Examining the Emigration of Elites from Iran: A System Dynamics Approach

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A B S T R A C T

Nowadays, countries are leading in growth and development, with their managers having a systematic approach and perspective toward external phenomena. In the past, the slow pace of changes and transformations in societies made it easier to analyze current and future conditions. However, in today's world, complex phenomena are non-linear and multidimensional. The migration of skilled and educated human resources from developing to developed countries is also considered one of these phenomena, which is influenced by numerous variables and factors that change and evolve over different periods. The system dynamics approach is a precise modeling method that allows us to simulate complex and dynamic systems computationally, both qualitatively and quantitatively. By utilizing the obtained results, more effective policies and organizations can be designed. This paper discusses the migration of elites from Iran to developed countries from a dynamic systems perspective. The problem is modeled and simulated using the software "Vensim". Important variables in elite migration are identified and adjusted. The model's outputs indicate the positive impact of the presence of elites in a country on its level of economic development.

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1. Introduction

The movement and migration of populations across borders have a long history in human civilization. However, this phenomenon has been rapidly increasing in recent years. International migration has been on the rise since 1970, and every year, a significant number of individuals migrate from developing countries to industrialized countries. According to the studies by Vakili and Mobini (2023) shown in Figure 1, the number of migrants worldwide approached 300 million in 2020, which accounts for about 4% of the total global population.
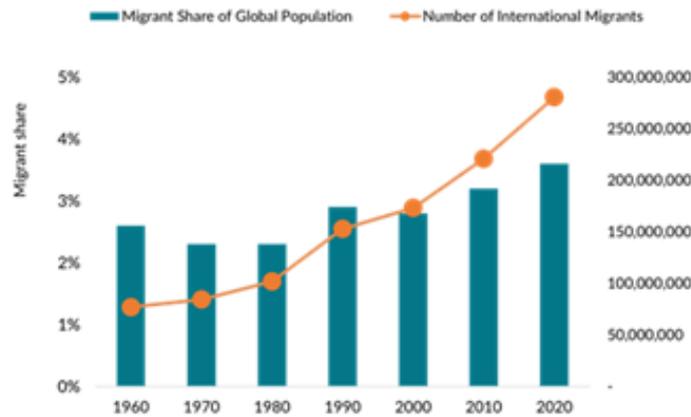

Figure 1. The number and share of immigrants worldwide

Throughout history, Iran has been famous for its numerous internal and external migrations and immigrations. However, the importance and complexity of international migration have increased in recent decades due to the increasing young population of the country. The Iranian migrant population in the world, based on the latest available and reliable statistics in 2020, is 1.87 million people, which constitutes 2.23% of the Iranian population, as indicated in Table 1. However, according to the Secretariat of the Supreme Council of Iranians Abroad, the estimated population of Iranian migrants outside the country is 4.04 million, which can be verified based on international sources (Sadeghi and Seyyed Hosseini, 2019).

Table 1. The status of Iranian immigrants in domestic and global statistics

Annual Population Factors	Statistics Based on International Sources				Internal Statistics
Year	1990	2000	2010	2020	2020
The population of Iranian immigrants in the world (million people)	0.82	1.15	1.49	1.87	4.04
Total population of Iran (million people)	56.4	65.6	73.8	83.99	83.99
The share of Iranian immigrants in the total population of Iran (percentage)	1.45	1.75	2.02	2.23	4.81

Since most of the emigrants are the elites and the skilled human resources of society, their departure from the countries of origin is often described as "brain drain" a term that the Royal Society of England first coined to describe the migration of scientists from England to North

America after World War II (Ha et al., 2016). Migration can lead to a decrease in the skilled and educated workforce in the country of origin, resulting in a reduction in economic capabilities, the inability to meet domestic needs, and a decrease in industrial competitiveness (Beine et Al., 2001).

Therefore, the emigration of elites at the caliber level can cause the backwardness of the countries of origin, and, in addition to being an economic and social issue, it has political and cultural consequences in the country. Since various factors influence these concerns, it is vital to investigate them using a methodology that addresses their dimensions. On the other hand, simple analyses and breakdowns do not provide suitable solutions for this issue because the influential factors change over time. For this reason, a systems dynamics approach is used in this regard, as this approach considers the time variable, provides a more realistic view of the problem, and can examine the effects of various factors in different dimensions. Finally, with the presentation of scenarios to improve the current situation, systems dynamics can have a more comprehensive impact on investigating the issue of elite emigration.

In this study, after reviewing previous studies and identifying the factors and variables used and the methods employed, the system dynamics will be introduced, and the advantages of using this approach will be discussed. The issue of elite emigration will be modeled qualitatively and quantitatively, and various scenarios will be implemented to discuss the resulting outputs and provide managerial solutions in this field.

2. Literature review

According to the definition provided by the United Nations, migration is the act of changing one's country of residence regardless of its nature, motivation, or legal status. However, in general, the goal of a migrant is to achieve better conditions and escape existing problems and challenges in the country of origin. Zuckerman (1977) also introduces the concept of an elite individual in his book "The Scientific Elite," who is the most successful and powerful person in a society in one or more outstanding and efficient fields.

Vakili and Mobini (2023) found that the outflow of talent from Iran is mainly influenced by external factors (such as attraction factors from developed countries) and internal incapacities (such as push factors). The migration rate is rapidly increasing; therefore, it is necessary to analyze and manage this phenomenon using existing theories in the field of attraction and push factors, Maslow's hierarchy of needs, and rational choice theory. Mozafari (2023) concluded that the current political atmosphere, economic sanctions, and lack of research opportunities

have led to an increase in the emigration of elites and the departure of talented professionals from Iran. This trend is expected to continue with the increase in the number of talented Iranian scientists seeking better opportunities and resources abroad. Moftakhari et al. (2021) investigated the impact of social capital on talent outflow in member countries of the Cooperation Organization of Shanghai from 2009 to 2018. The results indicate that social capital has a non-linear and threshold effect on talent outflow. Given that the coefficient of social capital is positive and the second power coefficient is negative, increasing social capital at lower levels exacerbates talent outflow from the countries under study. However, increasing social capital beyond the threshold level hurts talent outflow. By determining the threshold level in these societies and striving to enhance social capital to that level, as an effective factor in preventing talent outflow, one can prevent the emigration of elites in these countries.

By examining the situation of Iranian elites' migration, postgraduate students, married individuals, dissatisfied with their income, and individuals with high economic and social status, Derakhshan et al. (2023) found that the mentioned groups had a greater inclination towards migration. The inclination for migration had an inverse relationship with four dimensions of origin and destination conditions (economic, political, social, and cultural). Essential factors influencing student migration included various cultural, economic, occupational, and socio-political variables. A significant relationship was found between the inclination for migration and variables such as gender, educational region, educational degree, religion, having relatives and friends abroad, foreign travel experience, foreign language proficiency, number of published articles, and membership in the National Elite Foundation. Vedadhir and Eshraghi (2023) study aimed to explain the inclination for migration and found that migration reasons can be categorized into two main groups: attraction factors of the destination and push factors of the origin. Data analysis resulted in the extraction of two main categories:

(1) push factors, which included five subcategories of economic-occupational factors, socio-cultural factors, political-religious factors, educational factors, and personal factors, and (2) attraction factors of the destination, which included five subcategories of legal and relationships, security, welfare-financial conditions, educational and occupational opportunities. Ghorbanian and Salehi (2021) using a system dynamics approach, concluded that by implementing policies to reduce tensions in international relations, it is impossible to impact the emigration rate of elites significantly, and their number cannot be reduced. However, implementing policies to improve fair remuneration, job security, and employment status of

elites can lead to changes in the rate of elite migration and the number of immigrants. Therefore, implementing these two policies can effectively prevent the outflow of elites from the country and strengthen them. Hajigholamsaryazdi et al. (2017) modeled the factors of elite migration using a system dynamics approach and by collecting a group of scientific and technological elites to model this phenomenon with a systemic perspective. The current model showed that the main hypothesis of the article, which states that elites themselves play a role in creating the brain drain structure and are also influential in rectifying it, is valid. Mousavirad and Ghodsian (2015) also adopted a system dynamics approach, which, by implementing government policies to support entrepreneurship and increasing the level of cultural education, does not result in a change in the rate of elite formation. The elite development rate initially decreases due to a decrease in the migration rate in the first few years. Therefore, it cannot be said that implementing these two policies has led to the nurturing of elites in the country. Considering that the number of immigrants has also remained insignificant, it can be concluded that these policies have been unsuccessful in reducing the trend of brain drain. The current study attempts to reexamine elite migration under novel situations by expanding the variables of Shahsawaripour et al. (2019) model and updating the data of the scenarios under investigation.

A summary of the above studies can be reviewed in Table 2 in the form of a research background:

Table 2. An overview of the research background

Title	Researchers	Method	Results
An overview of brain drains, causes & policy issues in Iran	Vakili & Mobini (2023)	Review	The simultaneous effect of external attractiveness and internal disability
Science in Iran: A victim of political torn ail	Mozafari (2023)	Review	The role of political-economic and scientific parameters
Emigration pattern among medical & Non-medical Iranian elite & its associated factors: A review of literature	Derakhshan et al. (2023)	Review	The effect of scientific factors such as parent's education level and language proficiency
Investigating the effect of social capital on brain drain in the member countries of the Shanghai Cooperation Organization	Moftakhari et al. (2023)	Econometrics	Non-linear effect of social capital variable
The effect of economic complexity and globalization on elite migration in selected member countries of the Organization of Islamic Cooperation	Shahabadi and Pouran (2022)	Statistics	The inverse effect of research and development costs and globalization index on immigration
Presenting the study model of the phenomenon of elite evasion	Ghorbanian and Salehi (2021)	SD	The lack of impact of improving foreign relations on immigration statistics
Tendency to migrate in Iran's medical community	Vedadhir and Eshraghi (2019)	Inductive quality	Explaining the factors of repulsion of the origin and attraction of the destination
Analyzing the dynamics of elite migration using associative modeling	Hajigholamsaryazdi et al. (2017)	SD	Elites are responsible for increasing or decreasing the rate of immigration
Analysis of elite immigration and the effect of restrictive policies	Mousavirad and Ghodsian (2015)	SD	Lack of effect of government support policies
Comparative analysis of brain drains at micro and macro levels	Chalabi and Abbasi (2005)	Survey Secondary analysis	The influence of income-quality level of life and cultural development

3. Methodology

This study uses the system dynamics approach is used as a modeling method. One of the basic challenges in developing human societies is to predict the real world in the future. System dynamics (SD) analysis is a very efficient and well-known method for studying system behavior (Safaie et al., 2022). System dynamics refers to system changes and behaviors over time under different conditions. Professor Forrester (1961), in the book Industrial Dynamics, defines system dynamics as the study of information and feedback characteristics of industrial activities to show how organizational structure, reinforcement (policies), and time delays (in decisions and actions) affect the success of the company. The main features of this method include the existence of a complex system, the change of system behavior over time, and a closed feedback loop (Langroodi and Amiri, 2016).

The implementation of the system dynamics method in this research, according to Figure 2, has been implemented in five stages and recursively in the Vensim software, version PLE10, from 2006 to 2036.
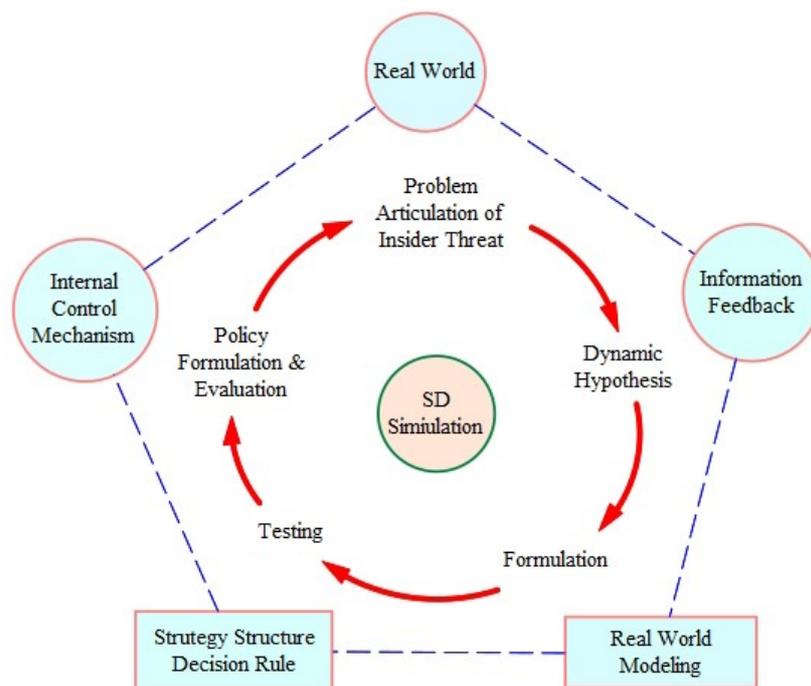

Figure 2. Implementation steps of the system dynamics method

4. Modeling, review and analysis of data

The modeling work is to be started after enlightening with the method and steps of the work. The necessary information about the studied problem must be collected and categorized, and a mental and descriptive model should be formed according to the above steps.

4.1. Dynamic hypothesis

In order to implement the elite migration model, the first step is to have a dynamic hypothesis about migration. The elites who intend to migrate, economic, cultural, and social factors influence their decision to migrate. If the above factors do not match the individual's wishes, the existing conditions are not entirely consistent with the individual's ideals. Therefore, in this hypothesis, the high migration rate is caused by unfavorable conditions in the country of origin.

4.2. Causal loop diagram (CLD)

The causal diagram depicts the cause-and-effect relationships between the various variables in the problem. It is used to record mental models and the mutual effects of the variables on each other.

The causality structure of a model is shown by a causal loop diagram, which is shown in Figure 3 for the discussed problem:
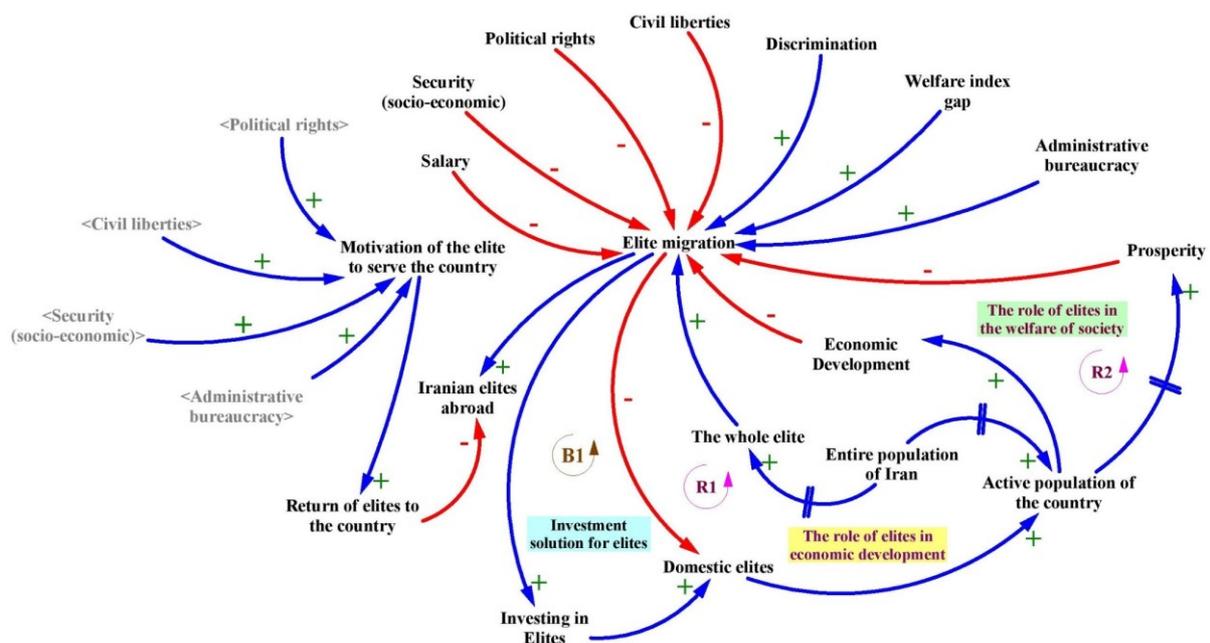

Figure 3. Causal loop diagram of elite migration

The diagram of causality has 3 feedback loops as follows:

(1) The role of elites in economic development (R1): With the reduction of elite immigration, the population of elites inside the country increases, and these people become the country's active population. As a result, with the activity of these people in the economy, the GDP increases. With the improvement of the country's economic situation, the immigration statistics of other elites decrease (Figure 4).
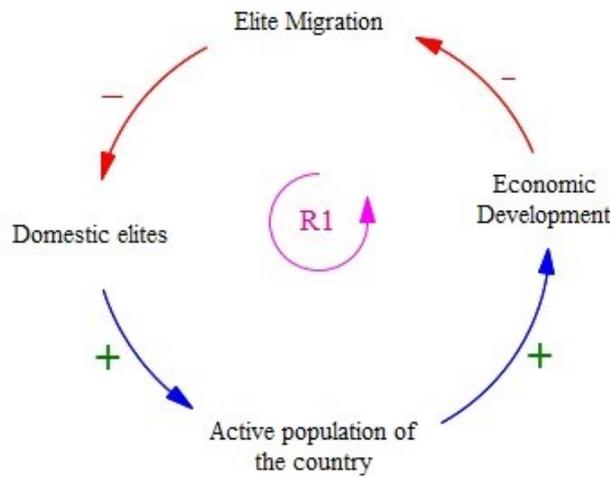
Figure 4. The role of elites in economic development

(2) The role of elites in society's welfare (R2): With the decrease in the number of immigrant elites and the continued increase in the number of resident elites, their entry, and activation in the country's economy has increased per capita income and general well-being, leading to a decrease in their migration statistics (Figure 5).
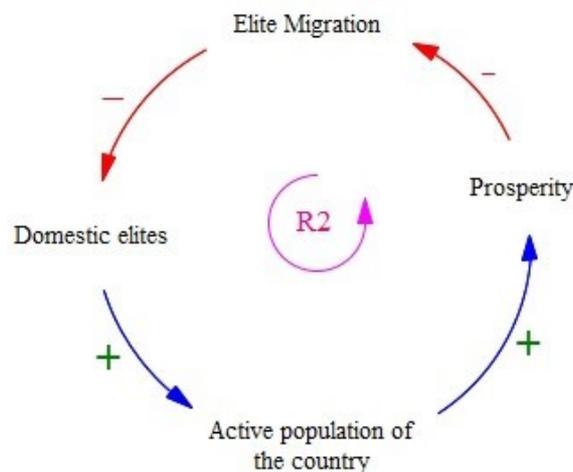

Figure 5. The role of elites in society's welfare

(3) The role of elites in economic development (B1): By increasing the investment in the elites through the solutions mentioned in the management recommendations section (section 5), the longevity and population of the elites in the country increased, and with the increase in the participation of the elites in economic activities, the economic growth and development of the country improved. It was found that with the improvement of the country's macroeconomic variables, the amount of migration of elites has decreased. As a result, the need for more investment in this field is decreasing (Figure 6).
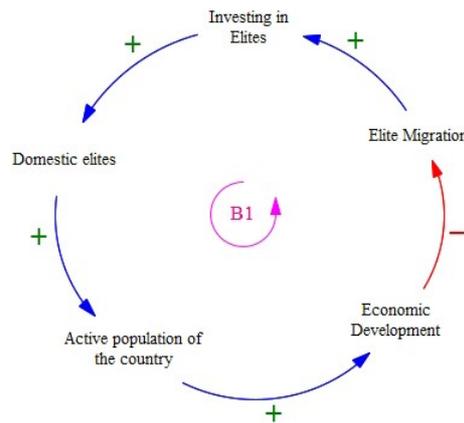
Figure 6. Investment solution for elites

4.3. Stock-flow diagram (SFD)

Causality diagrams are very useful in many situations. However, despite these advantages, they have limitations; one is their inability to show the state structure and system flow change. This problem can be solved by using the flow state diagram, and by displaying the state variables and flows, it is possible to track the state variables along the path (Sterman, 2002).

The state and flow diagram of the developed model is based on the study of Shahsawaripour et al. (2019) and is designed according to Figure 7:
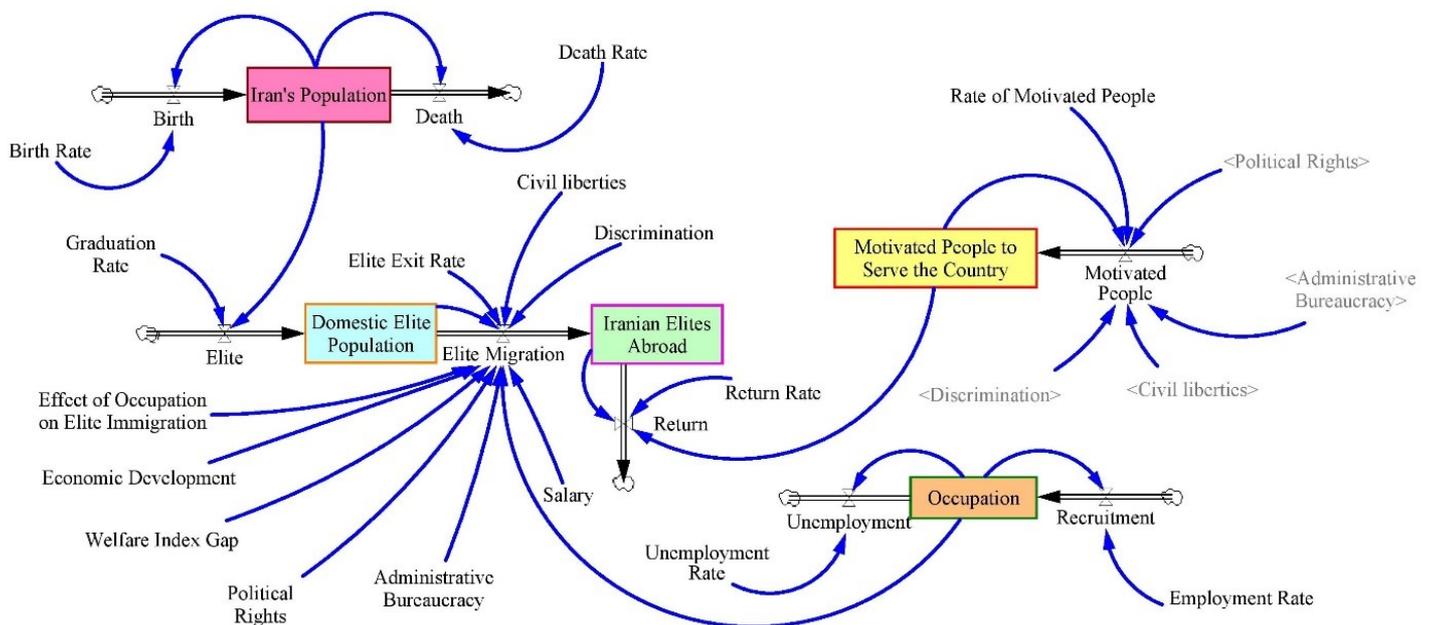

Figure 7. Stock-Flow diagram of elite migration

4.4. Formulation

The quantification of the model was done based on the stock-flow diagram in the form of mathematical relationships and by separating variables involved in the problem according to Table 3:

Table 3. Significant mathematical equations of model variables

Variable	Description	Formula	Unit	Type
Iranian Elites Abroad	Total of Iranian elites in other countries	INTEG (4e+06, Elite Migration -Return)	People	State
Domestic Elite Population	Number of elites living inside the country	INTEG (220649, Elite - Elite Migration)	People	State
Elite Migration	Number of immigrant elites per time unit	Domestic Elite Population × Elite exit rate – (Occupation × Effect of Occupation on Elite Immigration) – (Economic Development + Political Rights + Civil Liberties + Discrimination) × Domestic Elite Population + (Administrative Bureaucracy + Welfare index gap + Salary) × Domestic Elite Population	$\dfrac{\text{People}}{\text{Year}}$	Rate
Return	Number of elites returning to the country	(Motivated People to Serve the Country × Return Rate)+(Iranian Elites Abroad × Return Rate)	$\dfrac{\text{People}}{\text{Year}}$	Rate
Elite exit rate	Growth of departure of elites from the country	0.1583	1/Year	Constant
Return Rate	Return of elites to the country	0.03	1/Year	Constant
Economic Development	Qualitative changes in the economic structure of a society	0.0096	1/Year	Constant

4.5. Model validation

After the implementation of the model, to ensure the validity of the proposed model, 3 validation tests are performed on it.

4.5.1. Test of the model structure

As an experimental tool, this test compares the form of equations and models with the relationships in real systems. The work was done in the Vensim software, according to Figure 8.
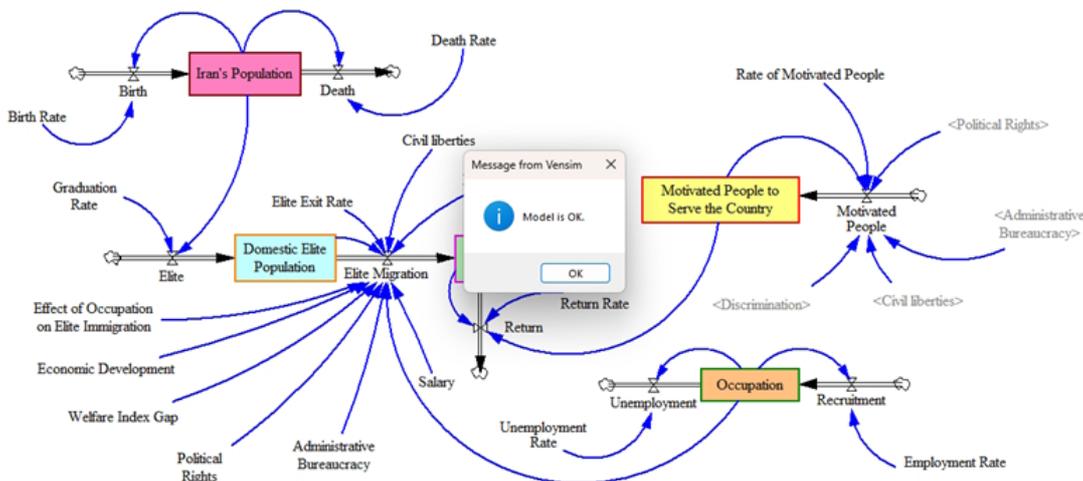

Figure 8. Model check

4.5.2. Test of the dimensional consistency

This test includes checking the right and left sides of the equation in terms of the dimensions of the variables, which must be the same. Based on the introduction of the unit of all the variables in the model, this test can also be performed in the Vensim software, according to Figure 9.
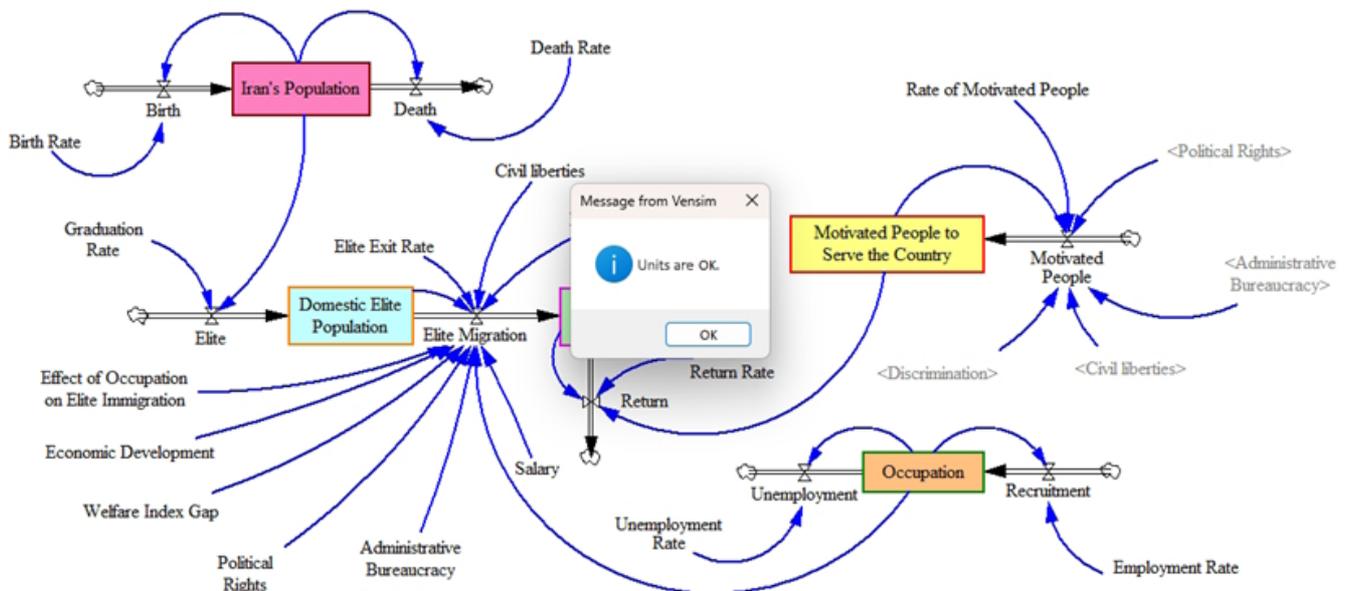

Figure 9. Units check

Here, as an example, the equality of units on both sides of the equation related to the variable " Elite Migration " is shown:

$$Elite\ Migration\ \{People/Year\} = Domestic\ Elite\ Population\ \{People\} \times Elite\ Exit\ Rate\ \{1\ /Year\} -$$

$$(\ Occupation\ \{People\}\ \times Effect\ of\ Occupation\ on\ Elite\ Immigration\ \{1\ /Year\}\ ) - (\ Economic$$

$$Development\ \{1\ /Year\} + Political\ Rights\ \{1\ /Year\} + Civil\ Liberties\ \{1\ /Year\} + Discrimination$$

$$\{1\ /Year\}\ ) \times Domestic\ Elite\ Population\ \{People\} + (\ Administrative\ Bureaucracy\ \{1\ /Year\} +$$

$$Welfare\ index\ gap\ \{1\ /Year\} + Salary\ \{1\ /Year\}) \times Domestic\ Elite\ Population\ \{People\}$$

People/Year = People/Year

4.5.3. Limit condition test

This test aims to measure the model's sensitivity to values far from reality and the limits of model decay. Here, by setting the return rate of the elites to a high value, as shown in Figure 10, we see an increase in the number of domestic elites and their gradual equalization with the total elites of the country, which means they all stay.
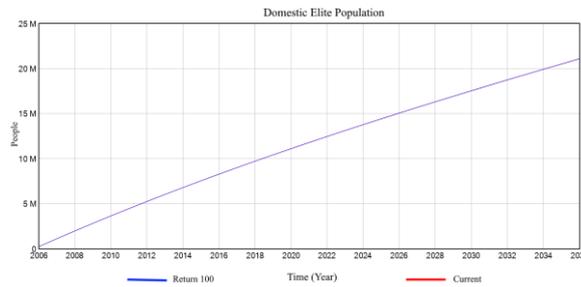

Figure 10. The boundary condition test in the case of the return of all elites to the country

4.6. Model output detailed analysis (Results)

Figure 11 shows the status of foreign elites, which shows that the increase in the number of university graduates, especially in the supplementary education courses, as well as the conditions of recent years, the increase in their number can be justified.
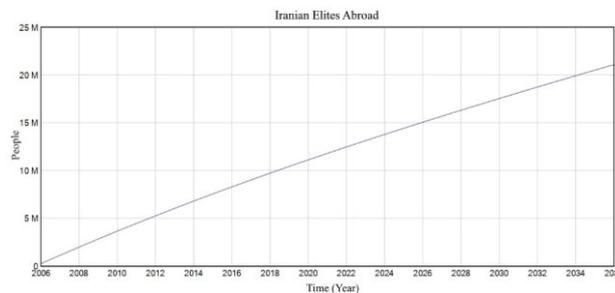

Figure 11. The elite population living abroad

Figure 12 is the trend of the main flow variable of this model, which clearly shows the alarming situation of elite immigration; if there is no change in the variables related to immigration, the increase will continue.
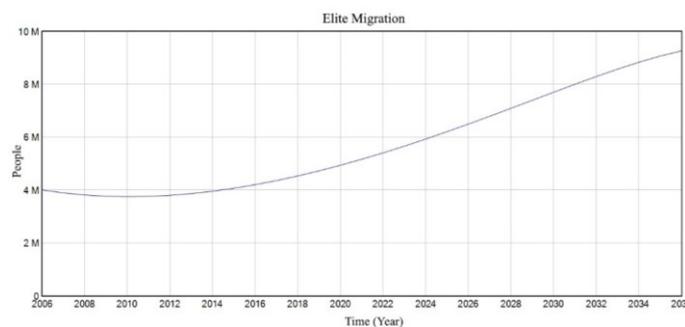

Figure 12. The process of elite migration in the simulation period

4.7. *Assessing policies and scenarios*

System dynamics is one of the approaches in simulation methods. Simulation models benefit from learning about complex problems and testing interventions (Beigian et al., 2022). At this stage, by setting values to selected model variables that are considered close to the economic variables of the seventh development plan, the simulation results are compared with the base state, and the most suitable options for management decisions are suggested in this issue.

4.7.1. *Salary increases scenario*

If we increase the wage index to 65%, according to Figure 13, the rate of elite migration will continue to increase, but it will have a lower slope compared to the current trend.
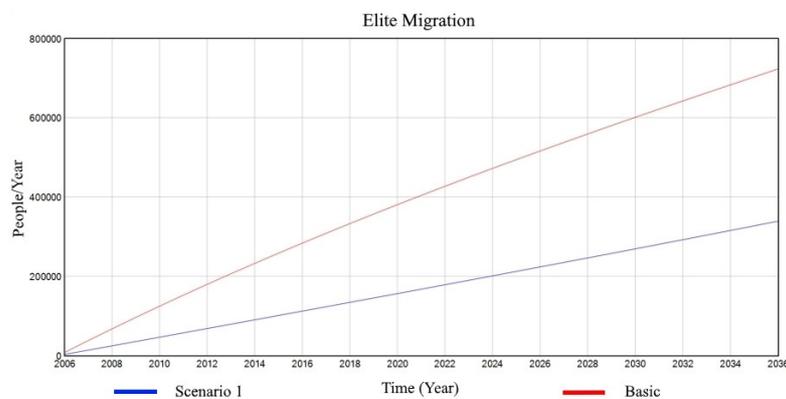

Figure 13. The rate of elite migration under the wage increase scenario

4.7.2. *Economic development scenario*

If the rate of economic development increases by 8% (according to the perspective of the country's seventh development plan), the elite migration rate will decrease, as shown in Figure 14. In other words, it will be noticed reverse migration.
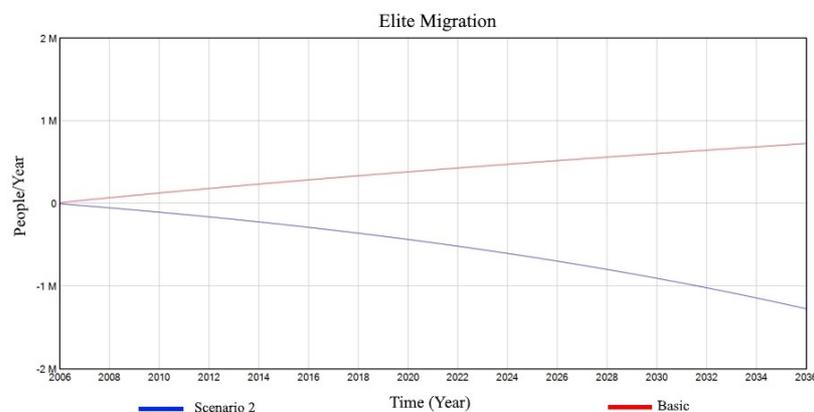

Figure 14. The rate of elite immigration under the scenario of improving economic development

5. Management recommendations

The scenarios examined in the present study have focused on the economic factors in the issue of elite immigration. Therefore, in this regard, there are several managerial points worth mentioning for policymakers. Given the lower level of service rates and wages within the country, considering the exchange rate parity of the national currency against foreign currencies and comparing it with other countries, especially developed and immigrant-receptive countries, it is necessary to review the pattern of determining salaries and wages, especially for specialists. Despite the possibility that this pattern may lead to an increase in income inequality among other social classes, it is possible to regulate the gap in the welfare level of this group with other income brackets through non-inflationary supportive measures. In this regard, in addition to improving salaries, it is possible to mention the improvement of working conditions ethically by increasing the attractiveness and competitiveness of the domestic job market by providing government incentives, especially for startups and new companies, which are run mainly by educated young forces. Moreover, providing professional and research opportunities for developing university elites' skills, cooperation with elites in industrial and technological sectors, and scientific and technological collaborations with other countries can improve the elites' internal migration deterrent indices.

6. Discussion and conclusion

Psychologically and politically, people prefer to identify the cause of any problem as an external factor rather than finding it within themselves. Despite our capacity for analysis and the advancement of technology, problems like elite migration continue to exist because they are fundamentally systemic—that is, they emerge from the unfavorable behaviors inherent in the system's structure. These issues will disappear when the courage and wisdom to restructure the system is gained (Meadows, 2008). The present research was conducted to simulate a dynamic model for the phenomenon of elite migration, in which a combination of quantitative and qualitative variables was implemented in an interactive relationship with each other over thirty years. Compared to mathematical models, this dynamic model has great flexibility in making changes, scenario planning, and sensitivity analysis. The output of the model shows the undeniable effect of the increase in economic development and the level of public welfare as a result of the role of elites in different fields of the country; the same discussion that is mentioned under the title of the meritorious year that has also been mentioned in past studies such as Shahsawaripour et al. (2019). On the other hand, improving economic components will reduce

elite migration and even reverse migration. Of course, the impact of improving the economic variables of the society on the improvement of other components of the cultural, social, and political fields, as well as multi-dimensional issues such as the migration of elites, is an experienced and undeniable matter.

7. Limitations and suggestions

The presented model may include only some variables involved in elite migration, such as the security variable (economic, political, social), for which reliable data was unavailable to the authors. In addition to the components discussed in this research, the influence of social and cultural policies and scenarios and non-economic motivational factors in the migration of elites can be investigated by converting them into quantitative parameters.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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