Forman Journal of Economic Studies
Vol. 13, 2017 (January–December) pp. 55-81

Brain Drain from Pakistan: An Empirical Analysis

Samina Farooq and Eatzaz Ahmad[1]

Abstract

The paper is an attempt to empirically analyze the drivers of emigration of highly-qualified and highly-skilled manpower from Pakistan to 27 destination countries over the past 36 years. The econometric model employed is a bipolar specification of augmented gravity model, which is hybrid of pull-push factors of migration models and gravity model of migration. Then study constructs indices to measure drivers of brain-drain through the technique of principal component analysis. These indices are then used to analyze their potential role in the process of migration. The study finds that the main factors contributing to migration from Pakistan include the pull factors like better socioeconomic conditions in the destination countries and push factors associated with demographic and labor market condition in Pakistan. Thus the empirical findings support the underlying demand and supply based theories of migration. Based on the findings of the study and keeping in view the importance of remittances that Pakistan receives from overseas Pakistanis, the study concludes that in an over-populated country like Pakistan, unplanned brain-drain needs to be re-oriented to take the form of planned brain-export.

Keywords: Brain Drain, Pull-and-Push Factors, Gravity Model, Principal-Component-Analysis.

JEL Classification: C23, C43, F16, F22, I23, J24, J61.

1. Introduction

Brain-drain is the large scale migration of highly-qualified and highly-skilled youth of economically less advanced countries to rich and developed countries of the world (Grubel and Scott, 1966a, 1966b, 1967, 1977; and Iravani, 2011). Such socio-economic trend of intellectual migration that delinks a great asset and cream of country of origin after one or two generations requires sacrifices from the economy and society as a whole. According to traditional brain-drain literature (Bhagwati and Hamada, 1974; Bhagwati, 1979; Gilani, Mir, and Malik, 2007; and Monteleone and Torrisi, 2010) emigration of highly-

[1] The authors are PhD Scholar at School of Economics, Quaid-i-Azam University Islamabad and Professor on SBP Memorial Chair, University of Peshawar, Peshawar, respectively. Corresponding author's email address: eatzaz@qau.edu.pk

educated and highly-skilled young people is a curse for developing source countries, as investment in higher education and training lost, when a highly-educated and trained-individuals leave the motherland and do not return back. Thus brain-drain benefits destination country with the amount of talented and trained manpower for which recipient country had not invested. At the same time the brain-drain reduces relative supply of human capital in the source developing countries and consequently badly affects the long-run economic growth of these source countries. Therefore, there is an ongoing debate for the exposition of the main attractions towards the destination countries and identification of factors contributing to the emigration of highly qualified manpower and highly-skilled and trained scientific and technical personnel from their motherland.

According to World Bank's dataset in Migration and Remittances Fact book 2016, in overall ranking, Pakistan stood third in South Asia (after India and Bangladesh) and sixth in the World (after India, Mexico, Russia, China, and Bangladesh) for human capital mobility. Since independence in 1947, and especially after 1971, the loss of highly-skilled Pakistani engineers, doctors, teachers, information technology specialists, computer programmers, accountants, and other professionals from industrial, medical, educational, and constructional fields is alarming (Doghri, et al. 2006). Immigration and Passport Director General Muhammad Safdar in his report submitted to the interior ministry reported that in the last five years more than thirty-four hundred Pakistani citizens (i.e., 4.65 percent of total registered emigrants from Pakistan during the period) have renounced their nationality, after adopting the citizenship of other countries, while another fifteen-hundred persons (i.e., 2.05 percent of total registered emigrants) are on waiting list to give up their association with the homeland (Gishkori, 2015). According to statistics provided by Bureau of Emigration and Overseas Employment as well as reported in Economic Survey of Pakistan 2015-16, the Pakistani emigrant stock has increased from one million in 1981 to 8.77 million till December 2016, to seek employment abroad. Following the definition of brain-drain used by Doghri, et al. (2006) in an Occasional Paper of Islamic Development Bank, "as an aggregate of highly-qualified and highly-skilled emigrants, who are needed and desirable for the country of origin". Also the fact that highly-talented Pakistanis settled abroad, excelling in almost every field of life, are able to build their capacity to the benefit of their adopted countries, create an interest to explore the drivers of massive exodus of highly-qualified and highly-skilled manpower from Pakistan.

According to Brettel and Hollifield (2014) international migration having roots in sociology, political science, law, economics, demography, geography,

psychology and cultural studies has intrinsically interdisciplinary nature. Therefore the existing literature lacks in providing a single comprehensive theory, adequate for the understanding and explanation of the composition and spatial dimensions of international migration. There is also a scarcity of well-defined secondary data on migration, specially brain-drain, therefore earlier studies conducted, particularly for Pakistan (Altaf and Obaidullah, 1992; and Arif and Irfan, 1997) were based on primary survey data, directly collected from the correspondents, which did not represent the whole population of Pakistan. Though limited empirical literature is also available on the exploration of the macroeconomic determinants of international migration from Pakistan (Ahmad, et al. 2008), yet the choice of the determinants in these studies is based on the discretion of researchers without any theoretical base.

To cover the gaps in existing literature and to supplement the ongoing research on the brain-drain following important points are particularly considered in present research; First, secondary panel data from year 1981 to 2016 are covered, for a cross-section of 27 destination countries. Selection of these destination countries is totally on the basis of the intensity of knowledge-based demand of migrants by these countries (based on United Nation's dataset, 2015; and Bureau of Emigration and Overseas Employment, 2016). The choice of panel data not only increases the number of observations but also widens the scope and prospects of the analysis. Another contribution of the study is towards the methodology to access the determinants of brain-drain. The methodology used for present empirical analysis is a bipolar specification of augmented gravity model (to be explained in next section).

Above all, instead of determining relationship between highly-qualified and highly skilled emigrants from Pakistan and individual determinant which limits the scope of analysis, the present study constructs and uses indices by grouping variables belonging to various categories through the technique of principal component analysis as was used by Monteleone and Torrisi (2010). This technique is used to sack a large number of variables into indices, without severely compromising the information available in data, as in principal component analysis we retain leading uncorrelated principal components with maximum information in data on a set of variables grouped in a single index. Finally, the estimation technique is not limited to only simple panel regression analysis; we further select between the fixed effects least square dummy variables specification and the random effects estimated generalized least squares specification. We apply post estimation model specification tests namely, Lagrange Multiplier (Breusch-Pagan, Honda, and King-Wu) tests, Wald test and

Hausman specification tests for the final more appropriate specification of the selected model.

Remaining portion of the paper is organized as follows. In section 2, we explain methodology to be pursued for specification of the model. In section 3, data sources are discussed. Section 4 presents the construction of indices on the basis of principal component analysis and in section 5, model selection on the basis of diagnostic tests is finalized. In this section, empirical results are also presented along with analysis. Finally, section 6 concludes the study and provides policy recommendations.

2. Methodology

In order to explore the factors possibly causing emigration of highly qualified and highly-skilled manpower from Pakistan, we consider a bipolar specification of augmented gravity model, which is hybrid of the pull-push factors of migration models (Lee, 1966; Rogers, 1967; Datta, 2002; and Mayda, 2007) and the gravity models of migration (Flowerdew and Salt, 1979; Karemera, et al., 2000; Rose, 2002; and Kim and Cohen, 2010). Pull and push factors are simultaneously used to depict the interregional disparities at macro level e.g., differences in employment opportunities between the source and destination countries resulting in differences in standards of living. In essence, the pull factors identify the positive characteristics and attracting features at the center of destination that induce immigration to destination country, while push factors attribute to the negative depressing characteristics or poor economic and social opportunities in homeland that trigger emigration. The terms bipolar and gravity are used for net effect of both the pull and push forces at centers of destination and home country. These net effects are depicted by differentials of push and pull factors in different indices. These indices are constructed by using principal component analysis based on ordinary correlations and eigenvalues associated with component of an index. The econometric specification of the augmented gravity model of human capital flight, more specifically net brain-drain is proposed to be as follows.

$$NETBD_{it} = \alpha_0 + \alpha_1 ECON_{it} + \alpha_2 FINS_{it} + \alpha_3 FININ_{it} + \alpha_4 LIVIN_{it} + \alpha_5 DEMO_{it} + \alpha_6 LMKT_{it} + \alpha_7 SNET_{it} + \alpha_8 OPEN_{it} + \varepsilon_{it} \quad (1)$$

The variables' notations are explained as follows.

$NETBD_{it}$: Net brain-drain per hundred thousand population of Pakistan to destination country i in year t

$ECON_{it}$: Index of relative economic incentives

$FINS_{it}$: Index of relative financial stability

$FININ_{it}$: Index of relative financial independence

$LIVIN_{it}$: Index of relative standards of living

$DEMO_{it}$: Index of relative demographic characteristics

$LMKT_{it}$: Index of relative labor market structure

$SNET_{it}$: Index for relative provision of social safety nets

$OPEN_{it}$: Index of relative social openness

ε_{it} : Random error term with zero mean

Each index in the above equation covers and is based on a set of variables. Principal Component Analysis is used to construct these indices, which are linear weighted combination of original uncorrelated components (particularly, pull and push variables affecting the human capital flows). The technique of principal component analysis introduced by Pearson (1901) and endorsed by Hotelling (1933, 1936) is best fitted for data set of multiple dimensions to reduce them into a smaller number of manageable dimensions and at the same time to retain maximum information in the data. This method is particularly appropriate when we are confronted with the utilization of a large number of similar variables in regression analysis and need to translate them into a manageable number of aggregates or indices.

For each index a number of push and pull factors are considered. For example, in the index of relative economic incentives a push factor is low per capita income in source country, Pakistan, while the corresponding pull factor is high per capita income in the destination country. The push and pull factors are combined by considering the percentage difference in the corresponding variable in destination country i relative to Pakistan, that is, $100\left(X_{it} - X_{Pt}\right)/X_{Pt}$. In case the variable is already unit free, like in percentage form, we consider the simple difference as $X_{it} - X_{Pt}$.

We now explain how all these indices presented in the equation (1) are constructed. According to Monteleone and Torrisi (2010) a dominating reason for emigration is economic incentive. Grogger and Hanson (2011) suggest that earning gaps are drivers of emigration. Besides other determinants of brain drain, Mayda (2007) consider average income and income dispersion in countries of

origin and destination. Solimano (2002) asserts that expectation of higher per capita income abroad is the main cause of decision to emigrate. On theoretical and empirical basis we propose the following index of relative economic incentives, $ECON_{it}$.

$$ECON_{it} = \beta_1 PCI_{it} + \beta_2 GPCI_{it} + \beta_3 GCF_{it} + \beta_4 ABS_{it} \qquad (2)$$

where

PCI_{it} : Relative per capita gross national income

$GPCI_{it}$: Percentage annual growth rate of per capita GDP relative to Pakistan

GCF_{it} : Gross capital formation as a percentage of GDP relative to Pakistan

ABS_{it} : Domestic absorption as a percentage of GDP relative to Pakistan

In equation (2), per capita income differential indicates current relative economic conditions, while the differential in growth and capital formation indicate relative future prospects. Domestic absorption relative to GDP (gross domestic product) is taken as an indication of business cycle. According to Solimano (2002), beside other factors, the magnitude and direction of international migration flow are influenced by the state of business cycle and economic prospects in both sending and receiving countries. Mitra, et al. (2011) explored the impact of financial liberalization on the migration of highly-skilled labor force to OECD countries. They used robustness of financial markets and their freedom as indicators of financial liberalization. Therefore, on the basis of the theories of migration the index of financial relative stability, $FINS_{it}$, is constructed as follows.

$$FINS_{it} = \delta_1 REER_{it} + \delta_2 GEQTY_{it} + \delta_3 RES_{it} + \delta_4 FDI_{it} + \delta_5 TURN_{it} \qquad (3)$$

where

$REER_{it}$: Real effective exchange rate index (2010=100) relative to Pakistan

$GEQTY_{it}$: Annual percentage change in S&P Global Equity Indices relative to Pakistan

RES_{it} : Relative total reserves (including gold) as a percentage of GDP

FDI_{it} : Relative foreign direct investment (net inflows) as percentage of GDP

$TURN_{it}$: Percentage of stocks traded, turnover ratio relative to Pakistan

According to Monteleone and Torrisi (2010), justification factors for migration include extension of power, prestige in host institutions, better employment opportunities and freedom of spending income. The study measures satisfaction level in host country by career prospects, favorable taxation environment, freedom to pursue professions, availability of scientific equipment, level of bureaucracy, and access to information and workplace safety. Differences in tax structure, in particular, matter for highly paid professions.

Clemens (2009) justifies professional advancement and better facilities to work in destination countries as pull factors for health workers from Africa. Keeping in view the existing literature on migration, we propose the following index of relative financial independence, $FININ_{it}$.

$$FININ_{it} = \phi_1 SEMP_{it} + \phi_2 TAX_{it} + \phi_3 MCAP_{it} + \phi_4 CREDIT_{it} + \phi_5 INTS_{it} \quad (4)$$

where

$SEMP_{it}$: Total self-employed workers as a percentage of total employed workers relative to Pakistan

TAX_{it} : Taxes on income, profits and capital gains as a percentage of total revenue relative to Pakistan

$MCAP_{it}$: Market capitalization of listed companies, per hundred thousand of population relative to Pakistan

$CREDIT_{it}$: Relative domestic credit to private sector by banks as a percentage of GDP

$INTS_{it}$: Percentage interest rate spread (lending rate minus deposit rate) relative to Pakistan

Although tax structures, taxation laws and compliance with tax laws differ across countries considerably, yet we restrict our attention to overall tax rate due to limited data requirements to calculate this variable. We claim that this variable is a good proxy for the overall taxation environment because it is the rate of taxation that determines how stringent and practical the tax laws are. Similarly, the way the CREDIT variable is constructed, it does not necessarily indicate the extent of financial availability of good indicator which warranted further discussion in that differing institutional independent because of differing

institutional factors across countries. For example, in developing countries like Pakistan, credit is also available through sources other than banks like informal money lenders and relatives[2].

According to Gibson and McKenzie (2011, 2012) and Clemens (2009), lifestyle and family safety are also important motives to emigrate. Therefore, we also consider the index of relative standard of living, $LIVIN_{it}$, constructed as following.

$$LIVIN_{it} = \gamma_1 GPCC_{it} + \gamma_2 HLTH_{it} + \gamma_3 LE_{it} + \gamma_4 ENER_{it} + \gamma_5 WATER_{it} + \gamma_6 SANI_{it} + \gamma_7 INF_{it} + \gamma_8 DOCS_{it} \quad (5)$$

where

$GPCC_{it}$: Annual growth rate of household final consumption expenditure relative to Pakistan

$HLTH_{it}$: Total health expenditure as a percentage of GDP relative to Pakistan

LE_{it}: Life expectancy at birth relative to Pakistan

$ENER_{it}$: Energy use (kg of oil equivalent per capita) relative to Pakistan

$WATER_{it}$: Percentage of population with access to improved water sources relative to Pakistan

$SANI_{it}$: Percentage of population with access to improved sanitation facilities relative to Pakistan

INF_{it}: Inflation rate (annual percentage increase in consumer price index) relative to Pakistan

$DOCS_{it}$: Number of physicians per hundred thousand people relative to Pakistan

Clemens (2009) finds that the rate of international brain-drain is based on a desire for skilled workers to agglomerate in highly populated developed areas. Mayda (2007) captures the impact of geographical, cultural and demographic

[2] The authors acknowledge with gratitude the suggestions made by referee in refining this index by including the index of economic freedom produced by Heritage Foundation of the USA. This suggestion, however, could not be taken up in the paper due to extreme tight time schedule.

factors of destination countries on migration flows. General form of the index of relative demographic characteristics, $DEMO_{it}$, is given by;

$$DEMO_{it} = \lambda_1 GPOP_{it} + \lambda_2 DENS_{it} + \lambda_3 URBAN_{it} + \lambda_4 YOUNG_{it} + \lambda_5 EDU_{it} \quad (6)$$

where

$GPOP_{it}$: Annual percentage growth rate of population relative to Pakistan

$DENS_{it}$: Population density (number of persons per square kilometer) relative to Pakistan

$URBAN_{it}$: Urban population as a percentage of total population relative to Pakistan

$YOUNG_{it}$: Population ages 15-64 as a percentage of total population relative to Pakistan

EDU_{it}: Labor force with tertiary education as a percentage of total labor force relative to Pakistan

Borjas (1987, 1996) notes a higher emigration level among tertiary-educated individuals than among less educated. Walsh (1974) showed that Irish net migration was responsive to relative labor market conditions in Ireland and Britain. The index of relative labor market structure, $LMKT_{it}$, is constructed as following.

$$LMKT_{it} = \pi_1 LFPR_{it} + \pi_2 UEMPR_{it} + \pi_3 DEP_{it} \quad (7)$$

where

$LFPR_{it}$: Labor force participation rate (Labor force as a percentage of total population) relative to Pakistan

$UEMPR_{it}$: Unemployment rate (unemployed labor force as a percentage of total labor force) relative to Pakistan

DEP_{it}: Age dependency ratio (age-dependent population as a percentage of working-age population) relative to Pakistan

According to a number of studies (e.g., Kapur and McHale, 2005; and Gibson and McKenzie, 2011, 2012), the factors like social safety nets, social protection welfare benefits lead to drainage of best and bright individuals to those destinations where all such facilities are available. We propose the following index of relative provision of social safety nets, $SNET_{it}$.

$$SNET_{it} = \theta_1 ODA_{it} + \theta_2 COMP_{it} + \theta_3 GRANTS_{it} + \theta_4 SUB_{it} + \theta_5 INS_{it} \quad (8)$$

where

ODA_{it} :Per capita net official development assistance relative to Pakistan

$COMP_{it}$: Compensation of employees as a percentage of government expenditure relative to Pakistan

$GRANTS_{it}$: Grants and other revenues as a percentage of gross national income relative to Pakistan

SUB_{it}: Subsidies and other transfers as a percentage of government expenditure relative to Pakistan

INS_{it}: Insurance and financial services as a percentage of service imports relative to Pakistan

According to Chichian (2012), media expansion and internet connections have facilitated globalization and hence brain-drain from Iran to United States of America. We propose the following index of relative social openness, $OPEN_{it}$.

$$OPEN_{it} = \rho_1 AIR_{it} + \rho_2 TOUR_{it} + \rho_3 INT_{it} + \rho_4 CELL_{it} + \rho_5 TRSER_{it} \quad (9)$$

where

AIR_{it}: Air transport registered carrier departures worldwide relative to Pakistan

$TOUR_{it}$: International tourism (number of arrivals) relative to Pakistan

$INTER_{it}$: Internet users per hundred thousand people relative to Pakistan

$CELL_{it}$: Mobile cellular subscriptions per hundred thousand people relative to Pakistan

$TRSER_{it}$: Trade in services as a percentage of GDP relative to Pakistan

3. Data Sources

The statistical analysis considers migration of skilled Pakistanis to 27 major recipient countries namely; Australia, Bahrain, Canada, China, Cyprus, France, Germany, Greece, Indonesia, Italy, Japan, Kuwait, Libya, Malaysia, Oman, Qatar, Russia, Saudi Arabia, Singapore, South Africa, Spain, Switzerland, Thailand, Turkey, the United Arab Emirates, the United Kingdom and the United States of America over the past 36 year i.e. 1981 to 2016. The dependent variable measures net-emigration of highly-qualified and highly-skilled persons from Pakistan per hundred thousand of population. Country-wise data on skilled migration are obtained from Bureau of Emigration and Overseas Employment, Government of Pakistan (BEOE). This data include all types of migrants (including students) who register them with BEOE and emigrate to seek job in destination countries. Data include a significant portion of migrants to Middle East countries that do not provide permanent residence to immigrants. Since this study mainly focuses on brain drain from Pakistan, it does not deal with return intentions of migrants or even with return migration.

Since the study uses extensive data on a large number of variables including socioeconomic, financial and demographic variables, we took advantage of a large number of sources. Full details on data source for each specific variable are available from the authors. To save space here we just mention the data sources used in the study, which include World Bank's World Development Indicators (WDI), Integrated Data Store (IDS) dataset, Entrepreneurship database and Doing Business database; IMF's International Financial Statistics Yearbook and Government Finance Statistics Yearbook; the United Nation's World Population Prospects and World Urbanization Prospects; World Health Organization's Global Health Expenditure Database and WHO Global Health Workforce Statistics; UNCTAD's Information and Telecommunication Technology Development Indices; ILO's Key Indicators of the Labor Market; Joint Monitoring Programme (JMP) of WHO and UNICEF; Standard and Poor's (S&P's) Global Stock Markets Factbook; Civil Aviation Statistics of the World of International Civil Aviation Organization and Yearbook of Tourism Statistics of World Tourism Organization. Detail of data required for construction of indices is provided in Table 1.

Table 1: Variables and Data Sources

Variables/Indices	Symbols	Definition/Explanation	Sources
Net brain-drain from Pakistan to destination country i in year t	$NETBD_{it}$	Net brain-drain from Pakistan to destination country per hundred thousand of population.	BEOE, GOP WDI, World Bank, World Population Prospects
Index of relative economic incentives	$ECON_{it}$	Weighted average of relative GNI per capita, percentage annual growth rate of per capita GDP, gross capital formation as a percentage of GDP and domestic absorption as a percentage of GDP relative to Pakistan.	WDI, World Bank ,IDS, World Bank, OECD database
Index of relative financial stability	$FINS_{it}$	Weighted average of real effective exchange rate index relative to Pakistan, relative annual percentage change in S&P Global Equity index, relative total reserves (including gold) as a percentage of GDP, relative foreign direct investment as percentage of GDP, and relative percentage of stocks traded.	WDI, World Bank ,IFS, IMF, GFS, IMF, IDS, World Bank, S&P's Global Stock Markets Fact Book
Index of relative financial independence	$FININ_{it}$	Weighted average of relative self-employed as a percentage of totals' employed, relative taxes on income, profits and capital gains as a percentage of total revenue, relative market capitalization of listed	WDI, World Bank, Doing Business Database, Entrepreneurship Survey, World Bank,

		companies per hundred thousand of population, relative domestic credit to private sector by banks as a percentage of GDP, and relative percentage of interest rate spread.	IFS, IMF, GFS
Index of relative standards of living	$LIVIN_{it}$	Weighted average of relative annual growth rate of household consumption expenditure per capita, relative total health expenditure as percentage of GDP, relative total years of life expectancy at time of birth, relative energy use, water source accessed by percentage of population, sanitation facilities in access of percentage of population, relative inflation rate, and physicians per hundred thousand of population.	WDI, World Bank, Global Health Expenditure Database, WHO, World Population Prospects, Eurostat: Demographic Statistics, JMP for water supply and sanitation, WHO/UNICEF, Global Health Workforce Statistics, WHO, IFS, IMF
Index of relative demographic characteristics	$DEMO_{it}$	Weighted average of relative annual percentage growth rate of population, relative population density, relative urban population as percentage of total population, relative	WDI, World Bank, World Population Prospects, World Bank Population

		population ages 15-64 as percentage of total population, and relative labor force with tertiary education as a percentage of total labor force.	Estimates, World Urban Prospects, World Bank, Labor Market Database, ILO
Index of relative labor market structure	$LMKT_{it}$	Weighted average of relative labor force participation rate, relative unemployment as a percentage of total labor force and relative age dependency ratio as a percentage of working-age population.	WDI, World Bank, World Population Prospects, World Bank Population Estimates, Labor Market Database, ILO
Index for relative provision of social safety nets	$SNET_{it}$	Weighted average of relative per capita net official development assistance, relative compensation of employees as a percentage of government expenditure, relative grants and other revenue as a percentage of GNI, relative subsidies and other transfers as a percentage of government expenditure, and insurance and financial services as a percentage of service imports.	WDI, World Bank , IDS, World Bank, GFS, IMF
Index of relative social openness	$OPEN_{it}$	Weighted average of relative air transport i.e., registered carrier departures worldwide,	WDI, World Bank, Civil Aviation

		relative international tourism (number of arrivals), relative internet users and mobile cellular subscriptions per hundred thousand of population, and relative trade in services as a percentage of GDP.	Statistics of World, World Bank, World ICT Development Report, Tourism Statistics

4. Construction of Indices

The indices mentioned in equations (2) to (9) are constructed by using principal component analysis (PCA) based on correlation coefficients and eigenvalues associated with each component of relevant index. In the panel setting, various indices can be computed either for each destination country separately or for all the destination countries combined. For each particular index, we prefer to compute one series by using one set of weights in PCA. In this way the variations in an index across countries indicate variations in the underlying factors rather than variations in weights. Since all decisions belong to one host country, that is, Pakistan; it makes sense that they assign equal weight to any particular factor irrespective of the potential country of destination to be chosen so that the migrants' decisions reflect the choices based on underlying socio-economic conditions prevailing in various countries relative to Pakistan. The results are presented in Table 2.

In applying PCA a number of considerations matter. Following Jaffers (1967), Cadima and Jolliffe (1995), Jolliffe and Uddin (2000) and Jolliff, et al. (2003) feasibility of components for the construction of each index is tested by Kaiser's measure of sampling adequacy (MSA). As shown in the table, the value of this statistic varies considerably across variables used in various indices ranging from 0.528 to 0.750, indicating moderate level of adequacy. Various criteria can be used to select the number of eigenvalues for the construction of indices. We apply the criteria of unity, that is, all the eigenvalues exceeding one are considered. In five of the eight indices, we end up retaining two eigenvalues. For the indices of relative labor market structure and for relative provision of social-safely nets ($LMKT_{it}$ and $SNET_{it}$) single eigenvalue is sufficient, while for relative standard of living ($LIVIN_{it}$), we retain three eigenvalues (see Table 2).

The factor score coefficients through Bartlett weighted least square (WLS) regression based algorithms (Bartlett, 1937) are then noted, which gives us a

complete picture of indices presented in first column of Table 2. Multiple-R is used to measure the validity of coefficients in each index, which ranges from 74.1 percent to 93.4 percent, indicating reasonably good fits. For the goodness of fit of Bartlett weighted least squares regressions, we rely on the value of Bentler-Bonnet Normed Fit Index (1980). The value of Bentler-Bonnet Normed Fit Index (NFI) is estimated to be above 90 percent in seven cases and 88.5 percent in one case (for index of relative economic incentives, $ECON_{it}$). Thus, based on goodness of fit indicators, the proposed models for construction of indices explains quite a high proportion of variation in the indices compared to the full potential model obtained by retaining all the eigenvalues.

Table 2: Drivers of Human Capital Flows from Pakistan (Based on Principal Component Analysis)

Indices (coefficient derived through Bartlett Weighted Least Square)	**Kaiser's MSA**	**Eigen-Values** (retained)	**Multiple-R** (for validity of coefficient)	**Goodness-of-Fit** (Bentler-Bonnet NFI)
$ECON_{it} = 0.145PCI_{it} + 0.164GPCI_{it} + 0.259GCF_{it} - 0.266ABS_{it}$	0.528	1.444 1.104	0.741	0.885
$FINS_{it} = 0.152REER_{it} - 0.036GEQTY_{it} + 0.659RES_{it} + 0.678FDI_{it} - 0.061TURN_{it}$	0.566	1.598 1.309	0.762	0.934
$FININ_{it} = -0.021SEMP_{it} + 0.112TAX_{it} + 0.335MCAP_{it} + 0.371CREDIT_{it} + 0.191INTS_{it}$	0.529	1.534 1.359	0.764	0.925
$LIVIN_{it} = -0.226GPCC_{it} + 0.518HLTH_{it} + 0.766LE_{it} + 0.439ENER_{it} + 0.878WATER_{it} + 0.721SANI_{it} - 0.038INF_{it} + 0.598DOCS_{it}$	0.727	3.205 1.132 1.097	0.934	0.984
$DEMO_{it} = 0.219GPOP_{it} + 0.259DENS_{it} + 0.399URBAN_{it} + 0.255YOUNG_{it} - 0.006EDU_{it}$	0.646	1.802 1.347	0.774	0.909
$LMKT_{it} = -0.845LFPR_{it} + 0.577UEMPR_{it} + 0.759DEP_{it}$	0.619	2.119	0.883	0.988
$SNET_{it} = 0.697ODA_{it} + 0.809COMP_{it} + 0.617GRANTS_{it} - 0.527SUB_{it} + 0.584INS_{it}$	0.750	2.717	0.893	0.960
$OPEN_{it} = 0.648AIR_{it} + 0.531TOUR_{it} + 0.678INT_{it} + 0.583CELL_{it} + 0.375TRSER_{it}$	0.555	2.249 1.157	0.857	0.965

5. Empirical Analysis of the Drivers of Brain Drain

After formulating eight potential drives through principal component method, we used to two methods namely, panel least squares and panel two-stage least squares (instrumental variables) models to estimate equation (1), to analyze

the impact of these potential on the observed net international migration of highly-qualified and highly-skilled manpower from Pakistan. Note that tests for existence of cross section and time effects are important for panel regression setting as these effects account for correct specification of regression equation and for its proper inference. Therefore Table 3 presents a brief sketch of how we proceed for appropriate model selection.

We apply model specification Lagrange Multiplier tests (Breusch-Pagan, Honda and King-Wu) for the possible presence of random effects. Since simultaneously both cross section and time series are not allowed in unbalanced panel data, we only consider cross-section random effects tests that are two-sided Breusch-Pagan and one sided Honda and one-sided King-Wu tests. In panel least squares as well as in panel two-stage least squares (instrumental variables) the null hypothesis for "no random effects" is rejected as all three of the cross section random effects tests have p-values well below conventional significance levels. Two-sided Breusch-Pagan (1980) statistics has value of 3201.81 and 2871.20 for panel least squares and panel two-stage least squares, respectively. While one-sided Honda (1985) statistics has value of 39.38 and 37.89 and King-Wu (1997) test statistics has value of 39.38 and 37.89 for panel least squares and two-stage least squares, respectively. In short, random effects specifications for both models are selected, which depict that all the destination countries are having same mean effect in present empirical analysis, due to common value for intercept term.

Next, we apply the fixed effects LSDV (least square dummy variables) specifications of both models. According to Cheng and Wall (2005), fixed effects LSDV specification is commonly used for augmented gravity models of trade in panel data analysis, as it allow for heterogeneity, as well as different intercept values. Two tests cross-section F (using sums-of-squares) and cross-section Chi-square statistics (using likelihood function) jointly constitute the Wald test, which is used to test whether all intercept dummies are equal to zero or not. Null hypothesis is that all dummies used for intercept differential are equal to zero against an alternative hypothesis that the fixed effects model specification is appropriate. The values of F and chi-square statistics (128.35, 840.41) leads us to rejection of null hypothesis and indicates that fixed effects LSDV specification is more appropriate than the pooled specification but this specification is not applicable for panel two stage least squares model.

A central assumption in random effects specification is that the random effects are uncorrelated with explanatory variables. One common method for testing this assumption is to apply Hausman (1978) test to compare the fixed and

Table 3: Fixed Effects and Random Effects Tests for Model Specification (Pair-Wise Selection Procedure)

<table>
<tr><th>S. No</th><th>Base Model</th><th>Model Specification</th><th colspan="4">Bench Mark Criterion</th><th>Test's Results</th><th>Conclusion</th></tr>
<tr><td rowspan="3">1.</td><td rowspan="3">Panel LS model</td><td rowspan="3">Cross section Random Effects specification of panel LS model</td><td colspan="4">Lagrange Multiplier Tests for Cross Section Random Effects</td><td rowspan="3">Panel LS model and panel 2SLS model, both have cross section random effects specification</td><td rowspan="9">In case of panel LS model fixed effects specification is appropriate while in case of panel 2SLS random effects specification is appropriate</td></tr>
<tr><td>Breusch-Pagan (p-value)</td><td>Honda (p-value)</td><td>King-Wu (p-value)</td></tr>
<tr><td>3201.805 (0.000)</td><td>39.375 (0.000)</td><td>39.375 (0.000)</td></tr>
<tr><td>Panel 2- SLS model</td><td>Cross section Random Effects specification of panel 2-SLS model</td><td>2871.203 (0.000)</td><td>37.887 (0.000)</td><td>37.887 (0.000)</td><td></td></tr>
<tr><td rowspan="3">2.</td><td rowspan="3">Panel LS model</td><td rowspan="3">Cross section Fixed Effects specification of panel LS model</td><td colspan="4">Wald Test for Fixed Cross Section Effects</td><td rowspan="3">Panel LS model has cross section fixed effects specification, but this specification is not applicable to panel 2SLS model</td></tr>
<tr><td colspan="2">Cross-section F-stats (df) Probability</td><td colspan="2">Cross-section Chi-square (df) Probability</td></tr>
<tr><td colspan="2">128.347 (26, 720) 0.000</td><td colspan="2">840.413 (26) 0.000</td></tr>
<tr><td>Panel 2 SLS model</td><td>Cross section Fixed Effects specification of panel 2 SLS model</td><td colspan="4">Cross section fixed effects specification is not applicable to 2-SLS model in present empirical analysis.</td></tr>
<tr><td rowspan="3">3.</td><td rowspan="3">Cross section Random Effects specification of panel LS model</td><td rowspan="3">Cross Section Fixed Effects specification of panel LS model</td><td colspan="4">Hausman Test for Model Specification</td><td rowspan="3">In case of panel LS model random effects specification is</td></tr>
<tr><td>Chi-square Statistics</td><td>Chi-square d.f</td><td>Prob of Chi-sq</td></tr>
<tr><td>9.389</td><td>8</td><td>0.402</td></tr>
</table>

	Cross section Random Effects specification of panel 2SLS model	Cross section Fixed Effects specification of panel 2SLS model	Cross section fixed effects specification is not applicable to 2SLS model in present empirical analysis.	appropriate but in case of panel 2SLS Hausman test is not applicable	

random effects estimates of coefficients. Insignificant Chi-square statistic (9.39) at 5-percent provides little evidence against the null hypothesis that there is no misspecification in the selection of random effects. Thus, in case of panel least squares method, random effects specification is appropriate while in case of panel two-stage least squares (instrumental variables) Hausman test is not applicable. The main conclusion that emerges from the this model specification procedure is that both simple panel least square and fixed effects specifications are rejected in favor of random effects model specification in case of panel least squares. In case of two-stage least square also random effects specification is more appropriate as compared to simple two stage specification.

After specification of models we now move to the estimation of the chosen models. These results are presented in Table 4. The sign and magnitude of coefficients obtained through these models support the theory of pull-and-push factors ascertaining to brain-drain in term of human capital flows from Pakistan. Results presented in the table show that both the models lead to more-or-less the same conclusions except for negligible difference in magnitude of the parameter estimates. The results show that the demand-based pull factors that are captured by the index of economic incentives $(ECON_{it})$, the index of relative financial stability $(FINS_{it})$, the index of relative standard of living $(LIVIN_{it})$ and the index of relative provision of social safety nets $(SNET_{it})$ positively and significantly induce immigration from Pakistan to destination countries. All these indices measure incentives for migration in terms of better socioeconomic and financial positions and, hence, act as strong pull factors at center of destination and induce immigration toward destination countries. These incentives are further supplemented by better score on the index of relative social openness $(OPEN_{it})$ which act as a pull factor. The components of this index include relative air transport *i.e.,* registered carrier departures worldwide, relative international tourism, relative internet user and mobile cellular subscriptions per hundred thousand of population, and relative trade in services as a percentage of GDP. All these factors mean that at the destination points the potential migrants expect to

have ample opportunities to remain integrated with their home countries and at the same time enjoy better living conditions.

Table 4: Regression Results of Selected Model Specifications

	Model-1: Cross Section Fixed Effects (LSDV Regression)			**Model-2: Cross Section Two Stage EGLS (IV) Random Effects Regression**		
	Coefficient	t-statistic	Prob.	Coefficient	t-statistic	Prob.
C	-2.245	(-0.054)	0.957	10.927	(0.861)	0.389
$ECON_{it}$	0.076	(3.804*)	0.000	0.079	(2.171*)	0.003
$FINS_{it}$	0.066	(2.917*)	0.003	0.072	(2.312*)	0.030
$FININ_{it}$	-0.083	(-2.377*)	0.007	-0.105	(-2.581*)	0.010
$LIVIN_{it}$	0.054	(2.009**)	0.044	0.121	(2.449**)	0.048
$DEMO_{it}$	-0.347	(-3.503*)	0.000	-0.413	(-3.551*)	0.000
$LMKT_{it}$	-0.042	(-1.512***)	0.076	-0.083	(-2.229*)	0.026
$SNET_{it}$	0.221	(4.905*)	0.000	0.296	(4.187*)	0.000
$OPEN_{it}$	0.331	(6.801*)	0.000	0.340	(7.304*)	0.000
R-squared	0.914			0.221		
Adj. R-square	0.901			0.211		
F-statistics	225.747			28.457		
Prob. (F-stats)	0.000*			0.000*		
Instrument Rank	---			9		

Note: in unbalanced panel data we are unable to use effects for cross section and time simultaneously. In parenthesis are the t-values. *, ** and *** indicate level of significant at 1%, 5% and 10%, respectively.

Beside these demand-based pull factors identifying positive characteristics and attracting features at center of destination, our empirical findings in Table 4 are also supportive to supply based push factors included in the index of relative demographic characteristics ($DEMO_{it}$) and the index of relative labor market structure ($LMKT_{it}$) that trigger emigration from homeland. When there is excess supply of labor force in the home country, people are compelled to leave the country for livelihood and sustenance. Composition of both these indices

presented in Table 2 shows that both $DEMO_{it}$ and $LMKT_{it}$ affect the supply of human capital and hence provide incentives for emigration and ultimately brain-drain from homeland. Surprisingly, the index of financial relative independence $FININ_{it}$ at center of origin, also acts as a push factor for emigration and hence human capital flight from Pakistan. The index $FININ_{it}$ is a weighted average of variables which facilitate the doing business prospects, and hence develop a confidence in migrant to be capable of bearing the cost of migration and be able to settle in destination country with sound economic base.

6. Conclusions with Policy Recommendations

The objective of this research was to identify the drivers of intellectual migration in terms of highly-qualified and highly-skilled manpower from Pakistan. The study is based on panel data of migrants from Pakistan to 27 major destination countries over the period 1981 to 2016. The study employs principal components approach to construct various indices of socioeconomic and demographic factors based on a large set of variables. The main results were derived on the basis of latest available formal econometric techniques.

The signs and the magnitudes of the parameter estimates of the model support the standard theory of migration and verify the presence of strong pull and push factors in the process of migration. The simultaneous analysis of push and pull factors provides guideline for policy making and further study to determine sources of human capital flight from Pakistan. In deriving policy implications of the result it is important not to forget that while brain drain inflicts significant losses for Pakistan in terms of the loss of highly qualified and skilled labor force, it also at the same time becomes a source of significant foreign exchange earnings for Pakistan. The first important lesson that we can derive from the study is that the excess supply of labor in Pakistan does not mean that all market driven solutions are necessarily optimal for Pakistan. In particular, it would take a long period of time to create sufficient new labor demand to absorb the excess supply of highly qualified and skilled workers. It would take even longer time period to create sufficient socioeconomic incentive for the highly qualified and skilled workers to stay in Pakistan rather than to migrate to relatively more attractive destinations. An alternative strategy could be to focus on replacing brain drain from Pakistan with training of competent locals at a rate faster than their departure. The composition of demographic and labor market indices used in the study indicates that for an over-populated country like Pakistan with high rate of unemployment, especially in the form of under and disguised

employment, the process of unplanned brain-drain has to be re-oriented to take the form of planned brain-export to improve the national balance sheet in favor of Pakistan through foreign earnings, in the forms of foreign direct investment and remittances, in case of brain export;, and the return of more-experienced manpower and the achievement of professional and technical education, in case of brain circulation through return intentions of Pakistani diasporas. In short, there is a need to conduct a comprehensive cost-benefit analysis of the prevalent migration trends.

References

Ahmad, N., Hussain, Z., Sial, M. H., Hussain, I., & Akram, W. (2008). Macroeconomic determinants of international migration from Pakistan. *Pakistan Economics and Social Review, 46*(2), 85-99.

Altaf, M. A., & Obaidullah. (1992). The spatial pattern of international labor flows from and to Pakistan: A preliminary analysis. *The Pakistan Development Review, 31*(2), 145-164.

Arif, G. M., & Irfan, M. (1997). Population mobility across the Pakistani border: Fifty years' experience. *The Pakistan Development Review, 36*(4), 989-1009.

Bartlett, M. S. (1937). The statistical conception of mental factors. *British Journal of Psychology,* 28, 97-104.

Bentler, P. M., & Bonett, D. G. (1980). Significant tests and goodness of fit in the analysis of covariance structure. *Psychological Bulletin,* 88, 588-606.

BEOE. (2016). *Migration statistics of Pakistan*, Bureau of Emigration and Overseas Employment database, Government of Pakistan. Retrieved from www.beoe.gov.pk/reports-and-statistics.

Bhagwati, J. N. (1979). International migration of the highly skilled: Economics, ethics and taxes. *Third World Quarterly Journal*, *1*(3), 17-30. doi:10.1080/01436597908419437.

Bhagwati, J. N., & Hamada, K. (1974). The brain drain, international integration of markets for professionals and unemployment: A theoretical analysis. *Journal of Development Economics, 1*(1), 19-42. doi:10.1016/0304-3878(74)90020-0.

Borjas, G. J. (1987). Self-selection and the earnings of immigrants. *American Economic Review, 77*(4), 531-53.

Borjas, G. J. (1996). The new economics of immigration, *Atlantic Monthly, 278*(5), 7280.

Brettel, C. B., & Hollifield, J. F. (2014). *Migration theory: Talking Across Disciplines*. Third edition, London and New York: Rout-ledge Publishers.

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specifications in econometrics. *Review of Econometric Studies,* 47, 239-253.

Cadima, J., & Jolliffe, I. T. (1995). Loadings and correlations in the interpretations of principal components, *Journal of Applied Statistics,* 22, 203-214.

Cheng, I. H., & Wall, H. J. (2005). Controlling for heterogeneity in gravity models of trade and integration. *Federal Reserve Bank of St. Louis Review, 87*(1), 49-63.

Chichian, M. A. (2012). The new phase of globalization and brain drain: Migration of educated and skilled Iranians to the United States. *International Journal of Social Economics, 39*(1/2), 18-38.doi: 10.1108/03068291211188857.

Clemens, M. (2009). Skill flows: A fundamental reconsideration of skilled-worker mobility and development, *Center for Global Development* (CGD), Working Paper No. 180.

Datta, P. (2002). Nepali migration to India. Paper presented in the *Regional Population Conference, South East Asia's Population in a Changing Asian Context* organized by International Union for The Scientific Study of Population, Bangkok, Thailand.

Doghri, L., Khalafalla, K. Y., Diagne, M., & Jam., A. B. (2006). Converting brain drain into gain in Pakistan, in report on brain drain in IDB member countries: Trends and development impact, *Islamic Development Bank,* occasional paper No. 12, Rabi Al-Thani 1427-Hijri.

Flowerdew, R., & Salt, J. (1979). Migration between labor market areas in Great Britain, 1970-1971, *Regional Studies, 13*(2), 211-31. Doi: 10.1080/09595237900185181.

Gibson, J., & McKenzie, D. (2011). The microeconomic determinants of emigration and return migration of the best and brightest: evidence from the Pacific, *Journal of Development Economics, 95*(1), 18-29.

Gibson, J., & McKenzie, D. (2012). The economic consequences of brain drain of the best and brightest: Microeconomic evidence from five countries. *The Economic Journal, 122*(560), 339-75.

Gilani, I., Mir, A. H., & Malik, E. (2007). Pakistan infrastructure implementation capacity assessment (PIICA). S*outh Asia Sustainable Development Unit (SASSD),* Report No. 43186-PK. doi: 448813-1202436185914/PIICfull.pdf.

Gishkori, Z. (2015). Worrying signs: 3,400 Pakistani give up nationality in five years. *The Express Tribune Pakistan,* (April 8).

GOP. (2016). *Economic Survey of Pakistan 2015-16*, Finance Division, Government of Pakistan, Retrieved from

http://hdl.handle.net/123456789/13877.

Grogger, J. & Hanson, G. (2011). Income maximization and the selection and sorting of international migrants. *Journal of Development Economics, 95*(1), 42-57.

Grubel, H. B., & Scott, A. D. (1966a). The international flow of human capital. *The American Economic Review, 56*(1/2), 268-274.

Grubel, H. G., & Scott, A. D. (1966b). The immigration of scientists and engineers to the United States, 1949-61. *Journal of Political Economy*, *74*(4), 368-378.

Grubel, H. G., & Scott, A. D. (1967). Determinants of migration: The highly skilled. *International Migration, 5*(2), 127-139, doi/10.1111/j.1468-2435.1967.tb00758.x/full.

Grubel, H., & Scott, A. (1977). *Brain Drain: Determinants, Measurement and Welfare Effects*. Waterloo, Ontario, Canada: Wilfrid Laurier University Press.

Hausman, J. A. (1978). Specification tests in Econometrics, *Econometrica,* 46, 1251-1272.

Honda, Y. (1985). Testing the error components model with non-normal disturbances. *Review of Economics Studies,* 52, 681-690.

Hotelling, H. (1933). Analysis of a complex of statistical variables into principal components. *Journal of Educational Psychology,* 24, 417-441, and 498-520.

Hotelling, H. (1936). Relations between two sets of variables. *Biometrika,* 28, 321-377.

Iravani, M. R. (2011). Brain drain problem: A review. *International Journal of Business and Social Science, 2*(15), 284-289.

Jaffers, J. N. R. (1967). Two case studies in the application of principal component analysis. *Applied Statistics,* 16, 225-236.

Jolliffe, I. T., & Uddin, M. (2000). The simplified component technique: An alternative to rotated principal components, *Journal of Computational Graphical Statistics,* 9, 689-710.

Jolliffe, I. T., Trendafilov, N. T., & Uddin, M. (2003). A modified principal component technique based on the LASSO (least absolute shrinkage and selection operator), *Journal of Computational and Graphical Statistics, 12*(3): 531-547. doi: 10.1198/1061860032148.

Kapur, D., & McHale, J. (2005). Give us your best and brightest: The global hunt for talent and its impact on the developing world. *Center for Global development,* Washington-DC.

Karemera, D., Oguledo, V. I., & Davis, B. (2000). A gravity model analysis of international migration to North America. *Applied Economics, 32*(13), 1745-1755.

Kim, K., & Cohen, J. E. (2010). Determinants of international migration flows to and from industrialized countries: A panel data approach beyond gravity. *International Migration Review, 44*(4), 899-932.

King, M. L., & Wu, P. X. (1997). Locally optimal one sided tests for multi-parameter hypotheses, *Econometric Review,* 16, 131-156.

Lee, E. S. (1966). A theory of migration, *Demography, 3*(1), 47-57. doi: 10.2307/2060063.

Mayda, A. M. (2007). International migration: A panel data analysis of the determinants of bilateral flows. *Journal of Population Economics, 23*(4), 1249-1274.

Mitra, A., Bang, J. T. & Wunnava, P. V. (2011). Financial liberalization and the brain drain: A panel data analysis. IZA Discussion Paper No. 5953

Monteleone, S., & Torrisi, B. (2010). A micro data analysis of Italy's brain drain. *Munich Personal RePEc Archive (MPRA),* Paper No. 20995.

Pearson, K., (1901). On lines and planes of closets fit to system of points in space. *Philosophical Magazine, 2*(11), 559-572.

doi: 10.1080/14786440109462720.

Rogers, A. (1967). A regression analysis of interregional migration in California, *The Review of Economics and Statistics, 49*(2), 262-267.

Rose, A. K. (2002). Estimating protection through residuals from the gravity model. *The World Economic Outlook (WEO),* by International Monetary Fund (IM F), Research Department.

Solimano, A. (2002). Globalizing talent and human capital: Implications for developing countries. Paper presented at the Annual Bank Conference on Development economics for Europe, held in Oslo Norway, June 24-26.

United Nations. (2015). *Trends in International Migrant Stock: The 2015 Revision*, The Department of Economic and Social Affairs, The United Nation's dataset.

United Nations. (2015). *World Population Prospects: The 2015 Revision*, Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. doi/10.1111/j.1728-4457.2015.00082.x.

Walsh, B. M. (1974). Expectations, information and human capital migration: Specifying an econometric model of Irish migration to Britain. *Journal of Regional Science,* 14, 107-120.

World Bank. (2016). *Migration and Remittances Fact Book 2016*, third edition, International Bank for Reconstruction and Development. ISBN-10:1464803196 and ISBN-13: 978-1464803192.