

# Why is Iran Experiencing Migration and Brain Drain to Canada?

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## Abstract

*Determining the driving factors of migration and brain drain helps Iranian policy makers to prevent migration and brain drain. This study considers two models of migration and brain drain from Iran to Canada. Variables include the number of educated and non-educated migrants, real Iranian National Income, the number of university students, the number of newspapers and periodicals, regime changes and war, and the Canadian unemployment rate from 1970 to 2000. The results of applying a Vector Autoregressive approach support the notion that lagged values of brain drain and migration are major driving factors of migration and brain drain from Iran to Canada.*

## Introduction

This paper investigates the driving factors of migration and brain drain<sup>2</sup> from Iran to Canada over 1970-2000.<sup>3</sup> Iran's upward trends of migration and brain drain (MBD) over this period<sup>4</sup> have aroused a lot of concern among Iranian policy makers. The Iran Daily on Sat, Jan 22, 2005 points out that Iran has highest rate of brain drain among 61 developing countries according to the International Monetary Fund (IMF). They argue that the Iranian government spends a lot of money on education and training programs,

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<sup>2</sup> Brain drain refers to educated people who leave their home-country toward host countries

<sup>3</sup> This is the earliest time that Iranian data are available.

<sup>4</sup> See figures (a) and (b) in figure 1

and every year a lot of these educated Iranians leave their home country. These people represent human capital in the Iranian economy and their leaving causes a loss for the country. Without educated people, the economic growth of Iran will be hindered.

Part of the MBD from Iran is directed at Canada. According to *Citizenship and Immigration Canada*, Iran has consistently been one of the top ten source countries for immigrants to Canada from 1998 to 2003.<sup>5</sup> Since I do not have access to data on the total number of Iranian migrants to the world, except for Canada, this study considers the large number of migrants to Canada as a proxy for the number of Iranian migrants to the world.

There are few studies on the socioeconomic factors which motivate MBD from source countries like Iran. Most of the literature considers host countries like Australia, Canada, New Zealand, and the United States,<sup>6</sup> which can be related to the availability of data on immigration and brain drain in these countries.<sup>7</sup> This shortcoming of studies on source countries in the literature is unfortunate, since such studies could allow the policy makers in source countries like Iran to reduce MBD as well as the consequent losses.

This paper is an empirical study on MBD from Iran to Canada and it shows why Iran is experiencing MBD to Canada over 1970-2000. Iran is a country of 64 million people but Canada had 32 million people (2005). From 1976 to 1991 Iran's population grew at an annual rate of 3.4% or from 34 million to 56 million individuals and experienced a baby boom in the 1980s.<sup>8</sup> Canada's population in contrast, grew 1% annually from 1976 to 1991.<sup>9</sup> After 1991 population growth in Iran has declined dramatically and in 2004 the population growth rate was 1.2%.<sup>10</sup> While the population growth rate has been reduced, the economy still struggles with the baby boomers' influence on the economy, such as a high unemployment rate.<sup>11</sup> Life expectancy in Iran has been improved from 56 years in 1970 to 69 years in 2004,<sup>12</sup> but life expectancy in

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<sup>5</sup> Table one in appendix

<sup>6</sup> They are the biggest host countries in the world.

<sup>7</sup> Some of these works on Canada are Marr (1973), Green (1976) and Marr and Syklos (1995).

<sup>8</sup> United Nation's World Population Prospect: 2002 Review.

<sup>9</sup> Table number 510001, CANSIM in Statistics Canada.

<sup>10</sup> United Nation's World Population Prospect: 2002 Review.

<sup>11</sup> 2003 United Nation Common Country Assessment of Iran's development.

<sup>12</sup> Yvett Collymore, Sep 2004, "Iran Faces Pressure to Provide Jobs, Address Health Disparities", in Population Preference Bureau, [www.prb.org](http://www.prb.org).

Canada in 2004 was 79 years.<sup>13</sup> Over the period 1970 to 2000 Iran experienced a revolution in 1978, the Iraq-Iran war lasting from 1980 to 1989, and a regime change from conservatives to liberals after the election in 1996. The Revolution impeded economic growth for a while. The war absorbed most of the resources in the economy and hindered economic growth as well. The liberals' taking office in 1996 opened some room for professional economic performance that has led to better growth. Furthermore, the National Income growth rate was 5%<sup>14</sup> on average, and the inflation rate according to the CPI index of the Central Bank of Islamic Republic of Iran<sup>15</sup> was 14.33% on average from 1970 to 2000. Conversely, Canada has had a 4% National Income growth rate, 4.22% unemployment rate, and 5% inflation on average from 1970 to 2000. Actually, Canada has experienced fair stability in its economic conditions over this period compared to Iran. A quick review of these indicators shows that Canada has had much better economic conditions than Iran in the time period investigated, which could be a good driving factor for Iranian migration to Canada.

There are many factors that could drive MBD from Iran: Instability in the Iranian economic condition and regime change shocks, the level of education, the level of democracy, the distribution of household income, the level of investment in Research and Development, the existence of friends and family in a host country, and the level of salary and the unemployment rate. Although all of these variables are necessary to be considered for this analysis, I can not consider all of them in this study due to the limited access to Iranian data. I therefore narrow down my study to the limited number of variables which are available in Iranian statistical sources or for which it is possible to find a proper proxy variable. The methodologies that I use in this study are two time-series methods: the Vector Autoregressive approach (VAR) and OLS. There are some precedents for these choices. Marr and Siklos (1995) used VAR model to explore the relation between immigration and unemployment in Canada as host country from 1920. They found that immigration and unemployment are inversely related. Kelly (1965) used OLS to compare annual net immigration with unemployment rates in Britain as source country and Australia as host country over 1865-1935. He found that only number of

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<sup>13</sup> Population Reference Bureau 2004 world population data sheet

<sup>14</sup> Statistical Center of Iran in [www.sci.org.ir](http://www.sci.org.ir)

<sup>15</sup> [www.cbi.ir](http://www.cbi.ir)

migrants in previous years and lagged unemployment rate of Australia are the driving factors of immigration to Australia.

The framework of this paper is as follows:

Section one analyzes MBD in theory and literature, Section two discusses the two time series models that are used in this study, Section three contains data analysis, Section four estimates the models of section two, and Section five has concluding remarks as well as suggestions for Iranian policy makers.

## **1. Migration and brain drain in theory and literature**

Analyzing the effect of MBD on the economy is as important as finding the driving factors of them. One of the effects of MBD on the economy is their effect on labour markets via their effects on labour supply. Economic theory suggests that MBD leads to a decrease in the labour supply, an increase in the wage level, and a decrease in the employment level in the source country. The point of brain drain is that a host country selects immigrants based on their occupational skills. As a result, a shortage in these skills may happen in the source country. MBD may also cause the labour demand curve to shift down in the source country, since there are fewer people who buy goods and services. The decrease in the demand for labour as a result of MBD also changes the wage and the employment level. The exact outcome depends on the amount by which labour supply and demand shift as well as their elasticities. Since it is not possible to observe what labour market conditions would be in the absence of MBD, estimating the impact of MBD on the labour market is difficult.

It is even more difficult to determine what the impact of MBD on growth might be. Factors such as the loss of human capital have to be weighed against positive demands such as remittances to the home country and possible increased trade. As with labour market, a large degree of endogeneity is also a problem.

On the issue of finding the driving factors of migration in source countries, there are only a few studies in the literature, and they do not include Iran. As a result, I review studies on MBD in Canada, since Canada can be counted as both a source and a host country and I am considering Iranian migration to Canada.

Marr and Syklos (1995) explore the relation between immigration and unemployment at a national level in Canada for both quarterly and yearly data since 1920 based on the vector autoregressive approach. They find that immigration and the unemployment rate are inversely related.<sup>16</sup> Kelly (1965) applies OLS to find the reasons of fluctuations in the number of migrants from Britain as source country to Australia as host country over 1865-1935. He uses the lagged unemployment rate of Australia and the lagged number of migrants as the driving factors of migration. He finds that the lagged number of migrants has a positive effect on the number of migrants, and the lagged Australian unemployment rate has a negative effect on the number of immigrants.

Brain drain has also been addressed in the literature. Brain drain as an interesting issue in migration was mentioned for the first time in the early 1960s.<sup>17</sup> Brain drain refers to educated people who leave their home-country toward host countries which selectively accept professional immigrants. The migration of skilled workers is of great concern for developing countries, since these professionals represent human capital which is required for higher growth rates and higher standards of living.

In order to measure brain drain, detailed statistical information on the occupational, educational, age and sex composition of migrants from source countries is required. Having access to such data is not easy because migration from source countries is unrestricted and governments often do not keep track of people who leave the country. In the literature, different authors find different ways for estimating brain drain. Grubel and Scott (1966) compute an index for brain drain by analyzing the immigration of scientists and engineers to the U.S from 1949 to 1961. Carrington and Detragiache (1998) use a two-step procedure to measure brain drain based on OECD<sup>18</sup> countries as host countries and 61 developing countries as source countries, with Iran among them. Their result on Iran shows that the Islamic Republic of Iran experienced substantial Brain drain to the U.S and other OECD countries in 1990. Since I could not get access to Iranian data, I am not able to apply these methods to estimate the brain drain of Iran. I will consider the number of Iranian migrants to Canada who had jobs in Iran that in Iran require a university degree as a measure of brain drain in this study.

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<sup>16</sup> This is the paper that I consider as the base for my analysis in Iran.

<sup>17</sup> See Kwok and Leland (1982)

<sup>18</sup> Organization for Economic Cooperation and Development

Empirical studies in the literature on brain drain for the perspective of source countries are limited, and I did not find any study on Iran. As a result, in this paper I try to fill this gap in literature by analyzing the brain drain issue and its driving factors in Iran.

## 2. The model

This section explains the methodology and the model for finding the reasons of MBD from Iran to Canada. The methodologies that I apply are VAR and OLS. VAR analysis has been introduced to economics by Sims' work (1980). Sims says that in the presence of economic shocks, a VAR approach as an alternative to a structural approach can be applied in order to incorporate the variability of coefficients under different shocks. In addition, when endogenous variables appear on both sides of the equation, estimations and inferences are complicated in structural models and VAR can give an easier solution.<sup>19</sup> In my study there are periods of regime change as economic shocks, and since the model is a macroeconomic model there are interactions among variables in a way that dependent variables appear on both side. Therefore I apply VAR technique to this study.

A multivariate VAR model is a system of  $k$  linear time-series equations with  $k$  variables that each of these variables are explained by their own lagged values and the current and lagged values of the other variables. The mathematical form of the VAR can be written as follows:<sup>20</sup>

$$Y_t = A_1 Y_{t-1} + \dots + A_p Y_{t-p} + B_1 X_t + U_t \quad (2)$$

Where  $Y_t' = (y_{1t}, y_{2t}, \dots, y_{kt})$  and  $A_1, A_2, \dots, A_p$  are  $k \times k$  matrices of coefficients,  $X_t$  is a vector of exogenous variables and  $U_t$  is a  $k$ -dimensional vector of innovations. According to Sims, the reason of having lagged variables in the model is that economic behaviour not only depends on the current variables but also depends on what has happened so there are lagged dependent variables in the model. In order to decide on the number of lags I apply Akaike and Schwarz criterions.<sup>21</sup>

<sup>19</sup> Eviews manual in section "Vector Autoregression".

<sup>20</sup> Maddala and Kim(2002) page34

<sup>21</sup> Greene (2003) page 159-160

VAR approach has identification problem so the causation and correlation is not clear in this model. Based on Sims' paper (1980) the solution is estimating the unrestricted reduced form VAR with OLS approach instead. I have applied this issue into this study on MBD. Sims believes that analysing the coefficients in the regression equations of VAR is difficult. The estimated coefficients on successive lags oscillate and there are cross equation feed backs. The best way to analyze this system in his point of view is analyzing the impulse response functions (IRF) of variables as well as variance decomposition (VD). IRF shows how a shock has effect on the future or current course of the variables. Sims continues that typical shocks are positive residuals of one standard deviation unit in each equation of the system. The VD decomposes variation in an endogenous variable into the component shocks to the endogenous variables in the VAR and gives information about the relative importance of each random innovation to the variables in the VAR.

There is a precedent in the literature which is Marr and Syklos (1995) work that has applied VAR in its analysis. The dependent variables in Marr and Syklos paper are the number of immigrants to Canada ( $imm_t$ ), the unemployment rate in Canada ( $un_t$ ), labour income in Canada ( $wage_t$ ), and real gross domestic product of Canada ( $gdp_t$ ). All of these variables are per-capita variables. They also have considered dummy variables for war and other macroeconomic shocks ( $X_{t-i}$ ). Their model specification is as follows:

$$\begin{pmatrix} imm_t \\ un_t \\ wage_t \\ gdp_t \end{pmatrix} = \begin{pmatrix} imm_{t-i} \\ un_{t-i} \\ wage_{t-i} \\ gdp_{t-i} \end{pmatrix} + X_{t-i} + \begin{pmatrix} e_{imm} \\ e_{un} \\ e_{wage} \\ e_{gdp} \end{pmatrix} \quad (1)$$

I employ more variables into this model to do the Iranian analysis. I explain these variables and the reason of including them in my study later. Also due to short comings in VAR technique, I analyze this study by OLS as well, based on the work of Kelly (1965), to check the robustness of my results under the VAR approach.

I consider several variables in my study. All of these variables except the unemployment rate of Canada and dummy variables are divided by the number of Iranian population or they are per-capita variables. The first variable is the unemployment rate of Canada as a labour market condition indicator for migrants and educated people since I

do not have access to Iranian unemployment rate. If the labour market conditions in Canada promises migrants a high chance of finding a good job, proper salary, and high social status, they migrate. I expect a negative correlation between the Canadian unemployment rate and the level of MBD from Iran. I also include dummy variables in this analysis since Iran experienced different regimes and the Iraq-Iran war over 1970-2000. Another variable is per-capita newspapers and periodicals in Iran as a proxy for the degree of democracy. I expect lower brain drain and migration when there are more newspapers and periodicals since this means more freedom and higher security. Another driving factor could be the per-capita level of education of Iranian citizens. I expect higher education leads to higher MBD because educated people are more sensitive about the quality of life like job security. I employ the per-capita number of university students as a proxy for education. Per-capita real National Income of Iran as an indicator of economic condition in Iran is another variable. My expectation is when real “National Income” increases, the economic growth increases which leads to higher standard of living so MBD decrease. In addition, I expect that variables like the number of newspapers and the number of university students have more effect on brain drain than migration, since all the people in brain drain group( not all the migrants) are educated and they care more about these two variables.

The VAR representation of per-capita migration and per-capita brain drain based on Marr and Syklos (1994) with my variables are in equations (3) and (4), respectively. The OLS representation of per-capita migration and per-capita brain drain based on Kelly’s specification (1965) and my variables are in equations (5) and (6), respectively:

$$\begin{pmatrix} em_t \\ unca_t \\ NI_t \\ unsi_t \\ new_t \end{pmatrix} = \begin{pmatrix} em_{t-i} \\ unca_{t-i} \\ NI_{t-i} \\ unsi_{t-i} \\ new_{t-i} \end{pmatrix} + X_{t-i} + \begin{bmatrix} e(em_t) \\ e(unca_t) \\ e(NI_t) \\ e(unsi_t) \\ e(new_t) \end{bmatrix} \quad (3)$$



$$\begin{pmatrix} bd_t \\ unca_t \\ NI_t \\ unsi_t \\ new_t \end{pmatrix} = \begin{pmatrix} bd_{t-i} \\ unca_{t-i} \\ NI_{t-i} \\ unsi_{t-i} \\ new_{t-i} \end{pmatrix} + X_{t-i} + \begin{pmatrix} e(bd_t) \\ e(unca_t) \\ e(NI_t) \\ e(unsi_t) \\ e(new_t) \end{pmatrix} \quad (4)$$

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$$em_t = a_1 em_{t-i} + a_2 unca_t + a_3 rc_{t2} + a_4 NI_t + a_5 war_t + a_6 unsi_t + a_7 new_t + \varepsilon_t \quad (5)$$

$$bd_t = b_1 bd_{t-i} + b_2 unca_t + b_3 rc_{t1} + b_4 NI_t + b_5 war_t + b_6 unsi_t + b_7 new_t + e_t \quad (6)$$

Where  $em_t$  is migrants,  $bd_t$  is brain drain,  $unca_t$  is unemployment rate in Canada.  $rc_{t1}$  and  $rc_{t2}$  are dummy variables for conservative and liberal regimes in Iran respectively.  $NI_t$  is National Income of Iran,  $war_t$  is a dummy variable for Iraq-Iran war.  $unsi_t$  is the number of university students in Iran.  $new_t$  shows the number of newspapers and periodicals.  $\varepsilon_t$  and  $e_t$  stand for residuals.  $X_{t-i}$  is a matrix of all the dummy variables in my VAR approach which contains a dummy for regime change and a dummy for war period. Also  $i$  is from  $1 \dots n$  or actually  $i$  shows the number of lags in both models. As mentioned, in order to decide on the number of lags, I apply Akiake and Schwarz criterions.

### 3. Data

This study employs different statistical sources to estimate equations (3) to (6). CANSIM in Statistics Canada provides the Canadian unemployment rate from 1970 to 2000.<sup>22</sup> The table “landed immigrants by country of last permanent resident” in *Citizenship and Immigration Canada*<sup>23</sup> provides the number of Iranian migrants to Canada. From 1970 to 1973 the table “Country of last permanent residence by groups of intended occupations of immigrants” in *Citizenship and Immigration Canada*<sup>24</sup> offers information on the jobs of migrants that allows estimating brain drain<sup>25</sup> according to:

$$\text{Brain drain from Iran to Canada} = \text{managerial jobs} + \text{professional jobs} + \text{clerical jobs} + \text{jobs in communication} + \text{commercial jobs} + \text{financial jobs} \quad (7)$$

<sup>22</sup> Series V2461224, table number: 2820002 and series V508780, table number 3840035.

<sup>23</sup> <http://www.cic.gc.ca/english/pub/index-2.html#reports>

<sup>24</sup> <http://www.cic.gc.ca/english/pub/index-2.html#reports>

<sup>25</sup> The available data on brain drain is from 1970 to 1996.

The jobs in equation (7), among jobs in this table, are the one that usually require university degree in Iran. From 1974 to 1996 this table in *Citizenship and Immigration Canada*<sup>26</sup> reported more detailed information on Iranian migrants' jobs that allows estimating brain drain according to equation (8) for these years:

Brain drain from Iran to Canada= entrepreneurs + managerial jobs+ jobs in science, engineering, and math + social science and related jobs+ jobs related to religion+ teaching jobs + jobs in medicine and health + jobs in performing arts + university students(18 years old and higher) (8)

Since data sources for equations (7) and (8) are the same and equation (7) only covers three years (1970-1973), these differences are small and ignorable. Also the information in this table of *Citizenship and Immigration Canada* is limited to the end of 1996. As a result brain drain analysis could not be extended beyond 1996.

The Statistical Center of Iran<sup>27</sup> provides the information on the number of University students and the number of newspapers and periodicals in Iran over 1970-2000. I did not have access to data after 2000 on these variables. Moreover, data on University students in this analysis only considers public universities since I do not have access to data on the number of private university students.<sup>28</sup> Iranian National Income, in million Rials,<sup>29</sup> is from the Iranian Economic Literature & Data bank in Allameh Tabatabayi University in Tehran. All these variables are per-capita variables except unemployment rate of Canada and dummy variables. Dividing level variables by predictions<sup>30</sup> of Iranian population over 1970 to 2000 which are available in Statistical Center of Iran constructs per capita variables. Figures (a) to (f) in Figure 1 in the appendix summarize the behaviour of all the variables in my study.

Table 2 in appendix displays the variance and mean of these variables. There are historical reasons for the depicted behaviour of variables in figures (a) to (f) in Figure 1. Figure (a) shows an upward trend and fluctuations in migration from 1976 to 1986. Revolution happened in 1978 that caused insecurity due to changing government. Furthermore, the Iraq-Iran war began in 1980 which absorbed most of the resources in

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<sup>26</sup> <http://www.cic.gc.ca/english/pub/index-2.html#reports>

<sup>27</sup> [www.sci.org.ir](http://www.sci.org.ir)

<sup>28</sup> I checked the data on the number of university graduates but in the data source that I have access to, there are too much missing observations in only thirty years time series data. This can not be a good data for analysis.

<sup>29</sup> Unit of Iranian currency.

<sup>30</sup> I did not have access to real data

economy, universities were closed from 1980-1981 to make reforms, and there are two years of compulsory military service for Iranian males, which was undesirable especially during the war. These conditions and circumstances caused an upward trend and fluctuations in migration. Figure (b) shows almost the same pattern as Figure (a) for brain drain over 1976 to 1986. After the government of Canada eliminated the condition of having arranged employment before coming to Canada in 1986, the increase in MBD were even more intensified. However, this sharp increase turned to a decrease in 1988. This was concurrent with the ending of the war, and people were hoping for upcoming stability. From 1990 to 1992, even though Canada was in a recession, there was not a decline in migration. This might have happen since Canadian officials were not able to predict macroeconomic conditions in advance and respond by changing immigration levels through immigration policies. In 1996 liberals took office from conservatives in an election in Iran. There was a decrease in number of migrants from 1997 that could be related to taking office of liberals.

Figure (c) displays a sharp decrease in the number of “newspapers and periodicals” from 1978 to 1980. This was the time of revolution. It recovers from 1980 to 1990. In 1990 there is another sharp decrease in the number of “newspapers and periodicals” which is concurrent with the end of the war. In 1993, it began to increase again and this increase continued up to 2000. This could be an indicator of Iranian society moving toward a higher level of democracy. Iranian National Income in Figure (d) has a declining trend from 1975 to 1988, since this time is the era of revolution and war. After the war the economy began to recover and real National Income increased from 1990 to 2000. In Figure (f) the number of university students was increasing over 1970 to 2000 except for 1980 and 1981 that universities were closed. This could be related to the point that the increase in the capacity of public universities.

Applying an Augmented Dicky-Fuller (ADF) test helps to check the stationarity of these variables. Table 3 in the appendix displays the results of ADF test for all the variables in this study. All these variables are non-stationary except Iranian National Income. With one time differencing all the non-stationary variables except brain drain turn to stationary. Brain drain turns stationary by two time differencing. The Granger causality test based on Granger (1969) is a descriptive test that indicates causation and

correlation of variables. I apply this test to all the variables in models of MBD over 1970-2000 in tables 4 and 5 in the appendix. Table 4 shows that none of the variables except the Canadian unemployment rate Granger causes migration. Table 5 displays that only the Canadian unemployment rate and the number of newspapers and periodicals Granger causes brain drain. I still need formal modeling to find the driving factors of MBD since Granger causality test results are only descriptive.

## **4. Estimation**

### **4.1) Brain drain**

This section displays the VAR analysis of brain drain. VAR(1,2) specification on stationary variables is a proper model for analyzing brain drain since its Akaike and Schwarz criterions are at their lowest levels which are -20.14 and -19.50 respectively. The dummy variables of this model are dummy variables for War and conservative periods. Since liberals have taken office from 1997 and brain drain data is available from 1970 to 1996, there is no need to have a dummy variable for the liberal regime. The rest of the variables are the ones that are explained in section two. Table 6 in the appendix shows the variance decomposition (VD) results of the brain drain model. VD of brain drain two periods ahead means that 86.09% of the variation in brain drain two years into the future is explained by its own past history alone, and the rest of its variation is explained by innovation of other variables in the model. Results show that on average more than 70% of the behaviour of brain drain is explained by its own history or is exogenous. This means that when educated people in previous cohorts emigrate, they have influence on the current cohort's decision. The Canadian unemployment rate explains 5.50% of brain drain variations, on average. This result implies that the condition of Canadian labour market does not play a great role in brain drain. Real Iranian National Income as an indicator of Iran's economic condition does almost nothing to explain the behaviour of brain drain. I expected more influence from this variable, since an increase in real National Income increases the economic growth which leads to higher standard of living, which is predicted to decrease brain drain.

The number of newspapers and periodicals on average explains 15% of variations in brain drain. I took this variable as a proxy for democracy in this study and I expected

more effect of this variable on the decision of educated people to leave Iran. The reason could be banning these newspapers by government soon after their opening due to different political reasons over the period investigated. The number of university students explains on average only 5% of variation in brain drain. This indicates that even though the number of university students was increasing over 1970-1996, these students could not easily join the flow of brain drain since they might not afford the cost of migration. This may raise the issue that these students could not borrow money in order to cover the costs of their migration. This may happen if lenders do not trust them to pay the money back. Figure 2 in the appendix displays VD diagram of brain drain. VD of brain drain is substantially above other decompositions which indicates this variable is not strongly related to the other variables in the model.

Table 7 in the appendix shows the values of impulse response function (IRF) of brain drain to a one-standard-deviation positive shock.<sup>31</sup> Column one of table shows the effect of a positive shock into innovation of brain drain on brain drain. This shock causes fluctuations in brain drain and finally the effect of shock almost dies out after the fourth period from shock. This behaviour is displayed in “response of BDPOP2 to BDPOP2” diagram in Figure 3 and indicates that at first the cohort of educated migrants in the period that the shock happens alleviate the cost and risk of migration for new cohort through channels like family reunification so migration increases but the number of educated people who are ready to migrate decreases in next period. As a result brain drain decreases up to the second period after the shock. From second period up to fourth period after the shock the migrant educated people emerges again and brain drain increases. After fourth period the effect of shock dies out.<sup>32</sup> Since the effect of shock disappears fast, the shock into innovation of brain drain is not persistent.

Second column of Table 7 shows the response of brain drain to a shock to the unemployment rate of Canada. This shock at first does not have an effect on brain drain; probably there is always some information lag. Afterward, fluctuations in brain drain are commenced and the effect of the shock almost dies out after eight periods from the shock. The shock effects are not persistent. Column three displays that an increase of the real

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<sup>31</sup> All the numbers in this table have been scaled up by  $10^7$

<sup>32</sup> The numbers in table 7 have been scaled up. Actually in fourth period the response of brain drain is 0.000000003 which is almost zero.

Iranian National Income has no effect on brain drain in first period after the shock and from second period variations begin. From the fourth period the effect of the shock dies out or changes in real National Income are not influential on brain drain. The reasoning could be related to this issue that a sudden increase in National Income is likely due to oil prices shock<sup>33</sup> that decreases brain drain but oil prices do not remain high for a long time so the effect of shock decreases and brain drain increases until the effect of shock dies out.

The effect of shock to the number of newspapers and periodicals does not have effect on brain drain at first but from second period increases brain drain. I expected more newspapers lead to lower brain drain. However, the result of this analysis displays an increase in brain drain rather than a decrease from second period after shock. Then brain drain decreases until the shock disappears. This increase after shock up to second period imply that educated people simply do not take the increase in the number of newspapers and periodicals as an indicator of more democracy and they keep leaving the country. Finally the last column of table 7 shows that an increase in the number of university students does not have effect on brain drain in first period after shock. After that fluctuations begin up to tenth period after shock when shock dies out. The reaction of brain drain to shock is compatible with expectations in section two.

None of these shocks has permanent effect on brain drain but in these temporary effects, the effects of the increase in the number of newspapers and periodicals and university students are larger and their effect on brain drain die out after ten periods while the effect of other variables' shock on brain drain disappear sooner. These results are compatible with VD results that all of these variables play small role in explaining variation of brain drain. Figure 3 shows impulse response function diagrams of brain drain to shocks of other variables. The dotted lines show the plus and minus two standard deviation bands along the impulse responses.

## **4.2) Migration**

VAR (1, 2) based on the lowest amounts of the Akaiake and Schwartz criterions, which are -17.27 and -16.65 respectively, is a proper specification for migration model. In this model the exogenous variables are dummy variables for liberal regime and Iraq-

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<sup>33</sup> Iran's major source of income is from natural resources, mostly oil.

Iran war years. Over 1970 to 2000 since monarchy regime was in office only for a short period of time and during their office the society was moving toward revolution, monarchy government could not play a big role. As a result this study considers two regime changes in migration model and takes a dummy variable for liberal regime. The rest of the variables are explained in section two.

Table 8 in appendix shows the VD of migration model. In table 8, the variance decomposition of migration displays that on average 90% of behaviour in migration is explained by its own history or it is an exogenous variable. This indicates when people in previous cohort migrate; they have influence on current cohort's decision to migrate. Canadian unemployment rate in second column of table 8 explains only 2% of the behaviour of migration on average. It shows that like brain drain, the condition of Canadian labour market does not play a great role in migration. About the other variables, real Iranian National Income explains 4% of the behaviour of migration on average but I expected more explanatory power since an increase in real National Income should increase the economic growth and lead to higher standards of living that matters for migrants.

The number of newspapers and periodicals on average only explains 1% of variations in migration. I expected when the number of newspapers changes, number of migrants changes since number of newspapers is a proxy for current level of democracy. This result indicates this variable is not important for the people who leave Iran. The number of university students as a proxy for the level of education explains almost nothing of variation in migration. I expected that this variable has at least some influence. I can conclude that even though the number of university students was increasing over 1970-2000, these students could not easily migrate due to reasons like affording the cost of migration. Figure 4 in appendix displays VD of migration is above other decompositions, which indicate this variable is not strongly related to the other variables in the model.

Table 9 in appendix shows IRF results.<sup>34</sup> Column one of this table shows when there is a positive shock to migration, migration fluctuates and with regards to first diagram in Figure 5 the effect of shock dies out in tenth period after shock which means

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<sup>34</sup> All the numbers in this table have been scaled up by  $10^6$

this shock lasts for a long time but its effect on migration is not permanent. This shows that most of the variation of migration can be explained by its own history which means when shock increases the number of migrants; this first cohort alleviates the cost and risk of migration for new cohort through a channel like family reunification.

Second column of table 9 shows the response of migration to a positive shock to the unemployment rate of Canada. This shock does not have any effect on migration at first and then causes fluctuations. The point is there are fluctuations in migration and the size of fluctuations decreases over time in a way that from ninth period after shock, the effect of shock on migration dies out. Column three of table 9 shows when real Iranian National Income increases, at first it does not have effect on migration and later leads to fluctuations. Almost in tenth period after shock, the effect of shock dies out. The effect of this shock on migration is not permanent.

A shock to the number of newspapers and periodicals leaves migration unchanged at first but then decreases it up to second period. The reason for this decrease is people at first take these more newspapers as an indicator of higher democracy and assume that country is improving and they decide to stay in Iran. Later since the effect of shock disappears which means the number of newspapers decreases, people see that actually there is no improvement and they migrate. This result of model is compatible with Iran's situation because for example from 1990 to 2000, Iranian government banned a lot of newspapers due to political reasons. Finally the last column of table 9 displays this shock at first has no effect on migration but then decreases it up to second period. Later when the effect of shock declines, migration increases. The effect of this shock dies out after almost eight periods from shock.

These results demonstrate that the effect of one standard error positive shock to the unemployment rate of Canada and Iranian real National Income on migration dies out after nine and ten periods respectively while the effect of other variables' shocks except migration disappear after six periods. These results indicate that Canadian labour market condition and Iran's economic condition matter more for migrants. Figure 5 in the appendix shows IRF diagrams for migration with respect to the shock into innovation of other variables in the model. The dotted lines show the plus and minus two standard deviation bands along the impulse responses.



In order to check the robustness of VAR results, I have estimated each model by OLS. The results show that in both models of brain drain and migration all the coefficients are insignificant in 10% level of significance which means none of these variables are driving factors of brain drain and migration.

## **5. Conclusion**

This paper has considered the macroeconomic relation of brain drain and migration with explanatory variables such as unemployment rate of Canada, real Iranian National Income, the number of newspapers and periodicals, the number of university students, and dummy variables for structural changes and war.

Based on the Variance Decomposition analysis, on average 70% and 95% of the variations in brain drain and migration are mainly explained by their own lagged values, respectively. These variables are exogenous and other variables in this analysis explain a small portion of their variation. Impulse Response Function diagrams show positive shocks to brain drain and migration result in higher brain drain and migration respectively. Among other variables with small effect on migration and brain drain, the explanatory power of National Income in the behaviour of migration is almost four times bigger than its role in explaining the behaviour of brain drain. This indicates that the economic condition of Iran is more important for migrants in general than educated migrants. However, the unemployment rate of Canada has more explanatory power on brain drain than migration. This implies that the Canadian labour market condition is more important for educated migrants. The number of newspapers and periodicals and the number of university students have more explanatory power on brain drain than migration, based on Variance Decomposition. Impulse Response Function diagrams display that the effects of shocks to newspapers and periodicals and university students is bigger on brain drain than migration since their effect on migration dies out after 6 periods while their effect on brain drain dies out after 10 periods.

The results of Granger causality as a descriptive test show that none of the variables except the Canadian unemployment rate and the number of newspapers and periodicals Granger causes brain drain. The Canadian unemployment rate is also the only variable that Granger causes migration. The results of OLS estimation indicate that the

variables in the model are not major driving factors of brain drain and migration. All of these results are mostly compatible with each other which are a good indicator of robustness in results.

If Iranian policy makers want to hinder migration and brain from Iran to Canada, they should try to find a way to neutralize the effect of previous cohorts of educated and non-educated migrants on the people inside of Iran. Possible policies for neutralizing these effects are categorized in two groups:

Short-run policies:

- Displaying programs on media like Television about the problems of migration like its cultural effect on future generations of migrants and problems of finding job in job markets of Canada.
- Facilitating visiting professorships to educated people outside of Iran and helping them to find a good job with proper salary in Iran. Such facilitation can persuade migrants to come back home with better education and knowledge which is to the advantage of Iran.

Long-run policies:

- Improving overall economic conditions to encourage people to stay. For example, Iran can spend its accumulated reserve account from oil incomes in investment on different sectors of economy like Research and Development- to keep educated people in Iran, and agriculture- where Iran has high potentials to become competitive- to increase its competitive power in the global market. This can increase the export level which leads to higher income for economy as well as new job opportunities for both educated and non-educated people.
- Preparing security and a proper degree of freedom in authority for educated people in hierarchical jobs, where they are more probable to get job, to perform efficiently.

Finally, this empirical study does not include some of the variables like unemployment rate of Iran that might be important in this analysis. Also the VAR approach in this paper did not consider a dummy variable for immigration policy of Canada. This variable could be an important variable. In addition, since most of the

variables are non-stationary, this study uses the differencing method to make them stationary, but all of the theories which have been applied in this paper are based on level variables, not the differenced variables. Further more; it is not clear why migration time trend has lots of spikes but the brain drain time trend does not show these spikes.

Another issue, which I refer it to future work, is considering the poverty trap in this analysis. If the majority of population are poor, incentive to leave is constrained by poverty and it arises the question that whether poverty trap increases or decreases the number of migrants. Further extension to this study could be comparing migration trend of Iran with other Middle Eastern countries as source countries to see why the number of educated and non-educated migrants are different among them

This analysis does not consider uncertainty or actually expectations on the future behaviour of variables in the model. Sims (1980) said that since there is rational expectation assumption in macroeconomic models so expectations should be formed optimally and it is possible to have forward looking variables. Another concern on this paper and its results is related to applying VAR approach. The shocks which are used to estimate the impulse response functions may contain the omitted variables from the model. If these omitted variables are related to included variables in VAR specification then VAR estimates suffer from the omitted variables problem.

## Appendix

Immigrant landings(All classes), Top ten source countries 1998-2003										
Country	1998	Rank	1999	Rank	2000	Rank	2002 <sup>35</sup>	Rank	2003	Rank
China	19766	1	29116	1	36664	1	33231	1	36116	1
India	15350	2	17431	2	26004	2	28815	2	24560	2
Pakistan	8086	4	9299	3	14163	3	14164	3	12330	3
Philippines	8183	3	9163	4	10063	4	11000	4	11978	4
South Korea	4913	8	7213	5	7602	5	7326	6	7086	5
Sri Lanka	N/A	N/A	N/A	N/A	4699	9	4961	9	4442	10
USA	4786	9	5539	7	5806	7	5288	8	5990	6
<i>Iran</i>	<i>6768</i>	<i>7</i>	<i>5905</i>	<i>6</i>	<i>5598</i>	<i>8</i>	<i>7742</i>	<i>5</i>	<i>5648</i>	<i>7</i>
Yugoslavia	N/A	N/A	N/A	N/A	4699	9	N/A	N/A	N/A	N/A
Great Britain	N/A	N/A	4480	10	4644	10	9720	10	5194	9
Taiwan	7178	6	5478	8	N/A	N/A	N/A	N/A	N/A	N/A
Russia	4285	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hong Kong	8079	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 1**<sup>36</sup>

<sup>35</sup> The data source considered 2001 and 2002 data together

<sup>36</sup> Note: “N/A” in this table means the number of migrants of that country was not in the top ten countries in that year.

Source: for 1998-2000: Benjamin,D.,G.Morley, and R.W.Craig. (2002). For 2002 and 2003: “Annual report to parliament on immigration 2003” and “Annual report to parliament on immigration 2004,” Citizenship and Immigration Canada website, accessed January 24, 2005 [www.cic.gc.ca/english/pub/index-2.html#reports](http://www.cic.gc.ca/english/pub/index-2.html#reports).

<b>Variable</b>	<b>Mean</b>	<b>Standard Deviation</b>
Brain drain	$1.41 \times 10^{-5}$	$1.13 \times 10^{-5}$
migration	$5.23 \times 10^{-5}$	$4.33 \times 10^{-5}$
Newspapers periodicals	$5.99 \times 10^{-6}$	$4.74 \times 10^{-6}$
“National Income”(in million Rials)	0.000701	0.000204
Unemployment rate of Canada	4.22	1.55
University Students	0.005315	0.002968

**Table 2**

<b>From 1970 to 2000 (All the variables are per-capita)</b>				
<b>Variable</b>	<b>ADF test</b>	<b>MacKinnon critical values at 10% level of significance</b>	<b>Stationary</b>	<b>Integrating order</b>
Brain drain	1.81	2.65	Non-stationary	I(2)
migration	1.19	2.62	Non-stationary	I(1)
Newspapers and Periodicals	0.06	2.62	Non-Stationary	I(1)
Iranian “National Income”	3.13	2.62	Stationary	I(0)
Canadian unemployment	2.05	2.61	Non-Stationary	I(1)
University Students	0.52	2.62	Non-Stationary	I(1)

**Table 3**

<b>Granger causality test on migration</b>	<b>F-Statistics</b>	<b>P-Value</b>	<b>At %10 level of significance</b>
<b>Null hypothesis</b>			
Canadian unemployment [dng] ] <sup>37</sup> migration	0.76	0.47	Null hypothesis is rejected.
Migration [dng] Canadian unemployment	0.52	0.59	Null hypothesis is not rejected.
Iranian “National Income” [dng] eMigration	0.45	0.63	Null hypothesis is not rejected
Migration [dng] Iranian “National Income”	0.79	0.46	Null hypothesis is rejected.
Number of newspapers and periodicals[dng] migration	0.18	0.83	Null hypothesis is not rejected.
Migration [dng] Number of newspapers and periodicals[	2.88	0.07	Null hypothesis is rejected
Number of University Students [dng] migration	0.45	0.64	Null hypothesis is not rejected.
Migration [dng] Number of University Students	0.72	0.49	Null hypothesis is rejected.

**Table 4**

<b>Granger causality test on brain drain</b>	<b>F-Statistics</b>	<b>P-Value</b>	<b>At %10 level of significance</b>
<b>Null hypothesis</b>			
Canadian unemployment [dng] ] <sup>38</sup> brain drain	1.02	0.38	Null hypothesis is rejected.
brain drain [dng] Canadian unemployment	0.28	0.75	Null hypothesis is not rejected.
Iranian “National Income” [dng] brain drain	0.029	0.97	Null hypothesis is not rejected
brain drain [dng] Iranian “National Income”	0.38	0.68	Null hypothesis is not rejected.

<sup>37</sup> [dng] means “ does not Granger cause”

<sup>38</sup> [dng] means “ does not Granger cause”

Number of “newspapers and periodicals”[dng] brain drain	2.02	0.16	Null hypothesis is rejected.
brain drain [dng] Number of “newspapers and periodicals”	0.41	0.67	Null hypothesis is not ejected
Number of University Students [dng] brain drain	0.022	0.97	Null hypothesis is not rejected.
brain drain [dng] Number of University Students	0.18	0.83	Null hypothesis is not rejected.

**Table 5**

<b>Variance Decomposition (VD) of Brain Drain model</b>					
Data from 1970 to 1996 (per-capita)					
Model: [bd, Unca, NIi, New, Unsi, one regime dummy(for conservatives), dummy for war]					
Periods Ahead	Brain drain (bd)	Unemployment of Canada (unca)	“National Income” of Iran(NIi)	Number of “newspapers and periodicals”in Iran(new)	Number of university students in Iran(Unsi)
2	86.09	2.83	0	10.31	0.75
4	71.68	6.40	0.40	15.61	5.89
8	66.05	7.23	0.68	18.63	7.39

**Table 6**

<b>Impulse response function (IRF) of brain drain to one-standard-deviation shock of each variable</b>					
Data from 1970 to 1996					
Model: [bd, Unca, NIi, New, Unsi, one regime dummy(for conservatives), war dummy]					
Period	bd	Unca	NIi	New	Unsi
1	58.1	0	0	0	0
2	-14.7	-10.9	-0.135	20.7	5.61
4	3.67	-1.03	3.01	-15.7	13.7
8	0.635	2.68	2.14	-2.07	1.32

**Table 7**

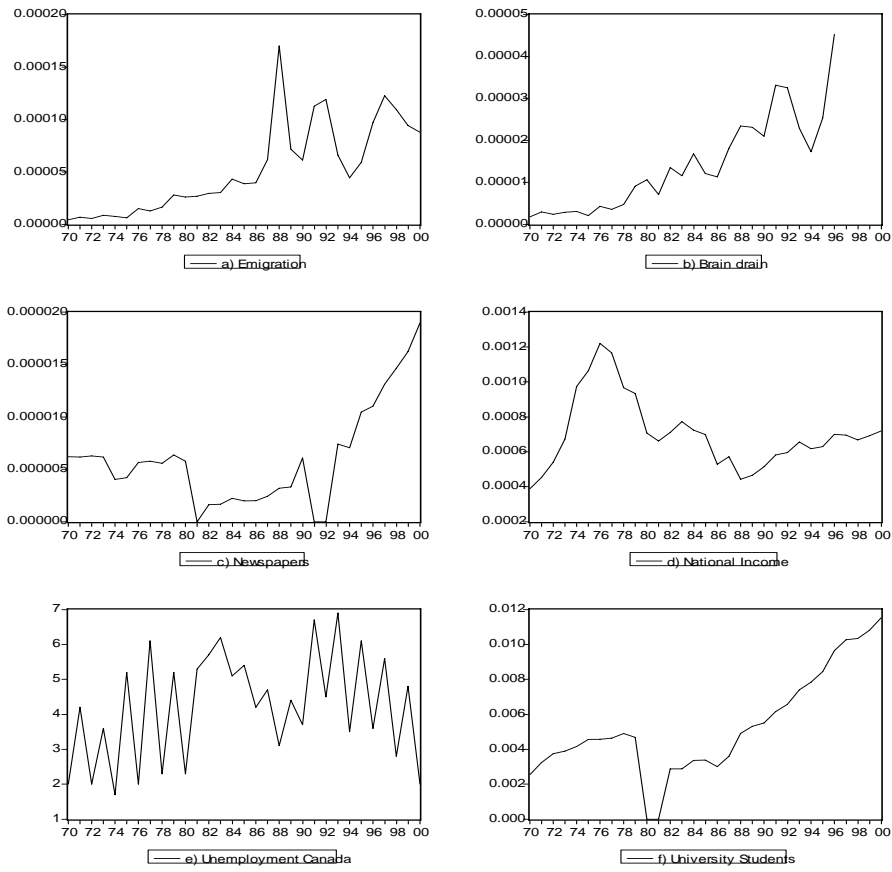
<b>Variance Decomposition (VD) of Migration</b>					
Data from 1970 to 2000					
Model: [em, Unca, NIi, New, Unsi, two regime dummies, war]( All in per-capita term)					
Periods Ahead	migration (em)	unemployment rate of Canada (Unca)	Iranian real "National Income"(NIi)	number of newspapers and periodicals(New)	number of university students (Unsi)
2	95.91	0.21	2.87	0.97	0.01
4	92.15	2.95	3.77	1.03	0.07
8	89.45	3.87	4.39	1.51	0.77

**Table 8**

<b>Impulse Responses of Migration</b>					
Data from 1970 to 2000					
Model: [em, Unca, NIi, New, Unsi, one regime dummy (for liberals), war]					
Impulse response of migration to one-standard-deviation positive shock					
Period	em	Unca	NIi	New	Unsi
1	25.9	0	0	0	0
2	-11.9	1.36	4.93	-2.88	-0.321
4	8.12	-0.979	-3.78	-0.285	0.783
8	2.58	1.07	-1.44	-0.503	-0.868

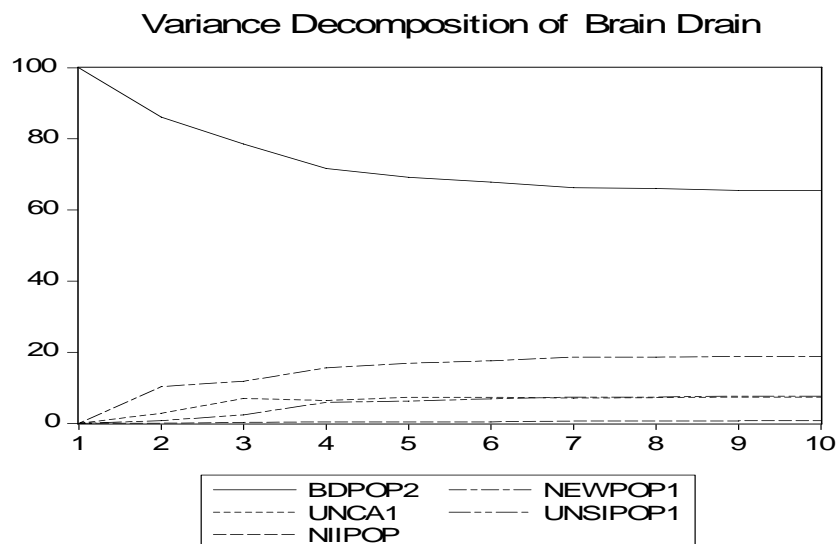
**Table 9**



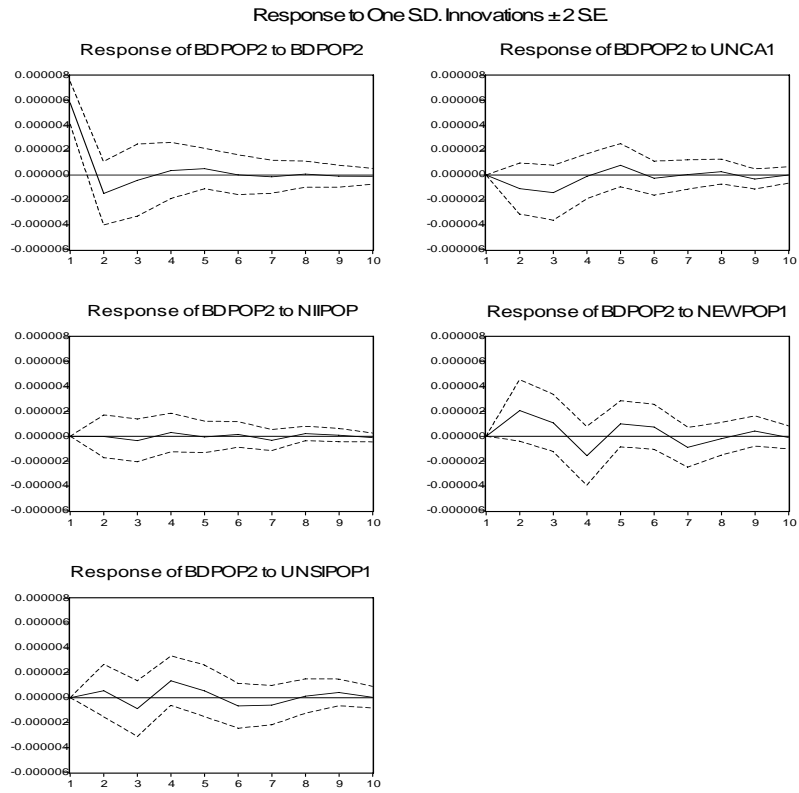


**Time Trend of variables**

**Figure 1**



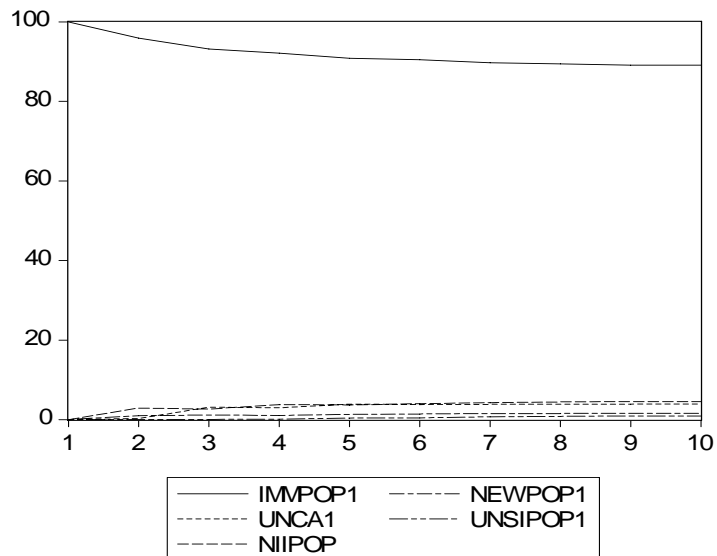
**Figure 2**



### IRF diagrams of Brain drain model

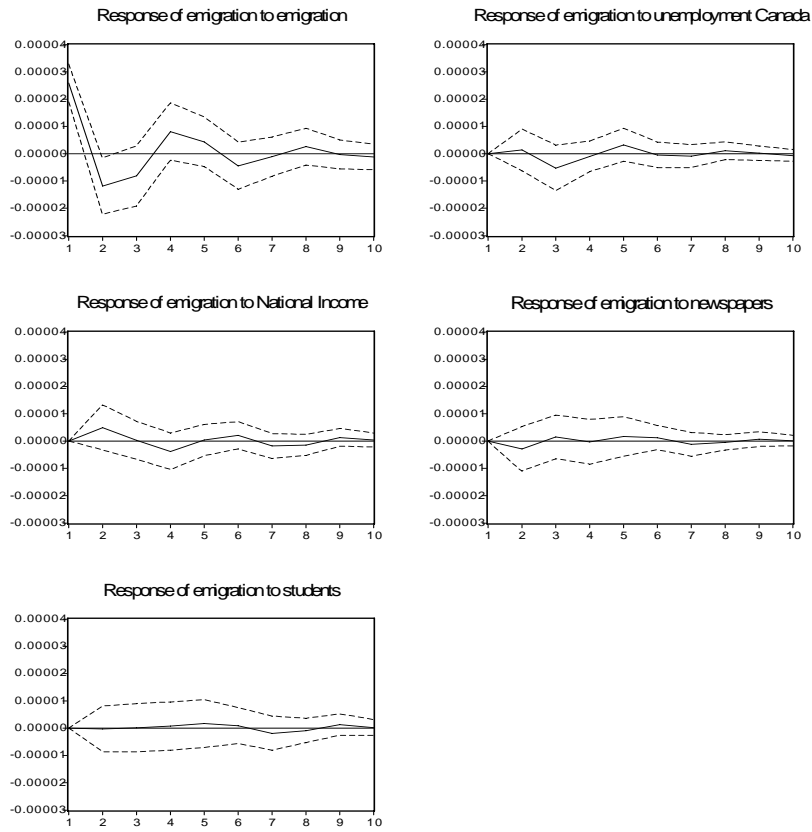
**Figure 3**

### Variance Decomposition of IMMPOP1



**Figure 4**

Response to One S.D. Innovations  $\pm 2$  S.E.



**IRF diagrams of migration model**

**Figure 5**

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