Research Article

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Modern interregional migration: evidence from Japan and Poland

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Abstract: This paper provides data-based analyses of recent interregional migration considering the examples of Japan and Poland. The analyses are conducted against the background of the general demographic and economic situations of both countries, in particular, regional disparities and economic growth. They aim at describing migrants' behavior in Japan and Poland through a model consistent with the New Economic Geography (NEG) theory. Inspired by the model originally proposed by, the study constructs a migration model coherent with the NEG framework and tests the behavioral hypothesis. Interestingly, in both Japan and Poland, migrant behavior is responsive to stimuli stemming from the two following mechanisms: the relationship between the level of income inequalities and net migration toward capital regions; and similarly, the relationship between income inequalities movement and gross domestic product growth rate.

Keywords: Japan, Poland, migration, regions

1 Introduction

The history of Polish economy differs strongly from that of Japanese economy. However, data-based analyses prove that in both countries, there is a relationship between the level of income inequalities and migration toward capital zones and, similarly, there is a relationship between income inequalities movement and gross domestic product (GDP) growth rates.

This paper aims to present the approach proposed by Crozet [2004] to migration modeling considering the New Economic Geography (NEG) theory. The two countries were chosen to test the theory from two perspectives: firstly, from the angle of the second most advanced economy in the world (worldatlas.com), a centralized and homogeneous island country where decisions on migration can be assumed to be strongly linked to economic reasons [Kondo and Okubo, 2012, p. 3] and, secondly, from the angle of a catching-up European economy where economic reasons of migration can be more affected by distance and the cost of a move. Moreover, Japan is divided into prefectures, which can be matched with the EU regional data at level 2 (EU Nomenclature of Territorial Units for Statistics level 2 [NUTS-2][1]), making the results of the two cases comparable.

Several attempts to estimate the above-mentioned model turned out to be unsuccessful, in both Japanese and Polish cases. There are diverse reasons for these failures. Among the most persuasive are the structures and the country distributions of the following variables: price index, wage, and unemployment rate. As to the first variable, in spite of the fact that, in the NEG theory, wage is determined by the price index, implying supply access, real data in both countries, Japan and Poland, show that the price index is usually higher in big cities, though the supply access to them is better than to other cities. The problem with the second variable is that, as also mentioned by Crozet [2000], generally, wages are not good determinants

1 NUTS is a nomenclature providing a hierarchical structure of subnational regions covering Europe.

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of migration patterns and introduce multicollinearity to the model [Crozet, 2000, p. 18]. In consequence, the results, especially in the case of Japan, show that migrants' decisions are not influenced by wage levels, or even that they choose regions characterized by lower wages. Besides, model estimation reveals strong correlation between market potential and wage terms. The third variable, unemployment rate, turns out to be unstable too. This can be related to the fact that, according to the Japanese data, the unemployment rate, e.g., in Tokyo or Osaka, is higher than that in other Japanese cities.

The above-mentioned problems with the estimation of the original equation pushed the study toward alternative specifications of the model, yet consistent with the NEG theory.

The novelty of this study is a modification of the Crozet [2004] approach undertaken by splitting the estimation of the equation in the NEG framework into two stages. First, the wage equation, as a function of market potential, is estimated to obtain distance and elasticity of substitution parameters. Then, the identified parameters are used to analyze the impact of labor market variables on interregional migration flows.

Still, there are not too many empirical studies on migration location choices considering the NEG theory, so it is worth searching for adequate examples of this theoretical approach in the real world and adding them to the empirical evidence on NEG.

2 Literature review

This paper is based on research on the relationship between mobility of labor and regional disparities, with regard to the NEG theory, where, in a world of increasing returns to scale, the locations of the factors of production (labor) are endogenous. First, Krugman [1991] argues that manufacturing firms tend to be located in regions with larger demand, but the location of demand itself depends on the distribution of manufacturing [Krugman, 1991, p. 483]. Moreover, Tabuchi and Thisse [2002] show the impact of heterogeneity of the labor force on the spatial distribution of activities. However, this paper's methodology focuses on the study by Crozet [2004], wherein the author publishes a new model through which he explains forward linkage that relates labor migration to the geography of production through real-wage differentials based on the example of some European countries. Quite a similar approach was later presented by Pons et al. [2007], based on the example of Spain, and by Hering and Paillacar [2008], based on the example of Brazil.

2.1 Gravity approach

The gravity equation is a good illustration of a multidimensional reality that current research studies meet. This reality is made of many complex chains of indirect spatial effects and should be considered while analyzing migration [Behrens and Thisse, 2006, p. 8]. Though gravity modeling is mainly applied in studies on international trade, it also constitutes the foundation for research on migration.

Following the early Law of Gravity proposed by Newton (1687) and the analogous Ravenstein's Laws of Migration (1885), numerous modifications to the formulation of the gravity model were made by introducing parameters to weight the influence of the sending and receiving region's factors and by further combinations with alternative distance functions [van der Gaag et al., 2003, p. 18]. During the 1940s, Stouffer [1940] introduced the notion of intervening opportunities. In other words, the nature of the potential destination may be even more important than the distance in the process of migration decision.

In general, the gravity theory of migration [Stewart, 1941; Zipf, 1946; Isard, 1960] assumes that migration flows between regions i and j, M_{ij}, are proportional to the population sizes in the origin and destination regions (P_i and P_j) and inversely proportional to the βth power of the distance between the two regions, d_{ij}, which is a discounting factor [Bijak, 2006, p. 13]

$$M_{ij} = G\frac{P_i P_j}{d_{ij}^{\beta}}$$

Isard (1960) pointed out that the conceptions of mass and distance may be defined in different ways. According to his theories, the sizes of the population masses (P_i, P_j) may be substituted by some economic variables, such as employment or income level, and the distance may be measured in different metric units [Bijak, 2006, pp. 13–14].

2.2 NEG approach

The NEG approach is thought to facilitate the understanding of flows, which are, according to the assumptions, influenced by the dynamics of the agglomeration of economic activity. Many studies on the effect of distance on trade flows through the gravity equation gave birth to research on how geography affects the distribution of economic activity across countries [Cafiso, 2007, p. 27]. The NEG models tend to explain why economic activity is concentrated in some regions and not in others by using the interaction between trade costs and firm-level scale economies as the source of agglomeration.

Combes et al. [2008] mention that the general form of the gravity model may be linked to the Dixit–Stiglitz–Krugman (DSK) model (1980), which endows it with microeconomic foundations [Combes et al., 2008, p. 102]. Cafiso [2007] quotes, following Head and Mayer [2003], the main theoretical points that distinguish NEG models from other approaches to economic geography [Cafiso, 2007, p. 28]:

a) Increasing returns to scale (IRS) internal to the firm;
b) imperfect competition;
c) trade costs;
d) endogenous location of firms; and
e) endogenous location of demand.

According to Biagi et al. [2018, p. 37], mainstream economics has recognized the impacts of distance, agglomeration economies, and economies of scale on migration decisions. The examples of research dealing with NEG tools in the field of migration are the papers by Crozet [2004], Kancs [2005], Pons et al. [2007], and Hering and Paillacar [2008]. All the before-mentioned papers have been strongly influenced by the NEG approach, first presented by Tabuchi and Thisse [2002], which examines whether access to markets has a significant influence on migration choices. Crozet [2004] and Pons et al. [2007] perform a structural contrast of an NEG model that focuses on the forward linkage[2] through the estimation of the equation in the NEG model that relates labor migrations to the geography of production through real wage differentials. The obtained results prove the existence of a direct relation between workers' localization decisions and the market potential of the host regions. Hering and Paillacar [2008] search for the answer to the question whether people migrate in their capacity as consumers and choose the regions where the price level is low (forward linkage) or they migrate considering the production factor (backward linkage). The authors explore the implications derived from the following two economic frameworks: the NEG theory and the labor economics tradition, which stresses the role of individual characteristics as the determinants of spatial inequality and a possible selection bias in individual migration decisions. The main difference among the studies of Crozet [2004], Pons et al. [2007], and Hering and Paillacar [2008] is in the market potential equation. Crozet (2004) and Pons et al. (2007) present the market potential function as the inverse of a price index of the manufactured goods derived from the real wage equation, Hering and Paillacar (2008) uses the equation of the real market potential or market access, which is defined as the sum of the final demand addressed to region *i*, weighted by the accessibility from *i* to these markets *j* (the authors consider also the freeness – also termed phi-ness – of trade) and by the market crowding level of every region *j*. Kancs [2005] applies a canonical reduced form of the NEG model for predicting migration flows. He derives his estimation equation directly from the NEG theory, makes both explanatory variables and the migration rate endogenic, derives the utility differential, and in the end, calculates the estimator for the phi-ness (of trade), adopted from Baldwin et al. [2003].

2 Linkage, which links workers' location choice with the geography of industrial production.

As Biagi et al. [2018] notice, the use of the NEG framework for the purpose of migration flow analysis is rather a recent development. Studies focus on investigating the forward linkage and assume that market potential is the strongest migration driver [Biagi et al., 2018, pp. 37–38].

2.3 Interregional migration in recent literature

There exist several empirical studies that deal with the problem of interregional migration and present different approaches to this phenomenon. A review paper by Faggian et al. [2017] sums up the literature on the consequences of interregional migration flows (in particular, high-skilled migrant flows) on the economies of both receiving and sending regions. Among others, the authors summarize the definitions of regions in recent interregional studies, splitting them into two groups, viz., administrative regions and functional regions, and then breaking them down into large (NUTS-1), medium (NUTS-2), and smaller scale (NUTS-3) for the former group and into local labor markets, travel to work areas, and metropolitan statistical areas for the latter group (Faggian et al., 2017, p. 131).

Factors that have a crucial role in migration were analyzed in the chapter "Interregional migration analysis" of the book *Handbook of Research Methods and Applications in Economic Geography* [Faggian et al., 2014]. Based on the examples of England and the U.S., it is concluded that, in general, such individual attributes as education, age, gender, ethnicity, and previous migration have an impact on migration. However, "the main drivers for people to migrate have historically been economic" [Faggian et al., 2014, p. 479]. In particular, the authors describe the following variables: unemployment or job vacancies, wage levels, amenities/quality of life (or utility), and so on.

Moving to more specific studies, interesting works on the subject of interregional migration in Spain, Italy, Korea, Indonesia, Japan, and Russia can be found.

As regards Spain, researchers find – by means of the extended model by Harris and Todaro [1970] – that decision on migration is to a large extent influenced by labor market variables, such as wages, in the case of poor labor market conditions. Otherwise, labor market factors are less important in the migration decision-making process [Clemente et al., 2016, p. 279]. Migration in Italy has been tested for its effects on regional unemployment dynamics in a research by Basile et al. [2018]. The results they obtain are in conflict with the neoclassical view of migration, which is believed to act as an equilibrating force for unemployment differentials [Basile et al., 2018, pp. 19–20]. Moreover, a gravity model has been applied to interregional migration in Indonesia [Wajdi et al., 2017]. That study proves that income or economic development indicator, expressed by GDP per capita, is positively related to a concentration of population and that distance has a negative impact on migration flows. Moreover, population size at the destination turns out to be positive and statistically significant. The case of Indonesia shows that economic development in regions of origin triggers migration toward more developed regions [Wajdi et al., 2017, pp. 322–323].

Interestingly, interregional migration in Korea has been analyzed in relationship with the aging society phenomenon, which is rather rare in the literature [Kim, 2015]. In that study, again, a gravity approach has been applied and proved successful. It is verified that migration flows are positively related to population size in the origin and the destination and that high price of land in the destination (high living costs) reduces all migration flows significantly. High GDP per capita in the destination was confirmed to be a strong pull factor for all age groups of migrants.

Last but not the least, there are two papers on interregional migration being investigated within the framework of the NEG theory: "Structural estimation and interregional labour migration: evidence from Japan", by Kondo and Okubo [2012]; and "A model of interregional migration under the presence of natural resources: theory and evidence from Russia", by Sardadvar and Vakulenko [2017]. Both articles refer to the approach used by Crozet [2004]; however, the first one estimates a nonlinear gravity model using manufacturing workers' flows in Japan (migration flows for 1990 and 2000) and finds that the real wage is a key driver for migration, while the second one augments Crozet's [2004] model using the commodities sector, proves that the size of this sector has positive effects on migration decision, and points that empirical results support the positive effect of the size of the service sector on in-migration in Russia. It is worth noting that the role of wages in migration across Russian regions has been hard to assess due to ambiguous results [Sardadvar and Vakulenko, 2017, p. 555].

3 The gravity-type model and the data

3.1 Model construction

In this paper, at the first stage of evaluation, a gravity-type equation will be estimated. Following Crozet [2004, p. 445], it can be said that a gravity equation is a benchmark that allows for the identification of possible specification issues. The below-presented gravity model is based on the equations originally presented by Crozet [2004] and Pons et al. [2007].

The results of these two gravity-type equations will be compared for both Japanese and Polish internal migration. Generally, as the very first results show, the migration flow between two regions increases with the size of the destination location and decreases with the geographic distance between the two regions. Crozet [2004] shows that such an equation can provide a good starting point for assessing whether migrants are attracted by large markets. Moreover, a gravity model of such a kind allows for the identification of possible specification issues and provides a sound competing model to the complete NEG framework [Crozet, 2004, p. 445].

As to the model specifications, a proxy for the probability of finding a job in the host region would be the regional employment rate $ER_{b,t-1}$ (more specifically, one minus unemployment rate), which is correlated with wages. That is why, a single variable would be defined by the wage and employment rate: $w_{b,t-1}(1\text{-}UR_{b,t-1})$. In the case of Japan, the dummies are set as “1” for prefectures with codes 11–14 and 25–29 as the host regions, and in the case of Poland, a dummy is set as “1” for Masovian voivodeship as the host regions. This would make it possible to control for specific structural difficulties of eventual destination regions. Consequently, the gravity-based equation to be estimated by the ordinary least squares (OLS) method is as follows:

$$\log\left(\frac{migr_{ab,t}}{\sum_{b'\neq a} migr_{ab',t}}\right) = \beta_1 \log\left(population_{b,t-1}\right) + \beta_2 \log\left(w_{b,t-1}\left(1-UR_{b,t-1}\right)\right) + \beta_3\left(Dist_{ab}\right) + \beta_4\left(Adj_{ab}\right) + \beta_5 \log\left(S_b\right) + v_{ab,t} \tag{1}$$

$$\log\left(\frac{migr_{ab,t}}{\sum_{b'\neq a} migr_{ab',t}}\right) = \beta_1 \log\left(population_{b,t-1}\right) + \beta_2 \log\left(w_{b,t-1}\right) + \beta_3\left(Dist_{ab}\right) + \beta_4\left(Adj_{ab}\right) + v_{ab,t} \tag{2}$$

Most data used in model estimation have been provided by Somusho Tokeikyoku (Ministry of Internal Affairs and Communications, Statistics Bureau) in the case of Japan and by Główny Urząd Statystyczny (GUS) – Bank Danych Lokalnych (Statistics Poland, Local Data Bank) in the case of Poland. Data on Japan are available at the prefectural level (47), while data on Poland are available at the level of NUTS-2 (16). The data span is from 1999 to 2008.

3.2 Results

The models show high explanatory power, and the estimated coefficients are highly significant and, generally, present the expected signs. In both cases, the influence of distance on migratory flows remains negative. In Poland, higher wages in the host region encourage migration; nevertheless, in Japan, this relationship is not so clear: the coefficients are highly significant but turn negative. People tend to concentrate in highly populated urban areas, especially in Japan.

Interpretation of the results within the framework of the NEG theory makes it possible to analyze the spatial concentration of economic activity and, what is very important in this analysis, interregional differences. Moreover, the NEG perspective is open to any exogenous shocks, which can result in or be a part of the cumulative causation that influences economic development.

While analyzing the models' results, we should have in mind such exogenous shocks for the Japanese and Polish economies. In the period from 2000 to 2008, we can, for instance, consider as unpredictable factors the following facts and their repercussions for both countries:

- in the case of Japan – legislation concerning temporary employment
- in the case of Poland – continuation of economic transformation, EU funds, EU accession
- in the case of both countries – the dot-com bubble (2001), the financial crisis of the late 2000s, and so on.

The following interpretation refers to the NEG theory by making use of the idea of agglomeration forces, in particular, centripetal and centrifugal forces, while analyzing the spatial divergence of the economy in both countries in question.

The Pearson correlation coefficient between population size and other variables, calculated by using Japanese and Polish data for population, unemployment rate, wages, and price index for 2000 and 2008, shows the following. In the case of Japan, the correlation coefficient between population size and unemployment rate is medium positive for 2000 (0.435) and decreases to small positive in 2008 (0.122); correlation coefficient between population and wages is strongly positive for both 2000 (0.597) and 2008 (0.610); and finally correlation between consumer price index (CPI) and population size is also strongly positive in 2000 (0.697) and 2008 (0.620). In the case of Poland, the correlation between population size and unemployment rate is strongly negative for 2000 (-0.626) and 2008 (-0.696); correlation between population size and wages is strongly positive for both 2000 (0.648) and 2008 (0.679); and the magnitude of correlation between population size and CPI is small negative (-0.298) for 2000 and (-0.237) 2008. These results point to the very interesting fact that in Japan, more populated areas are characterized by higher unemployment rate and higher prices. This relationship is inverse for Poland and, in more populated regions, a migrant can expect higher employment and relatively lower prices.

3.3 Interpretation

In Poland, higher wages in the host region encourage migration; nevertheless, in Japan, this relationship is not so clear; the coefficients are significant but often turn negative.

Wage probability coefficient in a Crozet [2004] model has a positive sign only for Poland. In this model, the coefficients for the size of the host region are both significant and negative for Japan, which can confirm the expected centripetal forces in the determination of the bilateral migratory flows. Yet, it is hard to evaluate the influence of the host region size (surface) simply, especially in Japan, where the most populated are relatively small regions.

Nonetheless, in the analyzed models, there is another variable that can be considered a measure of the regions' size, namely, population. According to the theory, the size of the population in a region reflects the size of its economic sectors, namely, the manufacturing and service sectors. Furthermore, regions such as Tokyo-to or Osaka-fu are densely populated, although their surface is rather small compared to NUTS-2-level statistics. Consequently, the influence of the population size of the host region in the Pons and Crozet models is always significant and positive, in particular for Japan. To assess its influence on the results of the models, an estimate "*a*" is presented in Table 1 and Table 2, which was calculated after subtracting the population variable from the model. The modification effect is easily observable: wage and employment probability coefficients turn highly positive and, in the Crozet model, the coefficient for region size becomes positive too.

Table 1 Estimates table for gravity-based migration equation (Eq. 1) for Japan and Poland

Parameters	Dependent variables	Japan				Poland			
		2000		2008		2000		2008	
		Estimate	Estimate *a*	Estimate	Estimate *a*	Estimate	Estimate *a*	Estimate	Estimate *a*
b_1	Log population	1.351***	–	1.444***	–	0.619***	–	0.632***	–
		(49.00)	–	(52.31)	–	(4.43)	–	(6.67)	–
b_2	Log employment probability	−1.501***	5.773***	−1.623***	5.842***	1.758***	2.859***	1.877***	3.369***
		(−6.87)	(24.79)	(−8.33)	(29.22)	(3.94)	(7.42)	(5.63)	(12.52)
b_3	Log distance	−0.803***	−0.598***	−0.749***	−0.555***	−0.845***	−0.956***	−0.871***	−0.971***
		(−34.36)	(17.89)	(−34.04)	(−16.98)	(−6.74)	(−7.49)	(−9.31)	(−9.66)
b_4	Dummy for no adjacency	−0.781***	−1.084***	−0.890***	−1.166***	−0.666***	−0.607***	−0.651***	−0.597***
		(−12.17)	(−11.68)	(−14.59)	(−12.75)	(−5.07)	(−4.47)	(−6.59)	(−5.77)
b_5	Log size	−0.246***	0.235***	−0.274***	0.145***	0.149	0.532***	0.505***	0.756***
		(−9.47)	(6.72)	(−11.54)	(4.30)	(0.96)	(3.99)	(4.96)	(7.34)
No. of observations		2,162	2,162	2,162	2,162	240	240	240	240
R^2		0.757	0.486	0.786	0.515	0.661	0.633	0.803	0.765

Note: For all tables: *, **, and *** denote significance level at 10%, 5%, and 1%. The *t*-value is presented in parentheses.

Table 2 Estimates table for gravity-based migration equation (Eq. 2) for Japan and Poland

Parameters	Dependent variables	Japan				Poland			
		2000		2008		2000		2008	
		Estimate	Estimate *a*	Estimate	Estimate *a*	Estimate	Estimate *a*	Estimate	Estimate *a*
b_1	Log population	1.230***	–	1.318***	–	0.671***	–	0.769***	–
		(45.19)	–	(48.06)	–	(6.45)	–	(9.20)	–
b_2	Log wage	−0.182	5.687***	−0.487**	5.953***	2.501***	4.093***	2.533***	4.880***
		(−0.92)	(27.26)	(−2.58)	(31.17)	(5.47)	(9.82)	(6.58)	(14.56)
b_3	Log distance	−0.781***	−0.571***	−0.742	−0.543***	−0.821***	−0.881***	−0.722***	−0.811***
		(−32.88)	(−17.56)	(−32.94)	(−17.04)	(−7.02)	(−6.98)	(−7.64)	(−7.41)
b_4	Dummy for adjacency	0.825***	1.140***	0.910***	1.203***	0.687***	0.691***	0.778***	0.752***
		(12.69)	(12.64)	(14.60)	(13.48)	(5.50)	(5.10)	(7.85)	(6.51)
No. of observations		2,162	2,162	2,162	2,162	240	240	240	240
R^2		0.748	0.509	0.773	0.513	0.679	0.622	0.800	0.728

Note: For all tables: *, **, and *** denote significance level at 10%, 5%, and 1%. The *t*-value is presented in parentheses.

Pons et al. [2007] state that the aim of such an analysis is to provide an initial empirical estimation of the attraction exerted by large regions on migrants and, thus, to be able to estimate the explanatory power of the complete functional form derived from the NEG model. Then, assume that, in the NEG context, the positive relation between the migratory flow and the size of the host region has other causes: it is associated with the market potential of the region, which will be transferred to the price index observed there [Pons et al., 2007, pp. 301–303].

3.4 Conclusions

a) Japan

As to the employment, there were slight changes in this factor in Japan between 2000 and 2008. Employment in the service sector grew a little, while employment in the manufacturing sector diminished gently.

According to Eurostat data, wages in Japan in the period from 2002 to 2008 were decreasing. Japanese regional data show that the growth dynamics in mean wages equaled −4.98 points in 2005 (relative to 2000). Furthermore, among the 47 prefectures, only five regions had positive growth dynamics in wages in 2005 (to 2000). Those prefectures were (in ascending order): Fukushima, Kanagawa, Aomori, Ibaraki, and Ehime. This situation raises the following question: is agglomeration still the most attractive localization pull for employees interested in earnings maximization?

The cost of living in Japan – measured by bukka kakusa (price differences index) data – seems to be flat in the period in question. From 2000 to 2008, an increase in costs exceeding one point was observed in 13 prefectures. The highest augmentation was recorded in the following regions (in ascending order): Yamanashi, Tokushima, Kanagawa, Ishikawa, Hiroshima, and Okayama. During this period, the cost of living in metropolitan areas such as Osaka-fu, Chiba (Chiba city), Hyogo (Kobe), and Aichi (Nagoya) slightly decreased, while it increased by 0.8 points in Tokyo-to.

The unemployment rate in Japan was insignificantly decreasing until 2007 and then augmented.

b) Poland

In Poland, employment was diminishing gradually till 2004 and then increased. Very similar changes were seen in the data on wages. These two facts can be related to the intensive labor migration to other EU countries before 2004.

More precisely, employment in the manufacturing sector decreased until 2003 and then, in 2008, reached the level at the beginning of the period in question. Employment in the service sector also showed drops until 2003 and then began to grow.

According to the CPI, after 2003, the cost of living in Poland started to increase and, in the period between 2003 and 2008, grew on the average by 3.5 points. This situation was present in all voivodeships, in particular, in Świętokrzyskie, Warmińsko-Mazurskie, and Kujawsko-Pomorskie. Interestingly, the growth of the cost of living in Mazowieckie Voivodeship (Warsaw) was the smallest and equaled 2.8 points (from 2008 to 2003). The unemployment rate in the country decreased visibly (by almost half) from 2000 to 2008.

The NEG model relates the regional development to the demand in that region, saying that the level of wages in that region stimulates in-migration and, consequently, demand. In Japan as well as in Poland, the wages are higher in agglomeration areas although the cost of living is also higher in metropolises. This means that costs do not constitute a centrifugal force strong enough to overcome the centripetal forces such as higher earnings, better employment possibilities, and so on. Moreover, in the case of Japan, locations such as Tokyo, Osaka, and Nagoya seem to be well established and serve as very strong gravity centers; despite this fact, in the years from 2000 to 2008, wages and employment in other regions grew faster, and migrants were prone to go to those cities in the first place.

4 The NEG theory-based model

4.1 Theoretical approach

Modification of the Crozet [2004]-like NEG approach presented in the earlier section is based on the literature focused on the market potential formula applied to modeling. Very useful studies have been presented by Head and Mayer [2003, 2004], Aoki [2007], and Bosker et al. [2010].

Head and Mayer [2003] underline that there are three main specifications of the estimated market potential. The first one corresponds to the theoretical equation for the profitability of each location [Head and Mayer, 2003, p. 17]:

$$V_j \equiv \ln\left[\sigma\left(\Pi_j + F_j\right)\right] = -(\sigma-1)\ln c_j + \ln RMP_j \tag{3}$$

where c_j is the constant marginal cost, F_j is the plant-specific cost, Π_j is net profit, and RMP_j is the real market potential.

The second reduces the market potential to the Harris [1954] formula, which simplifies the assumed trade costs and neglects the impact of competitors on the location choice. The third specification follows Redding and Venables [2000] and separates RMP_j into local and nonlocal components [Head and Mayer, 2003, p. 17].

In the study by Head and Mayer [2004], the point of departure for the theoretical and empirical data is the fact that the profit equation incorporates a term closely related to the market potential index, originally introduced by Harris [1954]:

$$\Pi_r = \frac{c_r^{1-\sigma}}{\sigma}\sum_{j=1}^{R}\phi_{rj}\frac{E_j}{G_j} - F_r = \frac{c_r^{1-\sigma}}{\sigma}M_r - F_r \tag{4}$$

where Π_r is the aggregate net profit to be earned in each potential location r, c_r is the marginal cost, E_j denotes the expenditure, F_r is the fixed cost, $G_j \equiv \sum_r n_r \left(c_r \tau_{rj}\right)^{1-\sigma}$, and

$$M_r \equiv \sum_j \frac{\phi_{rj} E_j}{G_j}$$

is the Krugman market potential, where Φ_{rj} is the freeness of trade. If we set $G_j = 1$ and $\Phi_{rj} = 1/d_{rj}$, then M_r reduces to $\sum_j E_j / d_{rj}$, the Harris [1954] market potential measure [Head and Mayer, 2004, pp. 960–961].

The authors use the market potential measures proposed by Harris [1954] and Krugman et al. [1992] to estimate the effect of the market potential on the location choice of Japanese investments in Europe. Additionally, they estimate the border and the distance effects that determine market accessibility using a bilateral trade equation implied by the same model that generates the profit equation [Head and Mayer, 2004, p. 969].

Interestingly, they find that the Harris [1954] market potential outperforms the Krugman et al. [1992] market potential in both magnitude and fit, though originally the Harris [1954] approach is atheoretical. Then, they conclude that their results suggest that the downstream linkages emphasized in Krugman et al. [1991] are not the only, or even the main, cause of agglomeration [Head and Mayer, 2004, p. 969].

Aoki [2007] uses the market potential term as a dependent variable in an equation of expected migration flows and runs a two-stage estimation. First, he derives the wage equation (5)

$$W_i = \left(\frac{\beta^{1-\sigma}}{\gamma\sigma}\right)^{\frac{1}{\sigma}}\left(MP_i\right)^{\frac{1}{\sigma}} \tag{5}$$

directly from the equation identical with that in Eq. (4), as well as the Krugman market potential term, and then he passes to the migration choice equation.

Bosker et al. [2010] use the NEG model to analyze the relationship among market access, labor mobility, and agglomeration for China. Their NEG approach is based on the Puga [1999] model, in which the balance between agglomeration and spreading forces, and hence, the equilibrium spatial allocation, depends explicitly on the degree of interregional labor mobility [Bosker et al., 2010, p. 2].

First, the authors estimate the NEG wage equation; however, they use a simplified version, which is as follows:

$$\ln\left(w_i\right)=\frac{1}{\sigma}\ln\left(\sum_{j=1}^{J} e_j \tau_{ij}^{1-\sigma} q_j^{\sigma-1}\right) \tag{6}$$

where e_j denotes the expenditure, q_j (manufacturing) represents the price index, and τ_{ij} means the distance costs.

The term within parentheses constitutes the market access. The authors use GDP per capita for each unit as their dependent variable expenditure (income) [Bosker et al., 2010, p. 14].

Following Hanson [2005], they estimate the wage equation directly and then use the obtained parameters to estimate their full-blown NEG model.

Leamer and Levinsohn [1994, p. 2] say we estimate and do not test and, further, remark that we should work hard to establish a clear and close link between theory and data. Having this in mind and according to the findings by Head and Mayer [2004], in the cases of both Japan and Poland, possibly, a well-established model similar to the market potential formula of Harris [1954], consistent with the NEG theory in the wide sense, should first be estimated.

As to the migration equation, the original specification of the model is specified by Crozet [2004, p. 444]:

$$\begin{aligned}\frac{migr_{srt}}{\sum_{r'\neq s} migr_{sr't}} &= \ln\left[\left(L^S_{r(t-1)}\right)^{\frac{\phi}{\sigma_s-1}}\right]+\ln\left[\sum_{s=1}^{s=R} L^I_{s(t-1)}\times\left(w_{k(t-1)}\times\left(d_{rs}\right)^{\delta}\right)^{1-\sigma_I}\right]^{\frac{\mu}{\sigma_I-1}}\\ &\quad+\ln\left[w^{1-\phi}_{r(t-1)}\rho_{r(t-1)}\right]+\ln\left[d_{rs}\left(1+bFRrs\right)\right]^{-\lambda}+d_{s(t-1)}\\ d_{s(t-1)} &= -\ln\left(\sum_{j=1}^{R} e^{V^k_{sj,t-1}}-e^{V^k_{ss,t-1}}\right)\end{aligned} \tag{7}$$

The estimation of this equation did not yield satisfying results, mainly due to the above-enumerated reasons. Taking under consideration the calibration problems and the before-mentioned research on the market potential term, a new specification considering the market potential, which is similar to the concept of the NEG model, can be proposed as follows:

$$\ln\left(\frac{migr_{ji,t}}{\sum_{i'\neq j} migr_{ji',t}}\right)=\alpha_0+\alpha_1\ln\left(MP_i\right)-\lambda\ln\left[d_{ij}\left(1+b_D D_{ij}\right)\right]+\alpha_w\, WAW \tag{8}$$

where λ denotes the distance elasticity of migration cost, b is the influence of borders on migration cost, D_{ij} is a time distance, WAW is a dummy set as "1" if a migration destination belongs to the Warsaw metropolitan area, and MP is a market potential term.

For Japan, the migration equation takes the following form:

$$\ln\left(\frac{migr_{ji,t}}{\sum_{i'\neq j} migr_{ji',t}}\right)=b_0+b_1\ln\left(MP_i\right)-\lambda\ln\left[d_{ij}\left(1+b_D D_{ij}\right)\right]+b_T\, TKY+b_o\, OSK \tag{9}$$

where TKY is a dummy set as "1" if a migration destination region belongs to the Tokyo metropolitan area. The dummy denoted as OSK is set as "1" if a migration destination region belongs to the Osaka metropolitan area. Further, "b_D" is set as "1" if the regions share a border, and D_{ij} is a time distance. Estimation is done by the nonlinear least squares (NLS) method.

Fortunately, data for both countries allow for estimation of the wage equation derived from Eq. (5). After taking the logarithm of both sides, we get the following:

$$\ln w_i = \alpha_0 + \sigma^{-1} \ln MP_i \tag{10}$$

Substituting the term MP_i with Krugman-like market potential formula, the following wage equation is obtained:

$$\ln w_i = \alpha_0 + \frac{1}{\sigma - 1} \sum_{j=1}^{R} d_{ij}^{\gamma(1-\sigma)} P_j^{\sigma} \frac{E_j}{P_j} \tag{11}$$

where d_{ij} is the distance between regions i and j, E_j denotes the gross regional product in region j, P_j is the price index in region j, and w_i is the payroll per worker in region i. This approach makes it possible to estimate sigma, the key parameter in the NEG theory-based models.

Since it is impossible to obtain σ and γ parameters simultaneously in migration equation estimation, a two-stage estimation is run. First, the wage equation, as a function of the market potential, is estimated and then the obtained parameters are used to estimate interregional migration flows.

4.2 Data and model estimation

The first element of the estimation constitutes the wage equation, which is as follows (11):

$$\ln w_i = \alpha_0 + \frac{1}{\sigma - 1} \sum_{j=1}^{R} d_{ij}^{\gamma(1-\sigma)} P_j^{\sigma} \frac{E_j}{P_j}$$

Estimation of this equation makes it possible to obtain the distance parameter, γ, and elasticity of substitution parameter, σ. In the next step of the estimation, those two parameters are substituted with the obtained values, and we can estimate the expected share of emigrants from region j choosing to go to region i.

Most data used in model estimation have been provided by Somusho Tokeikyoku and Cabinet Office of Japan in the case of Japan and by GUS – Bank Danych Lokalnych in the case of Poland. Data on Japan are available at the prefectural level, while data on Poland are available at the NUTS-2 level.

4.3 Results and interpretation

The estimation of the first-stage equation, Eq. (11), for Poland, yielded the distance parameter value $\gamma = 0.15$ and elasticity of substitution parameter $\sigma = 3.1$ (Table 3). After introduction of this value in the second-stage equation, Eq. (8), the following results are obtained (Table 4 and Table 5).

Table 3 Estimates table for the wage equation (Eq. 11) for Poland

	Poland	
Parameters	**Dependent variables**	**Estimate**
α_0	Constant term	5.847
		(1.30)
Σ	Elasticity of substitution	3.101**
		(2.00)
Γ	Distance elasticity of migration cost	0.149***
		(3.26)
No. of observations		16
R^2		0.683

Note: For all tables: *, **, and *** denote significance level at 10%, 5%, and 1%. The *t*-value is presented in parentheses.

Table 4 Estimates table for the NEG based migration equation (Eq. 8) for Poland

	Poland			
Parameters	**Dependent variables**	**Estimate**	**Estimate *a***	**Estimate *b***
α_0	Constant term	−53.448***	−54.192***	275.240***
		(−7.68)	(−5.56)	(3.43)
α_1	Log (Market Potential)	2.507***	2.538***	2.356***
		(8.07)	(6.00)	(7.77)
α_2	Log (Unemployment Rate)		0.024	
			(0.11)	
α_3	Log (CPI)			−70.181***
				(4.10)
Λ	Distance elasticity of migration cost	0.684***	0.683***	0.776***
		(5.99)	(5.94)	(6.88)
b_D	Influence of borders on migration cost	2.373**	2.382**	1.702**
		(2.06)	(2.05)	(2.37)
α_W	Dummy variable for Warsaw metropolitan area	0.419**	0.412*	0.284
		(2.06)	(1.93)	(1.42)
No. of observations		240	240	240
R^2		0.709	0.709	0.729

Note: For all tables: *, **, and *** denote significance level at 10%, 5%, and 1%. The *t*-value is presented in parentheses.

Table 5 Correlation matrix (Eq. 8) for Poland

	Correlation matrix				
	***ln* Outmigration share**	***ln* CPI**	***ln* Unemployment rate**	***ln* MP**	***ln* Time distance**
ln Outmigration share	1.000	–	–	–	–
ln CPI	−0.235	1.000	–	–	–
ln Unemployment rate	−0.377	0.242	1.000	–	–
ln MP	0.579	−0.251	−0.689	1.000	–
ln Time distance	−0.667	−0.102	0.154	−0.241	1.000

The above results show that elasticity of substitution and transport cost (σ and γ) in Eq. (11) have the expected sign and are significant and that, in Eq. (8), all dependent variables are significant and that the overall fit of the model is good. Moreover, they confirm that a relatively higher market potential in a destination is an important pull factor for interregional migrants. As to the two parameters expressing migration cost (b and λ), the first is strictly positive, the second is negative, and both are highly significant. The simplest interpretation of this fact is that migration flows decrease with distance. The coefficient b_D is relatively high, which means that most migrants choose adjacent regions for outmigration. The value of the parameter distance elasticity of migration cost is high as well, so, in the end, long-distance migration cost in Poland is high. In general, Polish internal migrants, similar to those in other European countries, are not very mobile. However, Polish migrants are still attracted by larger labor markets with high employment possibilities and relatively high wages. On the other hand, migrants are discouraged from migrating to locations with a higher price index. Interestingly, the capital region of Warsaw is not the most attractive location across the country.

For Japan, the results are as shown in Tables 6, 7, and 8.

The results of the first equation, Eq. (11), for Japan show that elasticity of substitution as well as transport cost (σ and γ) have the expected sign and are highly significant. Low value of the complete coefficient on mobility cost $\gamma(1 - \sigma) = -0.39$ suggests a high level of regional specialization in Japan. After substituting the parameters of Eq. (11) with the values of the parameters obtained before, finally, it is possible to estimate the migration equation. All parameters in Eq. (9) are highly significant. The parameter b_1 is strictly positive and confirms that market potential has an influence on workers' mobility. The distance elasticity

Table 6 Estimates table for the wage equation (Eq. 11) for Japan

Japan		
Parameters	**Dependent variables**	**Estimate**
α_0	Constant term	−12.650 (−0.31)
Σ	Elasticity of substitution	2.327*** (3.64)
Γ	Distance elasticity of migration cost	0.306*** (4.44)
No. of observations		47
R^2		0.399

Note: For all tables: *, **, and *** denote significance level at 10%, 5%, and 1%. The *t*-value is presented in parentheses.

Table 7 Estimates table for the NEG based migration equation (Eq. 9) for Japan

Japan				
Parameters	**Dependent variables**	**Estimate**	**Estimate *a***	**Estimate *b***
b_0	Constant term	−19.165*** (−2.69)	−63.711*** (−7.34)	−37.438*** (−5.29)
b_1	Log (Market Potential)	0.846*** (2.98)	2.537*** (7.75)	−0.552* (−1.84)
b_2	Log (Unemployment Rate)		1.313*** (8.65)	
b_2	Log (CPI)			11.454*** (11.78)
Λ	Distance elasticity of migration cost	0.815*** (15.99)	0.826*** (16.48)	0.819*** (16.57)
b_D	Influence of borders on migration cost	−0.856*** (−29.94)	−0.848*** (−29.38)	−0.854*** (−30.60)
b_T	Dummy variable for Tokyo metropolitan area	2.142*** (23.42)	1.931*** (20.71)	1.829 (19.72)
b_O	Dummy variable for Osaka metropolitan area	0.737*** (9.97)	0.567*** (7.54)	0.613*** (8.47)
No. of observations		2,162	2,162	2,162
R^2		0.511	0.527	0.541

Note: For all tables: *, **, and *** denote significance level at 10%, 5%, and 1%. The *t*-value is presented in parentheses.

Table 8 Correlation matrix (Eq. 9) for Japan

Correlation matrix					
	***ln* Outmigration share**	***ln* CPI**	***ln* Unemployment rate**	***ln* MP**	***ln* Time distance**
ln Outmigration share	1.000	–	–	–	–
ln CPI	0.443	1.000	–	–	–
ln Unemployment rate	−0.041	−0.365	1.000	–	–
ln MP	0.408	0.592	−0.534	1.000	–
ln Time distance	−0.481	−0.119	0.175	−0.261	1.000

of migration cost (λ=0.815) and the influence of borders on migration cost, b_D, prove that, in Japan, long-distance migration cost is relatively high. Besides, a high and robust parameter for dummy variable TKY indicates an outstanding influence of Tokyo metropolitan area on Japanese migrants' behavior. The value of the parameter for Osaka metropolitan area is also positive and strong; however, most migration flows in Japan are toward Tokyo area.

5 Final conclusions

This paper presents an attempt to analyze choice of migration location. Because the NEG model estimation met with several failures, which were mentioned earlier, the original formulation was modified on the basis of the before-mentioned studies on market potential formula. In spite of the fact that the new specification is not a pure NEG approach, the results of the modified model are consistent with the NEG theory. Migrants (workers) tend to choose destinations with higher market potential.

The results for both countries confirm the earlier-assumed differences between them. First, Japan is characterized by a very mobile population. Traditional migration destinations such as Tokyo and Osaka are still of great importance and Japanese tend to concentrate in metropolitan areas. Second, differences in wage levels and unemployment rates among the regions in Japan do not constitute significant pull factors for migrants. This can be related to the fact that the Japanese labor market is more controlled than the European labor markets and that migrants can be more attracted by regional specialization or geographic distribution of economic activities than by wages and employment rate.

Polish internal migration, in turn, proves to be most influenced by two fairly different factors. First, Polish migration occurs mainly among adjacent regions. This confirms the key role of Polish regional labor markets in migrants' choice behavior (interestingly, this pattern is also present in other EU countries). In Poland, agglomeration forces work at the regional scale than at the country scale, as seen in Japan. Second, employment opportunities in a destination region act as a very important pull factor. In general, in Poland, bigger cities and their areas are characterized by lower unemployment rate and people tend to move to regional centers in search of a job.

References

Aoki, K. (2007), *Chugoku no chiikikan jinko rodoryoku ido to shijo petensharu*, Konan keizai gakuronshudai 48 maki dai 2 go, September.

Basile, R., Girardi, A., Mantuano, M., Russo, G. (2018), *Interregional migration of human capital and unemployment dynamics: evidence from Italian provinces*, ISAE (Institute for Studies and Economic Analyses).

Behrens, K., Thisse, F. (2006), *Regional economics: a new economic geography perspective*, Regional Science and Urban Economics, Elsevier, Vol. 37, No. 4, pp. 457–465.

Biagi, B., Faggian, A., Rajbhandari, I., Venhorst, V. A. (2018), New Frontiers in Interregional Migration Research, Springer.

Bijak, J. (2006), *Forecasting International Migration: Selected Theories, Models and Methods*, CEFMR (Central European Forum for Migration and Population Research), Working Papers, 4/2006.

Bosker, M., Brakman, S., Garretsen, H., Schramm M. (2010) Adding Geography to the New Economic Geography, Journal of Economic Geography, Journal of Economic Geography, 2010, vol. 10, issue 6, 793-823.

Cafiso, G. (2007), *The Geographic Space in International Trade: from Gravity to New Economic Geography*, MPRA Munich Personal RePEc Archive, MPRA Paper No. 20269.

Clemente, J., Larramona, G., Olmos, L. (2016), Interregional migration and thresholds: evidence from Spain, *Spatial Economic Analysis*, Vol. 11, No. 3, pp. 276–293.

Combes, P.-P., Mayer, T., Thisse, J. -F. (2008), *Economic geography, the integration of regions and nations*, Princeton University Press, Princeton.

Crozet, M. (2000), *Do migrants believe in market potential?*, TEAM - Paris 1 Pantheon-Sorbonne University, CNRS, Maison des Sciences Economiques.

Crozet, M. (2004), Do migrants follow market potential? An estimation of a new economic geography model, *Journal of Economic Geography*, Vol. 4, No. 4, pp. 439–458.

Faggian, A., Corcoran, J., Partridge, M. (2014), Interregional migration analysis, *Handbook of Research Methods and Applications in Economic Geography*, April 14, 2014, pp. 468–490.

Faggian, A., Rajbhandari, I., Dotzel, K. R. (2017), The interregional migration of human capital and its regional consequences: a review, *Regional Studies*, Vol. 51, No. 1, pp. 128–143.
Hanson, G., H. (2005) Market potential, increasing returns, and geographic concentration, Journal of International Economics, 67, 1-24.
Harris, C., D. (1954) The Market as a Factor in the Localization of Industry in the United States, Annals of the Association of American Geographers, 44: 315-348.
Harris, J., R., and Todaro, M., P. (1970) Migration, unemployment and development: A two sector analysis, American Economic Review, 60(1): 126–142.
Head, K., Mayer, T. (2004), Market Potential and the Location of Japanese Investment in the European Union, *The Review of Economics and Statistics*, Vol. 86, No. 4, pp. 959–972.
Head, K., Mayer, T. (2003), *The Empirics of Agglomeration and Trade*, Handbook of Regional and Urban Economics, Vol. 4.
Hering, L., Paillacar, R. (2008), On the relation between market access, migration and wages: an empirical analysis, retrieved from http://team.univ-paris1.fr/teamperso/paillacar/.
Isard, W. (1960) Methods of regional analysis: an introduction to regional science.
Kancs, D. (2005) Can we use NEG models to predict migration flows? An example of CEE accession countries, Migration Letters, 2(1): 32-63.
Kim, K. (2015), Determinants of interregional migration flows in Korea by age groups, 1995-2014, *Development and Society*, Vol. 44, No. 3, pp. 365–388.
Kondo, K., Okubo, T. (2012), *Structural estimation and interregional labour migration*, Keio/Kyoto Global COE Discussion Paper Series, DP2011-040.
Krugman, P. (1991), Increasing returns and economic geography, *Journal of Political Economy*, Vol. 99, No. 3, The University of Chicago.
Krugman, P., Layard, R., Blanchard, O., Dornbush, R. (1992), *East-West migration. The alternatives*, The MIT Press, United Nations University.
Leamer E., E., Levinsohn, J. (1994) International Trade Theory: The Evidence, NBER Working Paper Series 4940, National Bureau of Economic Research, Inc.
Pons, J., Paluzie, E., Silvestre, J., Tirado, D. A. (2007), Testing the new economic geography: migration and industrial agglomeration in Spain, *Journal of Regional*, Vol. 47, No. 2, pp. 289–313.
Redding, S., Venables, A., J. (2000) Economic Geography and International Inequality, No 2568, CEPR Discussion Papers from C.E.P.R. Discussion Papers.
Sardadvar, S., Vakulenko, E. (2017), A model of interregional migration under the presence of natural resources: theory and evidence from Russia, *Annals of Regional Science*, Vol. 59, No. 2, pp. 535–569.
Stewart, J., Q. (1941) An inverse distance variation for certain social influences, Science, 93(2404): 89–90.
Stouffer, S., A. (1940) Intervening Opportunities: A Theory Relating Mobility and Distance, American Sociological Review 5: 845–867.
Tabuchi, T., Thisse, J. (2002) Taste heterogeneity, labor mobility and economic geography, Journal of Development Economics, 2002, vol. 69, issue 1, 155-177.
van der Gaag, N., Wissen, L. van, Rees, P., Stillwell, J., Kupiszewski, M., (2003), *Study of Past and Future Interregional Migration Trends and Patterns within European Union Countries In Search of a Generally Applicable Explanatory Model*, Report for Eurostat under contract 2002/S 67-052015/EN; Lot 5.
Wajdi, N., Adioetomo, S. M., Mulder, C. H. (2017), Gravity models of interregional migration in Indonesia, *Bulletin of Indonesian Economic Studies*, Vol. 53, No. 3, pp. 309–332.
Worldatlas. Retrieved from https://www.worldatlas.com/articles/the-economy-of-japan.html.
Zipf, G., K. (1946) The P1P2/D Hypothesis: On the Intercity Movement of Persons, American Sociological Review, 11(6): 677–686.