What Drives the Egyptian Brain Drain?: An Augmented Gravity Model

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THE PAPER ABSTRACT

This paper investigates the main determinants of the Egyptian brain drain using the augmented gravity model by a long run panel data of eight countries for the period of 1980 to 2013. The fixed effect estimation method is used to estimate the gravity model of migration. The results reveal that the two variables of the gravity model have positive and negative impacts on the Egyptian brain drain. These are compatible with the gravity model theory, but they are insignificant which means that their effects on the Egyptian brain drain are not considered as main factors of migration. However, economic and social factors, low wages and standard of living, spread of corruption and high unemployment rate in Egypt are the main factors of the Egyptian brain drain, as the results signify.

Keywords: migration; brain drain; long run panel data; augmented Gravity model; Egypt

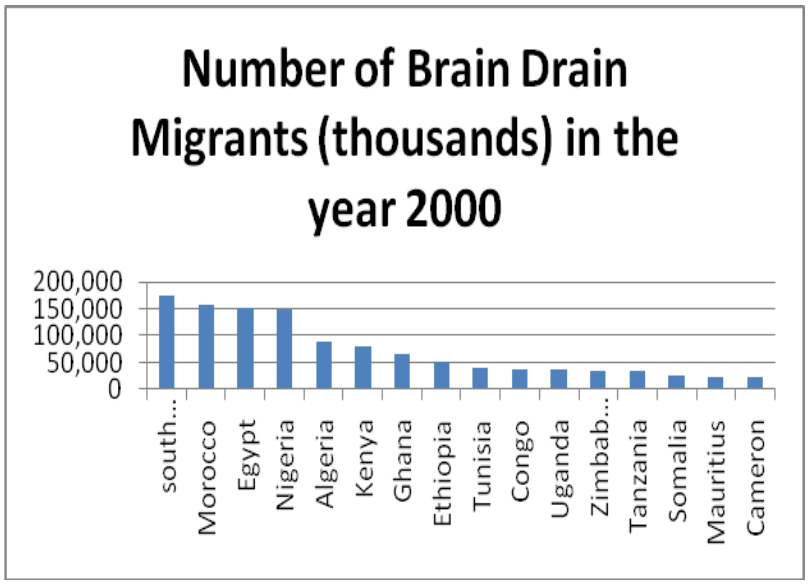
JEL Classification: F22 ; F24

1. INTRODUCTION

The term ‘brain drain’ was first coined by the British Royal Society in reference to a large exodus among scientists and technologists leaving the United Kingdom to settle in Canada and the United States during the 1950’s and 60’s. In economic terms, the phrase ‘brain drain’ denotes the transfer of human resources at an international level; transfers which tend to undergo some scrutiny within home countries. The use of the term ‘brain drain’ has been the subject of some controversy. For instance, **Hart, D. (2006)** prefers the use of the expression ‘high skill migration’ rather than ‘brain drain’ in order to refer to the migration of people with relatively high levels of skills and education who could make significant contributions to their own countries’ development process but decide to leave. However, differentiations between categories of highly skilled and low skilled workers are rather complex due to absence of a universal standard applicable to all countries regarding identifications of various groups of

workers. The reality is that all cases of migration do not entail similar levels of loss in terms of human capital. Recently, the issue of brain drain was more widely defined as the departure of highly educated people from one profession, geographic region or nation to another (**Wild, Wild and Han, 2010**); in other words, it is defined as the flow of human capital, specifically related to skilled individuals and tertiary graduates, moving out of a particular country (**Haylock, 2005**).

The migration of Egyptian brain drain to high-income countries is not a recent phenomenon. Egypt is considered the largest supplier of migrant labor in the Middle East and one of the largest emigrant populations in the world, estimated at 3.7 million in 2010 not including emigrants' descendants (**Tsourapas, G., 2015**). Over three-fifths of the current Egyptian migrants intend to stay in their current host country and only 18 percent intend to return to Egypt. The proportion intending to stay in the host country increases to 67 percent among Egyptian migrants in Europe and to 88 percent among those in North America (**Farid, S., and El-Batrawy, R., (2016)**.



Source: Hoba, P and Marfouk, A., (2011)."Why should we worry about brain drain from Africa", Journal of the European Higher education area, No. 4.

Figure (1) shows that highly skilled Egyptian migrants recorded 151,451 in 2000. There is doubt that brain drain affects the source countries badly. **Hoba and Marfouk (2011)** report that Cape Verde has lost 82% of its tertiary educated labor force because of emigration. This percentage recorded 77%, 68%, 49% and 45% in Seychelles, Gambia, Sierra Leone and Ghana. **Abdelbaki, H., (2009)** estimates the total losses and gains of the Egyptian brain drain during the period of 1998 to 2007. The estimation shows that the total losses increase from 12 billion Egyptian Pounds in 1998 to 20.4 billion Egyptian Pounds in 2004 and then 30.7 billion Egyptian Pounds in 2007. Whereas, the gains record 5.8, 9.7 and 14.6 billion Egyptian Pounds in the same years respectively. The challenges impacting Egypt in the face of Egyptian brain drain and residence of qualified Egyptians in different developed countries are prominent and substantial, especially

given the need to deliver on key economic reform and social development targets on one side and the expectation of increasing this problem because of the economic and political conditions after the Egyptian revolution in 25 January, 2011 (**Abdelbaki, H., 2013a, 2013b**). The main objectives of this paper are to investigate the main factors of the Egyptian brain drain, to examine the relative impact of factors on the Egyptian brain drain, and to assess the causality relationship among factors of brain drain and the Egyptian brain drain. The rest of the paper is organized as follows: section two is devoted to literature review to present advantages and disadvantages of brain drain for the source country and push and pull factors of brain drain and gravity model. Section three discusses the characteristics of the Egyptian brain drain by analyzing the educational status and destination countries of the Egyptian brain drain. Methodology of the paper to investigate the determinants of the Egyptian brain drain is discussed in section four. Section five shows the empirical results of the model. Finally, section six draws the conclusion of the paper.

2. LITERATURE REVIEW

Individual decisions to migrate are constrained by many different factors. As economic theory of migration shows, people migrate to achieve different tangible and intangible benefits. Literature has provided the reasons for emigration in two different methods; the first analyzed the motivation to migrate in regard to the benefits that the migrant expects to gain as reasons for leaving the home country and the second analyzed the expelling factors that led workers to leave their home countries and migrate to another country.

There has been a great deal of research on brain drain (e.g., **Carr et al., 2005; Docquier et al., 2007; Hart, 2006; Martineau et al., 2004; Oberoi & Lin, 2006; Rosenblatt & Sheaffer, 2001; Tansel & Gungor, 2003; Saint-Paul, 2004; Zweig, 2006**). Most of these studies are descriptive in nature.

2.1. Advantages and disadvantages of brain drain for the source countries

Many studies state the negative effects that skilled migrants tend to have on source countries; initially skilled migrant's contribution to the economy and his/her education being partly funded by taxes. The endogenous growth theory formulates the negative effects of the brain drain for home countries (**Miyagiwa, 1991; Haque and Kim, 1995; Wong and Yip, 1999**). Its more positive effects on the host countries become apparent in terms of human capital formation but also through the more dynamic impact it tends to have on economic growth and the overall development (**Mountford, 1997; Stark et al., 1997; Vidal, 1998; Beine et al., 2001 & Beine et al., 2008**).

Despite many case studies and subjective evidence, there is not a comprehensive and systematic study of the empirical assessment of brain drain and its economic impact. Results from international surveys considered migrants' levels of education state that the brain drain affects the stock of human capital of the home country, which affects the home country's capacity to develop if skilled emigration is not compensated by skilled immigration or by a stronger human capital accumulation (**Commander et al, 2004**). **Beine M., Docquier F., and Schiff M., (2006)**. By studying the determinants of brain drain from 189 small states, their findings report the usual inverted-U relationship between migration and GDP per head of origin countries. As the average GDP increases further, the income difference with the destination countries lowers, which leads to induce fewer people to migrate. Violation of property rights, political stability, and government effectiveness represented are also main determinants for brain drain in these small countries. **Abdelbaki (2009)** reports, for instance, that Egyptian losses from brain drain have several aspects, reflecting losses in economic welfare as measured by losses within the gross domestic product and as a consequence of non-migrant labor, representing only the direct loss from the brain drain. The migration of skilled labor also affects the Egyptian economy through the impact it tends to have on the national unskilled labor force. In other words, skilled labor has some positive impacts on unskilled labor, but workers' migration out of the national economy causes losses due to the reduction of productivity in the case of the remaining non-migrating labor, that is, a reduction of the marginal product from labor remaining within the economy. In addition, Egypt loses the value of all funds already invested in the education and health of migrants, the amount of tax revenues to be derived from all labor (in a

context with no migration), as well as the advantage to be gained from the role of its scientists whose expertise contributes to the formation of new generations of researchers. The benefits drawn by the 'destination country' from brain drain may translate as losses in the case of the 'expelling country'; losses affecting, among other things, the area of technical investigation and the field of scientific research, assuming that the country of origin is in a position to provide conditions for innovative work and levels of capabilities similar to those offered by the destination country.

In addition, other kinds of losses incurred need to be discussed, for instance, workers' remittance. Through the period 1990/91-2009/10, Egyptian remittances grew from 3775 to 9706 million USD at an annual average growth rate of 8.3%. In 2009/2010, the amount of Egyptian remittances was 9.7 million USD, 5.1% of Egyptian GDP. Seventy five percent of these flows come from five countries: the UK (50.9%), the USA (14.7%), Libya (3.5%), KSA (3.3%), and UAE (3.1%) (**MPC, 2013**). **Abdelbaki (2009)** considers that remittances from Egyptian migrants may be viewed as a kind of compensation that helps mitigate the negative impact of brain drain on Egypt itself. The flow of remittances from workers abroad tends to increase welfare and consumption styles for their families back home and thus potentially contributes to the alleviation of poverty levels. Such transfers of remittances may also contribute to the alleviation of public debt burdens, thus enabling the government to expel borrowing or current debt services without resorting to the adoption of any kind of policies of the recessionary kind for the Egyptian economy. One of the other advantages that may be drawn from brain drain is the incentive that high levels of migration may produce in home countries, pushing local governments to improve prevailing conditions (**Dugger, 2005**). **Farid, S., and El-Batrawy, R., (2016)** state that around 70 percent of the current Egyptian migrants send money to their households of origin. The Egyptian remittances are used for different purposes: 86 percent of households receiving remittance are using them for daily household needs, 44 percent are using remittances to pay for schooling costs; 30 percent are using them to pay for medical bills and only 12 percent are using remittances for savings and investments.

In a way, national decision-makers may enact legislation because they are led to perceive the political urgency to make changes. This tendency has become an increasingly popular

phenomenon as more and more governments are turning to their countries' diasporas, seeking to obtain their financial support. Other considerations need to be noted. Migrants living in developed countries may learn a number of specialized skills and acquire expertise and training that they would have probably forgone if they had remained in their home countries. This situation may therefore allow them to transfer part of their newly acquired skills and knowledge by sharing them with other workers back home. In this way, the 'Brain Drain' question acquires positive value, providing the context for the exercise of a sort of legitimate export industry (**Sanders, 2007**). It may thus be argued that migration of labor may allow for the transfer of knowledge and technology to parent countries. However, it is essential to recognize that most of the know-how and technological skills tend to be transferred in various forms through the means of international trade and foreign direct investments and, as such, would not necessarily be linked to the actual 'brain drain'. Moreover, labor migration movements from expelling countries can lead to increased employment opportunities for the remaining (non-migrating) labor force present within the local marketplace, an argument already made as part of aforementioned commentary within this study. Overall, labor migration plays a positive role as it allows the flow of direct foreign investments into the parent country; however it has also been argued that the inflow of such investments becomes contingent on a number of objective factors such as the national political, legal and economic stability. (**Abdelbaki, 2009**).

2.2. 'Push' and 'Pull' factors of brain drain

An important question needs to be raised regarding the specific issue of 'skilled labor': do labor expelling countries share any common characteristics? And, what are some of the most significant characteristics? In fact, the available economic literature has not fully addressed these questions. In other words, there has been no study so far identifying and analyzing those characteristics contributing to 'brain drain' from particular countries or the reasons why some countries attract highly skilled labor more than others. Despite this lack of data, many of the existing studies have already alluded to some of the defining characteristics through their examination of 'brain drain' phenomena or the wider topic of human migration more generally, for instance though discussions of the importance attached to migrants' remittances and other relevant concerns. We have attempted a listing of those common characteristics that drive labor,

especially skilled labor, to migrate from a particular location, by classifying them into three main categories that focus on economic, social and political factors. **First**; the economic expelling of brain drain which are (1) The low level of wages and the general living standards experienced by many employed university graduates whose earnings tend to fall below the fixed wages category as they undergo a gradual decrease or decline by contrast to salaries earned by members of other social groups and in relation to the continuous rise in prices that undermines their actual value (**Saad, H., 2005**). **Farid, S., and El-Batrawy, R., (2016)** analyze the determinants and consequences of international migration in Egypt using data collected in the 2013 Egypt Household International Migration Survey (Egypt-HIMS). They state that around 87 percent of total migrants for the first migration from Egypt migrated for economic reasons, 10 percent moved abroad for social reasons, and 3 percent for other reasons. The three most important economic motives for migration from Egypt are: to improve the standard of living, insufficient income in Egypt, and lack of employment opportunities. The three reasons are represented in the sample by 34%, 25%, and 12%, respectively. The important issue we want to mention here is the unemployment before migration is a more important reason for migration among highly skilled migrants (recorded 20%) than among migrants with low levels of education (recorded 5%). Low/insufficient income as a reason for migration is shown to be negatively association with the level of education being more important among those with a low level of education (recorded 30%) than among the highly skilled migrants (recorded 17%). These factors are the main reasons behind the lack of motivation for research and knowledge acquisition as many researchers face the dilemma of either taking on a second income generating job in order to improve their living standard or opting for migration. However, a low level of pay received in the source country is not always replaced by a higher paid job in the host country. So, considerations other than salary levels seem to matter, too. In her study about the motives behind brain drain in Malaysia, **Junaimah et al., (2009)** found that the quest for higher salaries but also access to various benefits programs and the need for international exposure are positively related to brain drain; (2) other aspects worth mentioning are linked to the lack of recognition and appreciation often experienced by scientists and researchers in their own societies; (3) the limited funding available for research activities; (4) the poor state of infrastructure pushing researchers to seek better equipment, funding and staffing within destination countries; (5) the absence of proper

conditions for the creation of an innovative climate of work, an issue considered being a motive causing 'brain drain' itself but also one of its consequences since it tends to adversely affect the native country of migrating researchers and impact positively on their destination country, as will be explained later.

Some other factors are used like exchange rate, remittances, and real wage in host countries (**Sulaimanova and Bostan, 2014**). **Second;** political reasons of expelling of brain drain which are (1) there is a general lack of appreciation by the local political regimes of highly skilled workers and scholars; (2) an unequal distribution of opportunities for social advancement; (3) An important problem has also been raised which is the violation of academic freedom in the case of university staff and researchers (**Horvat, V., 2004**). **Third**; social factors of expelling brain drain are: (1) in many cases, migrants who return home after a number of years spent living in more economically developed parts of the world tend to experience difficulties in re-adjusting to life back home, having been accustomed to different lifestyles within societies marked by different values and where respect for human dignity and the rule of order and discipline dominate. They find it relatively difficult to cope for instance with power failures, bad roads, poor health-care and conservative lifestyles within their home counties. In these cases, returning migrants who find it particularly hard to readjust to their original social environment, may quite often change their mind and return to the more developed country where they had previously resided to live there permanently; (2) difficulty integrating again when they return back to their home countries as a result of social and behavioral differences; (3) the rule of bureaucracy, routine, and centralization, and finally; (4) spread of corruption, charisma and nepotism.

2.3. Gravity model and brain drain

Gravity model was initially based on Newton's gravity law. **Tinbergen (1962)** first used the gravity model to study trade patterns, and then economists have consistently used it to explain relations and variables in international trade flows. Immigration is seen as an international trade influenced by attractive (pull and push) factors in home and host countries and impeded by the travel cost between the two countries. Gravity model is used to clarify that immigration between two countries depends on the difference between labor income and population size in the two

countries. Independently, they found that migration was from low-income and high-size of population countries to high-income and low-size of population countries. They found also that the stock and flow migration between two destinations assuming that the migration between countries depends on the distance between them (**Grogger and Hanson, 2011; Karemera et al, 2000; Kim and Cohen, 2010; among others**). The migration is expected to be a negative function of distance and a positive one to population size in both countries. The multiplicative gravity model in most empirical studies is transformed by taking natural logarithms (**Santos-Silva and Tenreyro, 2006 & Martinez-Zarzoso, 2013**).

Gravity model is used as well to estimate the potential future migration flows between different pairs of countries. To achieve this objective, authors carried out some scenarios which help in predicting migration flows in the future (**Kim, et al., 2010**). Although using gravity model for conducting these types of scenarios suffers from various limitations (**Ramos, R., 2016**). The main features of the model are that it can be used to conduct all types of data; and can be modified to include new variables as pull and push factors of migration, which is called augmented gravity model in literature. (**Volger & Rotte, 2000; Hatton & Williamson, 2002; Gallardo-Sejas et al., 2006; Mayda, 2010; and Ortega & Peri, 2013**).

From the aforementioned discussion, two main points are significant: first, there is no one specific theory that can analyze and determine the reasons of migration and second, comprehensive empirical study that investigates the two main determinants of migration: Motivations (pull factors) for migration and expelling factors that push the highly skilled laborers to leave their home countries (push factors) is still scarce, with few recent works using the gravity model to investigate the brain drain phenomenon. However, to the best of our knowledge, no study has ever empirically identified the determinants both pull and push, of the Egyptian brain drain. Hence, the current study intends to fill this gap.

3. CHARACTERISTICS OF THE EGYPTIAN BRAIN DRAIN

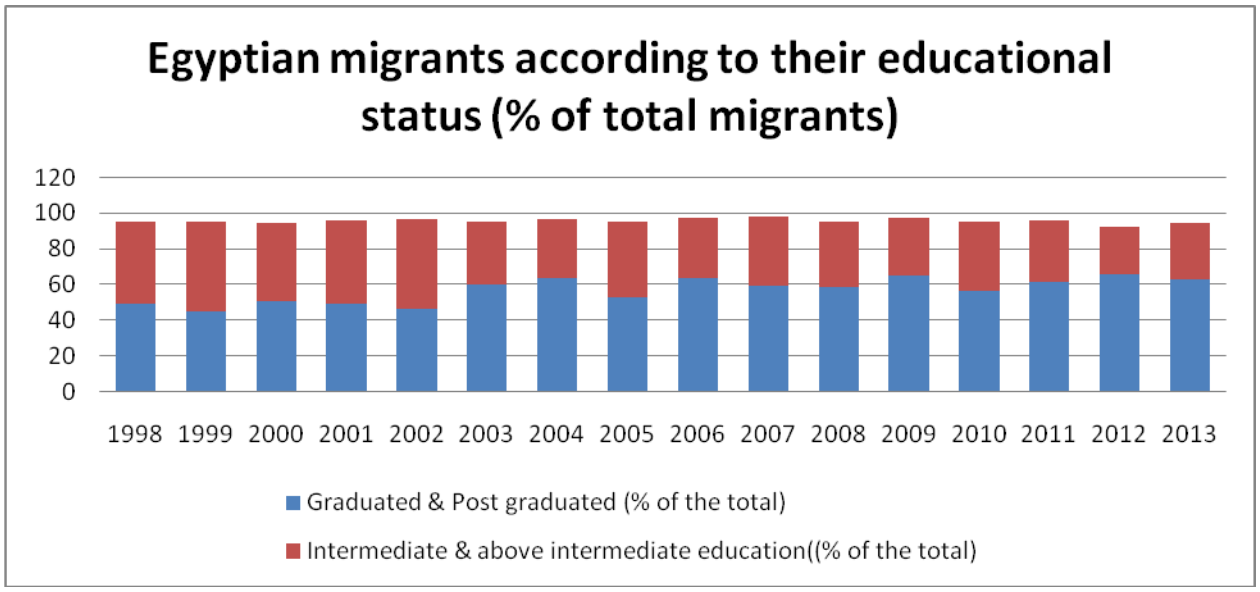
Bel-Air D. F. (2016) analyzes a profile for the Egyptian migration over time since the Abdel Nasser regime. The author states that Egypt is the largest migrant sending country in the region to date. As of late 2013, around 4.3 million Egyptians were living abroad. In Libya and Jordan, the main Egyptian workers are low skilled professional workers. In the Gulf States, the Egyptian

migrants are often employed in white-collar, skilled and semi-skilled technical fields. In Italy, the vast majority of Egyptian migrants are low skilled workers. In the US, the UK, and in general OECD, Egyptian migrants are often highly educated and skilled migrants. For instance, in 2006, 86.5% of total Egyptian migrants in OECD had a medium to high level of education, and 66.4% of them were employed in highly skilled occupations (**MPC, 2013**). Egyptian migration toward Arab countries is mainly involves low skilled workers. According to the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS), the proportion of tertiary educated Egyptians is living in Arab countries.

In this part, we present the characteristics and development of the Egyptian brain drain as follows:

3.1. Educational status

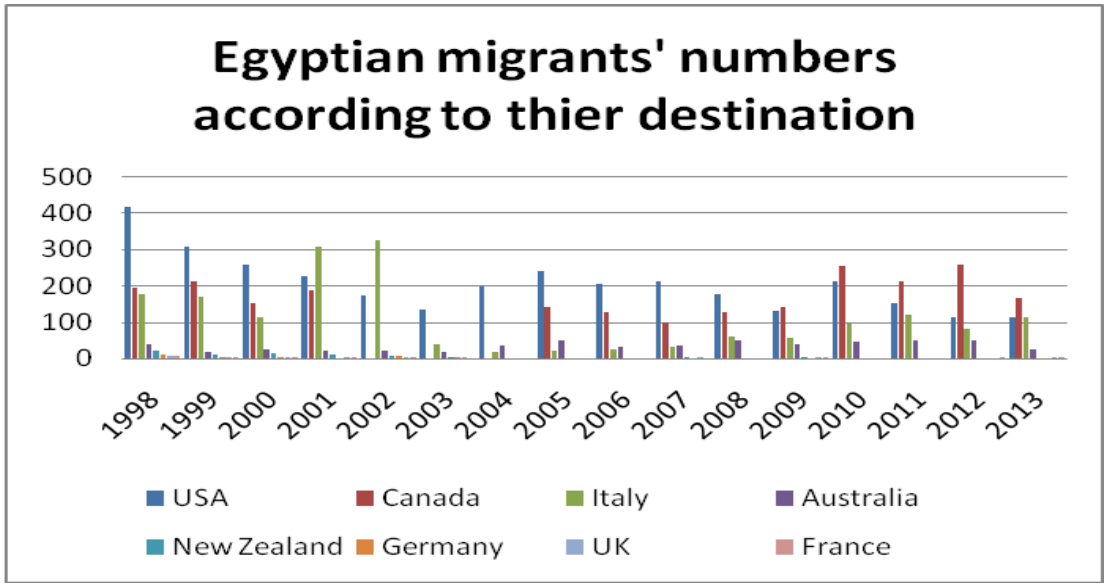
Figure (2) shows that the percentage of graduates and post-graduate graduates accounted for nearly half of all migrants, and more than half accounted in 2002, 2003, 2006 and 2007. Millions of Egyptian Pounds were expended without a doubt by Egypt to educate these individuals, and eventually they migrate and contribute to the development of other countries with their efforts and experience, and Egypt does not benefit from their training and expertise.



Source: CAPMAS, Statistical Yearly Book, different issues.

3.2. Destination country

Figure (3) shows that Egyptian brain drain is distributed among the United States by 30 per cent of the total Egyptian migrants in 2001 and 75 percent in 2004. Canada is second in attracting Egyptian labor, then Italy, Australia and other countries. The reason for the decline in the number of Egyptian migrants is the strong restrictions imposed by most countries after the events of September 11th in the United States.



Source: CAPMAS, Statistical Yearly Book, different issues.

4. METHODOLOGY

4.1. Dependent variables and data sources

This paper investigates the determinants of Egyptian brain drain to eight major destinations which are: USA, Canada, Italy, German, UK, France, Australia, and New Zealand over the period 1980-2013. The Egyptian brain drain in this paper refers to the sum of graduate and post-graduate Egyptian migrants during the considered period of time.

Based on previous studies of brain drain, we indicate that the most common factors that determine Egyptian brain drain are as follows: (1) low level of wages and general living standards. To capture these factors, the study uses a ratio of Egypt and destination country per capita GDP to reflect the difference in income in both Egypt and host countries; (2) lack of research infrastructure: the paper uses a ratio of Egypt and destination country research and development expenditure to GDP as a proxy of this variable; (3) unemployment rate; (4) level of corruption: Corruption Perceptions Index (CPI) is used to refer to the Egyptian and destination countries levels of perceived corruption. The CPI index is constructed with survey data to measure the perceived levels of public sector corruption in more than 170 countries (**Transparency International, 2014**); (5) economic instability: inflation rate is the most obvious measure of economic stability because fluctuations in prices distort consumer and producer decisions which lead to instability. However, we use in this paper an alternative measure, namely the exchange rate between the Egyptian pound and the destination country's currency. The main reason behind that is because the exchange rate responds more clearly to underlying macroeconomic situations than prices (**Satyanath and Subramanian, 2004**). Finally, we add two other variables to the aforementioned variables: the first is the distance between Egypt and the destination country, and the travelling cost is used as proxy of this variable; the second is the country's size and population in Egypt and the destination country is used to refer to this variable. The paper used annual data from 1980 to 2013 gathered from the World Bank (**World Bank, different years**) and Central Agency for Public Mobilization And Statistics (CAPMAS), Statistical Yearly Book (**CAPMAS, different issues**). The data on Corruption Perceptions Index (CPI) has been collected from the Transparency International (various reports). This index ranges from zero to six, with higher scores indicating lower corruption levels.

4.2. The Model structure

The basic form of the gravity model for brain drain function is as follows:

$$BD_{ij} = \mathrm{B}_0 \frac{(M_i)*(M_j)}{DIST_{ij}} \xi_{ij} \quad (1)$$

Where BD_{ij} is a brain drain from country j to destination country i, B_0 is a constant term, M_i is a factor to generate movement of brain drain, M_j is a factor to attract movement of international migration, and $DIST_{ij}$ is the distance between origin country j and destination country i. The equation of gravity model (1) can be expanded to accommodate other variables that generate and attract movement of brain drain which is called an augmented gravity model as follows:

$$BD_{ijt} = f(POP_{it}, POP_{jt}, TCOST_{ij}, PER_{ijt}, EXPE_{ijt}, UEM_{ijt}, CORR_{ijt}, EXCH_{ijt}) \quad (2)$$

Where BD_{ijt} is brain drain from Egypt to destination j in year t, POP_{it} is the population of Egypt in year t, POP_{jt} is the population of destination j in year t, $TCOST_{ij}$ is the travelling cost from Cairo to destination j , PER_{ijt} is a ratio of j to Egyptian per capita GDP in year t, $EXPE_{ijt}$ is a ratio of j to Egyptian expenditure on research and development to GDP in year t,is a UEM_{ijt} ratio of j to an unemployment rate in Egypt in year t, $CORR_{ijt}$ is a ratio of j to Egyptian corruption index in year t and $EXCH_{ijt}$ is the average exchange rate of Egyptian Pound and destination j currency in year t. The equation of augmented gravity model (2) can be rewritten in a linear form as follows:

$$BD_{ijt} = \mathrm{B}_2(POP_{it}.POP_{jt}) + \mathrm{B}_3 TCOST_{ij} + \mathrm{B}_4 PER_{ijt} + \mathrm{B}_5 EXPE_{ijt} + \mathrm{B}_6 UEM_{ijt} + \mathrm{B}_7 CORR_{ijt} + \mathrm{B}_8 EXCH_{ijt} + ENGj + \xi_t \quad (3)$$

Where $ENGj$ is a dummy variable which takes "1" if the main language of the destination country j is English and takes "0" otherwise. By taking logs, the gravity model of brain drain equation (3) takes the following form:

$$InBD_{ijt} = \mathrm{B}_2 In(POP_{it}.POP_{jt}) + \mathrm{B}_3 InTCOST_{ij} + \mathrm{B}_4 InPER_{ijt} + \mathrm{B}_5 InEXPE_{ijt} + \mathrm{B}_6 InUEM_{ijt} + \mathrm{B}_7 InCORR_{ijt} + \mathrm{B}_8 InEXCH_{ijt} + InENGj + \xi_t \quad (4)$$

To check if the correct specification is fixed effect or random effect (REM or FEM), we carried out a Hausman test. If Chi-Square statistic is significant at 5 per cent level, we reject the null hypothesis which states that no difference between fixed effect model and random effect model, which means we accept the alternative hypothesis i.e. there is a difference between the two models, then fixed effect is the most appropriate for the data. The result of Hausman's test well-matched with experience of using panel data which states that if the data is long term panel data, the fixed effect model is suitable to use whereas, the random effect model is suitable to use in the case of short term panel data (**Hill et al., 2012**). To introduce the fixed-effect approach, equation (4) is rewritten as follows:

$$InBD_{ijt} = \mathrm{B}_{1t} + \mathrm{B}_2 In(POP_{it}.POP_{jt}) + \mathrm{B}_3 InTCOST_{ij} + \mathrm{B}_4 InPER_{ijt} + \mathrm{B}_5 InEXPE_{ijt} + \mathrm{B}_6 InUEM_{ijt} + \mathrm{B}_7 InCORR_{ijt} + \mathrm{B}_8 InEXCH_{ijt} + InENGj + \xi_t \quad (5)$$

Fixed effect model suffers from heteroskedastcity and autocorrelation as problems of cross-section data and time series data. To avoid these problems, we used mean correct variables by using the deviation of each variable from its mean. The transformed model will be as follows: (**Hill et al., 2012**).

$$InB\overline{D}_{ijt} = \mathrm{B}_2 In(PO\overline{P}_{it}.PO\overline{P}_{jt}) + \mathrm{B}_3 InTCOS\overline{T}_{ij} + \mathrm{B}_4 InPE\overline{R}_{ijt} + \mathrm{B}_5 InEXPE\overline{E}_{ijt} + \mathrm{B}_6 InUE\overline{M}_{ijt} + \mathrm{B}_7 InCOR\overline{R}_{ijt} + \mathrm{B}_8 InEXC\overline{H}_{ijt} + InENGj + \overline{\xi}_t \quad (6)$$

The "tilde" notation in equation (6) ($B\overline{D}_{ijt} = BD_{ijt} - B\overline{D}_{\mathrm{I}}$) indicates that the variables are in deviation from the mean form. One main problem of fixed effect model is that it does not achieve the minimum variance i.e. it is not an efficient model. To correct this problem, we used White period (Robust standard errors) method.

Beside fixed effects, several econometric specifications of the dynamic panel are estimated, including OLS, Arellano and Bond GMM and VAR model. To examine the relative impact of independent variables on the Egyptian brain drain, we divided the period 1980–2013 into two time periods: the first from 1980 to 2009 and the second from 2010 to 2013 to investigate the impact of the January revolution on the Egyptian brain drain by estimating panel

VAR with the individual fixed effects. In matrix notation, the VAR model for m variables can be expressed by the following:

$$Y_t = A_1 Y_{t-1} + ... + A_s Y_{t-s} + U_t \quad (7)$$

where $Y_t = (Y_{1t,} Y_{2t,} ....., Y_{mt})$ and A_1, A_2, …, A_s are m × m matrix, Y_t = a m-dimensional vector of errors with $E(U_t) = 0$. In reducing form, the VAR model expressed as follows:

$$A\ L\ Y_t = U_t \quad (8)$$

where L = the lag operator, Y is a vector consisting of appropriately transformed variables, and U is a vector of innovations of these variables.

5. EMPIRICAL RESULTS

5.1. Results of *OLS, FE and GMM*

The important pull and push factors determining Egyptian brain drain to the major eight countries for the period of 1980 to 2013 is investigated using OLS, fixed effect least square dummy variable (LSDV) and GMM. Fixed effect and panel OLS results are approximately the same in the direct and the impact of the independent variables on the Egyptian brain drain during the considered period of time. The independent variables can explain (72%) and (77%) in the two estimators respectively. The model used is significant at 1% where F-statistics for both estimators are (34.7321) and (30.3725) respectively. For GMM results, the estimates are determined using Arellano-Bond GMM treating the instrument and the control of variables of population, geographical distance between Egypt and destination country, per capita GDP, expenditure on R&D, unemployment rate and exchange rate between Egypt, destination country, the destination country language dummy as endogenous and the dependent variable is the Egyptian brain drain. The Egyptian brain is motivated by many economic, social and political factors in both Egypt and destination countries. The two variables of the gravity model i.e. population and geographical distance between Egypt and destination countries have positive and negative relations with Egyptian brain drain respectively which are compatible with gravity model theory but they are insignificant which means that their effects on Egyptian brain drain are not considered as main factors of migration of Egyptian brain drain. The results show that all

other variables have significant and expected effects on Egyptian brain drain to the destination countries (table 1). Per capita GDP appears to be the main determinant and acts as both a pushing and a pulling factor of Egyptian brain drain. A high relative per capita GDP for the destination country encourages brain drain flows.

TABLE 1

OLS, FE and GMM results

Variable	Fixed effects	Panel OLS	Arellano-Bond GMM
POPi	0.435	0.411*	0.405
POPj	0.748	0.651*	0.559
TCOST	-1.54**	-0.43**	-0.56*
PER	4.531***	3.213***	3.726***
EXPE	14.361**	14.092**	12.108**
UEM	-10.436***	-11.760**	-10.218**
CORR	-6.932**	-5.854**	-5.207**
EXCH	21.048**	20.139***	19.753**
Constant	18.422***	18.027**	
R-squared	0.724	0.768	
Adjusted R-squared	0.632	0.714	
F-statistic	34.7321	30.3725	
Prob. F-statistic	0.0000	0.0001	
AB AR(1) test p-value			0.00
AB AR(2) test p-value			0.17
Sargan test			1.00
Observations	272	272	272

Notes: t-statistic values are in brackets. ***, **, and *indicate significance at the 1, 5, and 10% levels, respectively.

The higher relative expenditures on research and development in the destination country, the greater the Egyptian brain drain will be to that country. The estimated variable UEM indicates that the lower the relative unemployment rate of the destination country, the higher the rate of Egyptian brain drain to that country will be. Brain drain from Egypt increases with a decrease of the relative corruption index in the destination country to Egypt. The relative devaluation of the Egyptian Pound is found to exert a positive and significant impact on Egyptian brain drain to the particular destination country. Arellano-Bond (AB) test for AR(1) and AR(2) in first differences are rejected; this indicates that the error-terms are not serially correlated i.e. no autocorrelation between residuals. The Sargan tests' null hypothesis of over-identifying restrictions is not rejected.

5.2. Results of VAR Model

5.2.1. Variance Decomposition

Variance decompositions (VDCs) and impulse-response functions (IRFs) are conducted to investigate the relative strength of each factor in explaining the change(s) in the Egyptian brain drain and to explore the dynamic interaction among these factors. The VDCs enable us to examine the out-of sample causality among the variables in the VAR system. It measures the percentage of the forecast error of factor that is explained by another factor. Precisely, it indicates the relative impact that one variable has on another variable; at the same time, it provides information on how a variable of interest responds to shock(s) or innovation(s) in other variables. Thus, in our context, it allows us to investigate the relative importance of population, geographical distance between Egypt and destination country, per capita GDP, expenditure on R&D, unemployment rate and exchange rate between Egypt, destination country, the destination country language in accounting for variations in the Egyptian brain drain in the considered period of time. We employ the Sim's (1980) innovation accounting procedure to interpret economic implications from VDCs findings. The procedure includes the decomposition of forecast error variance of each variable into components attributable to its own innovations and to shocks of other variables in the system.

Table 2 reports the impact of the independent variables in the model on the Egyptian brain drain during the next 10 years in the two periods of time before the January revolution which is from 1980 to 2009 and after the January revolution which is from 2010 to 2013. The results state that per capita GDP is dominant in affecting the Egyptian brain drain in the short run. It records 18% and 32% in the first year before and after the January revolution respectively. On the other side, the table shows that in the long-run, the main factor influencing the Egyptian brain drain is the relative ratio of unemployment rate between Egypt and destination country during the period before the January revolution whereas per capita GDP came in the first rank in affecting the Egyptian brain drain size during the period after the financial crisis. the relative ratio of unemployment rate between Egypt and destination country came in the second rank in effecting the Egyptian brain drain in the short-run during the two periods before and after the January revolution.

Table 2

Period	PER		UEM		EXCH		CORR		EXPE	
	first	second	first	second	first	second	first	second	first	second
1	18.03647	32.13935	0.18939	9.112339	0.04914	0.002772	0.424188	0.244985	0.03251	0.001375
2	20.17372	41.88374	4.88637	6.071131	0.290482	0.019878	0.229304	0.117309	0.191367	0.020748
3	21.12192	36.63817	11.5814	4.529575	0.171547	0.145923	0.382574	0.794271	0.167340	0.132649
4	21.39834	37.05552	17.4049	3.533973	0.231757	0.251717	0.279433	0.584724	0.126501	0.246286
5	21.55633	39.00366	22.2306	2.937111	0.448176	0.392944	0.259501	0.527255	0.313945	0.380652
6	21.5981	39.80193	26.1024	2.487842	0.72903	0.382367	0.3253	0.423675	0.649021	0.395482
7	21.61828	40.37372	29.2126	2.238597	1.006989	0.378357	0.429121	0.360117	0.983262	0.384379
8	21.61788	41.02727	31.7287	2.024206	1.255357	0.379626	0.54107	0.322295	1.245820	0.384590
9	21.6139	41.52141	33.7889	1.857767	1.467607	0.367142	0.646228	0.286301	1.537498	0.373219
10	21.60679	41.8816	35.4963	1.727288	1.646138	0.35436	0.739833	0.257451	1.751086	0.364961

"First" refers to the first period from 1980 to 2009 whereas "second" refers to second period from 2010 to 2013.

Source:

5.2.2. Causality Relationship

One of the paper's objectives is to assess the causality relationship among Push' and 'Pull' factors of brain drain and the Egyptian brain drain. To do so, we construct Table 3 which is based on the panel Granger causality test. The results show that unidirectional causality exists from the relative corruption index, the relative devaluation of the Egyptian Pound and

the relative expenditures on research and development in the destination country to the Egyptian brain drain. The bidirectional causality has been found between per capita GDP and relative unemployment rate to the Egyptian brain drain. The results state that there is no evidence of a unidirectional or bidirectional causality relationship between population and distance between Egypt and the destination country in one side and the Egyptian brain drain on the other in both periods before and after the January revolution.

TABLE 3

	F-statistic		**Proba.**		**Result**	
Nill Hypothesis (H0)	***first***	***second***	***First***	***second***	***First***	***second***
PER does not Granger cause BD	3.476	2.349	0.016	0.031	Reject H_0	Reject H_0
BD does not Granger cause PER	2.249	2.831	0.023	0.028	Reject H_0	Reject H_0
UEM does not Granger cause BD	-3.354	-2.873	0.012	0.045	Reject H_0	Reject H_0
BD does not Granger cause UEM	3.549	4.228	0.002	0.012	Reject H_0	Reject H_0
CORR does not Granger cause BD	4.735	3.562	0.017	0.032	Reject H_0	Reject H_0
BD does not Granger cause CORR	2.054	3.258	0.238	0.316	Not reject H_0	Not reject H_0
EXCH does not Granger cause BD	5.584	4.651	0.025	0.042	Reject H_0	Reject H_0
BD does not Granger cause EXCH	2.037	1.958	0.422	0.518	Not reject H_0	Not reject H_0
EXPE does not Granger cause BD	4.647	3.851	0.032	0.046	Reject H_0	Reject H_0
BD does not Granger cause EXPE	3.172	2.749	0.527	0.621	Not reject H_0	Not reject H_0

"First" refers to the first period from 1980 to 2009 whereas "second" refers to second period from 2010 to 2013.

Source:

6. CONCLUSION AND POLICY IMPLICATIONS

The present paper applies the gravity model of migration to empirically investigate the determinants of Egyptian brain drain during the period 1980-2013. To estimate the gravity

model, fixed effects estimation method is used. The empirical results revealed that the main determining factors of Egyptian brain drain are per capita GDP, research and development expenditures to GDP as a proxy of research infrastructure, unemployment rate, corruption index, and exchange rate as a proxy of economic instability. Moreover, the two variables of the gravity model theory: population and distance between Egypt and destination countries. The results of the paper show that the crucial factor in the migration of Egyptian brain is low wage levels. Therefore, the wage scale and salaries paid to the Egyptian scientific brain should be reviewed radically. The government must provide them with all the means of comfort and decent living, enabling them to devote their time to research, which benefits the society as a whole. Providing the right climate for research and development (R & D) is a keystone in stopping brain drain by enabling researchers to identify the various knowledge sciences, scientific developments, information exchanges, ideas, studies, research, production, and authorship. All of these should be within the framework of ease and separated from the complexities and the abundance of legislation and complicated regulations and procedures.

In Egypt, government funding constitutes the largest share in research and development funding contributing 86% of total funding, while foreign financing contributes only 8% of total funding. In addition, the economic and financial problems facing the Egyptian economy lead to a decline in the percentage of expenditures on scientific researches in Egypt to represent only 0.4% of GDP, which is below the average of world expenditures on scientific research. The average per capita expenditure on scientific researches in Egypt is around LE 17 a year (**Abdelbaki, H., 2007**). This requires the adoption of a strategy aimed at sensitizing researchers and research centers to other non-government funding sources and educating them about ways to obtain external financing.

Corruption in Egypt has spread to all aspects of life, especially in the Mubarak Era (1981-2011). This has negatively affected production, productivity, distribution and other macroeconomic variables (**Abdelbaki, H., 2017**). Undoubtedly, the elimination of corruption involves justice in distribution and leads to a positive impact on production and productivity, ensuring that the competencies of the positions that enable them to support research, researchers, and the advancement of society as a whole. Combating corruption is crucial to the broader goal of achieving more effective progress and to halting Egyptian brain drain.

One of the important factors that cause the Egyptian brain drain, as stated by the results, is the unemployment rate among educated people in Egypt. Hence, the government must work to decrease this rate by enacting different policies.

Finally, the Egyptian government should benefit from the expertise of Egyptian workers abroad who work in the fields of research and technological studies to contribute to the development of inventions in accordance with the local conditions and to enable the development of Egyptian products to compete in international markets. At the same time, the Egyptian government should continue developing programs and methods of education to expand the use of multimedia to prepare new generations able to absorb information technology and employment in the service of development.

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