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The impact of Ukrainian immigration on inter-voivodship migration in Poland – an attempt to estimate the regional "displacement" effect using the input-output method

1. Introduction

The migration crisis caused by Russia's invasion of Ukraine in February 2022 was undoubtedly the greatest post-World War II humanitarian and logistical challenge for EU countries (and especially for Central and Eastern European countries). It is estimated that in the initial phase of the armed conflict (by March 2022), around 10 million Ukrainian citizens left their homes (Polska Agencja Prasowa 2022) with more than three million of them choosing to flee the war abroad (UNHCR 2022). Finally, by 31 December 2023, according to UNHCR data, nearly six million Ukrainians were in European countries (Operational Data Portal. Ukraine Refugees Situation 2023). These figures show the huge scale of emigration of Ukrainians, which could significantly affect local labour markets and internal migration in individual EU countries.

Poland took on the greatest burden of helping migrants. It is estimated that by October 2022, approximately 3.8 million people had crossed the Polish-Ukrainian border, of which as many as 1.5 million remained in Poland, and their stay being implicitly temporary (Uchodźcy z Ukrainy w Polsce 2022). Numerous community initiatives and more formalised foundations from all over the country made numerous efforts to accommodate migrants in private homes, hotels, hostels, motels, tourist shelters or even wedding halls. Despite the nationwide nature of the campaign, the distribution of Ukrainian citizens across the country turned out to

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be uneven. This was mainly due to the individual preferences of the immigrants, who mainly chose large urban centres such as Warsaw, Kraków, Wrocław and Poznań (Bugdalski 2022). These cities provide more convenient access to all kinds of services and are characterised by capacious labour markets with a diverse and large number of vacancies. The presence of family and friends in Poland and the similar cultural and linguistic background of Poland and Ukraine were also significant in terms of the choice of temporary residence (Długosz et. al 2022).

The main goal of the study is to construct inter-voivodeship migration tables for Poland using the input-output approach and to estimate the regional "displacement" effect of the population associated with the huge inflow of Ukrainian immigrants recorded in 2022. Achieving this goal will allow answering the following main research question: Was the ability of individual voivodeships to absorb Ukrainian immigrants, measured by the strength of the so-called "displacement" effect, spatially differentiated in 2022?

However, it should be noted that the model used for answering this question greatly simplifies the reality, treating the inflow of migrants as the only factor causing internal migration. Other potential internal migration factors, such as the situation of the local labour market (e.g. wages, unemployment rate, level of development of economic infrastructure) or quality of life (e.g. housing conditions, access to education and health care, possibility of satisfying higher needs), are ignored. The results obtained in the simulations based on the model should therefore be treated with some reserve, as it has not been investigated (e.g. using surveys) what proportion of internal migration is actually caused by the mass inflow of immigrants and what is due to other factors. The author bases his inference on the literature on the subject and on the assumption that increased immigration to a given region may cause supply shocks in the local labour market, which further imply the migration of people with a lower occupational and economic standing.

Nevertheless, the construction of migration input-output tables for Poland can be both an interesting descriptive exercise and an attempt to fill the gap in officially published statistical data – the lack of data on the geography of internal temporary migration and the regional distribution of immigrants has been recognised and a method for estimating them has been proposed. In addition, the paper may provide a useful information for policymakers and for employees of the Office for Foreigners, who control and shape the size of the flow of immigrants to Poland.

The article is divided into six sections, with the next one containing a literature review. The third section describes the input-output method adapted to the study of inter-regional migration flows and explains the operation of the "displacement" effect. Parts four and five describe the data sources and the results of the study. The final section analyses the results obtained and outlines their contribution to the practice and directions for further research.

2. Literature review

The uneven distribution of Ukrainian immigrants across the provinces of Poland in 2022 may produce economic and social effects of varying intensity. Studies of the impact of immigration on basic socio-economic variables tend to focus on filling the supply gap in the labour market (cf. Saleheen, Shadforth 2006; Blau et al. 2011; Jarecki 2017) or the level of the unemployment rate and resident[1] wages (cf. Longhi et al. 2010; Giulietti et al. 2013; Edo 2015;). The impact of immigration on domestic interregional migration is less frequently addressed in the research. This type of analysis emphasises the importance of the migratory adjustment mechanism in local labour markets as a response to the inflow of immigrants to a region. First of all, it has been noted that an increase in immigration to a given region may cause an outflow of both low-skilled and low-paid labour, as well as better-educated and better-paid labour, with stronger effects observed for the first group (Frey 1995; Wright et al. 1997; White, Liang 1998). The qualifications of immigrants are not insignificant, as some studies indicate an intensification of interregional migration of local labour with similar qualifications to those of immigrants (Walker et al. 1992).

Researchers of the problem of interregional migration have noted that the inflow of immigrants to a given region can cause the so-called "push out" or "displacement" effect. It consists in forcing residents to migrate to other regions in the country as a result of the emergence in a given region of labour market competitors (immigrants) with similar skills (Walker et. al, 1992; Hatton, Tani 2005). This effect may be in the form of a fading impulse. It consists in the fact that the initiating inflow of migrants to the j-th region triggers a "displacement" of some of its residents to the other regions. The "displaced" internal migrants from the j-th region settle in the other regions and begin to "push out" the existing residents – then there is a secondary "push out" effect, which is weaker than the initiating effect. Residents from these regions go on to other regions and the aforementioned effect continues until it expires (Vázquez et al. 2011).

The "push out" effect can be quantified using modified input-output methods. The modifications are that input-output tables attempt to capture interregional migrant flows in place of traditional inter-industry flows, a method that was originally developed by Garin and Lowry (Rogers 1966; Gordon, Ledent 1980). Today, in an era of mass immigration, the use of input-output analysis in this area is slowly starting to regain the interest of researchers. For example,

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[1] Residents are further defined as all natural persons living in a given region. This concept corresponds to the definition of residents formulated by the Central Statistical Office of Poland (cf. *Residents…* 2025).

E.V. Vázquez et al. (Vázquez et al. 2011) built a migration input-output model for Spain, which experienced (similarly to Poland in 2022) a large inflow of immigrants in 2005, amounting to 700,000 persons. In this study, a clear spatial differentiation of the "push out" effect was observed. The regions with the largest urban centres turned out to be the most capable of absorbing immigrants and at the same time having the least force to displace natives to other regions. At the other end of the spectrum were regions with relatively low economic growth, low GDP per capita and high unemployment rates. Similar conclusions were reached by F.S. Perobelli et al. (Perobelli et al. 2015), additionally emphasizing the concentration of neighbouring regions with low absorption capacity of immigrants in the northern and northeastern regions of the country (Brazil). However, the study revealed some exceptions to the main rule, e.g. Sao Paulo state. Despite its good economic condition, it recorded a high level of the "displacement" effect – this was explained by the huge attractiveness of this region for immigrants (over 20% share in their reception countrywide), which creates strong competitive pressure on the labour market and encourages the population living there to migrate. In other studies, like Ç. Değer et al. (Değer et al. 2016), there are also observations that do not fit into the generally prevailing trends. The Turkish Nevşehir region is an example here – the high absorption capacity of Syrian refugees was achieved artificially thanks to the migration policy applied, which consisted of housing assistance and registration of immigrants' places of residence.

The above examples of research show that it would be worth examining the strength of the interregional "push out" effect using another country (such as Poland) as an example, to confirm the high absorption capacity of immigrants by regions that are relatively more economically developed. An additional argument for estimating the "push out" effect at the regional level is the fact that the literature on this subject is not numerous and requires supplementation.

3. Capturing interregional migration and "displacement" effect in the input-output approach

3.1. Interregional input-output migration model

For a given moment in time (e.g. one year), migration flows occurring in N geographical units (hereafter referred to as regions) forming a compact system (country) can be captured in a modified input-output table like in Table 1.

Table 1

Migration flows in terms of input-output method

		Region j-th [migrating to]				Outflow of population to other regions	Migration abroad (emigration)	Total net migration	Total inflow of migrants to the i-th region
		region 1	region 2	…	region N	e	a	nm	x
Region i-th [migrations from]	region 1					$\sum m_{1j}$	a_1	nm_1	x_1
	region 2			m_{ij}		$\sum m_{2j}$	a_2	nm_2	x_2
	…					…	…	…	…
	region N					$\sum m_{Nj}$	a_N	nm_N	x_N
Inflow of people from other regions	n'	$\sum m_{i1}$	$\sum m_{i2}$	…	$\sum m_{iN}$				
Number of immigrants admitted	f'	f_1	f_2	…	f_N				
Total inflow of migrants to j-th region	x'	x_1	x_2	…	x_N				

Source: own study.

In the place of the I quadrant of the input-output table, showing the production demand of a branch of the economy for the goods and services of other branches, a matrix of inter-regional migrant flows is placed $M = [m_{ij}]_{N\times N}$. The elements of this matrix define the number of internal migrants from region i-th coming to region j-th. The diagonal of the matrix M contains only zeros, as no case of internal migration is allowed here. For each j-th region, the inflow of internal migrants from the other regions can be determined by considering the matrix M vertically. The result of these considerations is a vector n' consisting of the elements $[n_j]_{1\times N}$,

where $n_j = \sum_{i=1}^{N} m_{ij}$. In addition to internal migrants, external migrants (immigrants) may also flow into the j-th region, and their number is determined by the vector $f' = [f_j]_{1 \times N}$. This variable is exogenous. The sum of the vectors n' and f' determines the total inflow of migrants to the j-th region:

$$x' = n' + f' \tag{1}$$

The vectors n', f' and x' form a quasi-III quadrant of the input-output table are similar to vectors from the quadrant that concentrate the generated income in individual sectors of the economy. It is worth mentioning that the vector x' can be treated as a result vector, whereby it is not the total output of the productive activity of individual economic sectors (as in the traditional input-output approach), but the total inflow of migrants to subsequent regions.

There are four vectors in place of the II quadrant of the input-output table: population outflow from the i-th region to the other regions e, foreign migration (emigration) a, total net migration nm and, the vector discussed earlier in its non-transposed form, the total inflow of migrants to the i-th region x. The outflow of population from the i-th region to other regions is determined by horizontally summing the population moving from the i-th region to the other regions, i.e. $e_i = \sum_{j=1}^{N} m_{ij}$. This creates the vector $e = [e_i]_{N \times 1}$. In addition to internal migrants, foreign migrants (emigrants) may also flow out of the i-th region, and their number is determined by the vector $a = [a_i]_{N \times 1}$. This variable, like f', is exogenous in nature. Another vector is the balancing item – total net migration $nm = [nm_i]_{N \times 1}$. Total net migration can be written as:

$$nm = x - (e + a) \tag{2}$$

is therefore the difference between the total inflow and total outflow of population from a given region.

By transforming Equation (2), it is possible to obtain the total population inflow to the region in a horizontal orientation:

$$x = nm + (e + a) \tag{3}$$

Interregional migrant flows, like intermediate consumption in economic sectors in Leontief's classical input-output model (cf. Plich, Skrzypek 2016: 23), can be represented using the corresponding coefficients, hereafter referred to as migration coefficients (in the traditional sense of input-output tables, input-output coefficients or otherwise direct coefficients are considered here). The elements of

the matrix of migration coefficients D are formed by dividing each i-th row of the matrix M by the total inflow of migrants to the i-th region, that is:

$$D = [d_{ij}]_{N \times N}, \text{ where } \forall i = 1, \ldots, N \quad d_{ij} = \frac{m_{ij}}{x_i} \tag{4}$$

These coefficients are interpreted as the number of internal migrants leaving the j-th region per one person arriving in the i-th region. For example if the value of the coefficient d_{ij} is 0.003, this means that for every 1,000 people arriving in the i-th region, there are (through the action of the adjustment mechanism) three migrants "pushed" out of the j-th region. Obviously, the diagonal elements of matrix D are zeros, as migration within a given region (e.g. migration from Zakopane to Krakow within the same małopolskie voivodeship) is not taken into account as interregional migration. In addition, as in the case of traditional input-output coefficients, migration coefficients must meet the conditions: $d_{ij} \leq 1$ and $\sum_{j=1}^{N} d_{ij} \leq 1$.

These conditions boil down to the fact that the number of migrants "pushed" to the j-th region from the i-th region and the sum of all "pushed" migrants from the i-th region (the total outflow of people from the i-th region to the other regions) cannot be higher than the total inflow of migrants to the i-th region.

By transforming Equation (4) accordingly and writing the result in matrix form, the following relationship is obtained (cf. Vázquez et al. 2011: 194):

$$\boldsymbol{n'} = \boldsymbol{x'D} = \begin{bmatrix} x_1 & \cdots & x_N \end{bmatrix} \begin{bmatrix} 0 & d_{12} & \cdots & d_{1N} \\ d_{21} & d_{22} & \cdots & d_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ d_{N1} & d_{N2} & \cdots & 0 \end{bmatrix} = \begin{bmatrix} n_1 & \cdots & n_N \end{bmatrix} \tag{5}$$

Inserting relationship (5) into Equation (1), we obtain equations (model) of the total inflow of migrants to each region of the country in a given time period t (for simplicity, the time sub-script is omitted further):

$$\boldsymbol{x'} = \boldsymbol{x'D} + \boldsymbol{f'} \tag{6}$$

The system of equations (6) can be written in the form:

$$(\boldsymbol{I} - \boldsymbol{D})\boldsymbol{x'} = \boldsymbol{f'} \tag{7}$$

where $\boldsymbol{I}$ is the unit (identity) matrix. Assuming that there is an inverse matrix to the matrix $(\boldsymbol{I} - \boldsymbol{D})$, the model eventually takes the following form:

$$\boldsymbol{x'} = \boldsymbol{f'}(\boldsymbol{I} - \boldsymbol{D})^{-1} \text{ or } \boldsymbol{x'} = \boldsymbol{f'L} \tag{8}$$

The elements of the matrix $(I - D)^{-1}$ are the time-constant parameters of the model[2], while f' is an exogenous variable representing the inflow of immigrants to a region. Thus, the model makes the total population inflows (inward and outward) to subsequent regions conditional on changes in the number of immigrants arriving in these regions. The model makes sense if the sum of each row of the matrix D is less than unity[3]. The elements of the $(I - D)^{-1}$ matrix are interpreted analogously to the elements of the Leontief inverse matrix (cf. Miller, Blair 2009: 21), hence it can be denoted similarly as the $L = (I - D)^{-1}$ matrix. The matrix L is referred to as the matrix of total migration coefficients for the purposes of the study.

Model (8) can be used to forecast the total inflow of migrants to individual regions of a country (x') when the future values of the exogenous inflow vector of immigrants (f') are known. Unfortunately, a weakness of the model (8) is its focus on an annual period of analysis, which results from the frequency of the publication of statistical data and the very construction of regional migration flow tables, which require the collection and balancing of large amounts of information. In reality, adjustments in the local labour market caused by a sudden increase in immigration are sometimes longer than a 1-year period, and the emergence of incentives forcing residents to migrate to other regions may be a long-term nature.

Another weakness of the model (8), as already mentioned in the introduction, is its simplifying assumption that immigration is the only factor significantly influencing internal migration (immigrant-driven intermigration model). Other covariates, such as differences in income, housing conditions and access to educational and health services, are excluded from the analysis. The next difficulty is the limited possibility of verifying the correctness of the model, i.e. whether immigration actually significantly affects internal migration. Unfortunately, an analysis of data from the last 10 years has shown that the assumption of positive net migration has not been met in every period. This fact makes comparative analysis difficult – it can only be done under conditions of exceptional inflows of migrants into the country (this was the case in 2015 and in 2022). Limiting ourselves solely to periods of exceptional immigration inflows does not allow

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[2] The general description of the model includes time-constant parameters. For the purpose of the comparative analysis of the "push out" effect in 2022 and 2015 (see Section 5.1), a matrix of total migration coefficients was estimated for both periods.

[3] A similar thing happens in the input-output model, where final demand must be greater than zero (which is always true). In the migration model, the issue is not always conclusively determined, as net migration (found in the second quadrant of Table 1) can be negative (more migrants leave than arrive in a region). However, in the case of a massive inflow of Ukrainian migrants to the regions (as in the case of the migration crisis caused by Russia's invasion of Ukraine), the mathematical condition mentioned in this section is met.

for the verification of the thesis that increased immigration does indeed affect internal migration.

3.2. The effect of "pushing out" residents by immigrants

The elements of the matrix $L = [\delta_{ij}]_{N \times N}$ from Equation (8) are the partial derivatives of x_i relative to f_j, i.e. $\dfrac{\partial x_i}{\partial f_j}$. The parameter δ_{ij} thus shows the total population inflow to the i-th region induced by the arrival of an additional one immigrant to the j-th region. This coefficient not only takes into account the initiating inflow of migrants to a region, but also the indirect effects, i.e. the migration of residents from region to region and their "pushing out" of further migrants, which also cause (but already smaller) "pushing out" effects, etc. until they expire. An alternative notation of Equation (8), using matrix algebra techniques, may be helpful in understanding this mechanism (see Tomaszewicz 1994: 67–68):

$$x' = f' + f'D + f'D^2 + \ldots = f'\left(I + D + D^2 + \ldots\right) \tag{9}$$

At the beginning, there is an impulse that initiates internal migration in the form of region j receiving a given number of migrants f_j. This is noticed by the residents of region j-th and they start to migrate to other regions, and their "distribution" between regions takes place according to the elements of the matrix D. The arrival of residents from the j-th region is observed by residents in the other regions. The latter also start migrating and there is a redistribution of migrants according to the matrix D, then these migrations produce a secondary "push out" effect, etc. Eventually, the migratory movements stop and the system finds its equilibrium.

For each region, a total "push out" effect can be determined, i.e. the total number of population inflows to all regions caused by the receiving of one additional immigrant by the i-th region. The "push out" or "displacement" indicator is written with the formula:

$$p = \left(I - D\right)^{-1} i \tag{10}$$

where i is a vector of ones of dimension N. In other words, the vector p is the sum of consecutive rows of the matrix of total migration coefficients L. The indicator of the "displacement" of residents by a region due to the admission of additional immigrants is used to analyse the ability to absorb immigrant supply shocks. Regions with a higher level of this indicator will be more susceptible to such shocks, as local labour market conditions and increased competition in the labour market stimulate more internal migrants. Regions with a relatively low

level of this indicator have a greater capacity to absorb additional immigrants – here labour markets are characterised by high capacity, the competitive pressure from immigrants is lower and the "push out" effect on residents is weaker. Of course, these relations occur with other conditions unchanged (*Ceteris paribus*) and with the assumption that the main driver of internal migration is the inflow of immigrants.

The comparability of the level of the *p* indicator between regions is facilitated by relating the value of the indicator to the average. This operation can be written with the formula (cf. Vázquez et. al 2011: 196):

$$p^* = \frac{(I-D)^{-1}\mathbf{i}}{\mathbf{i}'(I-D)^{-1}\mathbf{i}} \cdot$$

(11)

The average for all regions takes a standardised value of 1. The value of the *p** index for each region shows its deviation from the average.

4. Data sources and data collection issues

4.1. Description of real and estimated data

In order to construct the table of interregional migration flows (see Table 1), appropriate data are needed to complete the matrix *M* and the vectors *a* and *f'*. Not all of the data functions directly in domestic or European migration statistics and this requires the researcher to make appropriate estimates under conditions of limited information. The most important data sources and how to obtain data not present in official statistics are discussed below. Regions will hereinafter be referred to as voivodeships, and their number in Poland is *N* = 16.

The core of the migration data is actually registered data collected by Główny Urząd Statystyczny (the Central Statistical Office) within of Bank Danych Lokalnych (the Local Data Bank) – internal and external migration in 2022. For the purpose of the comparative analysis (see Section 5.2), analogous data from 2015 were also used. Within the BDL, data on inter-voivodeship migration for permanent residence (registrations) are available, which were used to develop a matrix of inter-voivodeship migration for permanent residence. It should be noted that there is no data on inter-voivodeship migration for temporary residence in the BDL. The statistical office only provides information on the total number of admitted internal migrants in a given province without indicating their regional origin (see Table 2).

Table 2

Main data used to build the inter-regional input-output migration table for 2022 and 2015

No.	Voivodeship	2022			2015		
		Number of internal migrants admitted (temporary migration) n_j	Estimated number of Ukrainian immigrants admitted f_j	Emigration for permanent residence a_i	Number of internal migrants admitted (temporary migration) n_j	Estimated number of Ukrainian immigrants admitted f_j	Emigration for permanent residence a_i
1	Dolnośląskie	32 761	84 759	1 356	47 127	2 460	2 105
2	Kujawsko-Pomorskie	22 359	15 967	640	36 153	460	988
3	Lubelskie	20 724	69 872	512	27 725	1 952	599
4	Lubuskie	13 303	28 813	404	18 050	591	771
5	Łódzkie	20 562	67 231	484	35 234	726	654
6	Małopolskie	38 790	161 354	1 407	59 028	2 272	1 631
7	Mazowieckie	58 069	303 378	889	73 697	9 161	861
8	Opolskie	11 958	12 005	979	17 900	679	1 583
9	Podkarpackie	23 214	49 343	759	31 470	1 411	820
10	Podlaskie	12 377	13 206	226	18 340	251	455
11	Pomorskie	23 357	60 628	1 182	33 664	824	1 548
12	Śląskie	42 589	61 828	2 133	68 801	1 233	3 785
13	Świętokrzyskie	11 191	18 488	243	15 289	607	307
14	Warmińsko-Mazurskie	15 151	10 685	676	25 145	333	1 034
15	Wielkopolskie	36 698	57 386	948	54 381	993	1 302
16	Zachodniopomorskie	20 615	50 783	795	31 919	935	1 586
	Total	403 718	1 065 726	13 633	593 923	24 887	20 025

In order to estimate the matrix of inter-voivodeship migrations for temporary residence *M*, the number of migrants for temporary residence was distributed among voivodeships after fixed shares according to the matrix of migration for permanent residence. This assumes that the directions and structure of migrants for temporary and permanent residence are similar (see next section). Actual data on internal migration show a similar spatial pattern, i.e. in 2022 and in 2015, the largest number of internal migrants was received by the Mazowieckie Voivodeship, while the smallest number was received by the Świętokrzyskie Voivodeship, but in 2015 the scale of internal migration was noticeably higher than in 2022 (by approximately 190,000 persons).

Model (8) is based on the simplifying assumption that internal migration is mainly caused by the inflow of immigrants represented by the vector *f'*. In this study, the flow of immigrants should be identified with Ukrainians arriving in Poland. The focus on Ukrainian citizens in Poland was dictated by the domination of the immigration stream by Ukrainians[4] and their cultural and professional proximity to Poles. This proximity means that Ukrainian citizens have the right qualifications to start working in various professions, speak Polish communicatively (unlike, for example, most immigrants from Asian countries) and assimilate well in the country. The above factors may indicate high competitiveness of Ukrainians on the labour market with respect to Polish citizens. It is presumed that this group of immigrants has the greatest impact on the emergence of regional "push out" effects.

When examining the issue of Ukrainian immigration, it should be noted that there were problems in finding relevant data in the case of determining how many Ukrainian immigrants decided to stay in Poland and what number were received by individual voivodeships. Reports on migration of Ukrainian citizens, press articles or data from Urząd do spraw Cudzoziemców (the Office for Foreigners) were not consistent in this respect. For example, think-tanks and media reports indicated that up to 1.5 million migrants were estimated to have temporarily decided to stay in Poland in 2022 (cf. *Uchodźcy z…*, 2022: 5). Unfortunately, it was not specified here how many migrants were received by individual voivodeships. Data from the Office for Foreigners should be considered more precise, indicating that in 2022 the number of Ukrainian citizens with a valid residence permit (temporary and permanent residence, refugee status, temporary protection, etc.) increased by approximately 1.065 million compared to the previous year (Urząd do spraw Cudzoziemców 2024). This total number of migrants was taken in the input-output tables for 2022 (see the total row in Table 2) and treated as a stream of immigration

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[4] According to the Urząd do spraw Cudzoziemców (the Office for Foreigners), Ukrainians accounted for 95% of the stream of all immigrants in 2022. The rate in 2015 was 68% (Urząd do spraw Cudzoziemców 2024).

of Ukrainian citizens to Poland. This stream was further distributed among the provinces using regional data on issued decisions on permanent residence (according to fixed shares) from the same source. It was assumed that the directions and structure of immigration for permanent and temporary residence are similar to each other, analogous to the data on internal migration. This assumption is based on the aforementioned studies by B. Bugdalski (Bugdalski 2022) and P. Długosz et al. (Długosz et al. 2022), suggesting that new Ukrainian immigrants often go to places where earlier immigrants from this country have already settled.

According to the estimates in Table 2, the most popular direction of immigration of Ukrainian citizens in 2022 was the Mazowieckie Voivodeship (about 303,000 immigrants), while the least popular direction of immigration was the Warmińsko-Mazurskie Voivodeship (about 11,000 persons). In 2015, the overall scale of migration of Ukrainian citizens to Poland was much smaller than in 2022 and amounted to only about 25,000 persons. At the same time, it should be emphasised that since 2015, the number of Ukrainians migrating to Poland has systematically increased, which can be considered as the beginning of intensification of this phenomenon. As in 2022, Ukrainians most often chose the Mazowieckie Voivodeship as their immigration direction (approximately 9,000 persons). In contrast, the least popular immigration direction was the Podlaskie Voivodeship (approximately 300 persons). The distribution of immigrants between provinces should be considered highly uneven in both 2022 and in 2015.

Actual data from the Central Statistical Office on the number of emigrants from Poland originating from individual voivodeships were also used to construct inter-regional input-output tables for 2022 and 2015. This data was used to supplement the vector a. The year 2015 was characterised by a higher scale of emigration from Poland than the year 2022. The analysis of the actual recorded data of the Central Statistical Office shows that 20,000 residents emigrated permanently from Poland in 2015 while 14,000 in 2022. Despite the differences in the level of the studied phenomenon in the indicated years, one can notice a certain similarity in the regional distribution of emigrants – the largest number of emigrants came from the Śląskie Voivodeship. On the other hand, the smallest number of emigrants was recorded in the Świętokrzyskie Voivodeship (for 2015) and in the Podlaskie Voivodeship (for 2022).

4.2. The limitations of estimated migration data

The assumption made in the study that the structure and directions of internal migration for temporary and permanent stay are similar is questionable. This highly simplifying assumption was dictated by the lack of disaggregated spatial data on temporary migration. An argument for assuming the same structure of

the interregional migration matrix for permanent and temporary residence is the fact that, in 2022, the structure of the vector of the total population inflow to individual voivodeships for permanent residence and the analogous vector for temporary residence was very similar – the average absolute difference between the individual elements of the vectors was only about 1.6 percentage points.

The assumption that the directions and intensities of internal migration for permanent and temporary residence are similar is difficult to base on adequate research in the literature, as there is not a large number of publications addressing this topic. Some of the few publications, such as M. Bell and G. Ward (Bell, Ward 2000) or Y. Liu and W. Xu (Liu, Xu 2017), even indicate that the directional choices of internal migration for temporary and permanent residence may be different. These studies concerned large, heterogeneous countries in terms of their level of economic development, such as Australia or China, which are difficult to juxtapose spatially with Poland's economy. Poland does not have huge desert areas or areas of forced internal immigration as a result of the introduction of migration policies. Nevertheless, the above-mentioned studies emphasise that intensive immigration to metropolitan areas for permanent and temporary residence is observed, which would confirm the important role of the Mazowieckie Voivodeship (and Warsaw) in both types of migration.

On the other hand, one can also find examples of studies confirming a positive correlation between the directions of temporary and permanent migration. Silvestre (Silvestre 2007) points to the occurrence of such a phenomenon in Spain in the 1930s, when workers willingly migrated to economically fast-growing provinces (Barcelona, Vizcaya and Zaragoza) for both permanent and temporary residence. On the basis of national research, similarities in the directions of permanent and temporary migration can be seen in the destination choices of Polish emigrants. According to a study by A. Zborowski and J. Gałka (Zborowski, Gałka 2008), between 2003 and 2006, emigrants for temporary and permanent residence most often chose the same destinations, i.e. Germany, the United Kingdom, Ireland and the Netherlands. Admittedly, these are not internal migrations, but it may be assumed that Poles are guided by similar criteria, e.g. economic, in their choices of permanent and temporary migration. Of course, any judgements on the destination choices of internal migration for permanent and temporary residence should be supported by in-depth research.

Another problem related to the estimation of data on migrants is the approach to estimate the size of the immigrant stream (the number of Ukrainian citizens coming to Poland) adopted in the paper. The approach shown in the previous section is not accurate, as it is more in the nature of a simplified economic estimate than an accurate demographic analysis. The stream, as in economic sciences, has been treated as a change in the stock, here as the change in the number of Ukrainian

citizens with a valid residence permit compared to the previous year. Focusing on the change in stock status has its advantages and disadvantages. The advantage is the simplicity and speed of the estimates, while the disadvantage is the inclusion in the register of persons obtaining a permanent residence permit (who have been living in Poland for a minimum of five years) and persons leaving Poland, i.e. "outflowing" from the stock (analogous to economic depreciation). The estimated stream is therefore not exactly a stream of *strictly* migrant inflows. In order to estimate this stream more accurately, it would be necessary to carry out detailed demographic analyses by reviewing the number of temporary residence permits issued, the number of work permits received in Poland for Ukrainian citizens or (especially for recent years) the number of Ukrainians with Polish temporary protection (UKR PESEL status). The problem of access to certain data, the time-consuming process of collecting them and their questionable reliability, however, led to the decision to use a simple economic approach.

5. Results

5.1. The "displacement" effect in 2022

The results of the construction of the "push out" indicator for each voivodeship, which was estimated according to Equation (10), were as follows: Dolnośląskie 1.354, Kujawsko-Pomorskie **1.865**, Lubelskie 1.462, Lubuskie 1.519, Łódzkie 1.410, Małopolskie 1.246, Mazowieckie 1.211, Opolskie **1.868**, Podkarpackie 1.473, Podlaskie **1.742**, Pomorskie 1.407, Śląskie 1.586, Świętokrzyskie **1.983**, Warmińsko-Mazurskie **2.208**, Wielkopolskie 1.436, Zachodniopomorskie 1.407. Please note that **bold** highlights five largest values, whereas shading highlights five smallest values. The average level of the p indicator for the country was 1.574, with a standard deviation of 0.272 and a coefficient of variation of 17.3%.

It turns out that the regions with the highest level of the p indicator are the Warmińsko-Mazurskie, Świętokrzyskie, Opolskie, Kujawsko-Pomorskie and Podlaskie voivodeships. Therefore, it can be expected that these regions show the lowest possibilities of absorbing Ukrainian immigrants, and the potential supply shocks caused by them in the labour market (triggering increased internal migration) are relatively the strongest. On the other hand, the regions with the lowest level of the "push out" indicator are the Mazowieckie, Małopolskie, Dolnośląskie, Pomorskie and Zachodniopomorskie voivodeships. The applied migration model shows that the indicated voivodeships are characterised by a high potential to absorb Ukrainian immigrants, and the possibility of labour market turbulence affects internal migration to a relatively lesser extent.

The values of the indicator p for 2022 have a relatively low statistical variability (measured by a coefficient of variation) of about 17%. The average indicator for the whole country is 1.574 which means that for every additional 1,000 immigrants admitted in a hypothetical averaged region, the total inflow of internal migrants to all regions is 574 people. In other words, each inflow of an additional portion of 1,000 Ukrainian immigrants into Poland results in an internal migration movement in which 574 people leave their home regions in successive iterations of the "push out" effect.

The results of the voivodeships in relation to the "push out" indicator can be detailed by multiplying all the values of the matrix L (see Equation 8) by 1000. The results of this operation are presented in Table 3. In this way one obtains the total inflow of migrants to individual voivodeships caused by the admission of an additional 1,000 Ukrainian immigrants in the i-th voivodeship. For example the value 49 for $i = 2$ and $j = 1$ is interpreted as the total inflow of internal migrants to the Dolnośląskie Voivodeship due to the admission of an additional 1,000 immigrants by the Kujawsko-Pomorskie Voivodeship.

On the diagonal of Table 3, there are values greater than 1,000. These values for the i-th region include not only the initiating inflow of 1,000 migrants from outside to a given region, but also the induced internal migration inflow from the other regions. For example, for $i = 1$ and $j = 1$ the value 1,017 means that as a result of the inflow of 1,000 immigrants to the Dolnośląskie Voivodship, an additional 17 internal migrants arrived to this region from other regions and whose migration was due to the "displacement" effect.

Columns A and B are summarised in the right-hand side of the table. Column A contains the total population inflow to all regions resulting from the i-th region receiving an additional 1,000 migrants, and is therefore the sum of the rows (from $j = 1$ to 16) in the presented matrix. If 1,000 is subtracted from the values in column A, the result of this operation will be the total inflow of internal migrants to all regions, which is the consequence of the "displacement" effect. Column B, on the other hand, details the number of all residents of the i-th region who have migrated to the other regions due to the inflow of 1,000 immigrants to that region. The values in this column are not the result of adding/subtracting the values found in the rows of the presented matrix, but are derived from the numerical solution of the model and should be treated as additional information.

Demonstrating the mechanism of the "push out" effect will be easier when two extreme cases of voivodeships are contrasted. In the case of the constructed table of migration flows for the year 2022, these will be the Warmińsko-Mazurskie and Mazowieckie voivodeships. Thus, according to the results of the model (8), the admission of an additional 1,000 migrants in the Warmińsko-Mazurskie Voivodeship (with the highest level of "push out" indicator) causes the largest

total (after the cessation of the "displacement" effect) inflow of internal migrants to the Mazowieckie (250 persons) and Pomorskie (242 persons) voivodeships. From the respective values of matrix **D** (see equation 4) it follows that in the first wave of migration 817 persons are "pushed out" from the Warmińsko-Mazurskie Voivodeship, of which 212 persons and 179 persons move to the Mazowieckie and Pomorskie voivodeships respectively. In the end, the total number of all "pushed out" residents from the Warmińsko-Mazurskie Voivodeship after the cessation of the effect is 841 people (per additional 1,000 admitted Ukrainian immigrants). The inflow of population to all regions together resulting from the admission of an additional 1,000 immigrants in the Warmińsko-Mazurskie Voivodeship is 2,208 persons, of whom 1,208 persons are the inflows caused by internal migration.

According to the simplified reasoning of the cause-effect relationship between inflows of immigrants and internal migration, the admission of an additional 1,000 immigrants in the Mazowieckie Voivodeship (with the lowest "push out" indicator) triggers the highest total inflow of internal migrants to the Lubelskie and Łódzkie voivodeships, but it is only 26 and 19 people respectively. Matrix **D** (see equation 4) shows that in the first wave 132 people are "pushed out" from the Mazowieckie Voivodeship, of which 23 people move to the Lubelskie Voivodeship and 16 people migrate to the Łódzkie Voivodeship. The total number of all "pushed out" residents from the Mazowieckie Voivodeship is 134 persons (per additional 1,000 admitted Ukrainian immigrants), so only an extra 2 persons will be "pushed out" from this Voivodeship as a result of the second and further waves of interregional migration. The population inflow to all regions together resulting from the admission of an additional 1,000 immigrants in the Mazowieckie Voivodeship is 1,211 persons, of whom 211 persons are the inflows caused by internal migration.

The analysis of the data collected in Table 3 shows that the strongest interregional (bilateral) "displacement" effects are observed in the case of the inflow of immigrants to the Opolskie, Podlaskie and Warmińsko-Mazurskie voivodeships. Disregarding the impact of other variables on internal migration, the admission of an additional 1,000 immigrants by these voivodeships results in the internal migration of more than 200 persons in the following directions: Opolskie – Dolnośląskie, Opolskie – Śląskie, Podlaskie – Mazowieckie, Warmińsko-Mazurskie – Mazowieckie and Warmińsko-Mazurskie – Pomorskie. On the other hand, the weakest interregional "displacement" effects are recorded in the Lubuskie, Małopolskie and Mazowieckie voivodeships. Here, the inflow of an additional 1,000 immigrants may entail internal migration of no more than four persons in the following directions: Lubuskie – Świętokrzyskie, Małopolskie – Lubuskie, Małopolskie – Podlaskie, Małopolskie – Wielkopolskie, Mazowieckie – Lubuskie and Mazowieckie – Opolskie.

Table 3

Total effect of "pushing out" residents from individual voivodeship estimated for the admission of an additional 1,000 immigrants by *i*-th voivodeship

Host *i*-th region for 1000 immigrants		Total population inflow to the *j*-th region																A. Population inflows to all regions in total (rsum 1-16)	B. Total number of people "pushed out" of the *i*-th region
		Dolnośląskie	Kujawsko-Pomorskie	Lubelskie	Lubuskie	Łódzkie	Małopolskie	Mazowieckie	Opolskie	Podkarpackie	Podlaskie	Pomorskie	Śląskie	Świętokrzyskie	Warmińsko-Mazurskie	Wielkopolskie	Zachodniopomorskie		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
Dolnośląskie	1	1 017	13	11	34	19	24	34	33	15	5	15	42	6	7	55	25	1 354	236
Kujawsko-Pomorskie	2	49	1 025	23	21	46	36	132	13	18	20	125	49	10	46	198	54	1 865	611
Lubelskie	3	27	14	1 009	8	17	46	156	7	56	12	20	34	11	10	20	14	1 462	338
Lubuskie	4	99	22	12	1 011	15	19	38	10	12	5	20	30	4	7	137	78	1 519	367
Łódzkie	5	45	21	14	9	1 007	29	86	14	14	8	20	53	13	9	49	17	1 410	284
Małopolskie	6	16	7	10	4	8	1 016	27	7	35	4	8	70	13	4	11	7	1 246	162
Mazowieckie	7	11	15	26	4	19	14	1 016	3	11	16	15	16	8	15	14	9	1 211	134
Opolskie	8	202	23	24	23	41	75	64	1 016	35	9	23	219	13	14	58	31	1 868	604
Podkarpackie	9	33	10	49	7	15	142	66	9	1 012	8	13	52	21	8	18	11	1 473	342
Podlaskie	10	29	34	39	11	24	33	257	8	19	1 017	65	37	7	100	39	23	1 742	505
Pomorskie	11	21	57	15	10	14	19	55	6	12	14	1 019	28	5	41	45	45	1 407	256
Śląskie	12	61	20	22	13	40	129	64	43	37	10	23	1 028	27	14	32	23	1 586	412
Świętokrzyskie	13	59	22	55	12	68	197	194	17	104	14	26	132	1 010	14	37	23	1 983	717
Warmińsko-Mazurskie	14	46	119	40	21	36	46	250	14	26	129	242	65	11	1 030	83	51	2 208	841
Wielkopolskie	15	67	55	10	35	30	21	45	11	11	7	26	32	5	10	1 024	45	1 436	296
Zachodniopomorskie	16	39	30	12	45	15	17	45	7	10	6	40	27	5	10	89	1 011	1 407	279

5.2. Comparison of the "push out" effect – 2015 vs. 2022

The results of a comparative analysis of the spatial distribution of the "displacement" effect in 2022 and 2015 for the Polish voivodeships are presented below. The year 2022 and 2015 are very important periods in the history of the phenomenon of immigration of Ukrainian citizens to Poland. In 2015, this phenomenon intensified as a result of the outbreak of the Russian-Ukrainian conflict in the Donbas and Lugansk regions the year before. At that time, Poland saw the first refugees from the area of hostilities, in addition to economic migrants (linked to the strong fall in Ukraine's real GDP in 2015). In turn, in 2022, there was an unprecedented inflow of Ukrainian citizens to Poland in excess of one million people. In the author's opinion, these two notable periods are worth comparing in terms of the differences in the spatial and quantitative inflow of Ukrainian immigrants to Poland and the effects of this inflow in the form of "push out" effects.

The spatial variation of the "push out" indicator in relation to the national average ($p*$ index) in 2022 and 2015 is shown in Figure 1. Both in 2022 and in 2015, the voivodeships falling in the first quartile group of the value of the $p*$ index were the Dolnośląskie, Małopolskie and Mazowieckie voivodeships. Assuming the strong relationship between internal migration and the inflow of immigrants, it can be concluded that the regions with the highest capacity to absorb Ukrainian citizens have not changed over the past seven years.

In 2015, the Wielkopolskie Voivodeship also belonged to this group of voivodeships, but in 2022 it lost its potential through the intensification of the "push out" effect. In 2022, the voivodeships in the first quartile group were characterised by a value of $p*$ between 10 and 23% lower than the national average. In 2015, this group recorded values of this indicator from 18 to even 30% lower than the national average.

Larger differences between 2022 and 2015 occur in the last quartile group of the index $p*$. Only the Warmian-Masurian Voivodeship and the Świętokrzyskie Voivodeship were present in it both in 2022 and in 2015. In 2015, additionally, the Lubelskie Voivodeship and the Lubuskie Voivodeship were also among the voivodeships with the highest "push out" indicator. However, the results for these regions in 2022 can be interpreted as an improvement in the absorption capacity of immigrants by reducing the "displacement" power of residents. On the other hand, in 2022, the last quartile group of the $p*$ indicator also included, in addition to the Warmińsko-Mazurskie and Świętokrzyskie Voivodeships – the Kujawsko-Pomorskie Voivodeship and the Opolskie Voivodeship. According to the mechanism of the model (8), it is concluded that in 2022 in these regions the

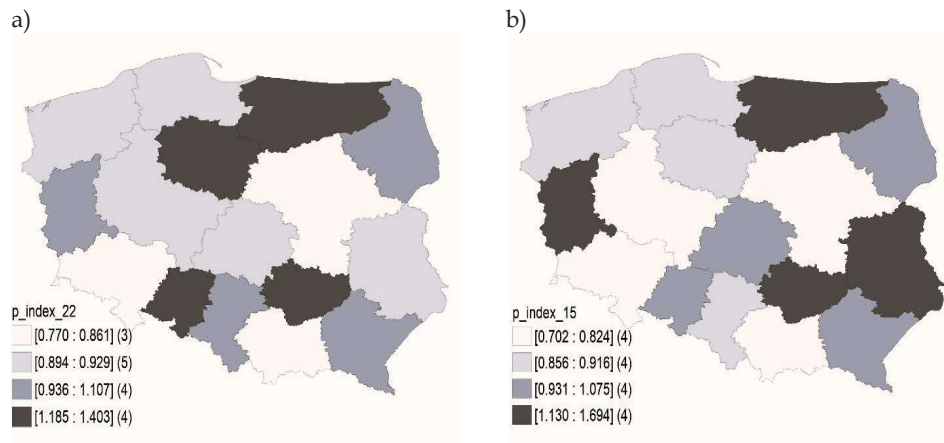possibility of absorbing immigrants has decreased through the intensification of the "displacement" effect.

a)   b)

Figure 1. Spatial variation of the *p** index in 2022 (a) and 2015 (b)

Voivodeships in the last quartile group in 2022 were characterised by an index value *p** from 19% to 40% higher than the national average. In 2015, this group recorded values of this indicator from 13% to even 69% higher than the national average. Taking into account the results for the first quartile group and the coefficients of variation of the *p** index, it can be concluded that in 2015 the regions of Poland were more differentiated in terms of the strength of the "displacement" effect than in 2022.

6.   Conclusions

In response to the research question formulated, the answer is: yes, the measurement of the "displacement" effect using the input-output method showed a noticeable spatial differentiation in the ability of individual voivodeships to absorb Ukrainian immigrants in 2022. In other words, the study revealed strong variation of the strength of the impact of the inflow of Ukrainian immigrants on the dislocation of residents in individual provinces. It turned out that the voivodeships characterised by the highest "push out" indicator are at the same time voivodeships with a relatively high level of unemployment rate and below the average wages, e.g. the Świętokrzyskie or Warmińsko-Mazurskie voivodeships.

This may indicate that the inflow of immigrants provides a strong incentive for residents to migrate from regions with unfavourable local labour market conditions. Such markets are more susceptible to immigrant supply shocks, and this probably manifests itself in more residents choosing to leave the region rather than compete with immigrants. These results are consistent with the results of the studies by E.F. Vázquez et al. (Vázquez et al. 2011), F.S. Perobelli et al. (Perobelli et al. 2015) and Ç. Değer et al. (Değer et al. 2016) conducted using the input-output method.

Voivodeships with large urban centres, such as Mazowieckie, Małopolskie and Dolnośląskie, are the least susceptible to labour market shocks. The absorption capacity of Ukrainian immigrants by these voivodeships may be the highest and this can be evidenced by the low values of the "push out" indicator. It is noteworthy that these regions are generally characterised by very low unemployment rates and relatively high average wages. They are also the regions with a very developed service sector. The aforementioned factors presumably have a negative impact on the strength of the "push out" effect. According to the mechanism of the introduced input-output model, each successive "portion" of immigrants arriving in these regions is associated with relatively weak internal migration – the total number of people "pushed out" from these regions did not exceed 240 per 1,000 additional Ukrainian immigrants. Arguably, the earlier inflow of Ukrainian immigrants to these regions before 2022 is also not insignificant. The earlier immigrants have already managed to find their way in the local labour markets and, through an extensive network of contacts with friends and family, using their acquired competences, may help the "new" Ukrainian immigrants of 2022 to assimilate better. Hence, among other things, we observed the differences between the spatial differentiation and strength of the "displacement" effect in 2022 and in 2015.

The analysis of the elements of the matrix of total migration coefficients showed that the strongest interregional "push out" effects are observed for pairs of neighbouring voivodeships, while the weakest – for pairs of non-neighbouring and significantly distant voivodeships. This is due to the preferences of "displaced" residents – when migrating, they usually choose the voivodeships that are geographically closest and strongly linked economically and infrastructurally to their home region.

There is an interesting juxtaposition of results for the Śląskie Voivodeship, which does not fit the pattern mentioned above. In this voivodeship, there are no noticeable problems with unemployment and there is no low level of wages. Nevertheless, the strength of the "push out" effect is high there. The explanation for this phenomenon can be linked to the structure of the Śląskie Voivodeship's

economy, which relies heavily on industrial activity. Ukrainian immigrants, eagerly employed in the industrial sector, may constitute noticeable competition for residents of the Śląskie Voivodeship with similar qualifications, which is why they are probably more often "pushed out" to other voivodeships as a result of losing the competitive battle on the labour market. Similarly to the Śląskie Voivodeship, economically well-developed Sao Paulo state did not follow the general trend, and F.S. Perobelli et al. (Perobelli et al. 2015) attributed the reasons for this situation to economic decentralization and the decline in this state's share in the generated GDP. The same features can be used to describe the Śląskie Voivodeship – it lost its importance due to the declining importance of coal mining in the national economy, and the voivodeship's share in GDP is also on a downward trend (see BDL).

The study revealed a paradox consisting of a relatively strong "displacement" effect and a relatively small number of immigrants going to the eastern provinces directly bordering Ukraine, i.e. the Podkarpackie and Lubelskie voivodships. This regularity applies to both 2022 and 2015. The geographical proximity of these provinces, in a situation where Ukrainian immigrants are fleeing military action to seek their first peaceful place of residence, seems to be a logical choice. Nevertheless, it was estimated that around 49,000 Ukrainian migrants entered the Podkarpackie Voivodeship in 2022, and 70,000 in the Lubelskie Voivodeship, with a regional average of 67,000. Mobility and the possibility of free movement to provinces with a better capacity to absorb migrants was probably more important for migrants than the geographical proximity of the Podkarpackie and Lubelskie voivodeships. In addition, it can be stated with a high degree of probability that in these voivodeships, economic incentives of other regions with better conditions on the labour market were stronger than good logistical preparation for the reception of migrants in 2022 and 2015. So, the high unemployment rate and low wages could stimulate a stronger "push out" effect of residents than in other more economically developed voivodeships. For this reason, the capacity to absorb Ukrainian migrants of Podkarpackie and Lubelskie should be considered low. It is worth noting that a similar paradox can be observed in the results of Ç. Değer et al. (Değer et al. 2016) analyses, where regions close to or bordering Syria were less able to absorb Syrian immigrants than the more developed western regions.

The study contributes to academic practice, in particular to the popularization of the input-output method in the field of demography. The study also indicates, although imperfectly, the methods of estimating migration data that are not available in officially registered statistical data. Unfortunately, the

greatest weaknesses of the study are: the assumptions of the model (8) that greatly simplify reality, basing this model largely on estimated data and the limited ability to verify the correctness of the formulated model. After all, the results of this study may be implemented within the framework of migration policy. The conducted analysis indicate regions in Poland where better conditions should be created on local labour markets so that supply shocks caused by the mass inflow of immigrants are as small as possible. This refers primarily to the Warmińsko-Mazurskie, Świętokrzyskie, Opolskie and Kujawsko-Pomorskie voivodeships. Levelling out income differences, creating new job vacancies, ensuring favourable conditions for housing construction and increasing access to educational and health services would probably help to mitigate the "displacement" effect in these voivodeships and to reduce the variation in the strength of the effect across the country.

The study of the impact of Ukrainian immigration on inter-provincial migration in Poland using the input-output method can be expanded to other areas in the future. It is, for example, possible to use model (8) to forecast internal migrations resulting from the (predetermined) expected inflow of Ukrainian immigrants in the coming years. The input-output method can also be used in a broader context – the study of the impact of Middle East and Sub-Saharan immigration on international migration within the EU. Using the method in a broader context would allow for better identification of regions with a greater potential to absorb immigrants across the European Union, which could be useful in the framework of the effective implementation of the Migration Pact.

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Summary

The aim of the article is to estimate the strength of the "displacement" effect of the residents of Polish voivodeships to other regions of the country and determine the regional differentiation caused by the mass inflow of immigrants from Ukraine to Poland in 2022. The study used a modified input-output method, which allows for capturing and balancing both internal and external migration. The first stage of the study consisted in constructing inter-voivodeship migration tables, taking into account the inflow of immigrants from Ukraine. In the second stage of the study, the "displacement" effect was measured using the input-output method, which showed its strong spatial differentiation – the strongest effect was observed in voivodeships with a relatively higher level of the unemployment rate and lower wages (i.e. Warmińsko-Mazurskie and Świętokrzyskie), while the weakest – in voivodeships with large urban centres and capacious labour markets (i.e. Mazowieckie, Małopolskie, Dolnośląskie). The study also revealed a paradox, namely that the eastern provinces closest to Ukraine (i.e. Podkarpackie, Lubelskie) showed a relatively weak capacity to absorb Ukrainian immigrants, whose admission could cause greater disruptions in the local labour markets in these regions than in more distant provinces. The construction of the migration input-output tables was mainly based on data from the Bank Danych Lokalnych Głównego Urzędu Statystycznego (Local Data Bank of Central Statistical Office of Poland) and the Office for Foreigners for the years 2022 and 2015.