

## An Investigation of Brain Drain from Iran to OECD Countries Based on Gravity Model\*

Heshmatollah Asgari\*

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### Abstract

**B**rain drain as a migration of skilled and educated labor is an important issue from years ago and this is one of the critical matters with which the developing countries like Iran are engaged. So because of the importance of this subject in this study we have concentrated on investigating on causes of brain drain from Iran to 16 OECD countries since 1991 to 2004 based on gravity model. This research shows that the gravity mode is able to justify the causes of brain drain as a set of pull and push factors like population, geographical distance, real per capita income, unemployment, degree of economics openness', participation of private sector....

**Keywords:** Brain drain, Gravity Model, OECD countries, Iran.

### **1- Introduction**

Brain drain is one of the most important subjects which are a matter of study in developing countries. So the economists try to investigate the causes and effects of this phenomenon. Since, Iran is among the developing countries with high rate of brain drain so this study focus on it. The brain is a kind of potential wealth and drain is referred to the high rate of skilled labor migration. The combination of this words create a compound brain- drain which refer to high rate migration of talent individual from developing

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\* This Paper prepared for project of " An investigation of brain drain from Iran to OECD based on gravity model" in university of Ilam.

\* Assistant Professor in university of Ilam, faculty of Human Science –Iran.

countries to developed ones. In fact, Brain Drain is a kind of outflow of human capital by means of which the skill and knowledge is also moved.

Illustrating the determinant factors of brain drain is prior to studying of its effects. In most studies about the motives and sources of brain drain such as, Tai (1973), Portes (1979), Friedberg & Hunt (1995), Card (2001), Borjas (2003), Entezar (2005), Mishra (2006) and Ivan (2007), standard labor market model has been used but they didn't apply gravity model in their works. In this model the labors react to difference of wages.

Since from decades ago Iran was engaged with brain drain, so the focus of this study is on analysis of its most important determinants based on gravity model. This article is composed of some section: review of literature, illustration of the data, model and then estimation of model and analysis and evaluation of outcome.

## **2-review of literature**

The gravity model is a mathematical theory that can be used to predict the amount of interaction between two places, in relation to their distance apart. Gravity model has been succeeded in illustrating the different interregional and international migration of labor market migration, international trade and capital.

The gravity model first has been used by economist in bilateral trade analysis. According to it, the trade between countries  $i$  and  $j$  is a directly proportional to the scale of economics (GDP) and inversely proportional to geographical distance between two countries. Defining  $TRADE_{ij}$  as total trade between countries  $i$  and  $j$ ,  $GDP_i$  as gross domestic production of  $i$ ,  $GDP_j$  as gross domestic production of  $j$  and  $DIS_{ij}$  as the distance between two countries equally. So, the gravity model of trade is as follow:

$$TRADE_{ij} = f \left[ \frac{(GDP_i \cdot GDP_j)}{DIS_{ij}} \right] \quad (1)$$

Showing natural logs in lower case, the regression equation is commonly specified as:

$$trade_{ij} = a + a_1 (gdp_i \cdot gdp_j) + a_2 \cdot dis_{ij} + u_{ij} \quad (2)$$

Since, the countries are different in some matters such as; social, political and cultural condition therefore researchers who using the gravity model to explain trade often include variables to control for demographic, geographic, ethnic/ linguistic and economic conditions, as for example:

$$\begin{aligned} trade_{ij} = & a_0 + a_1 (gdp_i \cdot gdp_j) + a_2 \cdot pop_i \cdot pop_j + a_3 \cdot dis_{ij} \\ & + a_4 \cdot BLOC_{ij} + a_5 \cdot LANG_{ij} + a_6 \cdot CONT_{ij} + a_7 \cdot LINK_{ij} + u_{ij} \end{aligned} \quad (3)$$

In equation (3), BLOC, LANG, CONT, and LINK are dummy variables for pairs of countries that share membership in a free trade area, a common language, a contiguous border, and colonial links, respectively,  $POP_i$  and  $POP_j$  the log of the populations.

Brain drain, like international trade, is driven by the pull and pushes force between immigrant source and destination countries and inhibit by the costs of moving from one country to another. The labor market model of immigration suggests that the attractive force between immigrant source and destination countries depends on the difference between labor incomes in the two countries. Population size also matters; *ceteris paribus*, the more people there are in a source country, the more people are likely to migrate, and the larger the population in the destination country, the larger is the labor market for immigrants. Like trade, migration costs are likely to be correlated with the physical distance between countries. These considerations suggest the follow gravity equation:

$$BD_{ij} = a_0 + a_1 \cdot (pop_i \cdot pop_j) + a_2 \cdot incom_{ij} + a_3 \cdot dist_{ij} + u_{ij} \quad (4)$$

In which,  $BD_{ij}$  represent the log of brain drain to destination country i from source country j, and  $incom_{ij}$  is the ratio of destination to source country per capita incomes. The expected signs of the coefficients are  $a_1 > 0$ ,  $a_2 > 0$ , and  $a_3 < 0$ .

Like trade model, over and above factors, other factors are important such as membership in a free trade area, a common language, a neighboring border, and colonial links. It is obvious that immigration is larger, *ceteris paribus*, when the language and culture in the destination country is familiar.

Evidence also shows that brain drain larger; when countries have an adjacent border, and colonial links. These considerations suggest the augmented brain drain gravity equation for example:

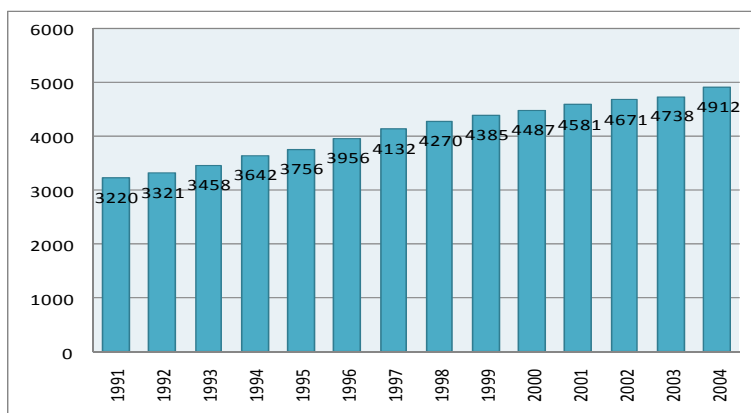
$$BD_{ij} = a_0 + a_1.(pop_i \cdot pop_j) + a_2.incom_{ij} + a_3.dist_{ij} + a_4.LANG_{ij} + a_5.CONT_{ij} + a_6.LINK_{ij} + u_{ij} \quad (5)$$

The adjusted version of this model which will be illustrated later on will be used in this study.

### 3-Trend of brain drain from Iran

One of the important dataset of brain drain provided by Alok Bhargava and Frédéric Docquier (2007). This dataset is a part of the International Migration and Development Program World Bank. According to this dataset, the brain drain to one country is defined by stock of physicians abroad as percent of physicians trained in their country. This dataset contain, brain drain from 192 developing countries to 16 OECD countries. Generally, this dataset is used as a proxy for brain drain.

There are two indexes for brain drain analysis. First index is total stock of skilled labor (physicians) abroad. Based on this index, figure 1 shows that brain drain from Iran to OECD for period 1991 – 2004.



**Figure 1: Brain Drain from Iran in Period 1991 to 2004**

It shows that the trend of brain drain from Iran to OECD countries was always increasing during 1991 – 2004, in a way that it has increased from 3220 in 1991 to 4912 in 2004. In other words, in this period, brain drain growth from Iran was equal to 50%.

United state was the most important country among destination countries which brain drain from Iran took place. Evidence shows that before the Iranian revolution and during the war, most of skilled labor have migrated to U.S. advantages for choosing U.S as a target country are, close political relationship between Iran and U.S ,ease of transportation, free trade between these countries and possibility of education for Iranian students.

About 2 million persons had migrated form Iran to U.S from 1977 to 1982. After war in 1979, political relationship between Iran and U.S had been break down and migration to U.S became limited. So, Iranian emigrant changed their destination toward the Europeans countries. They accept the Iranian emigrants with pleasure because the growth rate of their population was low and they were encountered with the shortage of skilled labor.

The second index of brain drain is the rate of brain drain which is shown below:

$$BD_{i,t}^h = \frac{M_{i,t}^h}{N_{i,t}^h + M_{i,t}^h} \equiv \left( \frac{\sum M_{i,t}^s}{\sum_S N_{i,t}^s + M_{i,t}^s} \right) \left( \frac{\frac{M_{i,t}^h}{\sum M_{i,t}^s}}{\frac{N_{i,t}^h + M_{i,t}^h}{\sum N_{i,t}^s + M_{i,t}^s}} \right) \quad (6)$$

In which,  $BD_{ij}^h$  rate of brain drain from i,  $M_{i,t}^s$  number of skilled labor emigrant,  $s$  degree of skill ( $s = h$  for high skill and  $s = l$  for low skill) and  $N_{i,t}^s$  is the number of skill labor resident in i country.

In table 1 report the rate of Iranian brain drains based on education attainment according to (6). This report is just for 1990 and 2000.

**Table 1: The Rate of Brain Drain from Iran in 1990 and 2000**

Year		1990				2000			
Educational attainment		low	Average	High	Total	Low	Average	High	Total
Brain drain from	Iran (in %)	0.49	1.93	25.26	1.7	0.50	2	14.5	1.9
	World (in %)	1.1	1.8	5.4	1.8	1.2	1.4	5	1.6
Brain drain to	Iran(in thousand)	80.7	78.2	204.2	362.2	89.7	129.1	308.7	527.6
	world(in thousand)	18804	10579	12461.5	41844	21511	17107	20403	59022
	% of world	0.43	0.74	1.64	0.87	0.42	0.75	1.51	0.89

Source: world Bank dataset on international migration

As table 1 show, as a whole the rate of brain drain from Iran in 1990 was 1.7 percent which increased to 1.9 percent in 2000. Although the rate of Iranian brain drain was less than world average rate of brain drain (1.8 percent) in 1990, but it rose higher than world average rate (1.6 percent) of brain drain in 2000.

In this period, U.S.A and Germany are two countries which absorbed most of Iranian skilled labor. The average rate of brain drain from Iran to U.S.A and Germany was 0.086 and 0.029 respectively.

#### 4-Econometric Model Specification

In order to determine the important effective factors on brain drain , equation 5 was used and adjusts it by other pull and push factors. Therefore regression model 7 is specified as follow:

$$\log BD_{ijt} = \beta_0 + \beta_1 (\log pop_{it} \cdot \log pop_{jt}) + \beta_2 dist_{ij} + \beta_3 \log(un_{ijt}) + \beta_4 \log(privat_{ij}) + \beta_5 \log(incom_{ijt}) + \beta_6 \log(open_{ijt}) + \beta_7 \cdot dum_{ij} + \gamma_{ij} + u \quad (7)$$

In the regression model (7), each variable is bilateral in that it applies to both countries i and j. In which, i is Iran, j is destination countries,  $BD_{ijt}$  is brain drain from Iran to j in year t,  $pop_{it}$  is population of Iran in year t,  $pop_{jt}$  is population of destination countries in year t,  $dist_{ij}$  is geographical distance between Tehran and capital destination countries,  $un_{ijt}$  is the ratio of j to i country unemployment,  $open_{ijt}$  is the ratio of j to i country of economic openness,  $incom_{ijt}$  is the ratio of j to i country real per capita income based on purchasing power parity(PPP),  $privat_{ij}$  is the ratio of j to i

country private investment as a percent of GDP and  $dum_{ij}$  is dummy variable in order to show the Iran's different political relationship with destination countries. As equation 4, the expected sign of the coefficient is  $\beta_1 > 0$ . Expected signs of the other coefficients are as follow:

$\beta_2 < 0$ , because, as geographical distance increase, the cost of migration and adjustment with new residential place also increased.

$\beta_3 < 0$ , because, when  $un_{ij}$  increases the cost of job seeking also increase. As a consequence the cost of migration raised and brain drain reduces.

$\beta_4 > 0$ , because the possibility of employment, making short run contracts and level of wages in private sector is higher than public sector therefore as private sector investment in destination countries increased brain drain from source country reduced.

$\beta_5 > 0$  Because, when relative per capita income in destination countries increased brain drain from source country also increased.

And  $\beta_6 > 0$  because, the high level of economics openness in destination countries is related to increase brain drain.

Since the Iranian political relationship with some of the destination countries is worse therefore the expected sign of  $\beta_7$  is positive.

In this study, the destinations are 16 OECD countries and since these OECDs haven't any cultural, linguistics, contiguous border and political relationship in common with Iran, therefore the dummy variables BLOC, LANG, CONT, and LINK didn't used in model.

$\gamma_{ij}$  Refer to fixed effects of other local differences between Iran and OECD countries.

## 5-Model Estimation

Brain drains data obtained from World Bank dataset<sup>1</sup>, and other factors like populations, real per capita income, and private investment as a percent of GDP, degree of economic openness (trade percent of GDP) of Iran and OECD countries got from world development indicator (WDI). And geographical distance data get from distance calculator site<sup>2</sup>.

Because the used variables are real and relative and also the time horizon is limited therefore unit root test of variables isn't necessary.

1- By Alok Bhargava and Frédéric Docquier (2007).

2- <http://distancecalculator.globefeed.com>

**96/ An Investigation of Brain Drain from Iran to OECD Countries...**

Table 2 reports the estimates of gravity regression (7) using panel data on total brain drain to each of 16 OECD destination countries from Iran for the ten years 1991–2000.

This model is able to explain 99 percent of brain drain mutation from Iran. Statistics which show the general signification of regression is relatively high and in statistical significance at 5% it justify the regression general significant. In addition  $R^2$  and  $\bar{R}^2$  statistics are very high and close to each other which indicate proper specification of regression model. Dorbin Watson statistics also refer to no autocorrelation between residuals.

**Table 2: Results from the Pooled Least Squares**

Dependent Variable: $\log(BD_{ij})$ sample:1991-2004			
Variable	Coefficient	t-Statistic	Prob
$\beta_1$	-22.88	-17.1	0.00
$\beta_2$	0.785	20.45	0.00
$\beta_3$	-0.008	-4.08	0.00
$\beta_4$	-0.028	-3.18	0.00
$\beta_5$	0.259	6.04	0.00
$\beta_6$	0.002	2.38	0.00
$\beta_7$	0.006	6.8	0.00
<b>R-squared</b>	<b>0.999</b>	<b>F-statistic</b>	<b>108770</b>
<b>Adjusted R-squared</b>	<b>0.999</b>	<b>Durbin-Watson stat</b>	<b>1.87</b>
Fixed Effects			
IRAN-US	1.021	IRAN-Australia	0.618
IRAN-UK	0.255	IRAN-Ireland	-2.664
IRAN-Canada	0.282	IRAN-Portugal	-3.562
IRAN-France	-1.177	IRAN-Italy	-0.316
IRAN-Germany	2.101	IRAN-Sweden	2.849
IRAN-Belgium	0.442	IRAN-Switzerland	-0.218
IRAN-Denmark	-0.960	IRAN-Austria	2.567
IRAN- New Zealand	-0.971	IRAN-Norway	-0.390



The result shows that all variables in general have significant and expected effects on brain drains from Iran to OECD.

There is a significant positive relation between population and the brain drain of source and destinations countries which is compatible with gravity model theory. Besides geographical distance between Iran and OECD which indicate migration cost, has a significant negative effect on brain drain from Iran which is also according to theory as we expect. So based on this estimation brain drain from Iran will be increased if real per capita in OECD in comparison with Iran raised. Also we find a significant negative relation between relative unemployment rate in OECD and brain drain from Iran, and a significant positive relation between relative private sector investment in OECD and brain drain from Iran.

In this model, dummy variable is significant which means that the relationship between Iran –U.S and U.K is different from other OECD countries.

In general we can conclude that, the brain drain causes from Iran can be justified based on gravity model and the set of pull and push factors such as population size, geographical distance, per capita income, and unemployment rate, the degree of economic openness and participation of private sectors are among the most important factors which can explain brain drain from Iran to OECD countries.

## **6-Conclusions**

In this study we have tried to investigate most important factors which affect brain drain from Iran to 16 OECD countries in 1991 to 2000 based on gravity model. So an econometrics model of gravity was introduced, estimated and investigated. The outcome of this research shows that the causes of brain drain from Iran can be justified based on gravity model and a set of pull and push factors like as population size, geographical distance, per capita income, and unemployment rate, the degree of economic openness and participation of private sectors.

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