ECONOMETRIC ANALYSIS OF HUMAN FLIGHT AND BRAIN DRAIN DETERMINANTS: EVIDENCE FROM THE FRAGILE STATES INDEX, 2006–2023

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Abstract

Current research seeks to explore the determinants of human flight and brain drain with the help of annual panel data gathered from the Fragile States Index (FSI) spanning 2006–2023. Employing suitable econometric modelling techniques to inspect the research to study political, economic, and social factors backing the emigration of skilled professionals from fragile nation-states. Our research applies a panel data approach, while the previous research was limited to cross-sectional analysis. This technique makes it possible to comprise temporal as well as entity-specific effects, and the research is therefore more robust and explanatory. This research reveals that Security Apparatus, Factionalised Elites, Economic Fragility, and Demographic Pressures all positively predict human flight. At the same time, Economic Inequality and Human Rights each negatively predict it, and thus show more complex, non-linear relationships than others. Additionally, External Intervention also positively predicts human flight, meaning that emigration declines as the intensity of foreign involvement declines. As such, institutional stability, resilience and demographics need to be addressed to mitigate talent outflow. The principal policy implications are therefore to restructure the governance mechanism and intensify job creation and “brain circulation” policies in fragile economies.

Keywords: Brain Drain, Human Capital Migration, Fragile States Index, Panel Data, Econometrics.

INTRODUCTION

On a global scale, the movement of human capital, particularly the emigration of highly qualified specialists, commonly referred to as "*intellectual migration*" or "*brain drain*", is one of the key factors influencing nations' socio-economic stability and competitiveness. And most of it is driven by economic, political, and institutional factors and profoundly affects countries’ competitiveness and growth. The Fragile States Index (FSI) by the Fund for Peace provides annual measures of political stability, economic decline, human rights, public services, and other factors that may influence emigration (FFP,

2023). Likewise, Lawan Ngoma and Wana Ismail (2013), described that domestic political instability and weaker governance correlate with higher-skilled migration (Groizard & Llull, 2007). Under globalisation, the outflow of skilled professionals driven by economic, political, and institutional factors has intensified the human capital shortage in national labour markets. In particular, the FSI's *Human Flight and Brain Drain indicator (E3)* considers the economic impact of human displacement, specifically the loss of productive, skilled professional labour. At the same time, in some countries, this process can have a positive impact, transforming into "brain circulation" or "knowledge exchange" that contributes to innovation and development. The research by Nawaz, Kadirova, Gazieva, Ismoyilov, and Nawaz (2025), shows that countries like the *United States* and the *United Kingdom* have effectively attracted highly skilled migrants, although they face continuing obstacles, including visa constraints, credential recognition, and integration challenges.

Previous studies suggest that political instability and weak institutions amplify brain drain (Docquier, Lohest, & Marfouk, 2007). Various international organisations and scholars have sought to identify the relationship between state fragility and migration in recent years. The research by Vega-Muñoz, González-Gómez-del-Miño, and Contreras-Barraza (2025) analysed the determining factor of human flight and brain drain with the help of an ANOVA model on cross-sectional data of all nations from the Fragile States Index established by the Fund for Peace. They acknowledged four statistically substantial variables persuading the phenomenon: Public Services (P2), External Intervention (X1), Economic Inequality (E2), and Economic Decline (E1). The research reported an inclusive R-squared of approximately 68%, giving valuable understandings. In accumulation, governmental stability and a strong security apparatus are key to mitigating talent drain by nurturing confidence in local institutions (Vega-Muñoz, Gónzalez-Gómez-del-Miño, & Espinosa-Cristia, 2021).

However, this cross-sectional approach offers a limited snapshot, as it does not account for entity-specific or temporal effects of variables. In contrast, this dissertation employs a panel data approach using the same data source, but data spanning 2006 to 2023 allows for control of entity-specific and temporal variations.

The main objective of current research is to investigate the causes of human flight and brain drain grounded on panel data covering the period 2006–2023, using econometric modelling procedures. Earlier research often relied on cross-sectional data, which provided only a short description and was unsuccessful in accounting for temporal dynamics or country-specific characteristics. In contrast, this research employs a panel data model that captures both time and entity variations, thereby increasing the reliability and explanatory power of the analysis.

The findings of this research will provide assistance in categorising the main causes of human capital migration and estimating the efficacy of state stability and social policy measures. Moreover, the findings offer valuable practical implications for international organisations and policy-making institutions in designing effective strategies for managing migration and promoting sustainable human capital development.

MATERIALS AND METHODS

This study uses data on the Fragile States Index developed by the Fund for Peace, which includes 14 variables: Security Apparatus, Factionalised Elites, Group Grievance, Economy, Economic Inequality, Human Flight and Brain Drain, Overall, State Legitimacy, Public Services, Human Rights, Rank, Demographic Pressures, Refugees and IDPs, and External Intervention.

We are going to exclude Overall and Rank variables, since they account for the rest of the 12 variables and have incredibly high correlation, as shown in Figure 1:

Figure 6: Kendall Rank Correlation Matrix

FINDINGS

The rest of the variables are calculated independently, without accounting for information from each other. High values for each variable mean greater fragility, whereas a lower score means better conditions.

Table 1: Descriptive Statistics

Based on descriptive statistics and its visualisations, our key observations about this dataset include:

i. Public Services, Group Grievance, and Security Apparatus have the highest average fragility scores, indicating major global weaknesses in infrastructure, social cohesion, and safety.
ii. External Intervention and Refugees/IDPs show the lowest average scores, suggesting fewer issues in these areas for most countries.
iii. Several indicators (e.g., State Legitimacy, Group Grievance) have bimodal distributions, indicating a divide between stable and unstable countries.
iv. High variability in Human Rights and Refugees/IDPs points to significant regional differences and outliers.
v. Most indices centre around moderate fragility (scores 5–7), calling for broad but tailored policy interventions.

DISCUSSION AND CONCLUSION

Expected Model

Y = B0 + B1X1 + B2X2 + B3X3 + B4X4 + B5X5 + B6X6 + B7X7 + B8X8+ B9X9 + B10X10 + B11X11, where:

Y = Fragile States Index - Human Flight and Brain Drain

X1 = Fragile States Index - Security Apparatus,

X2 = Fragile States Index - Factionalised Elites,

X3 = Fragile States Index - Group Grievance,

X4 = Fragile States Index - Economy,

X5 = Fragile States Index - Economic Inequality,

X6 = Fragile States Index - State Legitimacy,

X7 = Fragile States Index - Public Services,

X8 = Fragile States Index - Human Rights,

X9 = Fragile States Index - Demographic Pressures,

X10 = Fragile States Index - Refugees and IDPs,

X11 = Fragile States Index - External Intervention

These indicators are all related to instability, weak governance, or poor living conditions, typically leading to increased emigration, especially of skilled workers and educated professionals. Therefore, the expected sign for all Betas would be positive.

Actual Model 1

Model 1 (OLS)

There are seven Classical Assumptions:

i. The regression model is linear, is correctly specified, and has an additive error term ε..: FAILED
In order to check the linearity of the model, we plotted residuals versus fitted values, as shown in Figure 2. The figure's shape looks curved rather than perfectly linear.

Figure 7: Model 1 - Residual Values *vs* Fitted Values

In order to confirm the nonlinearity of this model, we have conducted the Ramsey RESET Test (Regression Equation Specification Error Test). Our test is based on the following hypothesis:

Null hypothesis (H_0): The model is correctly specified (linearity holds).

Alternative hypothesis (H_1): The model is mis-specified (linearity does not hold, or variables are missing).

If the test output has a p-value < 0.05, then we reject H_0, meaning that linearity is indeed violated. On the other hand, if p-value > 0.05, we accept H_0, suggesting that the linearity conditions hold.

The following output was generated for our OLS Model 1:

F-statistic: 12.5410, p-value: 0.0005

Here we reject p-value < 0.05 → reject H_0 → Linearity is violated.

ii. The error term ε has a zero population mean: PASSED
Model 1 has a mean of residuals: -0.000000

iii. All explanatory variables (X_Ki) are uncorrelated with the error term (ε_i): FAILED
Durbin-Wu-Hausman (DWH) test for endogeneity

Null Hypothesis (H_0): The variable is exogenous and is not correlated with the error term.

Alternative Hypothesis (H_1): The variable is endogenous and correlated with the error term.

coef = 1.0000, p-value = 0.000

This means the residual from the first-stage regression is statistically significant in explaining the dependent variable, so we reject the null hypothesis (H_0: regressor is exogenous).

iv. Observations of the error term are uncorrelated with each other (no serial correlation between ε_i and ε_j): PASSED
We tested for serial correlation using the Durbin-Watson statistic, which returned a value of 2.213. Since this value is close to 2, we conclude that no significant autocorrelation exists in the residuals. Therefore, Assumption 4 (No Serial Correlation) is satisfied.

v. The error term ε has a constant variance (no heteroskedasticity): FAILED

In order to check for heteroskedasticity, we have conducted the Breusch-Pagan Test with the following assumptions:

Null hypothesis (H_0): Homoscedasticity (constant variance of residuals).

Alternative hypothesis (H_1): Heteroskedasticity (non-constant variance).

The test output below shows p-value = 0.0004 (Lagrange) or 0.0002 (F-statistic) → Very small (well below 0.05), therefore we have to reject the null hypothesis.

Lagrange multiplier statistic: 33.6153

p-value: 0.0004

f-value: 3.5103

f p-value: 0.0002

So, there is heteroskedasticity in the model — this violates one of the classical OLS assumptions.

vi. No explanatory variable is a perfect linear function of any other explanatory variable(s) (no perfect multicollinearity): FAILED
For variables to pass multicollinearity tests, we expect their Variance Inflation Factor Test values to be less than 5. Our test outputs suggest that variables, namely Factionalised Elites, Economic Inequality, State Legitimacy, Public Services, Human Rights and Demographic Pressure, significantly violate this condition:

Also, if we check Figure 1 with Kendall Correlation, we can see that there is a high independent correlation between these pairs:

Economic Inequality and Public Services - 71%

State Legitimacy and Human Rights - 73%

Public Services and Demographic Pressure - 75%

vii. The error term ε is normally distributed (this assumption is optional but usually is invoked): PASSED
Jarque-Bera test tests for normal distribution:

Jarque-Bera (JB): 3.387

Prob (JB): 0.184

Null Hypothesis (H_0): The residuals are normally distributed.

Alternative Hypothesis (H_1): The residuals are not normally distributed.

p-value = 0.184 > 0.05 → We fail to reject the null hypothesis. According to the JB test, the model's residuals do not significantly deviate from normality, which is aligned with this assumption.

Actual Model 2

Based on failed conditions in the initial model, we decided to modify our model. First, to address nonlinearity, we will add nonlinear terms for nonlinear variables: Polynomial Transformation for Human Rights and External Interventions, and Log Transformation for the Economy variable, because of their independent nonlinear relationship. To address multicollinearity, we will drop one from a pair of highly correlated variables, specifically State Legitimacy and Public Services. In order to address

heteroskedasticity, we will use WLS (with Robust standard errors (HC3)) instead of OLS, which corrects heteroskedasticity.

These remedies leave us with the Model 2:

Model 2 (WLS with Robust Errors)

There are seven Classical Assumptions:

i. The regression model is linear, is correctly specified, and has an additive error term ε: PASSED
Figure 3 shows us an improved relationship between residuals and fitted values, compared to Figure 2:

Figure 8: Model 2 - Residual Values *vs* Fitted Values

To prove that we were able to get rid of the nonlinearity issue, we again conducted the Ramsey RESET Test:

F-statistic: 3.6158

p-value: 0.0590

With a p-value just above the 0.05 threshold, at $\alpha = 0.05$, we fail to reject the null, so we no longer have strong enough evidence of nonlinearity.

i. The error term ε has a zero population mean: PASSED
Mean of residuals: 0.000000

ii. All explanatory variables (X_Ki) are uncorrelated with the error term (ε_i).: N/A
Not applicable for the WSL model, so we cannot run the Durbin-Wu-Hausman Test

iii. Observations of the error term are uncorrelated with each other (no serial correlation between ε_i and ε_j): PASSED
Durbin-Watson: 2.244

Similarly to Model 1, the value is close to 2; we conclude that there is no significant autocorrelation in the residuals.

iv. The error term ε has a constant variance (no heteroskedasticity): N/A
Breusch-Pagan test results are the following:

Lagrange multiplier statistic: 23.1076

p-value: 0.0060

f-value: 2.7834

f p-value: 0.0046

Since both p-values are below 0.05, we reject the null hypothesis, confirming the presence of heteroskedasticity in our model. However, this is not concerning in the case of Model 2, because WSL accepts heteroskedasticity.

v. No explanatory variable is a perfect linear function of any other explanatory variable(s) (no perfect multicollinearity): PASSED
This time all of our variables have passed the VIF test, with none of them exceeding a value of 5:

vi. The error term ε is normally distributed (this assumption is optional, but usually is invoked): PASSED JB test here revealed the same performance as Model 1:

Jarque-Bera (JB): 3.387

Prob (JB): 0.184

Model 2 Interpretation

X	Variable Name	Interpretation
X1	**Fragile States Index - Security Apparatus**	***Coefficient: 0.1738***. Interpretation: A higher value for Security Apparatus means greater state control over security forces, theoretically leading to more repression and less stability, potentially causing more people to flee. The positive coefficient fits the expected model, where greater state control (a marker of fragility) is associated with increased human flight.
X2	**Fragile States Index - Factionalised Elites**	***Coefficient: 0.0721***. Interpretation: Factionalised elites reflect divisions within the ruling class, and higher values suggest less cohesion and more instability in governance. The positive coefficient is expected, as more internal conflict typically leads to greater instability, increasing the likelihood of brain drain and human flight.
X3	**Fragile States Index - Group Grievance**	***Coefficient: 0.0171***. Interpretation: Group Grievance reflects societal divisions and tensions, where higher values indicate a society fractured by ethnic, religious, or political divisions. A positive coefficient suggests that more grievances may cause social instability, increasing human flight and brain drain. The coefficient here is small, reflecting perhaps less immediate impact on flight than other variables.
X4	**Fragile States Index - Economy (Log-transformed)**	***Coefficient: 2.3754***. Interpretation: A higher economic score (log-transformed) specifies a more fragile economy. This suggests that a fragile economy will likely drive people to leave for better opportunities. The positive coefficient fits the expected model, as economic fragility typically increases the motivation for people to migrate. The log transformation suggests the effect of a deteriorating economy becomes more pronounced as it worsens.
X5	**Fragile States Index - Economic Inequality**	***Coefficient: -0.0902***. Interpretation: Economic Inequality typically signifies a society with a vast wealth gap. However, in this case, the negative coefficient suggests that while inequality is often a sign of fragility, it does not directly contribute to human flight in this model. This might be due to the complex ways inequality can motivate people to leave and compel them to stay (e.g., desire to benefit from opportunities or fear of violence). An alternative theory could be that greater inequality could trigger internal migration or social movements, which offset brain drain.
X6	**Fragile States Index - Human Rights (Squared)**	***Coefficient: -0.0243***. Interpretation: Human Rights violations increase a country's fragility, and squaring this variable emphasises that the worst violations (extremely high values) have a stronger relationship with human flight. The negative sign here is surprising, as one would expect it to be positive, suggesting a non-linear effect. Severe human rights violations could either accelerate outflows (positive effect) or cause a reversal due to

		government repression of exit (negative effect). This paradox may indicate complex, dual effects of human rights abuses.
X7	**Fragile States Index - Demographic Pressures**	***Coefficient: 0.1842***. Interpretation: Demographic Pressures encompass high population growth or youth bulges, which are frequently correlated with insufficient resources and political instability. Strong performance on this index indicates more societal stress and vulnerability, which pushes people to emigrate for better opportunities. Therefore, a positive coefficient is as anticipated for demographic pressures.
X8	**Fragile States Index - Refugees and IDPs**	***Coefficient: -0.0013***. Interpretation: Refugees and internally displaced persons (IDPs) specify displacement and humanitarian crises. The negative coefficient at this point is unexpected, as we would characteristically assume more displaced people to correlate with more human flight. This might propose that displacement repeatedly occurs within a country or that international humanitarian efforts are mitigating outward migration.
X9	**Fragile States Index - External Intervention (Squared)**	***Coefficient: 0.0209***. Interpretation: External intervention replicates the inspiration of foreign powers in the country's internal affairs. The squared term suggests that moderate interventions may have one effect, while extreme interventions have a noticeable supplementary impact on human flight. The positive coefficient specifies that external interventions (such as foreign military or political involvement) contribute to fragility and boost outflows, though the effect rushes as the intervention becomes more intense.

Final Model suggests the following relationship:

$$Y=-1.0129+0.1738\cdot X1 +0.0721\cdot X2 +0.0171\cdot X3+2.3754\cdot X4 -0.0902\cdot X5 -0.0243\cdot X6+0.1842\cdot X7 -0.0013\cdot X8 +0.0209\cdot X9$$

The econometric results reaffirm key drivers of human flight and brain drain in fragile states. Security, economic fragility, factionalised elites, and demographic pressure all significantly influence outward migration. While consistent with previous studies like Vega-Muñoz et al. and Nawaz et al., our panel data approach shows these effects are long-term, not temporary. Positive coefficients for Security Apparatus, Factionalised Elites, and the Economy point to worsening institutions and economies pushing skilled workers away. Demographic Pressure also plays a strong role, linking youth unemployment and population growth to talent loss. Interestingly, Economic Inequality and Human Rights (squared) show unexpected signs, suggesting complex or non-linear impacts. In some contexts, inequality may incentivise elite retention, and repression may restrict outward movement. External Intervention (squared) is also significant, indicating that intense foreign involvement destabilises local systems and encourages emigration. Model 2 strengthens these findings through improved specifications, addressing earlier errors and improving reliability.

Policy Implications

Policy-wise, the results may draw a few main measures to mitigate brain drain. Basing on the above findings, the following measures may be suggested:

i.Strengthen public institutions and governance to reduce elite factionalism and unify politics.

ii. Stabilise the economy and create jobs for high-pressure demographic contexts.
iii. promote civil rights protection and restrict external political meddling to stabilise society.
iv. Facilitating "brain circulation" strategies, such as worldwide academic partnerships and diaspora engagement, to adapt human flight towards knowledge exchange.

Conclusion

This research enhances the growing literature on migration and state fragility by encompassing the analysis from a cross-sectional to a panel data framework setting spanning 18 years. It concludes that fragility dimensions related to security, economy, and governance persist as significant factors in amplifying human flight and brain drain. It is suggested that future studies entail the impact of governance and interaction effects with socio-economic stability measures, as well as analyse state-level differences to establish an increasingly polarized overview of the migration trend.

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