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What drives migration to Germany? A panel data analysis

J.A. Klöcker*, F. Daumann

Chair of Sports Economics and Health Economics, Friedrich Schiller University Jena, Seidelstrasse 20, D-07749 Jena, Germany

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ABSTRACT

Migration has increased in many parts of the world for a variety of reasons. In our study, we examine bilateral migration flows between one country and the rest of the world. To this end, we develop a formal model that assumes rational individuals and which is partly based on insights from the micro-theory of migration. In doing so, we include human development and distinguish between regular and aysl-related migration. We test the model empirically on the example of Germany. It turns out that climate change and life expectancy have a significant impact on migration. Contrary to our expectations, the economic development, the extent of social assistance and the level of education do not seem to have any significant influence. With our paper, we expand previous research on migration with an empirically based model.

1. Introduction

Since more than three decades, Germany is facing a massive inflow of immigrants from around the world. The goal of our contribution is on the one hand to figure out which components determine the push- and pull-factors, and on the other hand to quantify these components. Our analysis differs to other empirical studies as we explicitly estimate the effects of bilateral migration flows between Germany and the rest of the world. To do so, we consider all countries with a sufficient data stock. In addition, our paper is unique, because we do not only account for economic variables such as employment or income, but also consider determinants referring to human development, e.g. such as life expectancy, and education levels. Besides that, we analyze these manifold variables for both types of migration, the regular, and the asylum-associated.

The remainder of this paper is structured as follows: In the second section we give an overview of the relevant literature and the recent research. In the third section, we present our model based on the *Rational-Choice Approach*, and analyze its outcomes. In section 4 we present our methods and data sources. Besides that we show our empirical results and discuss them. Finally, we close with concluding remarks and an outlook on further research.

* Corresponding author.
E-mail address: julian.kloecker@uni-jena.de (J.A. Klöcker).

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2. Research Overview

Our analysis is based on the *Rational-Choice Approach*, one pillar of the large set of competing migration theories. Among these, the former belongs to the *Micro Theory*, just as the *Network Theory.* According to them, Individuals choose the destination where they can maximize their utility. However, the *New Migration Economics* does not regard the decision to migrate as the exclusive result of the logic of income maximization. Rather, according to this approach various other aspects flow into the decision to migrate. In reference to Massey et al. (1993), migration in this context is a collective decision; individuals move to other countries in order to minimize risks of income absence for the whole family. The *Network Theory* postulates a strong influence of diasporas, or networks, respectively. According to this approach, diasporas provide a lot of advantages to immigrants, especially by reducing the costs of migration. The Turkish community in Germany can serve as a vivid example: It is common knowledge, that the Turkish community has emerged over the last 50 years in Germany. That diaspora offers now informations on various topics, e.g. job opportunities, job conditions to new Turkish immigrants. In this way, a network reduces the integration costs for the new immigrant due to lower search and information costs. Additionally, a network improves the potential immigrant's social situation, as it is easier for him to find new social contacts, relationships, or to make new friends. Another advantage of diasporas is bridge building: They give rise to growing FDI to the emigration economy, and thus foster business and industry linkages, and contribute to bilateral spillover effects (e.g. Balasubramanyam, 2005; Beine, 2016; or Naujoks, 2022). On the other side, societies can be negatively affected by such diasporas. As Beine et al. (2011) point out in their seminal paper, diasporas foster adverse selection: less-qualified migrants are much more depended on the informations and job opportunities from the diaspora than well-qualified migrants. They underpin a considerable connection between bilateral migration flows and diasporas' sizes in general, too. The remarkable impact of networks is also examined by Carrington et al. (1996), who state that networks reduce integration costs, and on the top implement a constant inflow due to family reunions. McKenzie and Rapoport (2010) show based on data regarding Mexican immigrants in the United States, that Mexican networks promote self-selection in direction to lower educated workers. Though not only international movement is vastly determined by network effects, even the internal migration follows the paths of diasporas. For instance, Serlenga and Shin (2021) show that particular networks are main impacting factors to interprovincial migration in Canada. Naujoks (2022) states the important role of diasporas on FDI in the corresponding home countries.

In their seminal paper from 2019, Beine et al. (2019) expand the analysis to short-run economic fluctuations. They assume that business cycles may act as a channel for potential migrants in building expectations about job probabilities and thus participating on the booming economy.

Mayda (2010) uses the per-capita income in both, the domestic and the target country, in order to measure push and pull factors. Her findings suggest an asymmetry between both: The per-capita income in the target country significantly increases emigration rates, while the pushing factors' impact in the homeland is seldom negative, opposite as expected.

It is widely accepted that the climate change may impose the industrialized nations on huge migration challenges. Marchiori et al (2012), or Backhaus et al. (2015), state that deteriorate climate conditions set incentives to migrate. Contrary, Cattaneo and Peri (2016) find different results for either low-income and middle-income states. Climate changes thus act as a pushing factor in middle-income nations, wherewith emigration rates from low-income countries do not significantly increase.

In those countries, a rural exodus seems to be more likely. This development may lead to a reduced productivity of the agriculture, what is especially problematic in third-world nations with its large agricultural GDP share. Hence, as an exit strategy to get out of the situation with diminishing salaries, only the escape to agglomerations seems to be the last chance to maintain sufficient earnings. Beine and Parsons (2017) come to similar results. In fact, they do not get significance for aggregate data, but after splitting up the country set into income subsets, they find evidence for pushing effects regarding the middle-income nations. The migration from the lower-income states decline by approximately 7% corresponding to a rise in the temperature anomaly at 1 degree. One explanation for the asymmetric impact may be the monetary restrictions in such environments. As Drabo and Mbaye (2015) point out, not only rising anomalies push emigration, but also the higher probability to get haunted by natural disasters, too. In particular, the so-called *Brain Drain* may be vastly hit by that. By means of fixed effects estimations, Drabo and Mbaye (2015) further illustrate a split into qualification groups: while lower qualified people are not as much as affected, the higher qualified work force responses very sensitive to natural disasters. It could be a sign that this group has superior adaptive skills. Hence, developing countries are not only imposed with catastrophes, such as tropical storms or swamping, but in addition they get afterwards indirectly shocked by a *Brain Drain* of the intellectual elite. Abel et al. (2019) consider the effects of climate changes as well as armed conflicts in implementing a chain migration.

Because we are explicitly anxious for integrating non-economic variables to determine migration, we will consider the components of the HDI. It appears, that there is no relevant research in that area. Barrientos (2007), and Dao et al. (2018) take only into account the educational status into their analysis. The latter poses that a higher education level corresponds with higher emigration rates, stemming from the fact, that the wealthier a society gets, the more educated it becomes, and in this way, it increases the incentive to move. For instance, as a high-qualified class evolved in Korea, their mobility climbed. Arif (2022) illustrates the significant role in the presence of corruption, and corrupt authorities on the migratory decision. It is notably a key driver behind high-qualified exodus.

3. A Model of Migration

3.1. Basic Setup

Our model is based on the popular *Rational-Choice Approach*, which has been widely used (e.g. Beine et al., 2011; Serlenga and Shin, 2021; or Cun and Perseran, 2022). We presume 1. the existence of homogenous, totally informed individuals, who seek to maximize their utility by moving from country i to j. Besides that, we assume 2. that unemployment exists. Thus, there is risk of not getting a job at the destination. 3. The individuals build expectations over job probabilities, based on the short-run economic constitution in both countries, i and j. Therefore, we include both, unemployment, and business cycles in our model. We lay the emphasis on the bilateral migration flows between Germany and the rest of the world, hence, j=Germany. There is a set $\mathfrak{L}$ which includes 155 nations, so $i \in \mathfrak{L}$[1]. Finally, we consider an interval of $t = 1995, \ldots, 2019$.

Suppose the expected income (per capita) in i (or j, reversely) is a combination of the average salary w_t as well as the expected probability to be employed,

$$\mathbb{E}[y_t] = w_t \cdot \mathbb{E}[\mathbb{P}(b = 1)] \tag{1}$$

whereas we assume for simplicity a binary variable

$$b = \begin{cases} 1, & employed \\ 0, & otherwise \end{cases} \tag{2}$$

Since that certain job probability is just a reflection of the short-run economic situation, we deduce (3)

$$\mathbb{E}[\mathbb{P}(b = 1)] \equiv (1 - \alpha_t)^{\rho_1} r_t^{\rho_2} \tag{3}$$

That means, an individual's expectation to be employed is derived from the informations about the employment rate $(1 - \alpha)$, and the business cycle component r_t. The exponentials ρ_1, ρ_2 act therefore as elasticities. Having (3) in mind, we can write the expected income per capita as

$$\mathbb{E}[y_t] = (1 - \alpha_t)^{\rho_1} r_t^{\rho_2} \quad w = 1, \forall i, j \tag{4}$$

The rationale behind (4) is clearcut: The employment rate together with the contemporaneous economy situation serve as an anchor to potential emigrants for future employment opportunities. Furthermore, the business cycle informs about short-run developments, and consequently the individuals build expectations over the immediate future. The fundament behind that rationale lies in *Okun's Law*, the famous feedback-mechanism between production and unemployment (Beine et al., 2019, give an extensive argumentation).[2]

Let the utility be log-linear in the expected income. It depends on the expected income, country-specific attributes $\Lambda_{i,t}$, and the error term $\varepsilon_{i,t}$, too.

$$u_{ii,t} = log\mathbb{E}[y_{i,t}] + \Lambda_{i,t} + \varepsilon_{i,t} \tag{5}$$

whereas $\varepsilon_{i,t} \sim Gu(\cdot)$ and $i \in \mathfrak{L}$. In opposite, the utility of a migration from i to j is

$$u_{ij,t} = log\mathbb{E}\left[y_{j,t}\right] + \Lambda_{j,t} - c_{ij,t} - \delta_{ij} z_{j,t} + \varepsilon_{j,t} \tag{6}$$

whereas $\varepsilon_{j,t} \sim Gu(\cdot)$. We add a new term $c_{ij,t}$, which defines the migration-related costs, and the new variable $z_{j,t}$, an indicator measuring the immigration rule strictness. The dummy δ_{ij} indicates the membership in a free movement agreement

$$\delta_{ij} = \begin{cases} 1, i, j \notin H \\ 0, i, j \in H \end{cases} \tag{7}$$

with $\mathfrak{H} \subseteq \mathfrak{L}$ as the subset of all nations are being members in such an agreement.[3] Apparently, $z_{j,t}$ cancels out if countries i and j are simultaneously members, such as, for example, Germany and Austria.

We assume now, the country-specific characteristics reflect both, push and pull factors. Which ones could that be? In the one hand, there are climate traits. But the individual decision to migrate is supposed to be up to the real, local changes, rather than geographical issues. Several authors refer to use temperature anomalies for an adequate measurement of the climate changes, instead of looking to the ordinary, absolute temperature, as e.g. Marchiori et al. (2012), or Vera-Valdes (2021). The application of that rules out extreme temperature fluctuations in the extratropical regions.[4] In other words: »Anomalies thus describe how far the weather conditions depart from this normal in a given year [. . .] capturing deviations in the weather from the norm.« (Marchiori et al, 2012, p. 363)

[1] See Appendix A to get a List of all countries.
[2] In (4), we set the average salaries to one, because of lack of data.
[3] Appendix B contains a List with these countries.
[4] It is well known that the amplitude of the annual climate is greater in the extratropical regions (Marhciori et al., 2012).

Hence, a variance at about 1 degree in a region with relative stable annual mean temperature may be more impacting than a variance at 5 degrees in a region with large amplitudes in general (National Center for Environmental Information, 2021).

Our country-specific characteristics Λ are supposed to be as follows

$$\Lambda_{i,t} = \Lambda\left(k_{i,t}, \varkappa_{ij}, \vartheta_{i,t}\right) \tag{8}$$

they are functions of several variables, such as the anomaly $k_{i,t}$, the cultural connection with the homeland $\varkappa_{ij}$, the existence of an armed conflict $\vartheta_{i,t}$. Thus we have two binary variables

$$\varkappa_{ij} = \begin{cases} 1, & \textit{connected} \\ 0, & \textit{otherwise} \end{cases} \tag{9.0}$$

$$\vartheta_{i,t} = \begin{cases} 1, & \exists \textit{war} \\ 0, & \textit{otherwise} \end{cases} \tag{9.1}$$

As you can see, the variables $k_{i,t}$, $\vartheta_{i,t}$ are time-varying, but the cultural connection is assumed to be time-invariant, at least in the middle-term. By running the panel regressions, the $\varkappa_{ij}$'s cancel out. We further assume costs which are fed through two channels: the spatial distance, logically related to transport costs, as well as by the diasporas' size in j

$$c_{ij,t} = c\left(g_{ij}, m_{ij,t}\right) \tag{10}$$

g_{ij} stands for the geodesic between the capitals of country pair $\{i, j\}$.[5] It is the shortest, direct connection, measured in kilometers. The diaspora $m_{ij,t}$ is the stock of immigrants from state i now living in j. $c_{ij,t}$ would have actually be determined by the probability to have already relatives in j. As consequence of our presumed total informed individuals, this is not stochastic anymore, but deterministic. The individuals know at any time where international relatives live.

$$\frac{\partial c_{ij,t}}{\partial g_{ij}} > 0, \quad \frac{\partial c_{ij,t}}{\partial m_{ij,t}} < 0 \tag{11}$$

With (11), the costs increase with the distance. In turn, the diasporas' size effectively diminishes the migration-related costs through three different mechanisms: The first is related to formal support, for instance to get visa prolongations, or idiosyncratic cultural traits. There is a full range of possible, cost-reducing support from the community, take for example lingual supports, or the providing of cheaper housing. All of them effectively reduce the risk and so the cost for new immigrants. Massey and Espinosa (1997), McKenzie and Rapoport (2010), as well as Comola and Mendola (2014), too, emphasize the general cost-reducing momentum of migrant networks. As we already mentioned networks provide notably advantages in terms of employment for friends, or relatives (Munshi, 2003). Take the Mexican immigrants as example: The Mexican society in the United States offers jobs to newly arriving migrants, often with better payoffs, as Munshi (2003) points out. Thirdly, networks, or diasporas, respectively, support family reunions, particularly to asylum-seekers. A pioneer migrant goes to state j and proves itself under the local circumstances on the job market, morals and norms. When that migrant gets its unlimited visa, the way for his family members to join him is free, so a chain migration arises.[6]

3.2. Migration Policy

One of the important features of our analysis is to model a government's reaction function to migration inflow. Let $z_{j,t} \in (-\infty, \infty)$ be a rough indicator to quantify the toughness of the migration rules set by the policy makers. Let us now assume that policy makers just follow a naive approach, just regarding easily observable quantities, rather than doing any optimization. Then we have

$$z_{j,t} = z\left(Y_{j,t}, \mathbb{E}_t\left[n_{ij,t+1}\right], m_{ij,t}\right) \tag{12}$$

where $Y_{j,t}$ is the nominal GDP, $\mathbb{E}_t[n_{ij,t+1}]$ is the expected inflow of net migration, and $m_{ij,t}$ is the scope of diasporas. Although we are not able to write down concrete functional forms yet, we believe that governments react even harsher if there is contemporaneously a large diaspora. Actually, in society's eyes it does not matter if a certain migrant group may be bigger than the others, so we explicitly regard the sum of all diasporas. Only the total amounts of the migrant stock as well as the inflows are supposed to be relevant. Alike the migrant stock, an expected rise in the amount of net migrants impose the policy to react and re-adjust the rules. On the other side, higher GDP means both, climbing economy, inducing more jobs as well as higher tax means, so the government consequently eases the immigration rules. If the government would not ease the rules, it put itself in danger by not reacting to potential underemployment. The consequence would be an underproduction gap. But even though there is no such underemployment situation, a phase of economic recovery can be

[5] Since the geodesic is of course time-invariant, it later cancels out.

[6] A good example comes from the Syrians in Germany: In the interval 2015-2020 they almost get 140,000 family members to Germany (ZDF, 2021).

associated with higher acceptance for openness.[7] In cases that policy reacts relatively sensitive to the amount of inflows, we can then define $z_{j,t}$ as a squared sum over expected net migration and diasporas with

$$z_{j,t} \equiv \frac{\left(\sum_i \mathbb{E}\left[n_{ij,t+1}\right] + m_{ij,t}\right)^2}{Y_{j,t}} \tag{14}$$

Because $\lim_{\mathbb{E}[n_{t+1}]\to\infty} z_{j,t} = \infty$, and $\lim_{Y_{j,t}\to\infty} z_{j,t} = 0$, the rules get less restrictive, the larger the GDP gets, and reversely gets more restrictive, the larger the inflow gets.[8] The probability to migrate from the i-th country into the k-th utility maximizing target is

$$\mathbb{P}(u_{ij} > u_{ik}) \forall j \neq k \tag{15}$$

Since both stochastic parts of the utility functions follow the Gumbel-distribution, we have the distribution function $F(q) = e^{-e^{-q}}$. Therefore, we can use McFadden's results (1974, 1984) to get

$$\mathbb{P}(u_{ij} > u_{ik}) \equiv \frac{x_{ij}}{x_i} = \frac{exp\left(log\mathbb{E}\left[y_{j,t}\right] + \Lambda_{j,t} - c_{ij,t} - \delta_{ij} z_{j,t}\right)}{\sum_k exp\left(log\mathbb{E}[y_{i,t}] + \Lambda_{k,t} - c_{ik,t} - \delta_{ik} z_{k,t}\right)} \forall j \neq k \tag{16}$$

Therewith the migration probability is just the ratio of the exponential utilities between the target j and the entire i-th population. If we now set in individuals who decide to remain in i, we have

$$\mathbb{P}[u_{ii} > u_{ik}] \equiv \frac{x_{ii}}{x_i} = \frac{exp\left(log\mathbb{E}\left[y_{j,t}\right] + \Lambda_{i,t} - c_{ii,t} - \delta_{ii} z_{i,t}\right)}{\sum_k exp\left(log\mathbb{E}[y_{i,t}] + \Lambda_{k,t} - c_{ik,t} - \delta_{ik} z_{k,t}\right)} \forall j \neq k \tag{17}$$

Accordingly we get the ratio between the individuals who emigrate to j and the share who preferred to stay as

$$\mathbb{P}\left[u_{ij} > u_{ii}\right] \equiv \frac{x_{ij}}{x_{ii}} = \frac{exp\left(log\mathbb{E}\left[y_{j,t}\right] + \Lambda_{j,t} - c_{ij,t} - \delta_{ij} z_{j,t}\right)}{\sum_i exp\left(log\mathbb{E}\left[y_{j,t}\right] + \Lambda_{j,t}\right)} \forall j \neq i \tag{18}$$

After taking logs, inserting (4) and (5), as well as rearrange terms, we get an equilibrium (e.g. Büchel et al, 2020; Serlenga and Shin, 2021):

$$logx_{ij,t} = \rho_1\left[log\left(1 - \alpha_{j,t}\right) - log(1 - \alpha_{i,t})\right] + \rho_2\left[logr_{j,t} - logr_{i,t}\right] + \left(\Lambda_{j,t} - \Lambda_{i,t}\right) - c_{ij,t} - \delta_{ij} z_{j,t} + logx_{ii,t} \tag{19}$$

(19) means that the volume of inflows from i to j is up to the utility gap between moving and staying. The individuals thus compare the differences in the economic and social components.

3.3. Model Outcomes

3.3.1. Business Cycle

From the equation in (19) we can easily derive the marginal effects.

$$\frac{\partial logx_{ij,t}}{\partial r_{j,t}} = \frac{\rho_2}{r_{j,t}} + \delta_{ij} \frac{\left(\sum_i \mathbb{E}\left[n_{ij,t+1}\right] + m_{ij,t}\right)^2}{Y_{j,t}^2 \frac{dY}{dr}} > 0 \tag{20.0}$$

$$\frac{\partial logx_{ij,t}}{\partial \mathbb{E}\left[n_{ij,t+1}\right]} = -\delta_{ij} \frac{2\sum_i \mathbb{E}\left[n_{ij,t}\right] + m_{ij,t}}{Y_{j,t}} < 0 \tag{20.1}$$

(20.0) has a positive slope, but as you can see, there is a sum of two components. The first accounts for the direct effect of the business cycle on immigration from i to j. According to (4), we can interpret it as the change in the expected income: The totally informed individuals observe a increasing business cycle in. Hence, they adjust their expectations towards an intermediate recovering economy. Therefore, the expectation to participate in prosperity initiates the movements. The second term is related to the indirect pulling effect: Because the GDP is a function of the business cycle component, economic recovery induces a smoother policy variable, what additionally drives immigration. How changes (20.1) if $r_{j,t}$ increases?

$$\frac{\partial^2 logx_{ij,t}}{\partial r_{j,t} \partial \mathbb{E}\left[n_{ij,t+1}\right]} = \delta_{ij} \frac{2\sum_i \mathbb{E}\left[n_{ij,t}\right] + m_{ij,t}}{Y_{j,t}^{\ 2} \frac{dY}{dr}} > 0 \tag{20.2}$$

The cross-derivative in (20.2) is positive, which indicates a growing immigration inflow; hence, even if the migration policy becomes stricter in the first step, the boosting business cycle relaxes the policy in a second step. Most likely one

[7] Schnaudt and Weinhardt (2017) show that economically successful classes have a more positive attitude towards migration than economically less successful classes.

[8] Under the assumption of rational expectations is $\mathbb{E}[n_{ij,t+1}] = n_{ij,t}$.

faces a situation of simultaneously rise in both; the interpretation of single effects is thus more difficult. In order to handle it, we decompose the marginal effect, and see how large the expansion in the GDP, respectively in the business cycle, has to be compared to the expansion of the total amount of migrants.

$$dz_{j,z} < 0 \text{ if } \; dY_{j,t} > \frac{2Y_{j,t}}{\sum \mathbb{E}\left[n_{ij,t+1}\right] + m_{ij,t}} \left(dn_{ij} + dm_{ij,t}\right). \tag{21}$$

It turns out that there is a threshold when the contribution of $dY_{j,t}$ is that large, $dz_{j,t}$ gets negative, and so the immigration goes up.

3.3.2. Climate Change

The climate change indirectly affects the migration flow through the country-characteristics . However, we have to take into account the regional characteristics of each country: There are situations where rising temperature can indeed bring advantages for nations in colder zones, maybe in terms of a more productive agriculture. Consequently, we have $\frac{\partial \Lambda_{i,t}}{\partial k_{i,t}} \gtrless 0$ and thereby

$$\frac{\partial log x_{ij,t}}{\partial k_{i,t}} = -\frac{\partial \Lambda_{i,t}}{\partial k_{i,t}} \gtrless 0. \tag{22}$$

Notice, that we only look on the domestic climates, since we assume individuals know the temperature anomaly in both nations. In this way, individuals are not supposed to emigrate if the climate change is advantageous for them. Take an individual in i as an example, who is probably set out much more natural disasters, caused by climate change: This individual is aware of the costly conditions of an emigration to j. If these costs exceed the premium of an extend elemental damage insurance, the individual is not willing to emigrate anymore. Hence, the expected yield from migration has to exceed the insurance premium. To sum up, the marginal effect in (22) may be positive, but it may not be positive if the yields deceed the premium.[9]

3.4. Effects of Human Development

Our analysis should be extended to social traits, such as educational levels, or health services. In order to do so, the most effective way is to consider the *Human Development Indicators*, which are annual released by the UN. We replaces the difference in the expected income in (19) by the differences in the HDI-components; these are the GNI per capita ψ, the life expectancy e, and an indicator to picture up the general level of the educational system q, with $\psi, q, e > 0$. These are the three components, which were used to calculate the HDI up to 2010 (Rahi, 2011). Unfortunately, we only find unbalanced data sets on the official websites. Therefore we are compelled to construct the HDI by adding each component separately.[10] We believe human development corresponds to the migration flows. We illustrate two aspects, which can be observed without difficulties: Although the population growth diminishes in the developing countries since years, the populations still slightly grow. Despite obvious better health conditions, one can clearly say, that longevity is still underdiffused. We assume that people tend to move if the difference in the life expectancy gets greater, simply because people try to maximize their lifetime. Besides that, changes in the society such as a bigger openness, and diversity, drive migration, too. Economies transform from agricultural to industrial ones. Along that path, history teaches us that upcoming urbanizations comes with the vanishing of less important traditions. When traditional structures break up, societies modernize. As Vogler and Rotte (2000) notice, a modernization process as well as intercultural openness go along with migration desires, especially among university graduates.

4. Empirics

4.1. Data and Methods

Our panel consists of $i = \{1, 2, ..., 155\}$ nations with a time interval of $t = 1995, ..., 2019$. We stresses the balance of the panel with 3875 observations in total.[11] We retrieve all data associated with immigration, emigration, and diaspora from the *OECD International Migration Database,* among them count 1. All immigrants to Germany from i-th country whose have regular migration status (OECD, 2022a). 2. The emigrants from Germany to the i-th nation (OECD, 2022b). 3. The immigrants to Germany from i-th country, whose have an asylum status (OECD, 2022c). 4. The migrant stocks of each nationality in Germany (OECD, 2022d). The entire data on migration is measured in absolute values.

[9] Cattaneo and Peri (2016) state, there is a negative link between rising temperature anomalies and emigration flows in poorer countries. In this way, so their argument, the productivity in the important agricultural sector shrinks, and thereby the wages in that sector. Anyhow, it seems to be quite unrealistic people anticipate sinking wages, but do not evolve any incentives to speed up their emigration, although the consequences to fall into poverty are noticeable.

[10] Up to 2010, the formulae was $HDI = \sqrt[3]{\psi q e}$. Because we do not construct indices, we cannot only take the product of different measured variables.

[11] The panel's structure is of (155×25).

All data about temperature anomalies are obtained from the website of *Berkeley Earth*, an open-source database. It is measured in absolute values on the annual median. Since temperature data for Brunei Darussalam cannot be retrieved, we take Malaysia's time series as proxy. This approximation seems to be acceptable insofar Brunei Darussalam is an enclave of Malaysia on the island of Borneo (Berkeley Earth, 2022). From the *World Bank Database,* we retrieve the economic data, among them count 1. The GDP per capita, measured in US Dollar. The data is already converted by the annual average exchange rates (World Bank, 2022a). 2. The GNI per capita, measured in US Dollar. The World Bank applies the so-called *Atlas Method*[12] (World Bank, 2022b). 3. The unemployment rates, measured in percentages (World Bank, 2022c). 4. The life expectancies at birth, measured in years (World Bank, 2022d). 5. The total populations, measured in absolute values (World Bank, 2022e). From the website of the *Human Development Reports*, we obtain data for educational levels. They are measured in the interval $[0, 1000]$ (Human Development Reports, 2022). By constructing the dummy variable associated with wars, note that there are no strict definition when a conflict gets a war. The same holds, for instance, for armed conflicts among rebells, governments, or militias. On the top, the time intervals of each conflicts are not coherent in the different sources. Only the distinction between internal and external conflicts is clear.[13] Finally, we run the *Hodrick-Prescott Filter t*o decompose the GDP per capita time series for each country into trend and cyclical parts. By this way, we comply with Ravn and Uhlig (2002), and adjust the smoothing parameter at 6.25.[14] Because the datasets of $x_{ij,t}, m_{ij,t}$ contain zeros, we approximate the logs by $log(1 + x_{ij,t}) \approx log(x_{ij,t})$.

4.2. Results and Discussion

The most notably estimation methods are fixed effects (particularly the within estimator), ordinary OLS as well as PPML. We rely on fixed effects because they posse multiple features: first of all, one can consider either bilateral, or time-specific, or both together into the regression. We always run regressions with heteroscedastic-robust errors. (26) know poses the regression to estimate

$$\begin{aligned} log\big(1 + x_{ij,t}\big) = {} & \beta_1\big(log\big(1 - \alpha_{j,t}\big) - log(1 - \alpha_{i,t})\big) + \beta_2\big(r_{j,t} - r_{i,t}\big) + \beta_3 k_{i,t} \\ & + \beta_4 \vartheta_{i,t} + \beta_5 logm_{ij,t} + \beta_6 \delta_{ij} z_{j,t} + \beta_7 logx_{ii,t} + \gamma_i \end{aligned} \tag{26}$$

notice that we may not use the logs of r, since single values of r are negativ. γ_i represents the country-specific fixed effect. (27) shows the regression with the three components of the HDI

$$\begin{aligned} log\big(1 + x_{ij,t}\big) = {} & \tfrac{\beta_1}{3}\big(\psi_{j,t} - \psi_{i,t}\big) + \tfrac{\beta_2}{6}\big(q_{j,t} - q_{i,t}\big) + \tfrac{\beta_3}{6}\big(q_{j,t} - q_{i,t}\big)^2 + \tfrac{\beta_4}{3}\big(e_{j,t} - e_{i,t}\big)a \\ & + \beta_5 k_{i,t} + \beta_6 \vartheta_{i,t} + \beta_7 logm_{ij,t} + \beta_8 \delta_{ij} z_{j,t} + \beta_9 logx_{ii,t} + \gamma_i \end{aligned} \tag{27}$$

the single components cannot simply be viewed as a product, and insofar we are not able to take the geometric mean, but the arithmetic mean. Like Barrientos (2007), we assume a hump-shaped relation between education and immigration. Moreover, we are out to do distinct analysis for developing and developed states. Hence we compose a subset $\mathfrak{P} \subseteq \mathfrak{L}$, including the low-income countries. These are all states whose difference in GNI per capita compared to Germany is $\geq$ 45,195 US Dollar. The social care may play an important role if any individual emigrates, in particular for asylum-seekers. The reason is that they are not allowed to work during the first months after having arrived Germany. Having this, we get two cases what the expected income in j is:

$$\mathbb{E}\big[y_{j,t}\big] = \begin{cases} s_{j,t}, \, if \; l = 1 \\ (1 - \alpha_t)^{\rho_1} r_t^{\rho_2}, \, if \; l = 0 \end{cases} \tag{28}$$

where $l = 1$ indicates asylum-associated migrants. With (28), individuals who are eager to immigrate regularly can only do it with an employment permit. The domestic social care is negligible due to the fact that individuals being eager to receive German social care have to do it by asylum-associated immigration, so it does not play any role if there exists social assistance in the home country.[15]

$$\begin{aligned} log\big(1 + x_{ij,t}\big) = {} & \beta_1\big(logs_{j,t} - log(1 - \alpha_{i,t}) - r_{i,t}\big) + \beta_2 k_{i,t} \\ & + \beta_3 \vartheta_{i,t} + \beta_3 logm_{ij,t} + \beta_5 \delta_{ij} z_{j,t} + \beta_6 logx_{ii,t} + \gamma_i \end{aligned} \tag{29}$$

in (29), the first term on the right-hand side is the gap between the expected income in case $l = 1$, whereas no uncertainty in receiving the social assistance occurs.

[12] »To smooth fluctuations in prices and exchange rates, a special Atlas method of conversion is used by the World Bank. This applies a conversion factor that averages the exchange rate for a given year and the two preceding years, adjusted for differences in rates of inflation between the country, and through 2000, the G-5 countries (France, Germany, Japan, the United Kingdom, and the United States). From 2001, these countries include the Euro area, Japan, the United Kingdom, and the United States« (World Bank, 2022b).

[13] We provide a list of the armed conflicts inclusive the source in Appendix C.

[14] »The second approach uses the frequency domain and investigates the transfer function of the HP filter, thereby obtaining a general result. Again, a change-of-variable argument shows that one should adjust the HP parameter with approximately the fourth power of the frequency change. Both approaches therefore yield a value of approximately [...] 6.25 for annual data [...].« (Ravn and Uhlig, 2002, S. 371).

[15] The social assistance is measured in absolute values, converted into US Dollar. Data comes from https://www.isg-institut.de/download/Daten_Info_Sozialhilfe.pdf (between 1995-2003), and

Table 1
Fixed Effects Estimations of log(Immigration).

	Regular Model 1.0	Asylum Model 1.1	Regular (HDI) Model 1.2	Asylum (HDI) Model 1.3
log(Employment rate)	2.452***			
	(0.562)			
Business Cycle	0.00			
	(0.00)			
s		0.00		
		(0.00)		
GNI per capita			0.00	0.00006**
			(0.00)	(0.00002)
Life expectancy			0.076***	0.115**
			(0.029)	(0.05)
Education index			-0.011	0.0092
			(0.0005)	(0.009)
Education index^2			-0.00001	-0.00001
			(0.00001)	(0.00002)
War	0.166	0.729***	0.236	0.642**
	(0.155)	(0.266)	(0.151)	(0.257)
Temp. Anomaly	0.042	-0.259***	0.058**	-0.278***
	(0.027)	(0.057)	(0.027)	(0.055)
log(Diaspora)	0.819***	0.336***	0.825***	0.312***
	(0.062)	(0.124)	(0.063)	(0.118)
z	0.0054*	0.077***	0.0061*	0.087***
	(0.003)	(0.006)	(0.003)	(0.008)
log(Pop. origin)	0.364**	0.937***	0.747***	0.745**
	(0.166)	(0.299)	(0.169)	(0.293)
R^2	0.411	0.263	0.41	0.27

*p < 0.1; **p < 0.05; ***p < 0.01

Source: Own calculations.

Table 2 shows the results of the fixed effects estimation of (26), (27), and (29), respectively.

As we expect, a rise in the employment by 1% drives the immigration by approximately 2.45%. In contrast to Beine et al.'s (2019) findings, we do not observe significant signaling effects by the business cycle to individuals in terms of a higher job probability. Instead of them, our analysis includes the differences between both cycles. On the other hand, we see the positive and significant impact of diaspora's size to the immigrants, what is in line with many findings, e.g. in Beine et al. (2011), Comola and Mendola (2014), or Naujoks (2022). Model 1.1 is dedicated to the asylum-associated migration. We find no effect regarding the scope of social assistance to them. Though, if armed conflicts take place, the asylum immigration raises by about 73%. In addition, both, the temperature anomaly as well as diaspora's size have also significant impacts: while a surge of 1 degree in the anomaly shortens the migration volume at about 26%, the elasticity between diaspora and immigration counts 0.33%.

The models 1.2 and 1.3 are both related to the HDI-components. In case of the regular migration we can conclude that only one component is significant: the difference in the life expectancies. Because it is intuitively, we go further to the anomaly. Here we find - contrary to model 1.0 - a positive and significant push factor. To rivet on the asylum-seekers we find low, but significance in the difference in the GNI. Also an extending gap in the life expectancies pulls asylum-seekers by almost 12%. Similar to model 1.1, armed conflicts are a key driver in asylum-associated movements. In opposite to the non-asylum-migrants, whose anomaly sign is positive, the climate change poses a negative effect on the migration decision.[16] One can explain the negative signs in model 1.1 and 1.3 with adaptive expectations: People who seek to emigrate as exit strategy from climate deteriorations do it not instantly, rather after some manifestation of the climate change issues. Consequently they make plans to emigrate regularly.

The indicator of migration policy strictness seems to be contra-intuitive. All four cases point out a positive relation to the immigration volume, although it should be intuitively the opposite. The decomposition in (21) gives the explanation: There exists a threshold of $z_{j,t}$ getting lower. That is, when the enlargement in the GDP over-compensates greater expected net migration. Thus, we are obviously located in such a regime: Government's expectation about net migration is still positive, nevertheless GDP's growth is far larger, so the government is encouraged to relax the immigration rules.

Splitting up the country set into subsets as proposed, Table 2 shed light on the determinants of migration from low-income countries. Migrants from such countries are neither significantly be pulled by the gap in the employment rates, nor by the gap in the business cycles. However, even in cases for regular migration, there exists a strong (and significant) impact of wars on the migration volume (almost 110%). The temperature anomaly is also a pushing factor, too. A new picture shows the policy variable $z_{j,t}$, which is still positive, but non-significant. Model 2.1 includes the proposed variable $s_{j,t}$, which is by construction the gap between the expected incomes in j, the social assistance, and in the i-th nation. Apparently,

[16] Drabo et al. (2015), and Beine and Parsons (2017) find no significant push effect.

Table 2
Fixed Effects Estimation of log(Immigration), Low-Income Countries.

	Regular Model 2.0	Asylum Model 2.1	Regular (HDI) Model 2.2	Asylum (HDI) Model 2.3
log(Employment rate)	-2.077			
	(2.43)			
Business Cycle	0.00003			
	(0.00002)			
s		0.00		
		(0.0003)		
GNI per capita			-0.001*	0.00
			(0.00009)	(0..0)
Life expectancy			0.188	-0.103
			(0.152)	(0.314)
Education index			0.064	0.216
			(0.083)	(0.143)
Education index^2			0.00	0.00
			(0.00)	(0.00)
War	1.099***	1.084***	1.188***	1.836***
	(0.106)	(0.096)	(0.133)	(0.226)
Temp. Anomaly	0.188*	0.175	0.209*	0.141
	(0.105)	(0.107)	(0.115)	(0.205)
log(Diaspora)	0.425***	0.409***	0.469***	0.362**
	(0.116)	(0.115)	(0.114)	(0.162)
z	0.0004	-0.0053	0.005	0.014
	(0.013)	(0.011)	(0.017)	(0.031)
log(Pop. origin)	2.543***	2.828***	2.155**	2.432
	(0.816)	(0.946)	(1.092)	(1.918)
R^2	0.431	0.426	0.453	0.259

*p < 0.1; **p < 0.05; ***p < 0.01

Source: Own calculations.

there is no effect. Model 2.2 and 2.3 are again designed with the components of the HDI. To the first, we do not find any significant effect of either the difference in the life expectancies, or in the quality of the education systems. Since there is no significance in life expectancies, we can interpret it as an inverted *Healthy-Migrant Effect*, according to which migration shrinks by increasing difference in the life expectancy. The reason is not a rising life expectancy in j, but rather a decreasing in i due to bad health systems, or maybe starvations. As a consequence, the pool of potential emigrants, who are the fittest among the population, declines which is in line with the *Healthy-Migrant Effect,* declines.

Only the GNI per capita indicates statistically significance, but with a negative sign. However, we would expect a positive sign, and obviously, there is no sufficient explanation for that.

Some authors find a negative relation between the impacts of the climate change and immigration, especially in low-income nations (e.g. Cattaneo and Peri, 2016). We in turn find evidence of positive (and significant) relationships, analogous to Cai et al. (2016): The changing climate forces people from lower-income states to leave their home, caused by droughts, or starvations, for example. In spite of a possible reduced productivity in the agricultural sector, people are eager to move. Besides the strong impact of the diasporas, the strictness of migratory rules shows non-significance.

Table 3 states the estimation results for the subset of high-income countries. The significance levels as well as the signs of model 3.0 appear very similar to those in model 1.0. We further see no observable effect of the business cycle again. Taken together, the zero-impacts refers to four different explanations: 1. There is any kind of *Omitted Variable Bias* in the estimated regressions. 2. There is a case of *Simultaneous Causality*. 3. *Reverse Causality* occurs, for example between the log of immigration and the business cycle, or 4. There is indeed some phenomena what is up to now not explainable.

Alike the former estimations, the policy variables show positive signs again. Particularly the case of the high-income subset, we put the hypothesis of *Positive Selection* into discussion: high-qualified migrants from the richer nations get incentives from more restrictive immigration barriers, since empowerment or a sense of self-worth arises. Thereto, nations with harsh immigration rules transmit perception of being an »elite-screening island«. For instance, New Zealand or Canada have rigid rules, but they are preferred destinations for people from around the world.

Contrary to our expectations, social assistance does not seem to encourage the movement of asylum seekers. In addition, and what we can expect, the social care does not incentivize asylum-seeker's movements in that high-income framework.

Interestingly is that the significance changes in the anomaly between the two subsets: While we estimate positive impacts for the regular migration type in the low-income subset, the high-income group shows negative (and highly significant) results for the asylum-associated typ.

Model 3.2 reveals, besides the known estimates from model 1.2, the first time any significant effect of the education level. Because the squared difference indicates a negative sign, there is medium evidence referring to our assumption, as well as Barrientos' (2007) thoughts of a hump-shaped relation between education levels and migration. While the uneducated class is not able to fulfill an emigration, the mass of emigrants concentrates in the center of the society, being educated and

Table 3
Fixed Effects Estimation of log(Immigration), High-Income Countries.

	Regular	Asylum	Regular (HDI)	Asylum (HDI)
	Model 3.0	Model 3.1	Model 3.2	Model 3.3
log(Employment rate)	2.647***			
	(0.581)			
Business Cycle	0.00			
	(0.00)			
s		0.00		
		(0.00)		
GNI per capita			0.00	0.00006***
			(0.00)	(0.00002)
Life expectancy			0.073**	0.11**
			(0.032)	(0.052)
Education index			-0.00005	0.012
			(0.00005)	(0.009)
Education index^2			-0.00002**	-0.00002
			(0.00001)	(0.00002)
War	0.137	0.596**	0.228	0.559**
	(0.141)	(0.235)	(0.141)	(0.225)
Temp. Anomaly	0.037	-0.256***	0.058**	-0.276***
	(0.028)	(0.057)	(0.028)	(0.055)
log(Diaspora)	0.831***	0.323**	0.831***	0.302**
	(0.073)	(0.133)	(0.076)	(0.130)
z	0.0059*	0.081***	0.005	0.089***
	(0.003)	(0.007)	(0.003)	(0.008)
log(Pop. origin)	0.342*	0.932***	0.754***	0.764**
	(0.177)	(0.319)	(0.182)	(0.308)
R^2	0.404	0.263	0.397	0.275

*p < 0.1; **p < 0.05; ***p < 0.01

Source: Own calculations.

motivated. The well-educated class is not up to move to another country, at least in the mean. In the high-income nations, they are mostly well-paid and perceive a high-class status. Indeed we are not able to verify the hump-shaped hypothesis due to further significant results in the previous tables. All in all, our findings correspond to those of Vakhitova and Coupé (2014), who do not find any clear functional relationship as well.

The asylum-associated migration type, in turn, is not affected by the differences in the education levels. Following Clemens (2014), one cause could be the existence of de-facto barriers: Such barriers are often international non-accepted school degrees or professional qualifications, which hinder migrants to move. Analogous to Table 1 and 2 we find in three out of four cases eased migratory rules, induced by a greater expansion of the differential of the GDP compared to that of the expected number of net migrants.

5. Concluding Remarks

By looking on the final results, we can emphasize that our mathematical model fits the reality very well. Our contributions to the research are firstly the inclusion of human development to migration, and secondly the distinct analysis related to the two main migration types: regular and asylum-associated. In the general case, the results match the findings of many other empirical studies, e.g. Beine et al. (2011), Manchin and Orazbayev (2018), or Serlenga and Shin (2021). The impact of climate change on migration is in 7 out of 12 cases statistically significant. There is an asymmetric impact to the different migration types, depending on the welfare.[17,18] Regular migration from low-income states are positive affected, while the same from high-income states are negative affected. The identical holds reversely, too.

As already mentioned, we do not find effects from the business cycle differences, what is surprising to us. It seems to be very implausible by presumed rational agents: Individuals know that if the economy goes up, the probability to get employed is much higher, so potential migrants should have strong incentives to move to Germany. There is strong evidence that the coefficients associated to the business cycle are biased, perhaps through reverse causality. Future work is encouraged to implement dynamic panel methods to restore that problem, as suggested by Leszczensky and Wolbring (2022). Furthermore, there is no evidence that the scope of social care may affect asylum-associated migration, what is also in contrast to our expectations. However, Agersnap et al. (2019) find evidence for the *Welfare Magnet Hypothesis* in the case of Denmark. While the education level seems to have no relevant effect, the gap in the life expectancy drives both migrations

[17] Our results are thus supported by a meta study by Hoffmann et al. (2020): 27 out of 30 countries indicates significant positive relation between temperature anomaly and migration.

[18] Cattaneo and Peri (2016) emphasize *Positive Selection* in the context of differences in the return to skills, too, whereby only migrants with skills above a certein level are incited for relocation.

types in the high-income subset. One explanation in the case of the education level's effect could be, that a large majority of migrants do not seek a better education, because they are not in the schooling-age anymore. In this way, individuals act rational, since their focus is income maximization.

Of course, the rationale behind the life expectancy is clearcut: people try to maximize their life span. Additionally, our policy variable, which assumes a naive rationale at the governmental level, shows always a positive sign. At first glance, it seems to be contra-intuitive, but as we demonstrated earlier, it is consistent with the model. Because this is the first study which analyzes the bilateral migration between Germany and the rest of the world, it is obvious that our empirical results should be extended to other nations. Maybe the implausibility of the business cycle coefficient would vanish by considering a larger set of destinations. Furthermore, the existence of some non-linearities cannot totally be ruled out. Another value adding contribution concerns the demographic evolution in several home countries. In our opinion, it would be an interesting topic to analyze the migratory decision, taking account for the shifts in the population composition, for example. In particular the migration behavior of the younger cohorts should be vigorously affected if the i-th population is facing a regime of demographic transition.

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Declaration of Competing Interest

None.

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None.

Appendix

Appendix A – C

Appendix A
Country List.

Albania	Japan
Algeria	Jordan
Angola	Kazakhstan
Argentina	Kenya
Armenia	Korea
Australia	Kuwait
Austria	Kyrgyzstan
Azerbaijan	Laos
Bahamas,The	Latvia
Bahrain	Lebanon
Bangladesh	Lesotho
Belarus	Libya
Belgium	Lithuania
Belize	Luxembourg
Benin	Madagascar
Bhutan	Malawi
Bolivia	Malaysia
BosniaHerzegovina	Mali
Bahrain	Malta
Bangladesh	Mauritania
Belarus	Mexico
Belgium	Moldova

(*continued on next page*)

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Appendix A (*continued*)

Belize	Mongolia
Benin	Montenegro
Bhutan	Morocco
Bolivia	Myanmar
BosniaHerzegovina	Namibia
Canada	Nepal
CentralAfricanRepublic	Netherlands
Chad	NewZealand
Chile	Nicaragua
China	Niger
Colombia	Nigeria
Congo DR	NorthMacedonia
Congo	Norway
CostaRica	Oman
Coted'Ivoire	Pakistan
Croatia	Panama
Cuba	PapuaNewGuinea
Cyprus	Paraguay
CzechRepublic	Peru
Denmark	Philippines
Djibouti	Poland
DominicanRepublic	Portugal
Ecuador	Qatar
Egypt	Romania
ElSalvador	Russia
Eritrea	Rwanda
Estonia	SaudiArabia
Eswatini	Senegal
Ethiopia	Serbia
Finland	SierraLeone
France	Singapore
Gabon	Slovakia
Gambia,The	Slovenia
Georgia	SouthAfrica
Ghana	Spain
Greece	SriLanka
Guatemala	Sudan
Guinea	Sweden
Guinea-Bissau	Switzerland
Haiti	Syria
Honduras	Tajikistan
Hungary	Tanzania
Iceland	Thailand
India	Togo
Indonesia	TrinidadTobago
Iran	Tunisia
Iraq	Turkey
Ireland	Turkmenistan
Israel	Uganda
Italy	Ukraine
Jamaica	UnitedArabEmirates
	UnitedKingdom
	UnitedStates
	Uruguay
	Uzbekistan
	Venezuela
	Vietnam
	Yemen
	Zambia
	Zimbabwe

Appendix B
EU Free Movement Agreement.

Country	Time
Austria	since 1995
Belgium	since 1993
Bulgaria	since 2014
Croatia	since 2015
Cyprus	since 2004
Czech Republic	since 2011
Denmark	since 1993
Estonia	since 2011
France	since 1993
Finland	since 1995
Germany	since 1993
Greece	since 1993
Hungary	since 2011
Ireland	since 1993
Italy	since 1993
Latvia	since 2011
Lithuania	since 2011
Luxembourg	since 1993
Malta	since 2004
Netherlands	since 1993
Poland	since 2011
Portugal	since 1993
Romania	since 2014
Slovakia	since 2011
Slovenia	since 2011
Spain	since 1993
Sweden	since 1995
United Kingdom	1993-2020

Appendix C
Armed Conflicts.

Country	Time	Name
Afghanistan	2001-2021	War on Terror
Algeria	1991-2002	Civil War
Burundi	1993-2005	Civil War
Central African Republic	2004-2007	Bush War
Chad	2005-2010	Civil War
Congo DR	since 2000	Congorian Wars
Cote d'Ivoir	2002-2009	Civil War
Iraq	since 2003	War on Terror, IS
Israel	2000-2005	2. Infanada
Libanon	2006	Libanon War
Libya	since 2011	Civil War
Mali	2012	Mali Conflict
Nepal	1996-2006	Civil War
Senegal	since 1982	Casamance-Conflict
Sierra Leone	1991-2002	Civil War
Sri Lanka	1983-2009	Civil War
Sudan	since 2003	Civil War
Syria	since 2011	Civil War
Yemen	since 2004	Huthi Conflict

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