stage least squares (2SLS) regression analysis. Moreover, a panel dataset of Bhargova and Docquier (2010) consisting of 18 Latin American developing countries was given main focus as a primary data and utilized in order to assess the effects of medical brain drain on three channels of health outcome (life expectancy, child mortality and prevalence of HIV). According to results, the estimation of OLS model revealed that an increase in medical brain drain is negatively correlated with life expectancy, and positively with child mortality and prevalence of HIV. However, the results obtained by OLS model were biased due to its limitations regarding the problem of endogeneity. Additionally, fixed- effects panel regression model depicted insignificant results which also confirmed the existence of reversal causality or endogeneity problem between medical brain drain and health outcomes. Therefore, instrumental variable approach of 2SLS model was utilized and, in fact, "American Competitiveness and Workforce Improvement Act" (ACWIA) was applied as an instrument for medical brain drain in order to overcome the problem of endogeneity. The final outcome of our analysis revealed that increase in medical brain drain is associated with a decrease in life expectancy, an increase in number of child deaths, and with an acceleration of HIV prevalence among population. Considering factors and results aforementioned, we can summarize that being a crucial issue in Latin America, higher rates of medical brain drain can affect negatively to both healthcare structure of the country and health condition of population. Therefore, not only local governments but also international authorities are required to devote special attention, so as to alleviate the issue.

III. POLICY IMPLICATIONS

As we discussed in the review of literature as well, this topic is no doubtcontroversial, thus, it is a challenging task to develop ideal policy suggestions. However, there are several options that are more or less straightforward in reducing the movement of skilled health personnel and improving health in Latin America.

From local perspective, sending countries should make more investments in human capital by creating sufficient facilities for education, healthcare systems and research analysis; encourage distant learning; focus on enhancing science and technology, so that push-factors for brain drain are neglected and make staying more attractive for local citizens. As Sinnott (2013) suggests further research should be conducted to determine what types of policy implications are efficient in keeping their physicians. For instance, would high salary make them less incentive to emigrate, or would they respond better to an improved health structure, medical technologies, advanced pharmaceuticals? One more recommendation for local states is that, government should establish recorded databases of intellectual students and specialists on the time of departure from the country of origin, so that these people can be kept in touch and receive full governmental support after their return.

Regarding international authorities, there are special organizations and charters, such as World Health Organization, Human Rights Councils and World Health Organization Global Code on the International Recruitment of Health Personnel, which must regulate the work of recruitment agencies in developed countries. For instance, Plotnikova (2012) pointed out that special regulatory policies and schemes should be established which obliges recruitment agencies of advanced nations to attract less doctors from poor developing countries or even limit for certain period. Another proposal to address the problem of brain drain is compensation payments by destination country to source country for each recruited health personnel. This might cover cost of education or at least assist local state to replace those emigrating labor force. Although not all damages through brain drain are compensable, these policies are expected to reduce rate of medical brain drain and thus, improve health condition in suffering regions.

IV. LIMITATION OF THE RESEARCH

Nevertheless, current research, which was designed to evaluate the impacts of movement of skilled physicians on health outcomes, have certain limitations as well. To begin with, lack of prior research studies on the topic was a main problem that I encountered. This made it somehow troublesome to understand the research problem and investigate its concepts. Nonetheless, this limitation served as an essential opportunity to identify new gaps and explore the topic from different perspectives. Another limitation of the study is the constraint in terms of time period. Due to shortage of data sources, I utilized time frame between 1991 and 2004. However, there might have occurred some structural changes after that period due to economic recessions, supply shocks, financial crisis and etc., which can also have significant impact on results. Thus, the research is restricted around time interval of 1991-2004 and unable to cover beyond that scope. The second shortcoming of the paper is that due to unavailability of data I was able to work only with 18 Latin American countries, whereas some countries such as Puerto Rico, Guadeloupe, French Guiana were missed from analysis. Continuing the issue of data deficiency, current research focuses only on three health indicators, namely child mortality, life expectancy and prevalence of HIV. However, it can also be extended by including other health indicators (maternal mortality, sexually transmitted infections incidence rate, medical literacy rate of the population). This allows the researcher to capture majority aspects of health outcome and individual effects of medical brain drain on those variables as well.

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