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EVALUATION OF BRAIN DRAIN IN TERMS OF COUNTRY RISK RATINGS: APPLICATIONS OF SHRINKAGE METHODS

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ABSTRACT

Brain drain, defined as the one-way movement of educated and skilled human capital to developed countries, stands out as a major socio-economic problem for underdeveloped and developing countries. In this respect, brain drain has been examined from different perspectives in both theoretical and empirical literature. The aim of this study is to provide an empirical analysis of the brain drain in terms of economic, financial and political risk ratings of countries, which contain many components. To this end, cross-sectional data from high-income and middle-income countries for 2021 were used. The impact of the country risk ratings on the brain drain has been examined by using the Shrinkage methods. The results suggest that economic risk is important for both groups of countries, but the impact coefficient is higher for developed countries. While the impact of political risk is more pronounced in the developed world, the impact of financial risk is more pronounced in the developing world. Based on the conclusion that the impact of country risk factors on brain drain is important for both groups of countries, not only developing countries but also developed countries should focus on policies aimed at retaining skilled labour.

Keywords: Human Capital, Brain Drain, Regression, Shrinkage
Jel Codes: F22, J24, G20, C31

BEYİN GÖÇÜNÜN ÜLKE RİSK DERECELERİ BAKIMINDAN DEĞERLENDİRİLMESİ: SHRINKAGE YÖNTEM UYGULAMALARI

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ÖZET

Eğitimli ve vasıflı insan sermayesinin genellikle tek yönlü olarak gelişmiş ülkelere doğru hareketi olarak ifade edilen beyin göçü az gelişmiş ve gelişmekte olan ülkeler açısından önemli bir sosyo-ekonomik sorun olarak öne çıkmaktadır. Bu bakımdan beyin göçü gerek teorik gerekse ampirik literatürde farklı perspektiflerden mercek altına alınmıştır. Bu çalışmanın amacı beyin göçünün birçok bileşeni içinde barındıran ülke ekonomik, finansal ve politik risk dereceleri bakımından ampirik olarak incelenmesidir. Bu amaçla 2021 yılına ilişkin yüksek gelir grubu ve orta gelir grubu ülkelerine ait yatay kesit veriler ile çalışılmıştır. Ülke risk puanlarının beyin göçü üzerindeki etkisi Shrinkage yöntemi modellerinden faydalanılarak araştırılmıştır. Elde edilen bulgular ekonomik riskin her iki ülke grubu için önemli olduğunu ancak gelişmiş ülkelerdeki etki katsayısının daha yüksek olduğunu önermiştir. Politik riskin etkisi gelişmiş ülkelerde öne çıkarken, finansal riskin etkisi gelişmekte olan ülkelerde dikkat çekmektedir. Ülke risk faktörlerinin beyin göçü üzerindeki etkisi her iki ülke grubu için de önemli olduğu sonucuna dayanarak sadece gelişmekte olan ülkeler değil gelişmiş ülkeler de nitelikli iş gücünü elinde tutmayı hedefleyen politikalara odaklanmalıdır.

Anahtar Kelimeler: Beşeri Sermaye, Beyin Göçü, Regresyon, Shrinkage

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1. INTRODUCTION

Migration is the activity of individuals leaving the geographical and socio-cultural region they live in and entering a different geographical and socio-cultural region. On the other hand, when evaluated in terms of its results, it is known that migration activity does not only consist of changing the environment in which people live. It is possible to express the concept of migration as population movements that affect the social structure in social, cultural, political and economic aspects (Emgili, 2006:190).

When the concept of migration is analysed historically, it is seen that it has changed the fate of individuals, societies and geographies. While migration may occur in line with the desires of individuals, it may also occur for reasons such as social conflicts, politics, internal or external wars, drought, famine, food supply and the expectation of a better life. Like the changes in many concepts from past to present, the concept of migration has also diversified and undergone changes over time.

Migration, which is of great importance to societies, can be assessed under two general headings: internal and external migration. In addition, when evaluating it in terms of its purpose, it is possible to categorise it as economic migration - non-economic migration; voluntary migration - involuntary migration in terms of the factors that trigger migration; temporary migration - permanent migration in terms of duration; transit migration - resident migration in terms of final settlement; legal migration - illegal migration in terms of legal status; and skilled (brain) migration - unskilled migration in terms of the characteristics of the migrant (Güllüpınar, 2012:57).

As a result of reasons such as the effects of globalisation, which increased after the 1980s, and the transition from a bipolar world order to a unipolar or multipolar order, migration and immigration have gained new meanings and have been transformed into a structure different from their previous characteristic structure. Today, migration has gained an international structure and is no longer an issue that affects only few countries but has started to affect the whole world (Çağlar, 2018:28).

Although these migrations often cause some concerns and problems on the part of the country and its citizens, they cannot be completely stopped due to several reasons. From past to the present, several resources that countries have and how they can direct these resources have determined the fate of countries. In the economic literature, economic progress is attributed to the forces of production, including labour, capital, natural resources and technology. Other indirect determinants, in varying order of importance, constitute the channels of economic growth. One of the other variables, the political factor and the associated notions of stability and instability, stands out as a crucial element in influencing economic success. Various political variables affect the economy. These channels can occur through investment, finance, politics and other unpredictable channels (Timur, 2019:12).

This study focuses on *human capital*, which is one of the most important production factors of countries, and *brain drain*, which is defined as the migration of its qualified form. In this context, the rest of the study is organised as follows. Section 2 analyses the concept of brain drain, reviews relevant literature, and mentions the risk ratings developed by the International Country Risk Guide (ICRG). Section 3 describes the methodology and data collection process. The results are reported and interpreted in section 4. Finally, section 5 concludes the study.

2. BRAIN DRAIN CONCEPT AND RISK FACTOR

Today, with the help of increasing communication tools and technology, the speed of circulation of information has accelerated more than ever in the past. It is known that the nations that possess this information develop faster than others. For this reason, the wealth or potential of countries today is not only measured by their underground and surface wealth, but also by the values such as patents, inventions, innovations and brands they create. For this reason, human resources that have, can access or create this knowledge have become very valuable today.

In the current era, human capital is one of the most important elements of the development strategies of countries. Especially the rapid growth rates experienced in economies because of developments such as the industrial revolution and globalisation have further increased the importance of qualified human capital. The qualifications sought in the migration of human capital vary according to periods. While the resources related to the need for human capital were mostly provided by national dynamics until 1945, after the human losses caused by World War II, especially European countries demanded low-skilled labour from abroad. Since the 1990s, with the acceleration of labour mobility due to globalisation, qualified people have started to migrate to countries with better living conditions, more economic opportunities and personal development opportunities (Kahya, 2022:820).

Labour migration is generally evaluated differently from refugee or asylum seeker migration and is generally classified as skilled, semi-skilled and unskilled labour migration. The term "brain drain", which is qualified as skilled labour migration, refers to the movement of skilled, educated or competent people, mostly from developing countries to developed countries. It is defined as settling in a developed country that provides these opportunities due to reasons such as limited job opportunities in the field in which the person lives in his/her country of residence, inability to receive adequate remuneration for his/her work, or the desire to live in better living standards (Sayın et al., 2016:3).

Research on migration has attempted to explain it by analyzing 'push' and 'pull' factors. Push factors are those that force individuals to move voluntarily. Examples include poor economic activity, drought, internal conflict, famine, education, racism and war. Pull factors, on the other hand, are factors that attract people to leave the area in which they live. Attractive factors are usually the opposite of push factors and promise individuals opportunities for peace and prosperity (Krishnakumar and Indumathi, 2014:9).

Although the definitions suggest that brain drain is beneficial to the migrant, the migrant is often not the only beneficiary. Moreover, high employment opportunities alone cannot explain why developed countries continue to import highly skilled workers. No matter how much the supply of high-skilled workers increases, some countries may still face labour shortages. It takes time to train a skilled worker, and it also takes time and money. Importing a skilled worker instead means using that person at almost no cost for training. His or her education and acquisition of knowledge and skills are paid for by his or her nation. The country of immigration benefits from the presence of this person without having to invest in his or her education or make any expenditures. In this case, the immigrant's country is profitable in terms of investment in education and it is assumed that the immigrant saves as much as the investment made by the immigrant. These savings cover the cost of the R&D investment. As a result, the cost of educating these people in their own country is redirected to a more productive sector. Considering the contribution of this person to social and economic development, it is clear how much the immigrant country gains from this deal (Erkal, 2011:75).

Although migration has some limited positive effects for countries with problems such as unemployment and budget deficit, migration has some limited positive effects for the countries that emigrate, the migration of skilled people leads to problems in the long run. These countries, deprived of qualified human resources, cannot break out of the poverty spiral, entering a kind of vicious circle. When assessing the causes of brain drain in the literature, the importance of the effect of the risk factor stands out. Therefore, countries that want to reduce brain drain must first eliminate or at least reduce all existing and potential risks. In addition, it is very important to give these people the material and moral value they deserve and to provide them with a suitable working environment.

As the topic of migration has been discussed in the literature for many years, there are many studies analysing national and international migration in this field. Although the focus of the studies varies at the sub-section level, they generally focus on the causes of migration.

Naseem (1979) conducted a study on the brain drain from Pakistan. In his study, he analysed the migration according to periods and occupational groups. He also developed some suggestions by looking at issues such as Pakistan's development strategies and the approach of managers to brain drain. Connel and Engels (1983) analysed the migration of Indian doctors to Australia. They found that Australia has saved a considerable amount of money through these migrations, but the benefits have been limited because it has not been able to manage these migrations effectively. Oommen (1989) analysed migration from India in his study. In his study, which is primarily concerned with brain drain, he explained why these people migrate, why they return and what should be done to encourage them to return. Astor et al. (2005) conducted a survey of doctors who migrated from Colombia, Nigeria, India, Pakistan and the Philippines to developed countries. Better income, access to high technology, security, stability and better life expectancy for their children were identified as the main reasons for migration. Altaş et al. (2006) conducted interviews with academics who had been educated abroad and returned home.

They found that homesickness was the most important reason for the return of academics who earned their living there on scholarships, while compulsory service was the most important reason for the return of academics who received scholarships from Turkey. The study also found that both groups wanted to share their experiences. In line with these findings, Güngör and Tansel (2008), in their study of Turkish students studying abroad, found that high salaries offered in the destination country, long periods of stay and respected lifestyle preferences reduce the likelihood of students returning. Pazarcık (2010) interviewed 145 social scientists of Turkish origin who had migrated to the USA and conducted research on migration. According to the results, it was concluded that brain drain is influenced by social and material factors such as academic freedom environment, research funding and opportunities, and that marital status, having investments in Turkey and having academic-social relations with Turkey are effective in the decision to return. Güloğlu (2014) conducted interviews with 15 Turks who went to New York, which can be characterised as a brain drain. According to the results obtained, reasons such as high-income expectations, professional opportunities and more personal freedoms were shown as reasons for migration. In addition, suggestions such as increasing opportunities, supporting the research of these people, eliminating the incompatibility between education and work, and persuasion efforts were offered as solutions. Arslan (2017), in his interviews with Turkish Ph.D. scientists living in the US, pointed out that a diaspora could not be formed. Moreover, he concluded that these scientists have limited contact with Turkey and are not involved in projects for Turkey's development. Kari et al. (2018), in their research based on secondary sources, analysed the push and pull factors for Nigeria. They found that industrialisation, education and vocational training activities can have a positive impact on slowing down illegal migration. Zanabar et al. (2021) conducted a field study with 498 Mongolians living in Seoul and found that the push and pull factors for migration are economic. Keskin et al. (2021) interviewed 142 people living in New Jersey as part of their study and found that as the level of education and quality of work increases, people's desire to return home decreases. Urbański (2022) analysed the push and pull factors influencing migration in Poland and Romania. It concludes that in both countries' attraction factors are more important than push factors.

As can be seen from the empirical literature on brain drain, it has been proven that different economic, political and demographic indicators affect brain drain. The evaluation of brain drain in terms of international country risk indicators, which includes many indicators, constitutes the attractive power of this study. The international country risk ratings are based on econometric modelling of economic and financial data obtained from central banks and many multilateral institutions by the PRS Group. Risk ratings are derived from the adoption of a comprehensive approach to geopolitical risk assessment that allows for the weighting, measurement and comparison of various risks to investment and business activities across countries and time (Howell, 2011).

Four risk ratings are established for ICRG nations: Political Risk, Economic Risk, Financial Risk, and Composite Risk. The political risk rating is devised to compare the political stability of countries. Government stability, socioeconomic conditions such as unemployment, poverty and consumer confidence, investment profile including the enforceability of contracts and repatriation of profits, payment delays, internal conflict such as the threat of coups, civil wars, terrorism and political violence, and civil disobedience, external conflict including cross-border conflict, war, and external pressures, corruption, military, religious tensions, law and order, ethnic tensions, democratic accountability and quality of bureaucracy are all crucial factors for the assessment of a country's political risk. The components of the economic risk rating, developed to evaluate a country's current economic strengths and weaknesses, are calculated using the ratios accepted within the national economic and financial structure. These components comprise gross domestic product (GDP) per capita, real GDP growth, annual inflation rate, budget balance as a percentage of GDP, and current account as a percentage of GDP. Thirdly, the PRS Group computes a financial risk rating to evaluate a country's capacity to finance its government, trade, and commercial debt obligations. Financial risk components comprise external debt as a percentage of GDP, external debt service as a percentage of goods and services exports, current account as a percentage of goods and services exports, net international liquidity as months of import coverage, and exchange rate stability. Finally, the composite risk ratings are determined by dividing the sum of the ratings for political, financial, and economic risks by two. For the ICRG, the lower the total of the risk ratings, the higher the risk, and the higher the total of the risk ratings, the lower the risk (Howell, 2011).

3. DATA SET AND METHODOLOGY

In this study, brain drain is evaluated using country risk ratings. The sample includes 29 high-income group countries[2] according to the World Bank's per capita income ranking, as well as ICRG countries. Additionally, 30 middle-income group countries[3] from upper-middle and middle-income groups are included in the empirical analysis. To represent the brain drain (BD) for the selected countries, the "Human flight and brain drain - Country rankings" data for 2021 was compiled from the Fragile States Index database, powered by The Fund of Peace. Political (PR), economic (ER) and financial (FR) risk ratings for 2021 are derived from the PRS Group's International Country Risk Guide.

[2] Australia Austria Belgium Canada Cyprus Denmark Finland France Germany Iceland Ireland Israel Italy Japan Korea, Republic Kuwait Luxembourg Malta Netherlands New Zealand Norway Qatar Singapore Spain Sweden Switzerland United Arab Emirates United Kingdom United States.

[3] Albania Argentina Belarus Botswana Brazil Bulgaria China, Peoples' Rep. Colombia Costa Rica Dominican Republic Gabon Guyana Kazakhstan Malaysia Mexico Panama Peru Romania Russia Serbia South Africa Thailand Turkey Azerbaijan Ecuador Guatemala Jamaica Libya Moldova Paraguay.

Cross-sectional data from groups of countries are analysed comparatively using statistical shrinkage models. These models, also known as penalised regression approaches, have been proposed to provide the most accurate explanation of the regression model and to eliminate strict least squares assumptions and variable selection problems. For this purpose, Hoerl and Kennard (1970) developed the Ridge Regression method, Tibshirani (1996) developed the Lasso Regression method, and Zou and Hastie (2005) developed the Elastic Net method. Statistical shrinkage models make coefficient estimates based on the penalty term. Shrinkage methods produce a more interpretable model with less estimation error by converging or equalising the regression coefficients to zero. As a result, these models are more continuous and less affected by high variability (Hastie, Tibshirani and Friedman, 2008). Coefficient estimates are obtained by adding a penalty parameter λ to the linear least squares method (Ayers and Cordell, 2010):

$$(y - X\beta)'(y - X\beta) + P(\lambda, \beta) \tag{1.1}$$

$$\hat{\beta} = arg\min_{\beta}\{OLS(\lambda, \beta)\} \tag{1.2}$$

The penalty term P (λ, β) determines how much the coefficients are narrowed by the penalty parameter λ. As the value of the penalty parameter increases, so does the effect of the penalty term on the coefficient estimates. Thus, the properties of the coefficient estimation vector $\hat{\beta}$ are determined and significant variables are selected for the model (Flexeder, 2010). The ridge regression method reduces the regression coefficients by applying a penalty to the size of the regression coefficients, producing estimators with lower variance and biased estimates. Ridge coefficients minimise the sum of the penalised residual squares (Hastie, Tibshirani and Friedman, 2008).

$$\hat{\beta}_{Ridge} = arg\min_{\beta}\left\{\sum_{i=1}^{N}(y_i - \beta_0 - \sum_{j=1}^{p} x_{ij}\beta_{ij})^2 + \lambda \sum_{j=1}^{p} \beta_j^2\right\} \tag{2}$$

Write the criterion of equation (2) in matrix form

$$RSS(\lambda) = (y - X\beta)^T(y - X\beta) + \lambda\beta^T\beta \tag{3.1}$$

$$\hat{\beta}_{Ridge} = (X^T X + \lambda I)^{-1} X^T y \tag{3.2}$$

In equations (3.1) and (3.2), $\lambda \geq 0$ is a complexity parameter that controls the amount of shrinkage. I is a pxp -dimensional unit matrix. The ridge regression solution is again a linear function of y with the choice of quadratic penalty $\beta^T\beta$. The coefficients are minimised towards zero (and each other). The idea of penalising according to the sum of the squares of the parameters is also used in neural networks, known as weight decay. Under the scaling of the inputs, the Ridge solutions are not equal and therefore the inputs are standardised before estimating equation (2). The intercept point β_0 is excluded from the penalty period, as can be seen in equation (2). The ridge estimate is the mode of the posterior distribution. Since the distribution is Gaussian, it is also the posterior mean. Ridge regression calculates the coordinates of y with respect to the orthonormal base in the same way as linear regression (Hastie, Tibshirani and Friedman, 2008).

Least squares and ridge estimators have high predictive power but some drawbacks. The ridge estimator is a stable estimator that narrows down the coefficients. However, as the regression coefficients cannot be set to zero in ridge estimation and are therefore not easy to interpret, Tibshirani (1996) developed the least absolute shrinkage and selection operator (Lasso) technique. Lasso, like Ridge, is a shrinkage method with subtle but important differences. The Lasso estimation equation and Lagrange form are defined as (4) and (5) respectively.

$$\hat{\beta}_{Lasso} = arg\min_{\beta}\{\sum_{i=1}^{N}(y_i - \beta_0 - \sum_{j=1}^{p} x_{ij}\beta_{ij})^2\} \quad \text{subject to } \sum_{j=1}^{p}|\beta_j| \leq t \qquad (4)$$

$$\hat{\beta}_{Lasso} = arg\min_{\beta}\{\sum_{i=1}^{N}(y_i - \beta_0 - \sum_{j=1}^{p} x_{ij}\beta_{ij})^2 + \lambda\sum_{j=1}^{p}|\beta_j|\} \qquad (5)$$

As in ridge regression, the constant β_0 is reparameterised by standardising the estimators, the solution to $\hat{\beta}_0$ is assumed to be $\bar{y}$, but a model without a constant term is fitted. Like the L_2 correction $\sum_{j=1}^{p}\beta_j^2$ used in Ridge regression, the L_1 correction $\sum_{j=1}^{p}|\beta_j|$ is used in Lasso regression. This second constraint makes the solutions y_i non-linear. There is no closed form expression as in Ridge regression. There is a quadratic programming problem in computing the Lasso solution, as in ridge regression. Due to the nature of the constraint, making t sufficiently small will cause some coefficients to be exactly zero, and so the lasso will perform a kind of continuous subset selection (Hastie, Tibshirani and Friedman, 2008). The advantage of lasso regression over ridge regression is that it excludes variables that do not contribute to the model. Ridge regression and Lasso regression have approximately the same bias, but the variance of the ridge regression is smaller than the variance of the Lasso regression. The mean value of error squares in Ridge Regression is smaller than Lasso Regression. Lasso and Rridge regression have similar properties: as λ increases, variance decreases and bias increases (James, Witten, Hastie, and Tibshirani, 2013). The Lasso penalty is relatively insensitive to the choice between a set of strong but correlated variables. The Ridge penalty, on the other hand, tends to minimise the coefficients of correlated variables towards each other (Hastie, Tibshirani and Friedman, 2008). Zou and Hastie (2005) proposed an alternative method to address these shortcomings. They generalised the Lasso estimator. The Elastic Net regression method is a combination of the Ridge and Lasso regression methods. This combines the advantages of Ridge L_2 and Lasso L_1 regression methods. The elastic net regression method is expressed as in equation (6).

$$\hat{\beta}_{EN} = arg\min_{\beta}\{\sum_{i=1}^{N}(y_i - \beta_0 - \sum_{j=1}^{p} x_{ij}\beta_{ij})^2 + \alpha\sum_{j=1}^{p}|\beta_j| + (1-\alpha)\sum_{j=1}^{p}\beta_j^2\} \qquad (6)$$

In equation (6), $\alpha\sum_{j=1}^{p}|\beta_j| + (1-\alpha)\sum_{j=1}^{p}\beta_j^2$ is defined as the elastic net penalty term. The second term promotes the averaging of the highly correlated features, while the first term promotes a sparse solution in the coefficients of these averaged features. Especially for regression or classification, the elastic net penalty can be used with any linear model.

4. FINDINGS

It would be appropriate to examine the descriptive statistics of the data before fitting the country group data to the regression model.

Table 1: Descriptive Statistics

	High Income Countries				Middle Income Countries			
	BD	ER	FR	PR	BD	ER	FR	PR
Mean	2.0000	32.7414	38.2241	80.4483	5.2000	28.2667	38.8500	63.4833
Median	1.9000	32.0000	38.5000	82.0000	4.9000	27.5000	38.7500	63.0000
Maximum	3.7000	43.5000	46.0000	89.0000	9.0000	38.0000	46.5000	72.5000
Minimum	0.5000	28.0000	29.5000	62.0000	3.0000	19.0000	34.0000	52.5000
Std. Dev.	0.8460	3.9111	4.1222	6.5579	1.5338	4.2644	3.4917	5.3571
Skewness	0.2575	0.9807	0.0370	-0.9884	0.9754	0.3831	0.4577	-0.0248
Kurtosis	2.3760	3.3842	2.1991	3.5005	3.1293	2.9831	2.2650	2.1478
Jarque-Bera	0.7910	4.8264	0.7818	5.0249	4.7780	0.7341	1.7228	0.9108
Probability	0.6733	0.0895	0.6765	0.0811	0.0917	0.6928	0.4226	0.6342

The difference between groups of countries is shown in Table 1. While middle-income countries have an average brain drain of 5.2, high-income countries have a measurement of 2. Looking at the economic risk ratings, the average is 32.74 for high-income countries and 28.26 for middle-income countries. It is worth noting that the average values of the financial risk ratings for the two groups of countries are very close to each other. Political risk averages 80.4 for high-income countries and 63.4 for middle-income countries. Table 1 shows that all series for both groups of countries are normally distributed at the 0.05 significance level. The results of the standard least squares estimation for both models are presented in Table 2.

Table 2: Standard Least Squares Results

	Middle Income		High Income	
	Coefficient	Std. Error	Coefficient	Std. Error
LER	-0.166081	0.244924	-0.908024	0.892658
LFR	-0.228699	0.432611	-0.259942	0.987679
LPR	0.580601	0.554487	-2.211967**	0.920808
C	0.591701	2.057740	14.39636***	4.803429
R-Squared	0.041424		0.229570	
F-Statistic	0.772079 (0.741962)		0.084094 (0.049503)	
White	12.45659 (0.1888)		11.76280 (0.2270)	

***, ** and * represent 0.01, 0.05 and 0.10 significance levels, respectively. : Values in parentheses are probability values.

As can be seen in Table 2, the coefficients of the LER, LFR and LPR variables were estimated to be -0.1660, -0.2286 and 0.5806 respectively for middle income countries. For high-income countries, the coefficients were estimated to be -0.9080, 0.2599 and -2.2119 respectively. The coefficients should be interpreted in the light of the definition of risk ratings. Before interpreting the coefficients, the shrinkage procedure was used to test for consistency with standard least squares estimates and the accuracy of the coefficient estimates.

Table 4: Estimation Results of Elastic Net Regularisation for Middle Income Countries

	Lasso	Ridge	Elastic Net
LER	-5.67E-08	-0.062401	-9.30E-08
LFR	0.000000	-0.036256	0.000000
LPR	0.000000	0.082262	0.000000
C	1.610363	1.609585	1.610363
λ	0.00372	1.116	0.007441
R-squared	5.72E-09	0.013965	9.38E-09
RMSE	0.2715	0.2696	0.2715

Table 4 compares the rolling window cross-validation estimation results for the lasso, ridge and elastic net methods for middle-income countries. Looking at the Lasso and Elastic Net estimates, the coefficients for financial and political risk were set to zero. According to these models, the relevant variables are not important in explaining brain drain. However, it was observed that the coefficients obtained by estimating using the Ridge method did not converge to zero. Once again, the λ coefficient obtained as a result of the ridge estimation is larger than the other two models, i.e. the variance is smaller in this model. Since the R-squared was the highest and the variance the lowest, it was decided that it would be more appropriate to interpret the coefficients as a result of the Ridge method. Accordingly, a 1% increase in the economic risk ratings are expected to reduce brain drain by 0.0624%. The brain drain is expected to decrease by 0.0362% for a 1% increase in the financial risk ratings. According to the ICRG, an increase in risk ratings is interpreted as a decrease in risk; therefore, a decrease in economic and financial risk in middle-income countries is expected to reduce brain drain. On the other hand, rising political risk is expected to reduce brain drain. On the other hand, rising political risk is expected to reduce brain drain. However, this finding is not in line with the push and pull migration theories.

Table 5: Estimation Results of Elastic Net Regularisation for High Income Countries

	Lasso	Ridge	Elastic Net
LER	-0.130226	-0.430843	-0.593388
LFR	-2.01E-09	-0.109804	0.000000
LPR	-1.158780	-0.565177	-0.970791
C	6.124957	4.968722	6.913575
Lamda	0.01667	0.6245	0.009066
L1 Norm	7.413963	6.074545	8.477754
R-squared	0.141818	0.121888	0.167996
RMSE	0.4448	0.4499	0.4379

The results of the estimation of the shrinkage methods for countries in the high-income group are presented in Table 5. The coefficient estimates for the lasso, ridge and elastic net penalty types were found to be approximately similar. While the coefficient of financial risk converges to zero according to the Lasso estimation, this coefficient is set to zero in the elastic net estimation. As for the group of middle-income countries, it is noteworthy that the coefficients obtained as a result of the Ridge method estimation do not converge to zero. For interpreting the coefficients, it was decided that the elastic net estimate with the lowest RMSE value was appropriate. Correspondingly, increasing the economic risk ratings by 1% reduces brain drain by 0.5933%.

The financial risk ratings were found to have no substantial effect on brain drain in high-income countries. Increasing the political risk ratings by 1% is expected to reduce brain drain by 0.9707%. In other words, reducing economic and political risk reduces brain drain in high-income countries. The results obtained for high-income countries support the push and pull migration theories.

5. CONCLUSION

Human capital is one of the most important factors of production. Its impact on a country's productivity and welfare has been well documented in growth theories. In the information age that we are in, the demand for skilled labour in national economies is on the increase day by day as a result of technological developments. It is well known that countries and international companies, aware of this, are trying to attract value-added labour from the rest of the world to protect and upgrade the existing labour potential. Today, many international companies make use of this type of transfer in a wide range of positions, including at management level. On the other hand, when the brain drain is assessed by the countries of origin, the situation refers to the loss of human resources invested over years. People who emigrate from these countries often do not return home, cannot contribute in any way, or even participate in projects against their country. This is why it is so important for countries that want to compete internationally to take steps to slow down or stop the brain drain. Or to create an environment that attracts these skilled labour forces. To do this, countries need to examine the causes of brain drain from different perspectives. This study examines the impact of ICRG's country risk ratings on brain drain within a group of middle- and high-income countries. According to the results, the increase in economic and financial risk in middle-income countries increases brain drain. The results in terms of political risk do not meet the expectations. Evidence from high-income countries suggests that increased economic and political risk increases brain drain. It is found that the financial risk score does not have a substantial impact on brain drain. It is observed that economic risk affects brain drain for both groups of countries. In terms of impact coefficients, the effect of economic risk on brain drain is higher for high-income countries. Given the components of the economic risk rating, such as inflation rate and GDP per capita, high-income countries may be more sensitive to changes in these data. On the other hand, the volatility of income sensitivity and risk perceptions of individuals living in these countries are different. On the other hand, while the financial risk rating is not significant in high-income countries, its impact on brain drain has come to the fore in middle-income countries. This may be explained by the liquidity problems these countries experienced during the financial crisis. This is because liquidity problems in these countries, some of which lack institutional infrastructure and/or financial integration and have fragile currencies, are felt more deeply in the markets. The increase in the political risk rating increases the brain drain in high-income countries. This is consistent with the expected rational behaviour and is in line with migration theories. However, no consistent results could be obtained for middle-income countries. In this study, the results for both groups of countries show that potential economic, financial and political crises will lead to mobility of skilled human capital in countries.

As a result, countries need to strengthen their institutional infrastructure and carry out structural reforms to eliminate crises that affect their citizens so deeply that they migrate.

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