“Application of decision tree model for prediction of immigration policy in different countries of the world”

AUTHORS	Viktoriia Apalkova Sergiy Tsyganov Nataliia Meshko Nadiia Tsyganova Serhii Apalkov

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Viktoriia Apalkova, Candidate of Economic Sciences, Associate Professor, Faculty of International Economics and Management, Department of International Economics, Kyiv National Economic University named after Vadym Hetman, Ukraine. (Corresponding author)

Sergiy Tsyganov, Doctor of Economic Science, Professor, Department of International Finance of Institute of International Relations, Taras Shevchenko National University of Kyiv, Ukraine.

Nataliia Meshko, Doctor of Economic Science, Professor, Head of Department, Department of Marketing and International Management, Oles Honchar Dnipro National University, Ukraine.

Nadiia Tsyganova, Doctor of Economic Science, Associate Professor, Banking and Insurance Department, Kyiv National Economic University named after Vadym Hetman, Ukraine.

Serhii Apalkov, Candidate of Economic Sciences, Associate Professor, Faculty of International Economics and Management, Department of International Economics. Kyiv National Economic University named after Vadym Hetman, Ukraine.

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Viktoriia Apalkova (Ukraine), **Sergiy Tsyganov** (Ukraine), **Nataliia Meshko** (Ukraine), **Nadiia Tsyganova** (Ukraine), **Serhii Apalkov** (Ukraine)

APPLICATION OF DECISION TREE MODEL FOR PREDICTION OF IMMIGRATION POLICY IN DIFFERENT COUNTRIES OF THE WORLD

Abstract

In the past few decades, the ever-increasing dynamics of international migration flows can be observed. At this stage, the governments of major countries in the world are striving to balance the needs of their citizens and the support of immigrants. The paper analyzes factors that affect the immigration policies of various countries and determines the role of ecological factors (such as environmental conditions). The objective of the study is to predict the immigration policies of different countries of the world based on the analysis of the influencing factors, including environmental performance. The research method is based on the use of the RapidMiner software package to build two decision tree models and a static index database of more than 150 countries around the world. The results show that in most cases, the immigration policies of various countries will focus on maintaining the current level of immigration and increasing the number of skilled workers. At the same time, one of the key decision-making factors will be the country's current immigration level, environmental performance, GDP per capita, and the Education index. One of the main conclusions is that the country's environmental indicators have begun to become one of the priority values that determine the state immigration policy. This can be explained by the rising global community interest in the challenges of climate change.

Keywords immigration policy, skilled workers, climate change, decision tree, immigration, environmental performance

JEL Classification F22, Q56

INTRODUCTION

At the current stage of increased interaction of national economies, the proliferation of globalization and the tendency for management of international migration flows play an increasing role in public policy. The influence of developed countries on international trends in migration as well as the actions of governments of other countries necessitates the choice of the most optimal strategy for immigration governance.

In this context, it is important to understand that the growth of immigrants in the country has both positive aspects (growth of the consumer market, access to cheap labor, access to new technologies and communications, etc.) and negative (increased pressure on the budget, growth of social conflicts, risks of overpopulation and environmental degradation, etc.).

One of the key functions of countries' immigration policies, as a rule, is called the protection of the internal socio-economic balance through planned control and, if necessary, limiting the access of immigration flows to the country (Timmer & Williams, 1998; Anderson, 2010). At

the same time, at this stage of global development, an important key indicator is the environmental performance of the country. The growing problems of climate change and environmental degradation are more and more talked about at international forums and conferences, as well as reports of international institutions (McAuliffe & Khadria, 2019).

Obviously, the solution must be comprehensive, and since the root of negative environmental changes is human activity, it becomes logical to consider a question of how to minimize this impact and what countries do it in the best way. It is also important to understand the economic model of these countries and their policies for accessing their markets, and not only concerning goods and services, but also the availability of their labor market for immigrants.

1. LITERATURE REVIEW

Recently, an increase in interstate migration processes can be observed, leading to increased dynamics of migratory flows. Despite the restrictions on the movement of people between countries related to the fight against coronavirus infection COVID-19, which have been observed over the past 2 years, according to the International Organization for Migration (2019), in 2020, the number of international migrants was 272 million, or 3.5% of the world population. For comparison, in 2000 these figures were significantly lower: 150 million or 2.8%, respectively. At the same time, countries with a high level of development and income receive more than two-thirds of international migrants.

Labor migration dates to the birth of capitalism and international production, although migration per se has an even longer history. It arose simultaneously with the inception of humankind. The reasons for the constant movement of people in ancient times were hostilities, political conflicts, national and ethnic factors that have existed since the pre-capitalist age. Thus, migration processes have always existed, but only now this movement has such a great impact on the economy, politics, culture, and social component of countries.

The first attempts to explain the factors and analyze the causes that affect migration appeared in the XIX-XX centuries. This process was a consequence of the formation of nation-states and the marking of the borders of countries in which principles of citizenship, people's rights, and freedoms were in process of establishing.

It should be noted that traditionally immigration policy is considered in conjunction with the labor market and the difference in the level of its wages (Dustmann et al., 2005; Cangiano, 2012; Aleksynska & Tritah, 2015; d'Albis et al., 2018).

For example, Aleksynska and Tritah (2015) described the impact of immigration on the labor market based on the example of European countries. The causal effect of immigration on the employment rate of residents was identified using the instrumental variables strategy based on the historical model. It was found that the employment rate of the country's residents increased in those sectors that accept more immigrants.

Besides, Gabriel and Pellerin (2012) studied the phenomenon of migration and current trends in its modification. The emergence of a migration pattern in which the key factors are migration and its integration into the economies of industrialized countries can be observed. The example of Canada reflects the management of migration flows and the country's policy on immigrants.

Links between temporary immigration to France and the macroeconomic situation of the country have been studied by d'Albis et al. (2018). It was found that immigration flows have a positive effect on GDP per capita in France especially in the case of family immigration but immigration has some negative impact on employment in the country.

As part of a study by the European Policy Center, Ghimis (2016) outlined the migration policy of the European Union. Considering the situation in the labor market and the demographic decline in Europe, the EU should pursue a more ambitious immigration policy to attract labor.

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Lacroix (2012) considered the issue of French migration policy in the context of the problem of balance between national unity and market needs. On the one hand, France as a democratic country promotes equal treatment of foreigners, and on the other, promotes maintenance of the cultural homogeneity of the nation, implying selective immigration that can not fully satisfy the needs of businesses in the labor force.

Détang-Dessendre et al. (2016) also tend to believe that with interregional migration that redistributes labor resources local labor markets become more flexible and unemployment rates fall. The results show that most of the new jobs are occupied by migrants.

Ndiaye (2018) considered the aspect of student migration alongside labor migration. Migration of students is often underestimated and unaccounted for although it meets socially identifiable standards. This kind of migration may turn into long-term or permanent migration and affect the economic performance of the recipient country.

Within this context, the issue of immigrant wages is important, and it has been in the focus of study by Laffineur et al. (2017). Despite such employment trends, the wages of immigrants and residents are quite different. Immigrants' wages increase mainly because immigrants have a wide range of skills, which makes it possible for them to climb the career ladder.

Thus, the gradual increase in the number of international migrants with greater mobility is the subject of many research works at the present stage. The growing importance of migration processes also leads to the study of migration policy by researchers, primarily economists, from developed countries where immigration flows cause many controversial issues (France, Germany, USA, UK, Canada, etc.).

Regarding the impact of environmental factors on international migration, Feng et al. (2010) and Johnson (2011) considered climate change and the negative state of the environment to be the driving force behind migration from Mexico to the United States.

For instance, Feng et al. (2010) quantitatively investigated the relationships between climate variability, crop yields, and population migration responses using the instrumental variables approach. It was emphasized that due to global warming, crop yields in Mexico will significantly decrease (the forecast model was built until 2080). This, in turn, will force many Mexicans to immigrate to the United States. Although the results cannot be mechanically extrapolated to other regions and periods, according to Feng et al. (2010), these findings are important from a global perspective, given that many regions, especially developing countries are expected to significantly decrease crop yields as a result of projected warming.

Another more recent study by Prieur and Schumacher (2016) examines the relationship between immigration policy and climate change through the prism of internal and external conflicts. The main internal conflict is associated with the fact that attracting immigrants for the development of local production leads to a load on infrastructure and accelerates the processes of climate change, as well as causes internal conflicts. In addition, those potential migrants who wish to relocate due to climate change, but who are not allowed to immigrate, can provoke external conflicts. The coexistence of both conflicts makes it difficult to design effective immigration policies. Thus, depending on the parameters, the optimal will be either a steady state without immigration, but with mitigation of environmental impacts, or a steady state with a large number of immigrants, but less mitigation of the negative impact on the environment.

Defining the concept, causes, factors, and patterns of labor migration is a complex process that remains unclear to this day. The reason for this is the rapid development of the world that includes strengthening the social approach of the world economy, democratization of labor relations, internationalization of labor reproduction requirements, standardization of living and working conditions in different parts of the world, personal development, improvement based on universal values, and intensification of globalization processes in the international economy that cause the interdependence of countries and their regional groups. National labor markets are increasingly losing their insularity leading to the formation of a global labor market.

1.1. Highlights of relevant recent policies and programs

It is also worth considering the main trends in immigration policy in developed countries on specific examples. Immigration policy in the United States has undergone significant changes since the beginning of Donald Trump's presidency. The reorganization of the system included measures such as targeted restrictions on legal immigration, the construction of a "wall" on the border with Mexico, and the strict screening of persons allowed to enter. After Joe Biden came to power, there were reversible changes in immigration policy, in particular, the US President lifted restrictions on travel to "predominantly Muslim" countries imposed by the Trump administration, and began other adjustments towards liberalization (Ries, 2020).

The EU's latest immigration policy is based on attracting already qualified migrants. The focus is on improving the EU Blue Card with more flexible entry conditions, attracting innovative entrepreneurs, and developing methods for transparent and easy selection of migrants for relevant employers.

France has been attracting many migrants for a long time although its immigration policy is relatively new. At the current stage, three main trends are identified. First, the length of stay for adaptation has increased in recent years. Secondly, the government's attempts to attract skilled migrants have brought mixed results. On the one hand, the procedure for issuing work visas has become selective and measures have been taken to develop professional mobility, and on the other, such a policy has had a restrictive effect because only a small number of specialists meet the new French market standards. Thirdly, significant efforts have been made for integration at the national level.

The Canadian Express Entry System is designed to attract qualified professionals and facilitate labor immigration. Assessment is based on a scoring system that considers age, education, work experience, desired employment, language skills, and ability to adapt, while omitting criteria of origin, nationality, and religion. Such standards allow determining the potential contribution of a migrant to the national labor force and the welfare of the country.

Thus, in general, the immigration policy of developed countries is quite democratic allowing a significant number of migrants to enter the country. Most developed countries are trying to attract skilled workers as a means of economic development and support for sustainable growth.

1.2. Future directions of migration processes under the influence of immigration policy of developed countries

Forecasting future trends is a rather difficult task as migration and international mobility are influenced by several factors. Various reasons besides the migration flow and the emergence of new, flexible types of migration have complicated the conceptualization of the phenomenon. Therefore, it is necessary to dwell more carefully not on the quantitative measurement but the identification of causal relationships and qualitative characteristics of possible results.

Manifestations of the consequences of today's policy can be identified in the future through the development of scenarios, i.e., means of presenting plausible situations with a combination of different variables. Scenarios aim to help in understanding different points of view, opportunities, solutions, and possible failures. They provide an opportunity to look through informational data focusing on structural changes. By combining the results of independent research and work of the International Organization for Migration, the following model can be constructed:

1. The protectionist policy of protecting country's borders from the entry of foreigners may become widespread in the future. Opinions of contemporaries (e.g., Donald Trump) in 20-30 years will become the basis for limiting the mobility of human resources. The United States will come to this need due to the growing illegal migration from Mexico; Europe will not cope with the crisis and will be unable to accept new people. Only a small number of developed countries will allow migrant workers to enter if they pay a certain amount providing them with temporary work and a residence permit. Such a policy will be experimental. The need for low-skilled

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workers among these countries will be minimized due to the high development of technology. Asian countries will attract larger migration flows as their economies will become more attractive to workers. Accordingly, the regulatory policies of Western countries will become less liberal and will focus on domestic needs and national security considering the phenomenon of migration as a threat. Selectivity will culminate when only cost-effective workers will be allowed entry to fill gaps in certain sectors. International management cooperation will decline. In general, there will be a decrease in migration flows.

2. The opposite future is possible under the conditions of support of cooperation, liberalization, and observance of human rights. States will seek to optimize their policies towards openness and successful integration understanding the benefits of migration and its socio-economic contribution to development. Of course, migration will remain a controversial issue that will cause some difficulties in regulation. However, governments will put their efforts to make effective use of the potential for human resource mobility. Immigrants will support stable economic prosperity and make a positive contribution to the host societies. Due to the development of countries and recovery from the crisis, the demand for migrant workers will increase. Better integration will allow workers to be more secure and have a wider range of livelihoods. The value of human capital as a global resource and asset will increase, and more attention will be paid to cooperation and dissemination of information. Economic cooperation will outweigh protectionism facilitating international trade and human mobility. There will be favorable changes in the mood of society that will strive to achieve general well-being. The Canadian scoring system is likely to expand making it easier for migrants to assess their contribution to the economy. In general, migration will be seen as an opportunity to expand one's capacity for countries, get better jobs for migrants, and improve the quality of life for society.

3. The comprehensive impact of technology should not be ruled out. Advances in the fields of computerization and artificial intelligence may push traditional mobility into the background. Today, an increasing number of specialists work remotely via the Internet. Due to the global spread of high technology, there will be no need for physical movement of labor to developed countries. It is possible to create a separate area of immigration policy to manage cyberspace. The network will have its borders, the crossing of which will be regulated by specialists at the behest of the government. The freelance will become the main form of employment facilitating recruitment of required workers and minimizing the legal red tape. Immigration policy will focus on accepting refugees and restricting unregulated migration. The reduction of migration flows will be the result of evolutionary processes in the field of technological support eliminating the need for immigration and easing social tensions (Friedrich-Ebert-Stiftung et al., 2017).

It is impossible to unambiguously determine the future direction of migration. Most developed countries today pursue a policy of open borders and accumulate a significant influx of immigrants. States adopt strategies to help refugees and provide employment for foreign workers. However, any resources are limited. Countries are not able to accept everyone and are forced to use selective mechanisms. Focus on the economic value turns out to be the key criterion now. Some developed countries along with the change of government are moving to the other side of easing legislation. The aim is to protect the interests of the country and national borders that restrict freedom of migration around the world. Therefore, the future dynamics, centers, and features of migration flows directly depend on modern solutions.

The purpose of the paper is to build a predictive model of the immigration policy of states based on the study of various factors of influence. Another important task is to determine the role of environmental factors in the hierarchy of influencing factors.

2. CONCEPTUAL FRAMEWORK OF THE STUDY

The classification of immigration policies in practice is expressed in the fact that states at the legal level fix different regimes for the entry of immi-

grants into their country. One of the most comprehensive and consistent sources of information related to the analysis of international migration and immigration policies is the Population Division of the Department of Economic and Social Affairs at the United Nations. The Division publishes several detailed compilations of world population data, as well as descriptions and analyzes of global demographic trends.

According to the UN (2017) definition, immigration policy is expressed in the policy of the government to influence the level of documented immigration to the country. At the same time, it can be classified into four main categories: 1) *Raise* – aimed at increasing the level of immigration to the country; 2) *Maintain* – aimed at keeping the level of immigration at the current level; 3) *Lower* – aimed at reducing the level of immigration to the country; 4) *No interference*. There is also a fifth case where the country lacks any policy regarding immigration (Figure 1).

The key difference between the immigration policies of developed countries is their focus on the needs of employers or focus on the skills of immigrants (Stakanov, 2014). Today, labor migration policies in host countries have become more selective, with preference given to international migrants with deficient skills. A number of countries are implementing policies to attract or create favorable conditions for such involvement of highly skilled workers. Highly skilled migrants typically receive preferential access conditions and face fewer restrictions than low-skilled migrants in terms of admission conditions, length of stay, job change, and family reunification (Bernardini, 2019).

For analysis, the UN highlights *"policy on highly skilled workers"* that indicates the Government's policy to influence the level of immigration of highly skilled workers into the country (UN, 2017).

Immigration policy can include various instruments that, depending on the goals, can stimulate the active integration of immigrants into society, and create conditions of strict responsibility for their violation of rules and laws. For example, measures on the integration of immigrants include language skills training, transfer of professional credentials, and protection against discrimination. At the same time, measures on irregular immigration cover penalties for employers of migrants, fines, detention or deportation of migrants, and regularization of legal status under defined schemes or conditions.

Source: Authors' compilation.

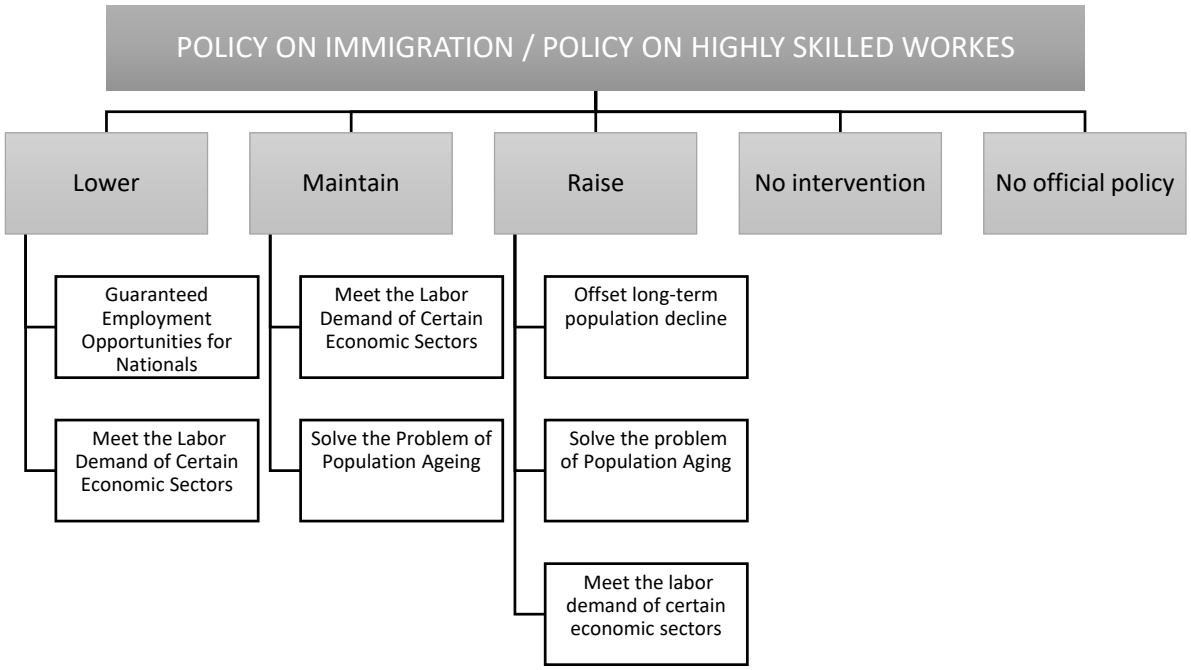

Figure 1. Classification of the main types of immigration policies based on the UN approach

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3. METHOD

To analyze the factors affecting the immigration policy of countries, as well as to determine the role of environmental factors, it is proposed to use the decision tree method.

Due to the versatility of the methodological apparatus, the decision tree has industrial applications both in different areas of economic science, which is reflected, for example, in works and other areas of activity, in particular, in information systems and management of technical systems (Patel & Prajapati, 2018). The possibility of including both qualitative and quantitative information in the decision tree allows analyzing the frequencies of phenomena, events, and objects (including the analysis of the compatibility of the frequencies of different combinations of events).

Thus, the combined application of the decision tree method and associative analysis can reduce the number of calculations by combining them, increase the visibility and interconnection of the results of the analysis of particular problems, and thereby increase business efficiency by increasing the validity and efficiency of management decisions (Chandrasekar et al., 2017).

For the actual calculations, it is planned to use the RapidMiner engine, which offers a variety of opportunities and integrated environments for data preparation, machine learning algorithms, deep learning, exploration of text, and predictive analytics (Kalra & Aggarwal, 2017).

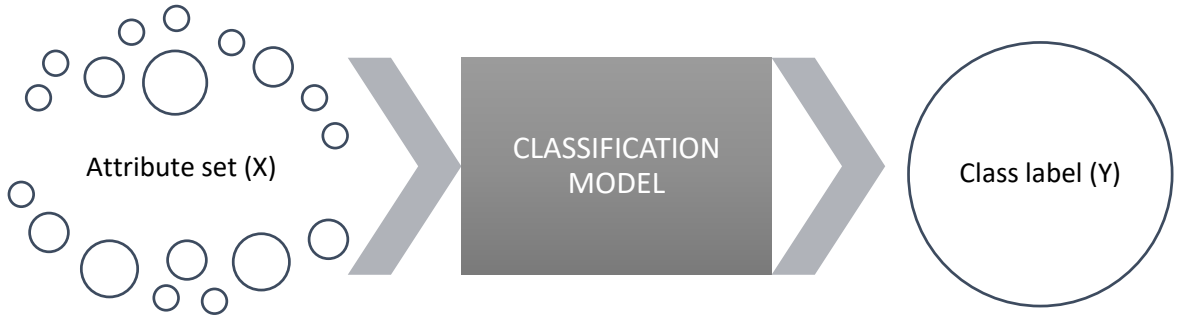
The tree consists of leaves and branches. At the root is the most significant factor. All factors are assigned variables called attributes (set of X attributes). In addition, an important step is the selection of the target label, which is the parameter by which it is expected to predict Y. It is planned to build the following two models with data sets represented in the Appendix A:

- 1st model: – will predict what type of immigration policy will be chosen by the state,
- 2nd model: – will predict which type of policy on highly skilled workers will be selected by the state.

Therefore, the label in the first case will be the type of immigration policy (5 possible values: 1 – Raise, 2 – Maintain, 3 – Lower, 4 – No official policy, 5 – No intervention) (Figure 1).

Accordingly, in the second case, the type policy on highly skilled workers will become the label. The value options are the same as in the first case. The operating principle of the decision tree model was formulated by Kalra and Aggarwal (2017). For research purposes, it has been modified by adding

Source: Authors' compilation based on Kalra and Aggarwal (2017).



- EPI
- GDP per capita
- Population
- Education index
- Sending vs Receiving
- Immigration Stock

- Immigration policy
- Policy on highly skilled workers

Figure 2. General view of 1st and 2nd classification models

necessary parameters for attribute set (X) and class label (Y). The results are shown in Figure 2.

The attribute is checked on every internal node, the check result is checked on the branch, and the class label is checked on the leaf node.

As influencing factors, the following indicators have been identified: 1) GDP per capita, 2) population; 3) sending vs receiving ratio, and 4) immigration stock. Two complex indexes have also been added. The first describes the state of the environment in the country – Environmental Performance Index. Using 32 performance indicators across 11 problem categories, the EPI ranks 180 countries for environmental health and ecosystem resilience (Wendling et al., 2020). These indicators make it possible to assess, on a national scale, how close countries are to the established environmental policy goals. EPI offers a scorecard that highlights leaders and laggards in environmental performance and provides actionable guidance for countries as they strive to move towards a sustainable future.

The second comprehensive indicator is the Education index, which is calculated by the UN as a sub-index for the Human Development Index. Education index is a widely accepted measure of educational attainment within a country and is calculated by combining the average years of schooling (of adults) and expected years of schooling (of children), both expressed as an index obtained by scaling with the corresponding maxima (Adisa & McSharry, 2020).

To test the proposed models, relevant analytics for all indicators were collected (Table 1).

4. RESULTS

The main tool for analysis and forecasting is the construction of a decision tree using the RapidMiner software package, for which a database of static indicators was collected for more than 150 countries of the world. After calculation, two decision tree models have been built: 1) forecasting immigration policy; 2) forecasting immigration policy for skilled workers.

4.1. Immigration policy

To build a decision tree on the Immigration policy, a database was collected according to the indicators indicated in Table 1 for 164 countries of the world. As a result of the calculations, the following conclusions can be drawn. Firstly, in most countries, it is clearly seen that the most significant vector in immigration policy is aimed at maintaining the existing level of immigration (Figure 3).

Secondly, the most important among the studied indicators is the EPI indicator. In the countries with the highest EPI, immigration policy is aimed at reducing the number of immigrants. However,

Table 1. Key indicators for calculating the model

Source: Authors' compilation.

Index	Type	Source	1st Model (Immigration police)	2nd Model (Policy on highly skilled workers)
Country name (ISO)	Attribute set (X)	United Nations (2017)	+	+
Region	Attribute set (X)	United Nations (2017)	+	+
Megaregion	Attribute set (X)	United Nations (2017)	+	+
Environmental Performance Index (EPI)	Attribute set (X)	Dahl and Gorodon (2020)	+	+
GDP per capita	Attribute set (X)	World Bank Data (n.d.a)	+	+
Population	Attribute set (X)	World Bank Data (n.d.b)	+	+
Education index	Attribute set (X)	United Nations (2020)	+	+
Sending vs Receiving	Attribute set (X)	Migration Policy Institute (n.d.)	+	+
Immigration Stock	Attribute set (X)	Migration Policy Institute (n.d.)	+	+
Policy on highly skilled workers	Class label (Y)	United Nations (2017)	–	+
Policy on immigration	Class label (Y)	United Nations (2017)	+	–
Total number of observations (countries)			164	155

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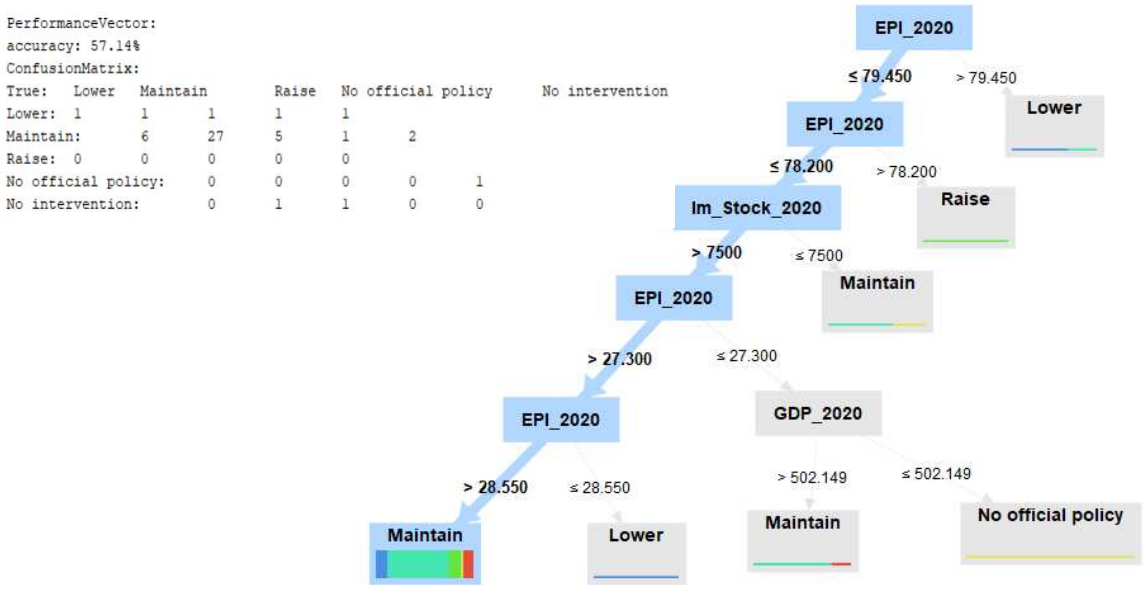
Source: Authors' compilation.



Tree

```
EPI_2020 > 79.450: Lower {Lower=2, Maintain=1, Raise=0, No official policy=0, No intervention=0}
EPI_2020 ≤ 79.450
|   EPI_2020 > 78.200: Raise {Lower=0, Maintain=0, Raise=2, No official policy=0, No intervention=0}
|   EPI_2020 ≤ 78.200
|   |   Im_Stock_2020 > 7500
|   |   |   EPI_2020 > 27.300
|   |   |   |   EPI_2020 > 28.550: Maintain {Lower=12, Maintain=60, Raise=13, No official policy=2, No intervention=10}
|   |   |   |   EPI_2020 ≤ 28.550: Lower {Lower=3, Maintain=0, Raise=0, No official policy=0, No intervention=0}
|   |   |   EPI_2020 ≤ 27.300
|   |   |   |   GDP_2020 > 502.149: Maintain {Lower=0, Maintain=4, Raise=0, No official policy=0, No intervention=1}
|   |   |   |   GDP_2020 ≤ 502.149: No official policy {Lower=0, Maintain=0, Raise=0, No official policy=2, No intervention=0}
|   |   Im_Stock_2020 ≤ 7500: Maintain {Lower=0, Maintain=2, Raise=0, No official policy=1, No intervention=0}
```

Figure 3. Decision tree for classification of policy on immigration

there are relatively few such countries: they are Denmark, Luxembourg, Switzerland, United Kingdom, France, and Austria.

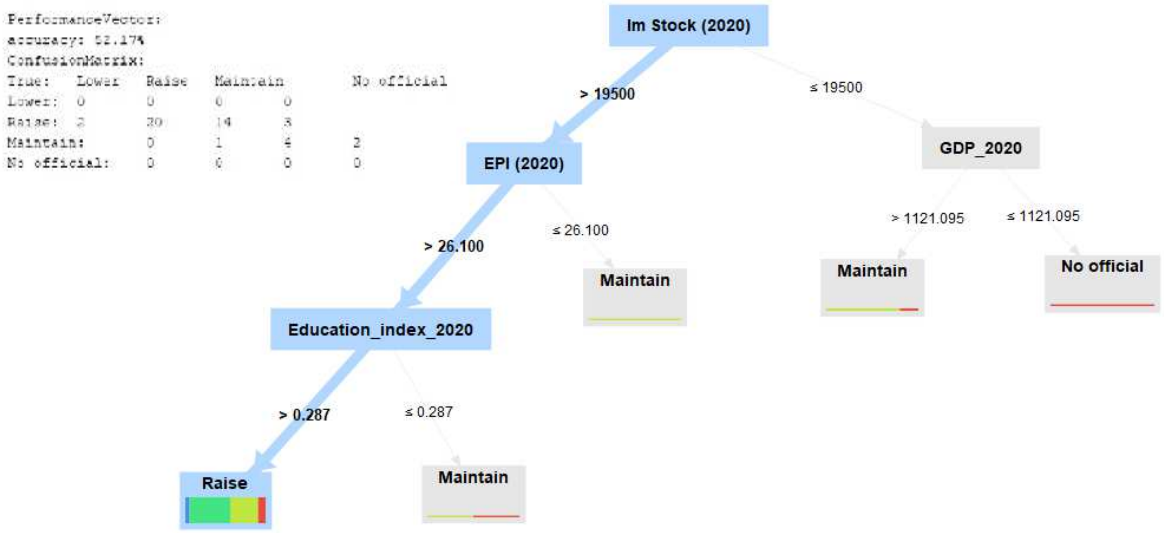
In almost all other cases, the importance of such parameters as the number of immigrants in the country, as well as the level of per capita income, increases. In general, one can see the regularity of the desire of immigration policies to keep the level of immigration at the current level.

4.2. Immigration policy on highly skilled workers

To build a decision tree for immigration policy on highly skilled workers, a database was collected for 155 countries of the world according to the indicators indicated in Table 1. As a result of the calculations performed using the second model, the following conclusions can be drawn. First, in most countries, the immigration policy is aimed at increasing highly skilled workers (Figure 4).

Secondly, the most important among the studied indicators is the total number of immigrants in the country. When their number is minimal (less than 19,500), the country either does not have an official strategy regarding immigrants at all or is focused on maintaining the current level. However, there are few such regions, they are located mainly in Oceania, Africa, and Latin America. In other cases (when immigration stock accounts for more than 19,500), the critical value belongs to the level of the environmental performance of the country. If the value of a country's EPI is less than 26.1, it will follow the immigration policy of "maintain". Otherwise (if a country's EPI is higher than 26.1) the Education index becomes a valuable parameter. If it exceeds 0.287, then in 51% of cases, the country's immigration policy will aim to increase

Source: Authors' compilation.



Tree

```
Im Stock (2020) > 19500
|   EPI (2020) > 26.100
|   |   Education_index_2020 > 0.287: Raise {Lower=5, Raise=50, Maintain=34, No official=9}
|   |   Education_index_2020 ≤ 0.287: Maintain {Lower=0, Raise=0, Maintain=1, No official=1}
|   EPI (2020) ≤ 26.100: Maintain {Lower=0, Raise=0, Maintain=2, No official=0}
Im Stock (2020) ≤ 19500
|   GDP_2020 > 1121.095: Maintain {Lower=0, Raise=0, Maintain=4, No official=1}
|   GDP_2020 ≤ 1121.095: No official {Lower=0, Raise=0, Maintain=0, No official=2}
```

Figure 4. Decision tree for classification of immigration policy on highly skilled workers

"highly skilled workers" ("raise"). This means that countries with high immigrant populations, environmental performance, and education indicators are interested in attracting high-quality workers.

The results obtained allow making a very important observation and concluding that environmental factors are beginning to have an increasingly large influence on the immigration policy of the states. This can be explained by the growing attention of the world community to climate change. The analysis of databases showed a significant difference between the level of environmental performance in Europe and Africa. Therefore, in countries with a high level of environmental efficiency, immigration policy is often focused on curbing the flow of immigrants, even highly qualified ones, since immigration flows are associated with a load on the internal ecosystem.

CONCLUSION

The relevance of the studied problem is due to the growing number of international migrants and the internationalization of the labor force, as well as the impact of rapid economic development on the environment. The dynamics of the labor movement can have a significant impact on the socio-economic and environmental conditions of the countries to which they are migrated. It is important to understand all the advantages and disadvantages of immigration to determine the most optimal policy. Migrants, of course, can pose a threat to the national economy and place a burden on the state budget, which should provide them with social support, as well as worsen the environmental situation. On the other hand, foreign specialists make up a significant part of the labor force and have the ability to ensure the competitiveness of leading enterprises. Globalization necessitates the creation and implementation of

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optimal immigration policies that will allow countries to reap the full benefits of the immigration phenomenon in the long run.

Immigration policies vary greatly from country to country but are generally divided into five main strategies: *raise*, *maintain, lower, no interference*, and *no official policy* (United Nations method).

The purpose of the study was to predict the immigration policies of different countries in the world by analyzing environmental performance and other influencing factors. Two predictive decision tree models developed based on the RapidMiner software package and static indicator libraries in more than 150 countries around the world allow us to draw the following conclusions.

First, in most cases, the immigration policy of the countries of the world will be aimed at maintaining the existing level of immigration and increasing the number of skilled workers.

Second, in general, countries tend to formulate immigration policies aimed at increasing the number of skilled workers. However, an important indicator is the total number of registered immigrants in the country. Therefore, if the country has very few immigrants, the government will not allocate a separate plan to attract them or try to keep them at the current level. Countries with higher immigration stock, environmental performance (EPI exceeds at least 0.26) and education index (more than 0.287) are interested in attracting highly skilled workers.

Third, the analysis has shown, even now the country's environmental indicators have one of the priority values in determining the state's immigration policy. Database analysis revealed significant differences between levels of environmental performance in Europe and Africa. Thus, in countries with a high degree of environmental efficiency, immigration policy often aims to limit the flow of even highly skilled immigrants, since immigration flows are associated with loads on ecosystems.

AUTHOR CONTRIBUTIONS

Conceptualization: Viktoriia Apalkova, Sergiy Tsyganov, Nataliia Meshko.
Data curation: Viktoriia Apalkova, Nadiia Tsyganova.
Formal analysis: Viktoriia Apalkova, Sergiy Tsyganov, Nataliia Meshko, Nadiia Tsyganova.
Funding acquisition: Viktoriia Apalkova, Sergiy Tsyganov, Nataliia Meshko, Nadiia Tsyganova, Serhii Apalkov.
Investigation: Viktoriia Apalkova, Nadiia Tsyganova.
Methodology: Viktoriia Apalkova, Sergiy Tsyganov, Nataliia Meshko.
Project administration: Viktoriia Apalkova, Sergiy Tsyganov.
Resources: Viktoriia Apalkova, Serhii Apalkov.
Software: Viktoriia Apalkova, Serhii Apalkov.
Supervision: Viktoriia Apalkova, Sergiy Tsyganov, Nataliia Meshko.
Validation: Viktoriia Apalkova, Nadiia Tsyganova.
Visualization: Viktoriia Apalkova, Serhii Apalkov.
Writing – original draft: Viktoriia Apalkova, Serhii Apalkov.
Writing – review & editing: Sergiy Tsyganov.

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tors_of_a_country's_UN_Education_Index

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APPENDIX A

Table A1. Data set for 1st Model "Decision tree for classification of policy on immigration" and 2nd Model "Decision tree for classification of policy on immigration"

ISO	Region	Megaregion	Policy on immigration	Policy on highly skilled workers	EPI (2020)	GDP per capita, 2020	Population, mln (2020)	Education index (2020)	Sending vs Receiving (2020)	Immigration Stock, mln (2020)
DNK	Northern Europe	EUROPE	No official policy	Raise	82.5	60 909	5.83	0.92	2.792	0.718
LUX	Western Europe	EUROPE	Maintain	Raise	82.3	38 625	0.63	0.806	3.646	0.298
CHE	Western Europe	EUROPE	Lower	Maintain	81.5	16 082	8.64	0.9	3.491	2.491
GBR	Northern Europe	EUROPE	Lower	Lower	81.3	40 285	67.22	0.928	1.978	9.360
FRA	Western Europe	EUROPE	Lower	Raise	80	44 594	67.39	0.817	3.640	8.525
AUT	Western Europe	EUROPE	Raise	Raise	79.6	45 724	8.92	0.865	2.893	1.738
FIN	Northern Europe	EUROPE	Raise	Raise	78.9	49 041	5.53	0.927	1.238	0.386
SWE	Northern Europe	EUROPE	Raise	Raise	78.7	51 926	10.35	0.918	6.117	2.004
NOR	Northern Europe	EUROPE	Maintain	Raise	77.7	67 294	5.38	0.93	4.453	0.852
DEU	Western Europe	EUROPE	Raise	Raise	77.2	48 105	83.24	0.943	4.089	15.762
NLD	Western Europe	EUROPE	Maintain	Raise	75.3	52 304	17.44	0.914	2.430	2.358
JPN	Eastern Asia	ASIA	Maintain	Raise	75.1	40 146	125.84	0.851	3.426	2.771
AUS	Australia / New Zealand	OCEANIA	Maintain	Maintain	74.9	51 812	25.69	0.924	12.836	7.686
ESP	Southern Europe	EUROPE	Maintain	Raise	74.3	27 057	47.35	0.831	4.593	6.842
BEL	Western Europe	EUROPE	Maintain	Maintain	73.3	115 874	11.56	0.902	3.473	2.005
IRL	Northern Europe	EUROPE	Maintain	Raise	72.8	83 813	4.99	0.922	1.186	0.871
ISL	Northern Europe	EUROPE	Maintain	Raise	72.3	59 261	0.37	0.926	1.513	0.065
SVN	Southern Europe	EUROPE	Maintain	Raise	72	25 180	2.10	0.91	1.735	0.278
NZL	Australia/New Zealand	OCEANIA	Maintain	Raise	71.3	41 792	5.08	0.926	12.836	7.686
CZE	Eastern Europe	EUROPE	No official policy	No official	71	22 762	10.70	0.89	0.527	0.541
ITA	Southern Europe	EUROPE	Maintain	Raise	71	31 676	59.55	0.793	1.960	6.387
CAN	Northern America	NORTHERN AMERICA	Maintain	Maintain	71	43 242	38.01	0.894	6.229	8.049
MLT	Southern Europe	EUROPE	Maintain	Maintain	70.7	27 885	0.53	0.825	1.116	0.115
USA	Northern America	NORTHERN AMERICA	Maintain	Maintain	69.3	63 544	329.48	0.9	16.899	50.633
GRC	Southern Europe	EUROPE	Lower	Lower	69.1	17 676	10.72	0.849	1.231	1.340
SVK	Eastern Europe	EUROPE	Maintain	Raise	68.3	19 157	5.46	0.826	0.470	0.197
PRT	Southern Europe	EUROPE	Raise	Raise	67	22 440	10.31	0.768	0.481	1.002

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Table A1 (cont.). Data set for 1st Model "Decision tree for classification of policy on immigration" and 2nd Model "Decision tree for classification of policy on immigration"

ISO	Region	Megaregion	Policy on immigration	Policy on highly skilled workers	EPI (2020)	GDP per capita, 2020	Population, mln (2020)	Education index (2020)	Sending vs Receiving (2020)	Immigration Stock, mln (2020)
KOR	Eastern Asia	ASIA	Raise	Raise	66.5	31 489	51.78	0.865	0.784	1.728
ISR	Western Asia	ASIA	Raise	Maintain	65.8	43 611	9.22	0.883	5.446	1.954
EST	Northern Europe	EUROPE	Maintain	Raise	65.3	23 312	1.33	0.882	0.964	0.199
CYP	Western Asia	ASIA	Maintain	Lower	64.8	26 624	1.21	0.827	1.099	0.190
ROU	Eastern Europe	EUROPE	Raise	Raise	64.7	12 896	19.29	0.765	0.177	0.705
HUN	Eastern Europe	EUROPE	Raise	Raise	63.7	15 899	9.75	0.821	0.818	0.585
HRV	Southern Europe	EUROPE	Maintain	Raise	63.1	13 828	4.05	0.805	0.508	0.528
LTU	Northern Europe	EUROPE	Raise	Raise	62.9	19 998	2.79	0.898	0.221	0.145
LVA	Northern Europe	EUROPE	Maintain	Raise	61.6	17 620	1.90	0.883	0.630	0.239
POL	Eastern Europe	EUROPE	Raise	Raise	60.9	15 656	37.95	0.869	0.169	0.817
SYC	Eastern Africa	AFRICA	Lower	Maintain	58.2	11 425	0.10	0.726	0.446	0.013
SGP	South-Eastern Asia	ASIA	Maintain	Lower	58.1	59 798	5.69	0.844	7.242	2.524
BGR	Eastern Europe	EUROPE	Raise	Raise	57	9 976	6.93	0.779	0.110	0.184
ARE	Western Asia	ASIA	Maintain	Raise	55.6	31 982	9.89	0.802	42.892	8.716
CHL	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	55.3	86 602	19.12	0.81	2.555	1.645
SRB	Southern Europe	EUROPE	Maintain	Maintain	55.2	7 666	6.91	0.783	0.820	0.823
BRN	South-Eastern Asia	ASIA	Maintain	Raise	54.8	27 466	0.44	0.702	2.469	0.112
KWT	Western Asia	ASIA	Lower	Raise	53.6	22 105	4.27	0.638	14.652	3.110
JOR	Western Asia	ASIA	Lower	Maintain	53.4	4 283	10.20	0.667	4.243	3.458
BLR	Eastern Europe	EUROPE	Raise	Raise	53	6 411	9.40	0.838	0.719	1.067
COL	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	52.9	5 333	50.88	0.682	0.630	1.905
MEX	Central America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	52.6	8 347	128.93	0.703	0.107	1.198
CRI	Central America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	52.5	12 077	5.09	0.726	3.466	0.521
ARM	Western Asia	ASIA	Maintain	Maintain	52.3	4 267	2.96	0.74	0.199	0.190

Table A1 (cont.). Data set for 1st Model "Decision tree for classification of policy on immigration" and 2nd Model "Decision tree for classification of policy on immigration"

ISO	Region	Megaregion	Policy on immigration	Policy on highly skilled workers	EPI (2020)	GDP per capita, 2020	Population, mln (2020)	Education index (2020)	Sending vs Receiving (2020)	Immigration Stock, mln (2020)
ARG	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	52.2	8 442	45.38	0.855	2.120	2.282
BRA	South America	LATIN AMERICA AND THE CARIBBEAN	Raise	Raise	51.2	6 797	212.56	0.694	0.569	1.080
ECU	South America	LATIN AMERICA AND THE CARIBBEAN	Lower	No	51	5 600	17.64	0.702	0.696	0.785
BHR	Western Asia	ASIA	Lower	Lower	51	22 402	1.70	0.769	16.065	0.936
RUS	Eastern Europe	EUROPE	Raise	Raise	50.5	10 127	144.10	0.823	1.082	11.637
UKR	Eastern Europe	EUROPE	Raise	Raise	49.5	3 727	44.13	0.799	0.814	4.997
URY	South America	LATIN AMERICA AND THE CARIBBEAN	Raise	Raise	49.1	15 438	3.47	0.765	0.295	0.108
ALB	Southern Europe	EUROPE	Maintain	Maintain	49	5 215	2.84	0.746	0.039	0.049
ATG	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	48.5	14 450	0.10	0.665	0.441	0.029
VCT	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	48.4	7 298	0.11	0.684	0.085	0.005
JAM	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	48.2	4 665	2.96	0.689	0.021	0.024
IRN	South-Central Asia	ASIA	Lower	Maintain	48	2 283	83.99	0.756	2.111	2.797
MYS	South-Eastern Asia	ASIA	Lower	Raise	47.9	10 402	32.37	0.726	1.869	3.477
TTO	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	47.5	15 384	1.40	0.728	0.239	0.079
PAN	Central America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	47.3	12 269	4.31	0.7	2.245	0.313
TUN	Northern Africa	AFRICA	No intervention	No	46.7	3 320	11.82	0.661	0.067	0.060
AZE	Western Asia	ASIA	Maintain	Raise	46.5	4 214	10.11	0.711	0.217	0.252

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Table A1 (cont.). Data set for 1st Model "Decision tree for classification of policy on immigration" and 2nd Model "Decision tree for classification of policy on immigration"

ISO	Region	Megaregion	Policy on immigration	Policy on highly skilled workers	EPI (2020)	GDP per capita, 2020	Population, mln (2020)	Education index (2020)	Sending vs Receiving (2020)	Immigration Stock, mln (2020)
PRY	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	46.4	4 950	7.13	0.638	0.189	0.170
MNE	Southern Europe	EUROPE	Maintain	Maintain	46.3	7 686	0.62	0.803	0.534	0.071
DOM	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	46.3	7 268	10.85	0.666	0.375	0.604
GAB	Middle Africa	AFRICA	Raise	Raise	45.8	7 006	2.23	0.65	8.610	0.417
BRB	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Lower	Raise	45.6	15 191	0.29	0.782	0.350	0.035
BIH	Southern Europe	EUROPE	Maintain	Maintain	45.4	6 032	3.28	0.711	0.021	0.036
LBN	Western Asia	ASIA	Maintain	Maintain	45.4	4 891	6.83	0.604	1.999	1.713
THA	South-Eastern Asia	ASIA	Raise	Raise	45.4	7 189	69.80	0.682	3.342	3.632
SUR	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	45.2	6 491	0.59	0.675	0.175	0.048
MUS	Eastern Africa	AFRICA	Maintain	Raise	45.1	8 623	1.27	0.736	0.158	0.029
DZA	Northern Africa	AFRICA	Maintain	Maintain	44.8	3 310	43.85	0.672	0.124	0.250
KAZ	South-Central Asia	ASIA	Raise	Raise	44.7	9 056	18.75	0.83	0.888	3.732
DMA	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	44.6	6 527	0.07	0.632	0.106	0.008
BOL	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	44.3	3 143	11.67	0.695	0.177	0.164
UZB	South-Central Asia	ASIA	Maintain	Maintain	44.3	1 686	34.23	0.729	0.573	1.162
PER	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	44	6 127	32.97	0.74	0.806	1.225
SAU	Western Asia	ASIA	Lower	Maintain	44	20 110	34.81	0.789	44.959	13.455
TKM	South-Central Asia	ASIA	Lower		43.9	7 967	6.03	0.653	0.804	0.195
BHS	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	43.5	28 608	0.39	0.74	1.182	0.064

Table A1 (cont.). Data set for 1st Model "Decision tree for classification of policy on immigration" and 2nd Model "Decision tree for classification of policy on immigration"

ISO	Region	Megaregion	Policy on immigration	Policy on highly skilled workers	EPI (2020)	GDP per capita, 2020	Population, mln (2020)	Education index (2020)	Sending vs Receiving (2020)	Immigration Stock, mln (2020)
EGY	Northern Africa	AFRICA	Lower	Maintain	43.3	3 548	102.33	0.618	0.151	0.544
GRD	Caribbean	LATIN AMERICA AND THE CARIBBEAN	No official policy	No official	43.1	9 680	0.11	0.77	0.116	0.007
LCA	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	43.1	9 276	0.18	0.672	0.117	0.008
SLV	Central America	LATIN AMERICA AND THE CARIBBEAN	No intervention	Maintain	43.1	3 799	6.49	0.555	0.027	0.043
ZAF	Southern Africa	AFRICA	Maintain	Raise	43.1	5 091	59.31	0.724	3.127	2.860
TUR	Western Asia	ASIA	Maintain	Raise	42.6	8 538	84.34	0.731	1.774	6.053
MAR	Northern Africa	AFRICA	No official policy	Maintain	42.3	3 009	36.91	0.569	0.031	0.102
BLZ	Central America	LATIN AMERICA AND THE CARIBBEAN	Lower	Maintain	41.9	4 436	0.40	0.695	1.176	0.062
GEO	Western Asia	ASIA	Maintain	Raise	41.3	4 279	3.71	0.862	0.092	0.079
BWA	Southern Africa	AFRICA	Maintain	Raise	40.4	6 711	2.35	0.676	1.735	0.110
NAM	Southern Africa	AFRICA	Maintain	Raise	40.2	4 211	2.54	0.584	2.290	0.109
KGZ	South-Central Asia	ASIA	Maintain	Maintain	39.8	1 174	6.59	0.73	0.257	0.199
IRQ	Western Asia	ASIA	Maintain	No official	39.5	4 157	40.22	0.557	0.176	0.366
BTN	South-Central Asia	ASIA	Maintain	Maintain	39.3	3 122	0.77	0.496	1.031	0.054
NIC	Central America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	39.2	1 905	6.62	0.573	0.059	0.042
LKA	South-Central Asia	ASIA	Maintain	Maintain	39	3 682	21.92	0.746	0.021	0.040
OMN	Western Asia	ASIA	Lower	Lower	38.5	14 216	5.11	0.718	94.539	2.373
PHL	South-Eastern Asia	ASIA	Maintain	Maintain	38.4	3 299	109.58	0.678	0.037	0.226
MWI	Eastern Africa	AFRICA	Lower	Maintain	38.3	625	19.13	0.47	0.615	0.191
BFA	Western Africa	AFRICA	No intervention	No	38.3	831	20.90	0.312	0.453	0.724
TJK	South-Central Asia	ASIA	Maintain		38.2	859	9.54	0.682	0.470	0.276
GNQ	Middle Africa	AFRICA	Maintain	Raise	38.1	7 143	1.40	0.467	1.791	0.231

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Table A1 (cont.). Data set for 1st Model "Decision tree for classification of policy on immigration" and 2nd Model "Decision tree for classification of policy on immigration"

ISO	Region	Megaregion	Policy on immigration	Policy on highly skilled workers	EPI (2020)	GDP per capita, 2020	Population, mln (2020)	Education index (2020)	Sending vs Receiving (2020)	Immigration Stock, mln (2020)
HND	Central America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Maintain	37.8	2 406	9.90	0.499	0.040	0.039
IDN	South-Eastern Asia	ASIA	Maintain	Maintain	37.8	3 870	273.52	0.65	0.077	0.356
KIR	Micronesia	OCEANIA	Maintain		37.7	1 671	0.12	0.594	0.613	0.003
WSM	Polynesia	OCEANIA	Maintain	Maintain	37.3	4 067	0.20	0.713	0.030	0.004
CHN	Eastern Asia	ASIA	Raise	Raise	37.3	10 500	1402.11	0.657	0.099	1.040
QAT	Western Asia	ASIA	Lower	Raise	37.1	50 805	2.88	0.659	86.605	2.226
ZWE	Eastern Africa	AFRICA	No intervention	Raise	37	1 128	14.86	0.587	0.335	0.416
CAF	Middle Africa	AFRICA	No intervention		36.9	477	4.83	0.353	0.108	0.089
GUY	South America	LATIN AMERICA AND THE CARIBBEAN	Maintain	Raise	35.9	6 956	0.79	0.601	0.071	0.031
MDV	South-Central Asia	ASIA	Maintain	Raise	35.6	7 456	0.54	0.573	18.864	0.070
UGA	Eastern Africa	AFRICA	No intervention	No	35.6	817	45.74	0.523	2.201	1.720
TLS	South-Eastern Asia	ASIA	Maintain	Maintain	35.3	1 381	1.32	0.51	0.212	0.008
LAO	South-Eastern Asia	ASIA	Maintain	Raise	34.8	2 630	7.28	0.481	0.038	0.049
SDN	Northern Africa	AFRICA	Maintain		34.8	595	43.85	0.345	0.655	1.379
ZMB	Eastern Africa	AFRICA	Maintain	Maintain	34.7	1 051	18.38	0.557	0.936	0.188
KEN	Eastern Africa	AFRICA	Lower	Maintain	34.7	1 838	53.77	0.534	1.962	1.050
FJI	Melanesia	OCEANIA	Maintain	Maintain	34.4	4 882	0.90	0.764	0.060	0.014
ETH	Eastern Africa	AFRICA	No intervention	Raise	34.4	936	114.96	0.341	1.147	1.086
MOZ	Eastern Africa	AFRICA	Maintain	Maintain	33.9	449	31.26	0.395	0.529	0.339
RWA	Eastern Africa	AFRICA	Raise	Raise	33.8	798	12.95	0.458	1.043	0.514
KHM	South-Eastern Asia	ASIA	Maintain	Maintain	33.6	1 513	16.72	0.484	0.072	0.079
CMR	Middle Africa	AFRICA	Maintain	No official policy	33.6	1 499	26.55	0.547	1.313	0.579
VNM	South-Eastern Asia	ASIA	Maintain	Raise	33.4	2 786	97.34	0.63	0.023	0.077
PAK	South-Central Asia	ASIA	Lower	Maintain	33.1	1 194	220.89	0.402	0.518	3.277
CPV	Western Africa	AFRICA	Maintain	No	32.8	3 064	0.56	0.562	0.084	0.016
NPL	South-Central Asia	ASIA	Maintain	Maintain	32.7	1 155	29.14	0.521	0.188	0.488
PNG	Melanesia	OCEANIA	Maintain	Raise	32.4	2 637	8.95	0.439	6.459	0.031
MNG	Eastern Asia	ASIA	Maintain	Raise	32.2	4 007	3.28	0.736	0.260	0.021
COM	Eastern Africa	AFRICA	No intervention		32.1	1 403	0.87	0.482	0.083	0.012

Table A1 (cont.). Data set for 1st Model "Decision tree for classification of policy on immigration" and 2nd Model "Decision tree for classification of policy on immigration"

ISO	Region	Megaregion	Policy on immigration	Policy on highly skilled workers	EPI (2020)	GDP per capita, 2020	Population, mln (2020)	Education index (2020)	Sending vs Receiving (2020)	Immigration Stock, mln (2020)
GTM	Central America	LATIN AMERICA AND THE CARIBBEAN	No intervention	Maintain	31.8	4 603	16.86	0.519	0.062	0.084
NGA	Western Africa	AFRICA	Maintain	Raise	31	2 097	206.14	0.499	0.783	1.309
NER	Western Africa	AFRICA	Maintain	Maintain	30.8	565	24.21	0.249	0.871	0.348
SEN	Western Africa	AFRICA	No official policy	No official	30.7	1 488	16.74	0.345	0.396	0.275
BEN	Western Africa	AFRICA	No intervention	No	30	1 291	12.12	0.478	0.578	0.394
AGO	Middle Africa	AFRICA	Maintain	Raise	29.7	1 896	32.87	0.5	0.983	0.656
TGO	Western Africa	AFRICA	No intervention	No	29.5	915	8.28	0.517	0.513	0.280
MLI	Western Africa	AFRICA	Maintain	No	29.4	859	20.25	0.286	0.373	0.486
GNB	Western Africa	AFRICA	No intervention	No	29.1	728	1.97	0.414	0.161	0.018
BGD	South-Central Asia	ASIA	Maintain		29	1 969	164.69	0.529	0.286	2.115
VUT	Melanesia	OCEANIA	Maintain	Maintain	28.9	2 783	0.31	0.561	0.449	0.003
DJI	Eastern Africa	AFRICA	Lower	Maintain	28.1	3 426	0.99	0.325	6.520	0.120
LSO	Southern Africa	AFRICA	No intervention	No	28	861	2.14	0.532	0.060	0.012
GMB	Western Africa	AFRICA	Lower	Lower	27.9	787	2.42	0.406	1.549	0.216
GHA	Western Africa	AFRICA	Lower	No	27.6	2 329	31.07	0.563	0.474	0.476
IND	South-Central Asia	ASIA	Maintain	Maintain	27.6	1 901	1380.00	0.555	0.273	4.879
HTI	Caribbean	LATIN AMERICA AND THE CARIBBEAN	Maintain		27	1 177	11.40	0.456	0.011	0.019
BDI	Eastern Africa	AFRICA	No official policy	Raise	27	274	11.89	0.417	0.626	0.345
TCD	Middle Africa	AFRICA	Maintain	Raise	26.7	614	16.43	0.288	2.463	0.547
MDG	Eastern Africa	AFRICA	No official policy	Maintain	26.5	495	27.69	0.486	0.184	0.036
GIN	Western Africa	AFRICA	No intervention	No	26.4	1 194	13.13	0.354	0.220	0.121
CIV	Western Africa	AFRICA	Maintain	Maintain	25.8	2 326	26.38	0.453	2.232	2.565
SLE	Western Africa	AFRICA	No intervention	No	25.7	485	7.98	0.406	0.352	0.054
AFG	South-Central Asia	ASIA	Maintain	Maintain	25.5	509	38.93	0.414	0.025	0.144
MMR	South-Eastern Asia	ASIA	Maintain	Raise	25.1	1 400	54.41	0.464	0.021	0.076
LBR	Western Africa	AFRICA	Maintain		22.6	583	5.06	0.426	0.377	0.088

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