Research article

Unveiling the Determinants of High-Skilled Migration in Indonesia: A Gravity Model Approach

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ABSTRACT

High-skilled migration in Indonesia can potentially reduce regional inequality by driving economic growth in destinations. However, Indonesia's lax internal migration laws lead to highly skilled people migrating to developed provinces, increasing regional disparity. This study focuses on getting the overview of high-skilled migrants, forming a Public Facilities Accessibility Index (PFAI) using factor analysis PCA, and analyzing determinants of high-skilled migration flows with the ZINB model using a gravity model approach. The findings show that the phenomenon of interprovincial high-skilled migration in Indonesia is "Java Centric." Most highly skilled migrants are aged 21–35 years. Economic reasons are the main reason for moving. Provinces of Java Island have better public facilities than the others. High-skilled population size in origin and destination, geographic distance, urban unemployment rate in destination, worker's wage in origin and destination, proportion of agricultural workers in origin, migrant stock, and PFAI in origin influence the flow of Indonesian high-skilled migration. The policy implications of these findings include maximizing the rural agricultural sector, raising labor wages, expanding access to public facilities, and creating job opportunities to either retain highly skilled individuals in the underdeveloped province or draw in highly skilled migrants to achieve regional equality.

ARTICLE INFO

1. INTRODUCTION

Interregional inequality is a national development issue that has not been resolved in Indonesia to date. From a population perspective, population mobility is an integral part of the development process that cannot be separated (Tjiptoherijanto, 2017). Migration, as a permanent population mobility, has an important role in addressing the problem of interregional inequality (Bayraktar & Özyılmaz, 2017), distributing each population to each region in Indonesia. Migration can have both positive and negative impacts on the origin and destination regions. Economic growth for the destination and remittances for the origin (Bayraktar & Özyılmaz, 2017) are positive impacts of migration. Meanwhile, the negative impacts can be in the form of congestion, high criminality, urban poverty, overpopulation, and terrorism (Simpson, 2022). Based on BPS data in 2020, DKI Jakarta, as the country's capital, has the densest population in Indonesia, namely 15,907 people per km^2. This number is far higher than the Indonesian national average which is only 141 people per km^2. In general, provinces on the island of Java have a higher population density compared to other provinces outside the island of Java. This is an example of overpopulation in Java Island. If we look at other BPS data, DKI Jakarta, Banten and West Java are the three provinces with the highest percentage of villages with slums area in Indonesia. As many as 60.67% of villages in DKI Jakarta have slum areas in 2018, 20.43% in Banten, and 18.36% in West Java. Those are the examples of negative effect of migration.

The balance of the positive or negative impacts depends on the quality of the human resources it sends. Low-quality human resources tend to increase the population burden in the destination area, leading to overpopulation. On the other hand, high-quality human resources are the base of rapid economic growth in the destination area (Rustam et al., 2023). Obviously, the arrival of high-quality residents in the destination is an advantage for the destination with the potential for rapid economic growth (Uprety, 2018). On the other hand, the loss of high-quality human resources tends to be a loss to the region of origin (Rustam et al., 2023). The origin region will experience losses such as (1) losing one of the scarce resources; (2) losing fiscal contributors; (3) losing economic growth potential (4) losing the capacity to innovate with rapid technological growth.

Based on the potential of a high-quality population migration phenomenon, it would be great if the high-quality population could be redistributed evenly across regions in Indonesia through migration. Therefore, the discussion of this phenomenon has begun to attract more attention. This phenomenon is often referred to as high-skilled migration. Although the definition of high skilled migrant is uncertain whether using an education or work approach (Parsons et al., 2020), Shen & Liu (2016) define high-skilled migrants as migrants whose highest educational attainment is college (higher than high school) or tertiary education. High-skilled migration has the significant relationship with economic growth (Oliinyk et al., 2021) and income inequality (Uprety, 2019). Increased accumulation of superior human capital and innovation that could boost endogenous growth at the destination are the benefits of the high-skilled immigrant workforce (Liu & Shen, 2014).

High-skilled migrants can be a solution to overcome regional inequality, if they are spread evenly in every region of Indonesia. Uprety (2019) also states that high-skilled migration policy can be a way to reduce regional inequality. However, Indonesia's internal migration policy is still relatively loose. This is allowing high-skilled people to move to more developed and metropolitan areas. This is in line with data of Indonesian Long Form Population Census 2020, which displays that provinces in Java Island have the largest inflow of high-skilled migrants in Indonesia in 2022 (Badan Pusat Statistik, 2023b). If ordered from the largest, there are 149,967 high skilled migrants who entered West Java, 69,113 high skilled migrants who entered Central Java, 57,082 skilled migrants who entered Banten, and 49,146 skilled migrants who entered DKI Jakarta. It means that there is a buildup of high-skilled migrants in some core areas, i.e. the capital area as the center social-economic and political on the Java Island. The high accumulation of high-skilled migrants in Java Island will not reduce the problem of regional inequality but will instead encourage an increase the regional inequality in Indonesia (Krasulja et al., 2016; and Uprety, 2019). Therefore, this research is very important to discuss for solving the regional inequality in Indonesia through high-skilled migration potency. Research related to high-skilled migrants will be closely related to economic growth and development in origin and destination regions (Kerr et al., 2017).

Therefore, knowing the characteristics and determinants of high skilled migration is important in optimizing that potential. The characteristics of the origin and destination regions play an important role in migration analysis. Lee (1966) describes the important effect of push and pull factors in migration. Economic factors are the main factor (Jandová & Paleta, 2015; Pirani et al., 2019; Piras, 2017; and Urbański, 2022). Income and unemployment are of concern in this case. Most migrants move from their area of origin to their destination to get a job (if they have never had a job before) or to get a better job (Atmani M et al., 2021; and Sari & Tanur, 2023). As an agricultural country, migration analysis in Indonesia certainly cannot escape the influence of the existence of the agricultural sector, especially the relationship between rural and urban areas. Relationships and networks between residents are also a major factor in understanding migration in Indonesia. Communication and information about the destination area is a determining factor (Liu & Shen, 2014), especially in Indonesia with its archipelagic regions.

Migration in general is a response to differences in income between origin region (rural) and cities (Jandová & Paleta, 2015). Several previous studies have reviewed it from an economic aspect, there are two variables used, namely the unemployment rate and wages. The urban unemployment rate in origin is expected to have a positive effect on high-skilled migration flows (Franc et al., 2019; Liu & Shen, 2014; Setyanti et al., 2021; and Simpson, 2022), while the urban unemployment rate in destination is expected to have a negative effect (Wajdi et al., 2017). Furthermore, the wage level

in the origin region is expected to have a negative effect on high-skilled migration flows, while the wage level in the destination region has a positive effect (Komaruddin & Sakinah, 2022; Liu & Shen, 2014; and Pardede et al., 2020). When looking at the existence of the agricultural sector, the proportion of agricultural workers in the origin has a positive influence on migration flows, while the proportion of agricultural workers in the expected destination has a negative influence. Migrant stock, as the aspect of social networks, is used and is expected to have a positive effect on the flow of high-skilled migration (Liu & Shen, 2014; and Wajdi et al., 2017). In addition, to see the influence of the convenience factor on public facilities, the Public Facilities Accessibility Index (PFAI) variable is formed. Aslany et al. (2021); and Gu & Shen (2021) find that amenities and public services have an influence on migration. PFAI in the original region is expected to have a positive effect on the flow of high-skilled migration, while PFAI in the destination region is expected to have a negative effect.

The intense development of infrastructure access and public facilities in various remote areas carried out during the era of President Joko Widodo in recent years has also become a major concern for high-skilled migrants. High-skilled migrants do not only look at economic factors in the destination area, but have looked at amenity factors, such as public facilities (Wajdi et al., 2017). Until now, there is no comprehensive indicator that describes the level of accessibility of public facilities in Indonesia. Therefore, this study will also form an indicator of the level of comprehensive public facilities in each province and analyze its effect on the high-skilled migrant phenomenon in Indonesia. We obtain an overview of high-skilled migrants, develop comprehensive indicators on the level of accessibility of public facilities, and analyze the determinants of high-skilled migration in Indonesia. Constructing the Public Facilities Accessibility Index (PFAI) and adding it to the migration analysis is one of the novelty of this research. From the results of this analysis, we will relate it to efforts and solutions to reduce regional inequality in Indonesia. In addition to this background section, describe our data and methods in the second section, explain the results and discussion of the research in the third section, and we will provide conclusions and suggestions in the last section.

2. RESEARCH METHODS

2.1. Data

This study uses the quantitative approach. This study includes 1,122 interprovincial high-skilled migration flows as observation units. It is based on 34 provinces in Indonesia in 2022. The dependent variable in this study is interprovincial high-skilled migration flows in Indonesia, which is analyzed with 13 independent variables as in Table 1.

Table 1. List of Dependent and Independent Variables

Variable	Notation	Type of Data	Data Source
High-skilled migration flows interprovincial in 2022	M	Discrete	LFSP 2020 raw data estimation
High-skilled population size by province in Indonesia in 2022*	POPHS	Discrete	LFSP 2020 raw data estimation
Geographical distance between provinces in Indonesia	D	Numerical	Researcher calculations from the SHP map of Indonesia
Urban unemployment rate by province in Indonesia in 2022*	UNEMP	Numerical	Publication "Keadaan Angkatan Kerja di Indonesia Agustus 2022"
Average monthly wage of workers by province in Indonesia in 2022*	WAGE	Numerical	Publication "Keadaan Pekerja di Indonesia Agustus 2022"
Proportion of agricultural worker by province in Indonesia in 2022*	AGRI	Numerical	Publication "Keadaan Pekerja di Indonesia Agustus 2022"
Stock migrants between provinces in 2022	STOCK	Numerical	LFSP 2020 raw data estimation
Public Facilities Accessibility Index (PFAI) 2022*	PFAI	Numerical	Researcher's calculations based on indicators in Table 2
Dummy Variable Island	Island	Categorical	Researcher's calculation

Note: *provides two variables, the province of origin and destination

We define each variable clearly. High-skilled migration flows interprovincial is the number of high-skilled migrant who migrate from province i to province j. High-skilled population size is the number of people whose highest level of education is college (higher than high school) or tertiary education in a province. Geographic distance is the closest distance (straight line) between the centroid points of two provinces. The urban unemployment rate is the percentage of open unemployment to total labor force in the urban area of a province. Average monthly wage of workers is average worker's income which includes net wages earned by laborers or net income earned by casual workers in agriculture or non-agriculture during the past month in a province. The proportion of agricultural workers is the ratio of the number of workers whose main job is in the agricultural sector in a province divided by total number of workers. The stock of migrants from province i to j is defined as the percentage of the total population born in province i and living in province j at the time of enumeration (lifetime migration) divided by the total population born in province i and living in the other province at the time of enumeration. PFAI is an index formed from various indicators of public facilities including economic, educational, and health facilities in Table 2. Dummy Variable Island is a categorical variable with two categories, namely the category of migration within one island (code 1) and the category of migration between islands (code 0).

2.2. Model Specification

This study uses the recent migration type because it is considered more dynamic in describing the dynamics of current population mobility compared to other types of migration (Wajdi et al., 2017). Recent migration occurs when a person's place of residence at the time of enumeration is not the same as the place of residence five years before enumeration (Badan Pusat Statistik, 2023b). Meanwhile, high-skilled migrant is defined as migrant whose highest level of education is college (higher than high school) or tertiary education (Shen & Liu, 2016). Zipf (1946) is the founder of the migration gravity model (1946). It models the migration flows using his P_1P_2/D hypothesis, according to which the magnitude of migration flows (M_{ij}) is inversely proportional to the distance (Dij) between the origin and destination regions (POPi and POPj), and proportional to the total population in each region. This can be seen using the following mathematical model:

$$M_{ij} = g. \frac{P_i^{\beta_1} P_j^{\beta_2}}{D_{ij}^{\beta_3}} \tag{1}$$

Then, to reduce the interpretation bias of the basic gravity model, several other variables (push and pull factors, or inhibiting factors) are added to the model to form an extended gravity model. This study, in accordance with the discussion of the high-skilled migration phenomenon, uses the variable high-skilled population size to replace the general population size. PFAI is the main proxy used to represent public infrastructure comfort variables in a region. Nugroho (2018) states that public infrastructure variables can be represented by three dimensions, namely economic facilities, educational facilities, and health facilities. The PFAI is formed with several indicators listed in Table 2. To form PFAI, factor analysis with Principal Component Analysis (PCA) method is used. Migration is influenced by several factors that can be categorized into push factors, pull factors, barriers, and personal factors (Lee, 1966). These factors are combined with the extended gravity model approach in macro migration analysis. These factors can include economic factors, the existence of the agricultural sector, social networks, and convenience to public facilities.

As the core variable of the gravity model, the high-skilled population size in origin and destination as well as geographical distance are included in this analysis. areas that have a large population or high-skilled population will have a greater possibility of sending high-skilled migrants out in large numbers as well. Distance, as a proxy for cost variables, can be a barrier to migration. According to equation (1), high-skilled population size is expected to have a positive influence on high-skilled migration flows, either at the origin or destination (Liu & Shen, 2014; and Wajdi et al., 2017), while distance is expected to be negative (Greenwood, 1975; and Wajdi et al., 2017). To augment the analysis related to inter-island migration in Indonesia, island dummy variables were included in the analysis.

Table 2. Indicators of Public Facilities Accessibility Index

No	Dimension	Indicators
1	Economic Facilities	Number of permanent markets
		Number of convenience stores
		Number of shopping centers
2	Education Facilities	Number of elementary schools
		Number of junior high schools
		Number of senior high schools
		Number of universities/colleges
3	Health Facilities	Number of medical health workers (doctors)
		Number of nursing health workers
		Number of health centers (inpatient and non-inpatient)
		Number of hospitals (general and specialized)

Source: Nugroho (2018), c1ustomized

This study uses a factor analysis with the PCA method approach for constructing PFAI. Furthermore, to analyze the high-skilled migration flows, count regression is used. The reasons for choosing count regression instead of OLS are: (1) bias in the estimation results due to natural logarithm transformation in high-skilled migration flows, while count regression, such as Poisson and others, does not require such conversion; (2) accommodate if the residual normality assumption is not met in OLS; (3) accommodate if the homoskedasticity assumption is not met in OLS; and (4) accommodate the existence of zero migration flows (Wajdi et al., 2017).

For reducing the interpretation bias of the basic gravity model in equation 2, several other variables (push and pull factors, as well as inhibiting factors) are added to the model to form an extended gravity model in equation 3. This study, in accordance with the past discussion of the high-skilled migration phenomenon, uses the variable high-skilled population size to replace the general population size.

$$M_{ij} = g . \frac{P_i^{\beta_1} P_j^{\beta_2} UNEMP_i^{\beta_3} UNEMP_j^{\beta_4} WAGE_i^{\beta_5} WAGE_j^{\beta_6} \ldots\ldots\ldots\ldots\ldots Island_{ij}^{\beta_{12}}}{D_{ij}^{\gamma}} \qquad (2)$$

To estimate using the regression model, the extended gravity model is transformed in linear form with natural logarithm transformation and several adjustments (change the ln *g* into β_0 and (-γ) into β_{13}) are made to produce equation 3. Equation 3 is the linear form of our extended gravity model. It will be easier to estimate using several regression analysis techniques. This study also selects the best count regression model to analyze equation 3 in case of high skilled migration in Indonesia.

$$lnM_{ij} = \beta_0 + \beta_1 lnP_i + \beta_2 lnP_j + \beta_3 lnUNEMP_i + \ldots + \beta_{12} lnIsland_{ij} + \beta_{13} lnD_{ij} + \varepsilon_{ij} \qquad (3)$$

In addition, basically, the variables in this study are discrete variables. The count regression used in this study contains several regression models, i.e. Poisson regression, negative binomial regression, Zero-inflated Poisson (ZIP) regression, and Zero-inflated negative binomial (ZINB) regression, from which the best model is selected using the criteria of equidispersion assumption, AIC, BIC, ln-likelihood, vuong test, and Likelihood Ratio Test of alpha.

3. RESULTS AND DISCUSSION

3.1. The overview of High Skilled Migrants in Indonesia

Based on the Long Form Population Census 2020 data, the population of Indonesia is around 275.7 million people (Badan Pusat Statistik, 2023a). We find that around 1.51% of Indonesia's total population or around 4.17 million people were residents with recent migrant status. Then we also find that 16.80% of them in Indonesia or around 700.17 thousand people are high skilled migrants. This is not a small number. It can certainly have an impact on the economy in a region. Some of the characteristics obtained from these high-skilled migrants can be seen in Table 3.

Table 3. Characteristics of High Skilled Migrants in Indonesia in 2022

Characteristic	Categorics	Sex		
		Male	Female	Total
Age Group	< 20	0.22%	0.39%	0.31%
	21 - 25	10.97%	18.48%	14.97%
	26 - 30	29.01%	36.40%	32.95%
	31 - 35	23.51%	20.42%	21.86%
	36 - 40	13.45%	10.67%	11.97%
	41 - 45	8.27%	5.50%	6.79%
	46 - 50	5.29%	3.18%	4.17%
	51 - 55	3.66%	2.02%	2.79%
	56 - 60	2.73%	1.41%	2.02%
	61 - 65	1.61%	0.71%	1.13%
	66 - 70	0.78%	0.53%	0.64%
	71 +	0.51%	0.29%	0.39%
Main Reasons for Moving	Employment/Seeking Employment	58.72%	24.22%	40.26%
	Education	6.51%	7.65%	7.12%
	Change in marital status	6.54%	10.44%	8.63%
	Joining husband/wife/other family	16.44%	54.68%	36.90%
	Housing	11.40%	2.83%	6.82%
	Other	4.58%	3.59%	4.05%
High Skilled Migrant		46.68%	53.32%	100.00%

Source: Long Form Population Census 2020 Indonesia

We found an interesting result. We found that men do not dominate the high-skilled migration phenomenon (Table 3). In fact, female high-skilled migrants reached 53.32% of the total high-skilled migrants in Indonesia in 2022. Pardede et al. (2020) also find that females have higher probabilities for migrating than males. The existence of gender equality makes there is no longer an assumption that the mobility that can be done by a woman is limited (Khoeri & Atmanti, 2021), especially among people who have higher education. With higher education, broad insight and knowledge, and equal opportunities in accessing socio-economic life, women are brave enough to make decisions, including migration. If we look at age characteristics, in general there are similar patterns between male and female high-skilled migrants. Most high-skilled migrants, both male and female, are in the age group of 21-35 years and the number decreases with each increase in their age. As migrants age, they are at a disadvantage of having a short working life to reap the benefits of migrating, which reduces their returns. The elderly have stronger family ties and higher job security considerations than the productive age population, which weakens their courage to migrate, especially with the general knowledge that high-skilled migrants have of the risks involved in migration.
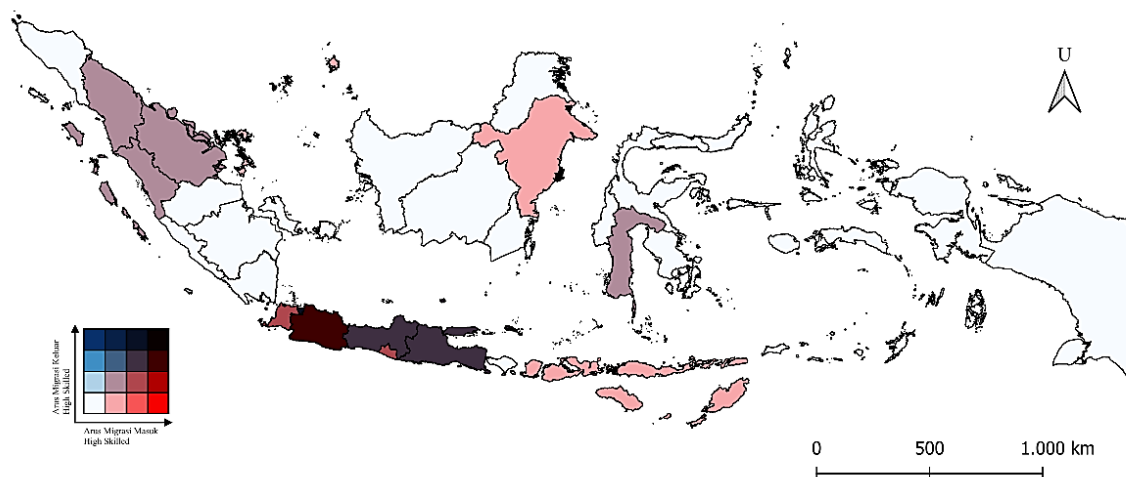

Figure 1. Thematic Map: Distribution of High Skilled Migrant in and out by Province in Indonesia, 2022
Source: Long Form Population Census 2020 Indonesia

Migration motives have always been an interesting topic in the migration phenomenon. In general, most high-skilled migrants migrate for employment or job-seeking reasons, reaching 40.26%. This result reaffirms the magnitude of economic motives in migration decisions, including in high-skilled migration (Jandová & Paleta, 2015). If we broken down by gender, most of male migrants move for working/looking for work, while the most of female move for following their husbands/parents/children/other family. Migration analysis cannot be separated from the spatial concept. In Figure 1, provinces in Java Island have much higher number of incoming and outcoming high-skilled migrants (more concentrated) compared to provinces outside Java Island. The high population in Java is one of the causes.

Figure 2 indicated that high-skilled migration phenomenon in Indonesia is also "Java-centric" where large flows of high-skilled migration are migrating from one province in Java Island and heading to another province which also in Java Island. To see the picture of high-skilled migration flows in Indonesia 2022, we can look at the circos plot in Figure 2. The thickness of the ribbon from the circos plot illustrates the size of the high-skilled migration flow that occurs from origin province to destination province.
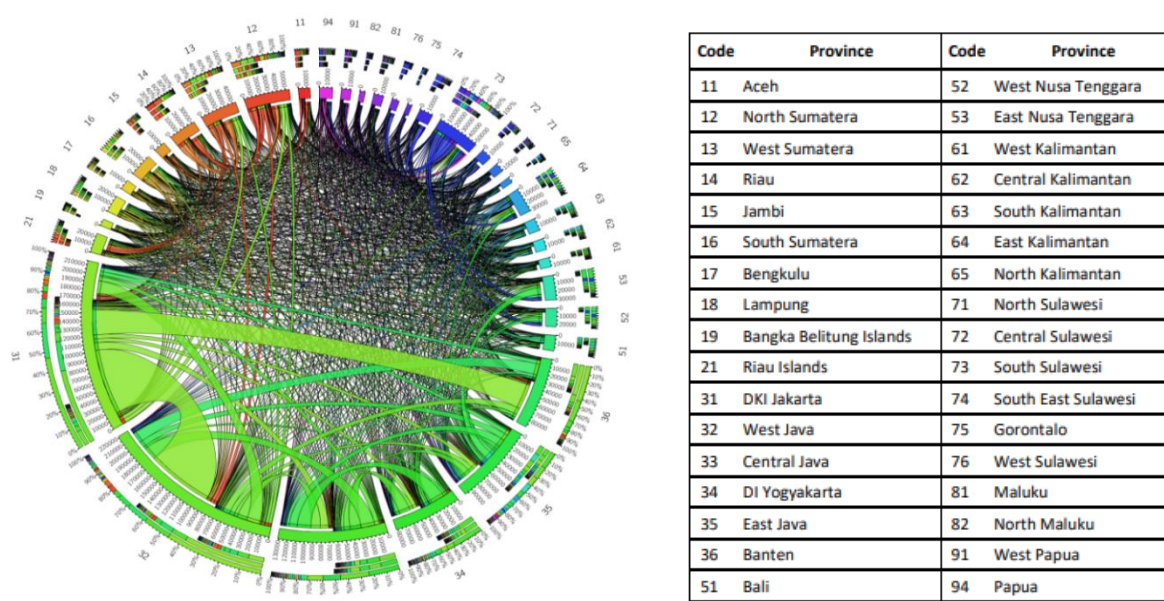

Code	Province	Code	Province
11	Aceh	52	West Nusa Tenggara
12	North Sumatera	53	East Nusa Tenggara
13	West Sumatera	61	West Kalimantan
14	Riau	62	Central Kalimantan
15	Jambi	63	South Kalimantan
16	South Sumatera	64	East Kalimantan
17	Bengkulu	65	North Kalimantan
18	Lampung	71	North Sulawesi
19	Bangka Belitung Islands	72	Central Sulawesi
21	Riau Islands	73	South Sulawesi
31	DKI Jakarta	74	South East Sulawesi
32	West Java	75	Gorontalo
33	Central Java	76	West Sulawesi
34	DI Yogyakarta	81	Maluku
35	East Java	82	North Maluku
36	Banten	91	West Papua
51	Bali	94	Papua

Figure 2. Overview of Interprovincial High Skilled Migration Flows in Indonesia 2022
Source: Long Form Population Census 2020 Indonesia

The largest flow is the flow from DKI Jakarta and heading to West Java and Banten. It means that over the past 5 years, there has been a movement of high-skilled migration from the capital region to the outskirts of capital. However, this does not indicate that DKI Jakarta, as the capital city, has lost its attractiveness. The other factors and the emergence of the commuting mobility phenomenon can encourage this phenomenon. Easy access to interprovincial transportation (such as trains) in Java Island can support the ease of migration between provinces in Java Island. The imbalance of high-skilled migration between provinces in Java and provinces outside Java further exacerbates the problem of regional inequality that occurs in Indonesia, even though this high-skilled migration phenomenon has great potential to overcome regional inequality in Indonesia by spreading high-skilled residents evenly in every province in Indonesia.

3.2. The Public Facilities Accessibility Index

We use factor analysis with PCA method for constructing the Public Facilities Accessibility Index (PFAI), just like Sahminan (2019) in creating an infrastructure index in Indonesia. The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0.832 and the results of Bartlett's Test of Sphericity which rejects H0 (Chi-Square Statistic = 962.99; p-value = 0.000) are the fulfillment of the conditions for using factor analysis with PCA to form the index. The categorical value of PFAI by province is in Figure 3 in the form of a thematic map.

In constructing the PFAI, we find that factor analysis technique with PCA can form the index well (Mardainis et al., 2019). The PFAI map in Figure 3 indicates that the development and access to public facilities in Indonesia is still uneven, especially between the western and eastern parts of Indonesia. Provinces in Java Island have higher PFAI values than other provinces. In addition to Java, provinces in Sumatra also tend to have PFAI values that are quite high, such as in North Sumatra. Meanwhile, outside Java and Sumatra, PFAI values tend to be low, except in South Sulawesi. North Kalimantan, Gorontalo, and West Sulawesi are three provinces with the smallest PFAI values in Indonesia in 2022.
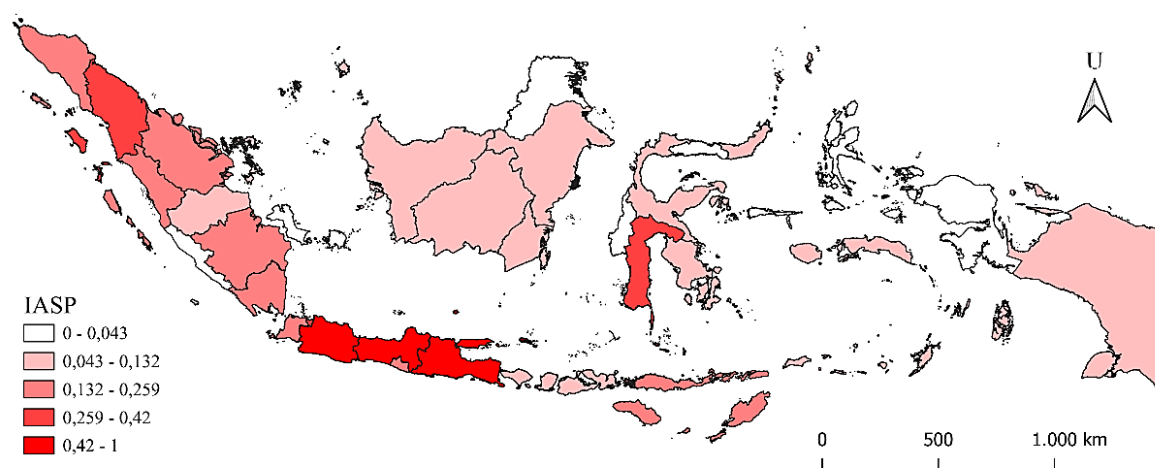

Figure 3. Thematic Map: Distribution of the PFAI by Province in Indonesia, 2022

3.3. Analysis of the Determinants of High Skilled Migration Flows in Indonesia

In this analysis, we first ran the model with the Poisson Model, as a benchmark of the count regression model. However, the results we got were not good. There is a peculiarity in the results of the Poisson Model where it is found that all regression coefficients have significant values with very small standard error values (below 0.000). This oddity is an indication of violation of the equidispersion assumption. Therefore, the checks contained in Table 4.

Table 4. Examination of Equidispersion Criteria in Poisson Regression

Equidispersion Criteria	Value	Description
Deviance/df	230.174	Overdispersion
Pearson Chi-Square/df	347.989	Overdispersion
Percentage of zero obs	14.349%	Exess Zero

The criteria that meet the equidispersion assumption are Deviance/df and Pearson Chi-Square/df with a value of around 1. In addition, excess zero indicates that the number of data observations has a value of zero which can disrupt the equidispersion assumption in Poisson regression. However, the Deviance/df and Pearson Chi-Square/df values in the Poisson regression model are far higher than 1. Apart from that, the percentage of observations that have zero value is also large, reaching 14.349% of 1122 observations. Those results mean that the Poisson regression model formed has an overdispersion problem and an indication of excess zero. The problems of overdispersion and excess zero were addressed with negative binomial, ZIP, and ZINB models as the alternative models. The criteria values for each alternative model are listed in Table 5.

Simultaneous tests take decision that, with a significance level of 5%, the models contain at least one or more independent variables in each model (negative binomial, ZIP, or ZINB models) that have a significant effect on high-skilled migration flows. Next, the selection of alternative models was carried out using the ln-likelihood, AIC, BIC, Vuong test, and likelihood ratio (LR) test of alpha criteria. The model with the highest ln-likelihood and the smallest AIC and BIC is the best alternative model. Based on the ln-likelihood, AIC and BIC criteria, it was found that the ZINB model is the best

alternative model that can be used because it has the highest ln-likelihood, and the smallest AIC and BIC compared to the other two alternative models.

Table 5. Criteria for Choosing the Best Alternative Models

Criteria	Model		
	Negative Binomial	**ZIP**	**ZINB**
Likelihood Ratio test (Simultaneous test)	1,357.610 (0.000)	2,050,459.740 (0.000)	1,582,950 (0.000)
Ln-Likelihood	-6,644.103	-124,129.200	-6,406.150
AIC	13,318.210	248,314.300	12,870.300
BIC	13,393.550	248,455.000	13,015.960
Voung test (p-value)		6,740 (0.000)	6,590 (0.000)
LR test of Alpha (p-value)	2.5×10^5 (0.000)		$2,4 \times 10^5$ (0.000)

Source: author calculation

The vuong test is used to test whether the zero-inflated model is better than the standard model, for example testing the Poisson model vs ZIP and the negative binomial model vs ZINB. Based on the result in Table 5, it was found the significant results in testing Poisson model vs ZIP model and Negative Binomial model vs ZINB. It means the ZIP model was more suitable to use compared to the Poisson model and the ZINB model was more suitable to use than the negative binomial model. The LR test of Alpha is used to test whether the alpha value (overdispersion value) in the negative binomial and ZINB models is significant or not. In other words, testing the Poisson vs negative binomial model or the ZIP vs ZINB model.

Table 6. Partial test and Parameter Estimate of ZINB Model

Variabel	Logit Model		Negative Binomial Model	
	$\hat{B}$	**Standard Error**	$\hat{B}$	**Standard Error**
ln(POPHSi)	-1.418 **	0.247	1.149 **	0.057
ln(POPHSj)	-0.455 .	0.242	0.279 **	0.056
ln(Dij)	0.716 *	0.344	-0.383 **	0.070
ln(UNEMPi)	0.320	0.470	0.107	0.118
ln(UNEMPj)	0.496	0.487	-0.621 **	0.124
ln(WAGEi)	0.497	0.776	-0.540 **	0.186
ln(WAGEj)	-2.803 **	0.796	1.252 **	0.172
ln(AGRIi)	-2.811 **	0.917	0.506 *	0.229
ln(AGRIj)	-1.343	1.057	0.424 .	0.236
ln(STOCKij)	-0.745 **	0.128	0.487 **	0.028
ln(PFAIi)	-0.011	0.094	-0.084 *	0.037
ln(PFAIj)	0.073	0.106	-0.006	0.033
Island	-0.518	0.626	0.127	0.097
Coefficient	55.203 **	16.987	-20.633 **	4.080
Alpha	0.686 (0.030)			

Note: *p<0.1; **p<0.05; and ***p<0.01

Based on Table 6, it was found that negative binomial model is more suitable than Poisson model and ZINB model is more suitable than ZIP model. Therefore, from those criteria, the best alternative model used in this research is the ZINB model. Furthermore, the results of the estimated parameter values (coefficients) and partial testing of the ZINB model are attached in Table 6.

3.4. Discussion

In the determinants analysis of high skilled migration flows, we find some findings. We discovered that high-skilled migration in Indonesia is positively impacted by highl-skilled population size, both at the origin and at the destination. These findings support those of Wajdi et al. (2017), who found a positive correlation between migraton flows and total population of the origin and

destination province. According to Liu & Shen (2014), there is a higher likelihood of high-skilled migrants leaving an area in significant numbers if it has a large high-skilled population. Additionally, we discovered that the high-skilled population in the origin has a bigger influence (higher coefficient value) than it does in the destination. This is due to the high-skilled population's large sending capability in these provinces (Wajdi et al., 2017).

Apart from population variables, distance is also one of the basic components of a migration gravity model. Distance is a representation of travel distance, costs, difficulty of access, and limited information faced by migrants and acts as the main barrier in a migration phenomenon (Greenwood, 1975). The negative and significant coefficient results mean that as the distance that must be traveled increases, the high-skilled migration flow from that province to a destination province will decrease. Botezat & Ramos (2020); and Greenwood (1975) also found that there is a negative relationship between distance and migration. Highly educated residents will make better considerations regarding moving costs, distance and quality of life in the destination. Considering various costs and access to information, migrants tend to choose nearby places as migration destinations (Atmani M et al., 2021). However, if the benefits that will be obtained in the destination area are greater than the distance factor which includes various costs, then the possibility of migration can still occur. However, apart from that, it cannot be denied that distance remains an important factor in the migration phenomenon, including high-skilled migration.

One of the main motives for migration, including for those with high-skilled status, is economics (Urbański, 2022). We include wage and unemployment variables into the model as proxies for economic factors. Most migrants move from their area of origin to their destination to get a job (if they haven't had a job before) or to get a better job (Atmani M et al., 2021; and Sari & Tanur, 2023). As a result, the urban unemployment rate in destination has a negatively significant influence on the high-skilled migration flows in Indonesia. This result is also in accordance with the findings of Botezat & Ramos (2020); and Atmani M et al. (2021) where unemployment has a negative infuence on migration. It could be due to the phenomenon of hidden unemployment in the area of origin, which can influence the relationship between unemployment and migration (Liu & Shen, 2014; Urbański, 2022; and Wajdi et al., 2017) also found that labor market competition in destination areas is one of the things that can affect the high-skilled migration. High unemployment in destination reduces the interest of incoming migrants (Czaika & Parsons, 2017). On the other hand, urban unemployment rate in the origin does not even have a significant influence. These results indicate that high-skilled migrants, from an unemployment perspective, are more interested in what is in the destination area compared to what is happening in their area of origin. As a result, in this case, the urban unemployment rate is more likely to represent a pull than a push factor.

The worker's wage, both in origin and destination, have a significant influence on high-skilled migration. It indicates that workers' wages are one of primary factors of high-skilled migration. Migration in general is a response to differences of wages between areas of origin (villages) and destination areas (cities) (Greenwood, 1975). If we look at the coefficients formed, the wage factor in destination has a positive influence, while wage factor in origin has a negative influence. These results are in accordance with the initial hypothesis set out in this study. There is a relationship between wages, migration, and welfare (Piyapromdee, 2021). Another finding obtained is that the worker wage variable is more likely to be a pull factor than a push factor of migration (Simpson, 2022; and Urbański, 2022). Greenwood (1975) also found that the income variable in the destination area provided a better explanation of the migration phenomenon compared to income in origin. Worker's wages in the destination have the largest marginal influence among all the independent variables used.

In line with these findings, Atmani M et al. (2021); and Urbański (2022) found that migrants tend to choose destination areas with high wage levels and low unemployment rates, while stating emphatically that economic motives are the biggest motive for migrating. High-skilled migrants tend to look for work that is decent and appropriate to the level of knowledge they have with better economic prospects (Greenwood, 1975), so that job opportunities and wage levels in the destination area are one of the main motive for high-skilled migrants. Equitable development and employment opportunities in each province will be able to overcome existing disparities (Khoeri & Atmanti,

2021). Therefore, developing regional potential and opening new economies in underdeveloped areas can increase the employment opportunities in these areas, as well as attract high-skilled migrants to create endogenous growth in these areas. In this case, opening foreign capital, under certain conditions, can be a consideration to overcome this problem.

We also include the proportion of agricultural workers as a proxy for economic development in rural areas (Wajdi et al., 2017). We find the proportion of agricultural workers in the origin has a positively significant influence on the flow of high-skilled migration in Indonesia. Another finding is the insignificance of the proportion of workers in the agricultural sector in destination. The great interest of high-skilled migrants in heading to urban areas in each province is due to the availability of higher income and better job opportunities (Urbański, 2022), without considering the rural characteristics of the destination province. If it is related to attractiveness, wages, job opportunities, guaranteed information and amenities, factors in destination are more prioritized by high-skilled migrants. From these results, the proportion of agricultural sector workers is more likely to be a driving factor in this case so that high-skilled migrants tend to leave areas with a high agricultural sector. However, in developing countries like Indonesia, the relationship between the agricultural sector, employment and migration needs to be studied more seriously. The agriculture sector is not the only factor of migration, but it has its own role in migration (Falco et al., 2019).

These findings do not directly say that blindly converting agricultural land to non-agricultural land is the best solution for keeping high-skilled migrants afloat. The agricultural sector, as a sector that produces basic food ingredients, cannot be left alone. Indonesia's abundant natural resources are one of the advantages that differentiate Indonesia from other countries. Therefore, optimizing the agricultural sector into agro-tourism and agroindustry is an attractive option. This plan can increase the economic margin that can be generated by the agricultural sector, which can attract interest from high-skilled residents so that they do not migrate to other areas so that it can also provide rapid endogenous growth in areas that predominantly rely on the agricultural sector or rural regions.

As proxy for social network of migration, migrant stock was included in this research. The findings obtained in this research are that there is a significant positive influence of migrant stock on high-skilled migration flows. It means that the stronger the social network, the higher the flow. This finding is also found by Greenwood (1975); Komaruddin (2022); Liu and Shen (2014); Wajdi et al. (2017); and Simpson (2022). The higher the stock of migrants in the destination province, the clearer the information about that province will be. High skilled people, who possess superior information filtering abilities, information about the characteristics of the destination played a crucial role in determining whether or not to move. Most migrants will tend to move towards destinations about which they have information, like the economic condition, social condition, etc. (Greenwood, 1975; and Wajdi et al., 2017).

Wajdi et al. (2017) considers migrant stock not only as a social network proxy for migration, but also as a past cumulative effect of migration forces. Strong ties between high-skilled migrants and relatives, friends or acquaintances in the destination area provide a guarantee of correct and accurate information regarding conditions in the destination province, whether information related to income, cost of living, travel costs, strategic location, business sector, and so on so that at a certain point the high-skilled migrants choose that place as a migration destination. Relatives and friends can provide the newly arrived migrant with food and shelter until he finds work, and they can also make the social transition easier for the migrant (Greenwood, 1975). Liu & Shen (2014) stated that although high-skilled migrants have many ways to obtain various information on the internet or other channels, the effects of social networks still play the key role in determining the chosen destination area.

PFAI, which is formed from the indicators in Table 1, is a proxy for the amenities or comfort factors of public facilities included in the model. As a result, PFAI has a negatively significant influence on migration in Indonesia, including in the context of high skilled. This indicates that the availability of access to public facilities is also a consideration for high-skilled migrants whether to migrate out of the province or not. Wajdi et al. (2017) also explains how important the development of public facilities, such as educational facilities, is in the considerations of migrants in choosing their

destination. Liu & Shen (2014) found that number of medical doctors in the origin has a negative influence on the flow of high-skilled migration in China. Although the effect of these public services is not as big as the impact of economic and career factors, level of accessibility to public facilities is starting to become a consideration for migrants (Shilpi et al., 2014), especially high-skilled migrants, when making their decisions to migrate or not. Equal access to public facilities or infrastructure is something that needs to be done to realize an even distribution of the high-skilled population in each region to reduce regional inequality in Indonesia.

The final variable entered the model is the island dummy variable. This variable is a conversion of a categorical variable with two categories, namely the category of migration within one island (code 1) and the category of migration between islands (code 0). This dummy variable aims to see the difference in the average migration flows of high-skilled workers who migrate within one island versus those who migrate between islands. It is a proxy for barriers or barriers to an inter-island migration phenomenon. As a result, we did not find any significant differences between the two. Access to transportation across islands is no longer a significant obstacle for high-skilled migrants (Krisnandita, 2023). It is necessary to improved access of inter-island transportation in Indonesia, both sea and air transportation. Development of sea transportation access in Indonesia can reduce the obstacles felt by land transportation and increase the distribution of products needed by consumers across the island (Wajdi et al., 2017). High-skilled migrants consider distance more than barriers to migrating between islands. For example, high-skilled migrants who migrate from Lampung will prefer to migrate to DKI Jakarta, which is on a different island but is closer than to Aceh, which is still on the same island but is quite far away.

4. CONCLUSIONS

The high-skilled migrants in Indonesia 2022 are mostly female, in the age range 21-35 years, migrating to other provinces on the same island, and moving for economic reasons (for men) and with their husband/wife/children/other family (for women). For further research related to high-skilled migration, gender issues and micro-analysis of migrants' personal factors need to be carried out to obtain a more comprehensive analysis. The majority of Indonesia's high-skilled migrant are moving inside the provinces of Java Island, or Java Centric. This threatens to increase regional inequality between Java and outside Java. The interesting finding is a large flow of high-skilled migration from DKI Jakarta to West Java and Banten. It shows a change in the behavior of high-skilled migrants in the national capital area and its surroundings. Migration analysis that includes commuters and cost of living can be a recommendation in future research.

The gravity model can explain the factors of high-skilled migration well. We recommend this model as an approach in macro migration analysis. High-skilled population size and distance variable, as the core variables of gravity model, have significant influence on migration flows of high-skilled people. High-skilled migrants are considering distance barriers more than barriers to migrating between islands. However, for further research, we recommend that this geographic distance variable be replaced by using other distance proxies such as economic distance (migration costs) which are more relevant in the current era. As proxy of the economic factor, the urban unemployment rate in destination, wage level in origin and destination plays the important role on high-skilled migration analysis. Therefore, to reduce interprovincial inequality in Indonesia through the potential of high-skilled migration, the government can pay special attention to provinces that are still less developed by improving the economy through increasing the worker's wages and the availability of adequate job opportunities in these provinces. Creating new economic centers in less developed provinces could be an option. Judging from the existence of the agricultural sector, the proportion of agricultural workers is a push factor on high-skilled migration. Therefore, in order not to become a driving force for high-skilled migrants to leave, increase the level of the agricultural sector in less developed areas to levels with higher economic margins, like the agro-industry or agro-tourism.

As a proxy for social network, information, and past cumulative power of migration, Migrant stock strongly implies a positive influence on migration in Indonesia. Therefore, it is necessary to increase access to information/promotion/social networks related to under-developed areas or

provinces from a positive side to increase the interest of high-skilled migrants to move there so that rapid endogenous development can be realized. The establishment of PFAI can be a proxy for the level of accessibility of public facilities. Provinces with high PFAI values are clustered on Java Island, especially in West Java which has the highest PFAI values in Indonesia. There is an inequality in the level of accessibility to public facilities between the western and eastern regions of Indonesia. PFAI is also one of the push factors of high-skilled migration. Therefore, increasing accessibility to public facilities in remote areas is necessary to provide high-skilled residents with a comfortable place to live. These public facilities can be in the form of (1) educational facilities such as the availability of elementary, middle school, high school and tertiary institutions; (2) health facilities such as the availability of hospitals, health centers and health workers; and (3) economic facilities such as the availability of shopping centers, supermarkets and market availability.

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REFERENCES

Aslany, M., Carling, J., Mjelva, M. B., & Sommerfelt, T. (2021). Systematic review of determinants of migration aspirations. In *QuantMig Project Deliverable D2.2.* (Issue 870299). University of Southampton. https://www.quantmig.eu/res/files/QuantMig D22 2021-01-29.pdf.

Atmani M, B., Pitoyo, A. J., & Rofi, A. (2021). Faktor Individual Dan Kontekstual Pada Migrasi Risen Di Indonesia: Analisis Data Survei Penduduk Antar Sensus 2015. *Jurnal Kependudukan Indonesia*, *15*(2), 183-196. https://doi.org/10.14203/jki.v15i2.432

Badan Pusat Statistik. (2022a). *Keadaan Angkatan Kerja di Indonesia Agustus 2022*. Badan Pusat Statistik.

Badan Pusat Statistik. (2022b). *Keadaan Pekerja di Indonesia Agustus 2022*. Badan Pusat Statistik.

Badan Pusat Statistik. (2023a). *Penduduk Indonesia Hasil Long Form Sensus Penduduk 2020*. Badan Pusat Statistik.

Badan Pusat Statistik. (2023b). *Statistik Migrasi Indonesia Hasil Long Form Sensus Penduduk 2020*. Badan Pusat Statistik.

Bayraktar, Y., & Özyılmaz, A. (2017). The Role of Internal Migration on Regional Inequality: Turkey Example. *Turkish Journal of Middle Eastern Studies*, 9–30. https://doi.org/10.26513/tocd.317663

Botezat, A., & Ramos, R. (2020). Physicians ' brain drain - a gravity model of migration flows. *Globalization and Health*, *16*(7), 1–13. https://doi.org/10.1186/s12992-019-0536-0

Czaika, M., & Parsons, C. R. (2017). The Gravity of High-Skilled Migration Policies. *Demography*, *54*(2), 603–630. https://doi.org/10.1007/s13524-017-0559-1.

Falco, C., Galeotti, M., & Olper, A. (2019). Climate change and migration : Is agriculture the main channel ? *Global Environmental Change*, *59*(September), 101995. https://doi.org/10.1016/j.gloenvcha.2019.101995

Franc, S., Časni, A. Č., & Barišic, A. (2019). Determinants of Migration following the EU Enlargement: A Panel Data Analysis. *South East European Journal of Economics and Business*, *14*(2), 13–22. https://doi.org/10.2478/jeb-2019-0010

Greenwood, M. J. (1975). Research on Internal Migration in the United States: A Survey. *Journal of Economic Literature*, *13*(2), 397–433.

Gu, H., & Shen, T. (2021). Modelling skilled and less-skilled internal migrations in China , 2010 – 2015 : Application of an eigenvector spatial filtering hurdle gravity approach various factors besides the gravity factors into gravity models. *Population, Space and Place*, *27*(6), 1–18.

https://doi.org/10.1002/psp.2439

Jandová, M., & Paleta, T. (2015). Gravity models of internal migration - The czech case study. *Review of Economic Perspectives*, *15*(1), 3–14. https://doi.org/10.1515/revecp-2015-0008

Kerr, S. P., Kerr, W., Ozden, C., & Parsons, C. (2017). High-Skilled Migration and Agglomeration. *Annual Review of Economics*, *9*, 201–234. https://doi.org/10.1146/annurev-economics-063016-103705

Khoeri, A., & Atmanti, H. D. (2021). Analysis of Internal Migration Determinants in Indonesia. *Jurnal REP (Riset Ekonomi Pembangunan)*, *6*(2), 126–143. https://doi.org/10.31002/rep.v6i2.3283

Komaruddin, & Sakinah. (2022). Analisis Migrasi Dalam Upaya Meningkatkan Kesejahteraan Ekonomi Masyarakat Madura Perspektif Ekonomi Syariah (Studi Kasus: Pedagang Asal Madura di Pasar Gadang Kota Malang). *Jurnal Ekonomi Dan Perbankan*, *3*(1), 314–332. https://doi.org/ https://doi.org/10.32806/ivi.v3i1.101

Krasulja, N., Vasiljevic-Blagojevic, M., & Radojevic, I. (2016). Brain-drain: The positive and negative aspects of the phenomenon. *Ekonomika*, *62*(3), 131–142. https://doi.org/10.5937/ekonomika 1603131k

Krisnandita, I. W. (2023). Determinants of Migration Flows in Highly Skilled Migrants Interprovince in Indonesia. *Populasi*, *31*(1), 13-30. https://doi.org/10.22146/jp.84371

Lee, E. S. (1966). A Theory of Migration. *Demography*, *3*(1), 47–57.

Liu, Y., & Shen, J. (2014). Spatial patterns and determinants of skilled internal migration in China, 2000-2005. *Papers in Regional Science*, *93*(4), 749–771. https://doi.org/10.1111/pirs.12014

Mardainis, Junadhi, & Jamaris, M. (2019). Analisa Faktor Principal Component Analysis dan Common Factor Analysis untuk Menentukan Minat Calon Mahasiswa Masuk STMIK Amik Riau. *Satin - Sains Dan Teknologi Informasi*, *5*(2), 82–89. https://doi.org/10.33372/stn.v5i2.536

Nugroho, Y. D. (2018). Penerapan Regresi Logistik Hierarki Biner Untuk Menentukan Determinan Kemiskinan Di Bengkulu Dengan Menggunakan Indeks Aksesibiltas Sarana Umum (IASU) Sebagai Variabel Kentekstual. *Jurnal Statistika Universitas Muhammadiyah Semarang, 6*(1), 40-48. https://doi.org/10.26714/jsunimus.6.1.2018.%25p

Oliinyk, O., Bilan, Y., Mishchuk, H., Akimov, O., & Vasa, L. (2021). The impact of migration of highly skilled workers on the country's competitiveness and economic growth. *Montenegrin Journal of Economics*, *17*(3), 7–19. https://doi.org/10.14254/1800-5845/2021.17-3.1

Pardede, E. L., McCann, P., & Venhorst, V. A. (2020). Internal migration in Indonesia: new insights from longitudinal data. *Asian Population Studies*, *16*(3), 287–309. https://doi.org/10.1080/ 17441730.2020.1774139

Parsons, C. R., Rojon, S., Rose, L., & Samanani, F. (2020). High skilled migration through the lens of policy. *Migration Studies, 8*(3), 279-306. https://doi.org/10.1093/migration/mny037

Pirani, E., Marino, M. F., & Petrucci, A. (2019). Correlates of inter-districts migrations in Tanzania. A gravity-type modeling approach. *Statistica*, *79*(2), 201–221. https://doi.org/10.6092/issn. 1973-2201/8538

Piras, R. (2017). A long-run analysis of push and pull factors of internal migration in Italy. Estimation of a gravity model with human capital using homogeneous and heterogeneous approaches. *Papers in Regional Science*, *96*(3), 571–602. https://doi.org/10.1111/pirs.12211

Piyapromdee, S. (2021). The Impact of Immigration on Wages, Internal Migration, and Welfare. *Review of Economic Studies*, *88*(1), 406–453. https://doi.org/10.1093/restud/rdaa029

Rustam, Hwihanus, Bayu, M., & Darmono. (2023). The Role of Investment , Infrastructure , Migration of Employment Opportunities ; Study Literature Review. *International Journal of Economics, Business and Innovation Research*, *02*(04), 562–574

Sahminan, S., Hermansyah, O., & Rakhman, R. N. (2019). Construction of infrastructure index for Indonesia. *Studies in Economics and Finance*, *38*(2), 173–188. https://doi.org/10.1108/SEF-09-2018-0299

Sari, D. K., & Tanur, E. (2023). Analisis Determinan dan Pola Migrasi Internal Penduduk Provinsi Kepulauan Riau. *Jurnal Archipelago*, *2*(2), 157–169. https://doi.org/10.69853/ja.v2i02.40

Setyanti, A. M., Ashar, K., & Susilo, S. (2021). The Effect of Individual and Regional Characteristics on Commuting (Study on Gerbangkertosusila Area, East Java). *International Journal of Social and*

Local Economic Governance, *7*(1), 8–16. https://doi.org/10.21776/ub.ijleg.2021.007.01.2

Shen, J., & Liu, Y. (2016). Skilled and less-skilled interregional migration in China: A comparative analysis of spatial patterns and the decision to migrate in 2000-2005. *Habitat International*, *57*, 1–10. https://doi.org/10.1016/j.habitatint.2016.06.007

Shilpi, F., Sangraula, P., & Li, Y. (2014). Voting with Their Feet ? Access to Infrastructure and Migration in Nepal. *Policy Research Working Paper*, *7047*(September).

Simpson, N. B. (2022). Demographic and economic determinants of migration. *IZA World of Labor*, *July*, 1–11. https://doi.org/10.15185/izawol.373.v2

Stillwell, J. (2005). Inter-regional Migration Modelling: A Review. *45th Congress of the European Regional Science Association*, 29–48. https://doi.org/10.4337/9781035306152.00009

Tjiptoherijanto, P. (2017). Mobilitas Penduduk Dan Pembangunan Ekonomi. *Warta Demografi 30(3)*, 1-35.

Uprety, D. (2018). Skilled migration and health outcomes in developing countries. *International Journal of Health Economics and Management*, *19*(1), 1–14. https://doi.org/10.1007/s10754-018-9242-3.

Uprety, D. (2019). Does Skilled Migration Cause Income Inequality in the Source Country? *International Migration*, *58*(4), 85–100. https://doi.org/10.1111/imig.12661

Urbański, M. (2022). Comparing Push and Pull Factors Affecting Migration. *Economies*, *10*(1), 1–15. https://doi.org/10.3390/economies10010021

Wajdi, N., Adioetomo, S. M., & Mulder, C. H. (2017). Gravity models of interregional migration in Indonesia. *Bulletin of Indonesian Economic Studies*, *53*(3), 309–332. https://doi.org/10.1080/00074918.2017.1298719

Zipf, G. K. (1946). The P1P2/D Hypothesis: on Intercity Movement of Persons the P1*P2 Hypothesis: on the Intercity D Movement of Persons. *American Sociological Association*, *11*(6), 677–686. https://doi.org/10.2307/2087063

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