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INTERREGIONAL MOBILITY OF STUDENTS AND GRADUATES IN THE TRANSITION ECONOMY. EVIDENCE FROM THE POLISH SOCIAL MEDIA NETWORK¹

Abstract: The aim of this article is to gain a better understanding of the patterns of human capital mobility in transition economies. It exploits a unique dataset from a Polish social networking web-site to develop a typology of skilled migration. Determinants of human capital flows are further elaborated using an empirical model of student and graduate migration. It is found that spatial mobility of human capital in Poland is low, and the distance between the home region and potential destination plays the most significant role in migration decisions. Migrations of skilled individuals favour metropolitan areas, which experience a net gain of human capital, while all other regions are subject to brain drain.

Keywords: human capital, mobility, regional development, Poland.

MOBILNOŚĆ PRZESTRZENNA STUDENTÓW I ABSOLWENTÓW UCZELNI WYŻSZYCH W CZASACH TRANSFORMACJI. ANALIZA NA PODSTAWIE DANYCH Z SERWISU SPOŁECZNOŚCIOWEGO

Streszczenie: Celem autorów artykułu jest pełniejsze zrozumienie mechanizmów mobilności kapitału ludzkiego w kraju przechodzącym systemową transformację. Autorzy zbadali unikalny zbiór danych pochodzących z internetowego serwisu społecznościowego. Przedstawiają typologię migracji wykształconych Polaków, a następnie opracowują empiryczny model przepływów migracyjnych studentów i absolwentów między województwami. Jak się okazuje, międzyregionalna mobilność kapitału ludzkiego w Polsce jest niska, a kluczowym czynnikiem skłaniającym do migracji jest niewielka odległość między miejscem zamieszkania a regionem docelowym. Wykształceni (lub chcący się kształcić) migranci preferują regiony metropolitalne, które doświadczają dzięki temu napływu netto kapitału ludzkiego. W regionach pozbawionych wielkich miast następuje natomiast drenaż mózgow.

Słowa kluczowe: kapitał ludzki, mobilność, rozwój regionalny, Polska.

Introduction

The two decades of transformation following the fall of communism in 1989 were a time of profound socio-economic change in Poland. Democratization and

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the opening of the economy was accompanied by a spectacular development of the Polish higher education sector. The transformation of the 1990s triggered a change from an elite to a mass tertiary education system. The net enrolment rate grew from 9.8% in the academic year 1990/1991 to 40.8% 20 years later. The share of people aged 25–64 attaining tertiary education grew between 1997 and 2010 by 7.2% annually in Poland, doubling the average OECD rate of growth for this period.

The transformation to a market economy provided an incentive, or even pressure, to attain higher education in order to keep pace in the increasingly competitive conditions (cf. Sojkin et al., 2012, Kwiek, 2011). Simultaneously, expansion of tertiary institutions notably improved the accessibility of higher education outside of the traditional academic centres. In 2012 there was at least one higher education institution operating in 65 out of 66 statistical sub-regions (NTS-3) in Poland.

The clustering of labour market opportunities in the biggest cities, observed in Poland over the transformation period, influenced the migration of graduates. Metropolization processes led to a growing concentration of highly skilled, highly paid jobs in just a few locations.

The sparse economic research on sub-national mobility in Poland lacks specific focus on high human capital individuals. The results obtained for the general population show that migration is a response to unemployment, wages, and urbanization (Fidrmuc, 2003), to unemployment, income, distance, housing provision, education and road infrastructure (Ghatak et al., 2008), and to EU funding, FDI and levels of international migration (Thomas, 2013). However, all these studies assess migration flows using data that fail to capture a significant part of spatial movements – especially temporal relocations and youth mobility (being based on the officially declared place of residence). The authors attempt to overcome this challenge by applying user-generated data from a social media network. The spatial connotations of social media are perhaps insufficiently explored, but this research method is constantly gaining in popularity and representativeness (Sagl et al., 2012, Hawelka et al., 2014).

The goal of this paper is fourfold:

- to measure educational and post-educational mobility in Poland, and to identify major trends with respect to skilled migration;
- to discuss a typology of student and graduate sequential migration in Poland, based upon the categories proposed by Faggian et al. (2007);
- to identify regions that are winning or losing in terms of human capital accumulation, based on indicators proposed by Hoare and Corver (2010);
- to elaborate on factors of human capital migration using an empirical model of interregional flows of students and graduates.

The paper is organized as follows: Section 2 reviews the literature on the role of human capital in economic development and on major determinants of skilled migration. In section 3 the authors discuss the conceptual framework and data used in the analyses. Section 4 presents the results of our empirical analyses concerning the interregional mobility of students and graduates in Poland. Section 5 concludes.

Human capital, economic growth, and major migration mechanisms

According to economic theory, supported by rich empirical evidence, the ability of an economy to accumulate high quality human capital is an important factor of economic growth. The effect of human capital on economic growth is realized either through the impact on labour productivity (Lucas, 1988) or through the impact on so-called total factor productivity (Nelson and Phelps, 1966).

The empirical studies on the human capital effect on economic growth rates typically use regression models to verify this effect. The milestones of this literature are represented by the works of Mankiw, Romer and Weil (1992), Benhabib and Spiegel (1994), Krueger and Lindahl (1999), Barro (1999), Chen and Dahlman (2004), Barro and Sala-i-Martin (2004), and more recently – Ciccone and Papaioannou (2009), and Arnold et al. (2011). Despite some early research studies shedding doubt on human capital's influence on economic growth, most of the recent works (using both national and regional data) confirm that the rate of economic growth is positively affected by the stock and quality of human capital.

Since economies better endowed with human capital grow at a higher rate, the mobility of skilled individuals should have a meaningful effect on the economic perspectives of different countries and regions. It is thus important to understand the factors determining the migration of highly educated individuals.

Broadly speaking, there are two lines of research on spatial features that drive migration. The traditional approach is based on gravity models that emphasize the role of structural factors, such as the size of and the distance between areas of origin and destination. The second approach – mainstream economic theory – posits that individuals seek to maximize expected returns from their human capital investments, and choose to move to more economically flourishing locations based on cost (of moving)-benefit (wage premium) analysis. Focusing initially on economic indicators, this theory was systematically broadened to include softer factors, such as quality of life and various amenities (cf. Florida, 2002) or the notion of migration as a collective rather than individual decision (Stark, 1991). The mainstream economic theory highlights the selective character of the migration process, with skilled individuals being more prone to migrate, as they face a higher opportunity cost of unsatisfactory employment or unemployment. These two approaches to migration are often considered complementary rather than alternative, accounting both for the structural features underlying migration flows and the mechanisms that actually enable and sustain it (Haug, 2008, Marinelli, 2011).

Personal variables taken under consideration in migration studies usually include gender and age as well as the type and quality of qualification obtained. Results regarding gender are mixed, with some evidence suggesting that highly skilled women are more migratory than their male counterparts (Faggian et al., 2007), while other studies find gender insignificant (cf. Groen, 2004, Haapanen and Tervo, 2011). Mosca and Wright (2010) suggest that after the age of 30, the likelihood of migrating sharply declines. According to Haapanen and Tervo (2011), migration probability increases two years before graduation, peaks in the year of graduation and then rapidly decreases due to cumulative inertia, i.e. grow-

ing attachment to the place of residence. Similarly, stronger family ties – e.g. marriage, enrolment of children in school – deter from migration (cf. Parsad and Gray, 2005, Haapanen and Tervo, 2011). Other personal variables which prove important for explaining mobility patterns include the class of qualification obtained – better graduates are more likely to migrate (cf. Faggian et al., 2006, Mosca and Wright, 2010, Ishitani, 2011), the field of study – findings are mixed, probably due to differences in the institutional settings of various national higher education systems (cf. Faggian et al., 2006, Faggian et al., 2007, Venhorst et al., 2010, Haapanen and Tervo, 2011), and earlier migratory experience – highly correlated with subsequent migration (cf. Kodrzycki, 2001, Gottlieb and Joseph, 2006, Mosca and Wright, 2010).

Migration decisions are made by individuals, but this process does not happen in a void. There is always a variety of attraction and repulsion incentives (push and pull factors), which are often derived from the features of a given locality. In our study we use a spatial approach, looking for migration patterns that emerge when enough people converge on destination regions with particular characteristics.

According to gravity models, **physical distance** plays a crucial role in explaining migration likelihood, but many studies on skilled migration focus only on the socio-economic features and neglect the spatial perspective. However, the distance deterrence effect is found both in regard to student flows (Sa et al., 2004, Gibbons and Vignoles, 2012) and graduate migration (Marinelli, 2011). In the former case, a well-developed network of higher education institutions seems to diminish the role of distance in explaining the behaviour of prospective students (Alm and Winters, 2009, Gibbons and Vignoles, 2012).

The mainstream economic theory emphasizes the role of a **regional economy** in determining migration flows. Graduates tend to leave economically lagging, peripheral regions (Ritsila and Ovaskainen, 2001, Haapanen and Tervo, 2011) and move towards or stay in more prosperous ones (Ishitani, 2011), especially knowledge-intensive regions (cf. Gottlieb and Joseph, 2006, Delisle and Shearmur, 2010, Winters, 2011). The present value of expected income and regional differences in return to skills are both well established as drivers of human capital mobility (Kodrzycki, 2001, Di Cintio and Grassi, 2011). An absorptive labour market is an important pull factor for students and graduates (cf. Krugman, 1991, Gottlieb and Joseph, 2006), while a high unemployment level encourages outmigration (Haapanen and Tervo, 2011). However, Faggian et al. (2006) argue that graduates are a self-selected group with lower unemployment risk and thus labour market features might be of relatively less relevance in their migration behaviour than for the general population.

Economically flourishing regions which provide both employment opportunities and high wages, have a potential disadvantage, i.e. high **living costs**. Apparently, students tend to avoid institutions located in higher-cost areas (Baryla and Dotterweich, 2001, Faggian et al., 2006), but there is insufficient evidence to support this claim in regard to graduates.

Different kind of amenities are often included in modelling migration flows, following the notion that highly skilled migrants look for quality of life when

choosing a place to settle (cf. Florida, 2002). The concept of amenities is rather vague and lacks well-established variables that would prove to have a robust impact on highly skilled migration. However, studies on general population mobility in Poland have found that **service availability** is an important pull factor for migrants, notably housing provision (Ghatak et al., 2008, Thomas, 2013) as well as healthcare availability (Thomas, 2013) and road network density (Ghatak et al., 2008, Sarra and Del Signore, 2010).

The notion of migration as a collective rather than individual process has led to the incorporation of **social determinants** of spatial mobility. Two concepts have proved particularly important, i.e. migration networks and cumulative causation (Radu, 2008). The former serves as a mechanism that allows for decreasing the costs and risks related to the search process, given the imperfect information available. The latter is reflected by a dynamic perspective on the search and settling processes which accounts for a virtuous cycle effect.

Data and conceptual framework

Empirical research on student and graduate migration commonly uses data from longitudinal labour force surveys or university databases designed to register students and track graduate careers. So far, there is no such data available for Poland. Public statistics on interregional migration are based on the officially declared place of residence, which means they overlook a major part of actual mobility, and do not include information on the educational attainment of migrants. Existing longitudinal research in Poland does not investigate the issue of spatial mobility deeply enough to provide useful data. Although most tertiary schools run electronic registers of students, these databases are not fully comparable between schools, and most schools do not track graduates in any systematic way. Moreover, none of the data in statistical systems provide enough observations to evaluate the performance of particular regions in attracting and accumulating human capital.

In this paper a source of data outside the sphere of public statistics is used. A large, unique dataset was collected from a social networking website *nk.pl*, which allows individuals to renew contacts with their former classmates in schools at all tiers. In order to find classmates, the potential user needs to virtually register in real schools and classes which he or she attended. Once the user registers in a school, it becomes visible in his or her user profile. Since the user also declares his or her current place of residence, virtually all information about his or her mobility is revealed, which makes data collected from user profiles highly useful for our research. Moreover, there are two major advantages of *nk.pl* in terms of its use for academic studies. First, despite the unofficial character of the data, the reliability of information is high. Users registering with the service need to reveal the actual schools they have attended if they want to contact their classmates. Second, what distinguishes the *nk.pl* website from other web-based services of this kind is its mass popularity. At the beginning of 2009 (when our data were collected), the website had over 11 million registered users, which accounted for about onethird of web-active Polish citizens.

Using an innovative dataset such as this calls for a careful review of misrepresentation concerns. The first question regards the uneven access to the internet in Poland. It is certainly biased towards younger and better educated people, but this is the group that we focus on in our research. Secondly, there are different social networking websites which might have varying target groups. However, at the beginning of 2009 *nk.pl* was by far the most popular service of this kind in Poland – in January 2009 it had almost 13 times more users than Facebook (Rzeczpospolita 2010). Hawelka et al. (2014) conclude that despite its limited penetration and a bias towards the younger section of the population, web-based social media is a source of increasingly robust data on patterns of human mobility.

In this article, the authors focus on migration related to university admission and job seeking after graduation. In other words, the analysis is restricted to tertiary school students and graduates. Within the category of graduates, the focus is on those who completed their studies after 1989 (although for some analyses broader cohorts are included, e.g. those graduating between 1965 and 2008). After imposing the appropriate selection queries on the *nk.pl* database, 1.98 million observations were obtained, of which 1.27 million referred to graduates, and 0.71 million were students at the time the data were collected (January 2009).

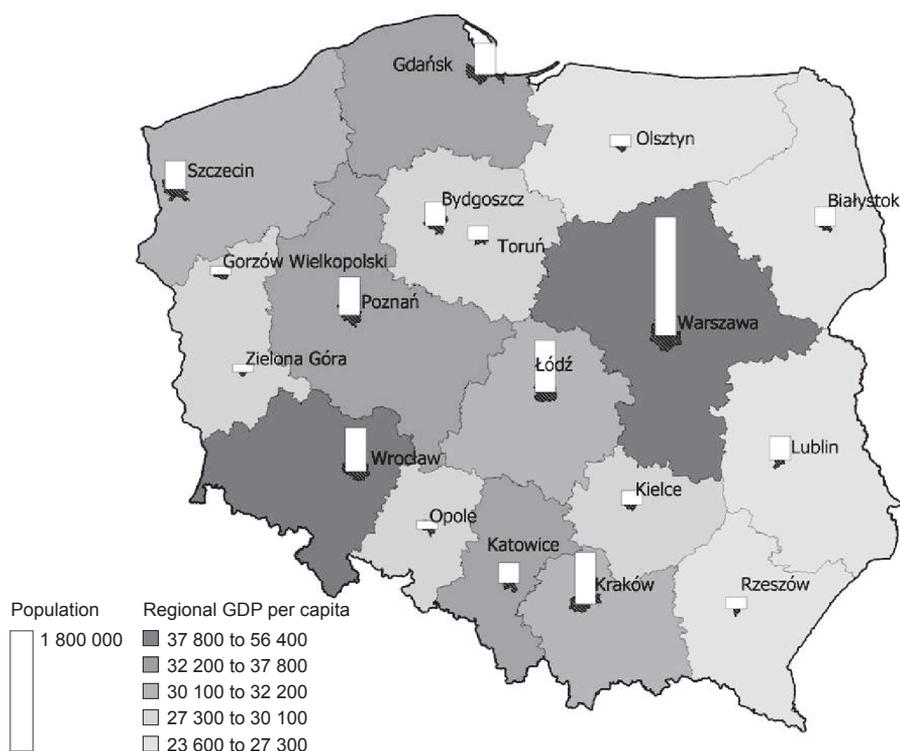


Figure 1. Polish regions, their GDP per capita (in PLN, 2009) and population of central cities

Source: Based on data from the Central Statistical Office.

Analyses were conducted on a regional level, investigating the flows of students and graduates between the 16 Polish provinces (NTS-2). Basic information on the regions, including the population, location of central cities, as well as recent GDP per capita is presented in Figure 1.

In order to study the mobility of high human capital individuals the authors applied a framework of home–university–labour market transitions. The typology elaborated by Faggian et al. (2007) was adapted, distinguishing five types of sequential migration behaviour associated with students and graduates. Repeat migrants leave their home region to acquire higher education and, after graduation, they move to another region to find employment ($H \rightarrow U \rightarrow L$). Return migrants come back to their domicile region to find first employment after having acquired higher education in a different region ($H \rightarrow U \rightarrow L = H$). University stayers leave their home region to acquire higher education and then find first employment in the same region where they got their education ($H \rightarrow U = L$). Late migrants attend higher education establishments in their domicile region and then move to find first employment in another region ($H = U \rightarrow L$). Non-migrants both acquire higher education and find first employment in their domicile region ($H = \rightarrow = L$).

When assessing regional performance in attracting human capital, sequential migration behaviour may be transformed into regional conversion rates. Regional conversion rates confront the actual number of graduates attracted by a given region's labour market with the potential number of individuals that might have been recruited through one of four pathways. Following the approach of Hoare and Corver (2010), the regional conversion rates for the 16 Polish regions were calculated with respect to four pathways of home-university-labour market transitions: locals, returners, stayers, and outsiders. For example, the locals' conversion rate would be defined as a ratio of individuals domiciled in region x who studied in region x and found employment there (those actually attracted), to individuals domiciled in region x who studied in region x and found employment either in region x or y (those who might potentially be recruited through a local pathway).

Mobility of human capital in Poland – results

Basic trends

The mobility of skilled individuals in Poland is much higher after graduation than while deciding where to acquire higher education. Among individuals who enrolled in a tertiary school after 1989, 67.9% chose universities in their home regions (i.e. the region where they graduated from secondary school). The average distance between the place of completion of secondary and tertiary education (including students remaining in the same city during their entire education) was 72 km. In turn, the average distance between the university from which an individual graduated and his or her current place of residence (observed in 2009) was 219 km.

The change in both student and graduate mobility over time is shown in Figure 2. In the case of migration related to university enrolment, we can observe a clear

downward trend in the covered distance since the 1960s. Over 40 years, it has decreased by approximately 30 km. The results suggest that the growing demand for higher education and increased mobility have both been outpaced by the rapid expansion of higher education institutions. A fourfold increase in the number of tertiary schools over the period 1990–2007 marks the growing geographical accessibility of higher education. The falling average distance between the completed secondary school and chosen university reflects the gradual emergence of the possibility to study near home.

The observed change in graduate mobility is less obvious. It is also more difficult to interpret, as we assess mobility based on the current (2009) place of residence. Thus, the period of time that has passed since graduation may vary greatly – from 50 years (older cohorts) to just one year after graduation (younger cohorts). The average graduates from the 1970s and 1980s live today 250–300 km from the higher education institutions where they completed their studies. Those who graduated in the early period of transition tend to live closer to their former universities – 200 km on average. The first years of the new millennium brought a significant increase in graduate mobility, with the average distance between tertiary school and current place of residence exceeding 250 km. This peak might be linked to EU accession in 2004. The opening of labour markets in Western European countries (notably in the UK and Ireland) attracted over a million Poles, among them many young graduates struggling with high unemploy-

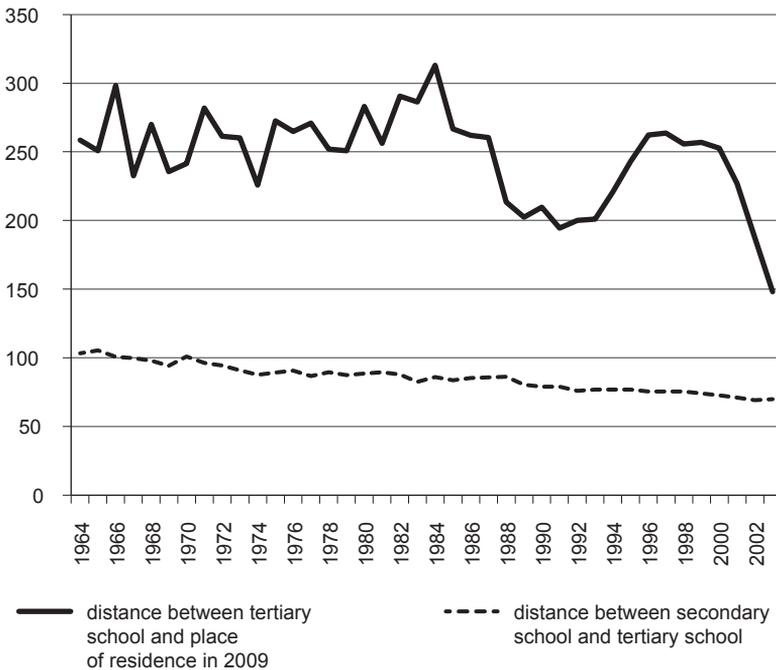


Figure 2. The average distances from secondary school to university and from university to current (2009) place of residence, by year of enrolment to university

Source: own calculation.

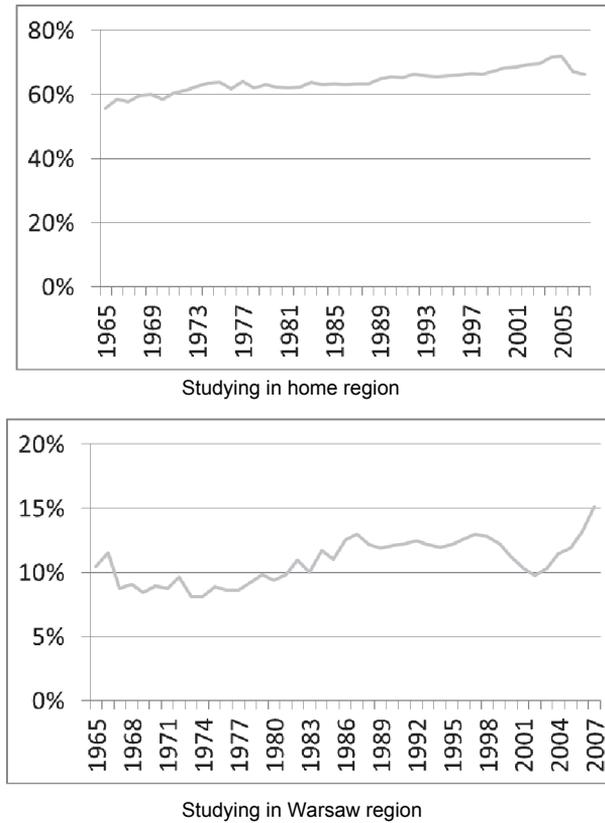


Figure 3. Percent of students enrolling in a tertiary school in their home region and in the Warsaw region, by year of enrolment

Source: own calculation.

ment in their home regions. A drop in mobility observed in subsequent years was probably caused by the short period between graduation and observation, as fresh graduates stick to the cities where they have studied, and only after some time decide where to live and work.

The two panels in Figure 3 show that, with respect to the spatial structure of tertiary education in Poland, we can observe both de-concentration and centralization processes running at the same time. On one hand, the spatial availability of tertiary schools has been improving over recent decades, resulting in an increase in the percentage of students studying in their home regions – from 55% in 1965 to 70% in 2007. Simultaneously, the percentage of individuals studying in the capital region has also risen. The upward trend in the latter case has been apparent for over 40 years, but the attractiveness of Warsaw has increased sharply over the last decade, with the capital's share in the total higher education market reaching 15%.

The mobility patterns of prospective students broken down by the size of their home town indicate that new higher education institutions have been lo-

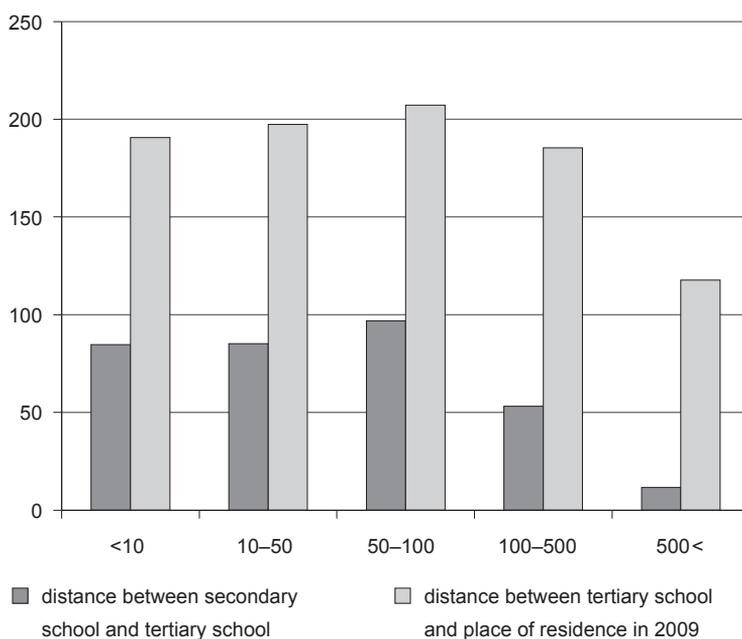


Figure 4. The average distance covered by (1) secondary school graduates to enrol in university, and by (2) tertiary school graduates to their current place of residence, by the secondary school city size

Source: own calculation.

cated mostly in cities with populations exceeding 100,000. As shown in Figure 4, based on data for students entering tertiary education between 2000 and 2009, the average individual graduating from secondary school covers a similar distance to university regardless to whether he or she originates from a small town (population below 10,000), medium-sized town (10,000–50,000), or a city with a population between 50,000 and 100,000. With respect to students raised in big cities (100,000–500,000), the mean distance between secondary schools and universities drops by 40% – to 50 km, and those raised in large metropolises with populations exceeding 500,000 most often study in their home cities.

The situation is different when it comes to post-educational mobility of graduates. Figure 4 shows that when compared to students raised in smaller towns, individuals growing up in the largest cities eventually cover (on average) a much shorter distance between the place where they graduated from university and the current place of residence. Interestingly, there is no significant difference in mobility between those who grew up in big cities (100,000–500,000 inhabitants) and individuals originating from much smaller settlements.

The difference between student and graduate mobility patterns suggest that labour market opportunities, as well as other pull factors impacting graduate mobility, are much more concentrated in the largest metropolises than they are in the case of the higher education network.

Typology of sequential migration behaviour

The typology of graduates' sequential migration behaviour elaborated by Faggian et al. (2007) and discussed earlier in this article provides us with a framework for the analysis of interregional mobility in Poland. We also compare the empirical results of Poland and the UK, although the observed differences need to be interpreted with some caution. Data on Polish graduate mobility come from a social media network which is obviously a very different source of information from the HESA survey used by Faggian et al.² Leaving aside the technical and methodological differences between the two sources, it is important to note that the UK sample was restricted to graduates in full-time employment, while in the Polish data employment could not be controlled.

The empirical investigation conducted by Faggian et al. for the UK shows (see column 3 in Table 1) that the most common path is repeat migration, followed by university stayers and non-migrants. It is important to note that, in the UK case, migration was defined as a move covering a distance of at least 15 km. Thus, individuals moving within this range were classified as non-migrants.

Table 1. Sequential migration behaviour in the UK and Poland

Type of migration behaviour	Definition	% of the sample Faggian et al. (2007)	% of the sample Herbst & Rok	% of the sample Herbst & Rok
1	2	3	4	5
grid		15 km	15 km	regional
time between graduation and observation		6–18 m	6–18 m	6m–8y
Repeat migrants	H → U → L	52.8%	18.4%	3.4%
University stayers	H → U = L	21.8%	24.2%	12.5%
Non-migrants	H = U = L	16.9%	28.2%	63.7%
Late migrants	H = U → L	6.5%	6.2%	5.7%
Return migrants	H → U → L = H	2.0%	23.0%	14.7%

Source: Faggian et al. (2007) and own calculations.

Column 4 in Table 1 shows the frequencies of different migration behaviour calculated for Poland, based on data from *nk.pl.*, using the same minimum distance criterion (15 km) as in the original research. The focus is on graduates who

² The study was conducted on 482,558 UK domiciled students who graduated from UK higher education institutions between 1997 and 2000 and were in full-time permanent employment between six and eighteen months after graduation. Data on unit post codes of the students' domicile, higher education institution attended and first employment were derived from the HESA student leavers' questionnaire. Finally, the sample consisted of 74,800 observations where all three post code locations were available (Faggian et al., 2007).

completed their education between 2007 and 2008, which means that their current place of residence is recorded between six and eighteen months after graduation (as in the UK study).

Several observations can be made on the distribution of Polish graduates across categories. First, the spatial mobility of educated individuals in Poland seems to be very low, with only 18% of graduates falling into the repeat migration category (compared to 53% in the UK). Similarly, the share of non-migrants in the total population of graduates is higher in Poland (28.2%) than in the UK (16.9%). The results for late migrants and university stayers are similar in both cases, with the former being 3-4 times more prevalent than the latter.

The most striking difference regards return migration behaviour – with 23% of the total population of graduates in Poland and only 2% in the UK following that path. At this point it is worth underlining that both in Polish and UK data, student movement at the time of enrolment in university is measured using university location, and not the actual place of residence during studies. This implies that at least some of the graduates classified as return migrants may actually have never left their primary place of residence, in the sense of moving permanently to another city. Instead, these students might have commuted to the university destination on a daily basis, or even less frequently, if they studied in a non-stationary mode. In other words, the return migration category may include cases of circular migration to university without changing the place of residence. This is certainly more common in Poland, where as many as 52% of tertiary students are enrolled in non-stationary programmes (Herbst and Rok, 2014), and 50% of all students live with parents, as compared to 24% in England and Wales (Orr et al., 2011).

Column 5 in Table 1 shows the frequencies of different sequential migration behaviours in Poland using a regional instead of a 15-kilometre grid. This means that an individual's displacement to university or after graduation is considered migration only if the migrant crosses a regional border. Measuring interregional mobility is aimed at assessing what part of the migrations observed in column 4 of Table 1 and discussed above is in reality limited within the functional areas of particular metropolitan cities. Despite allowing for a much larger time span between graduation and observation (up to 8 years as compared to 18 months in columns 3-4), the results show that interregional mobility in Poland is very low, so most of the migratory activity occurs between a metropolis and its hinterland, embedded within the administrative borders of a region. Almost two-thirds of graduates belong to the non-migrants category from the interregional perspective, and only 3.4% of them follow the repeat migration path which implies that they grow up, study, and live after graduation in three different regions.

Regional conversion rates and brain drain

An analysis of different transition flows from home to university to labour market might be useful as a tool for measuring the performance of regions in attracting highly skilled migrants. For example, it shows what percentage of individuals that have grown up and studied in a given region is retained by this region

after graduation, or what proportion of graduates that immigrated to study in a given region is then absorbed by the regional labour market. Hoare and Corver (2010) classified graduates into four recruitment pathways, i.e. locals, returners, stayers, and outsiders. The conversion rates for a hypothetical region i can be defined as follows:

- Locals: what % of students raised in i and educated in i lives in i ($H = i, U = i, L = i$);
- Returners: what % of students raised in i but educated outside i lives in i ($H = i, U \neq i, L = i$);
- Stayers: what % of students raised outside i but educated in i lives in i ($H \neq i, U = i, L = i$);
- Outsiders: what % of students raised and educated outside i lives in i ($H \neq i, U \neq i, L = i$).

The values of the conversion rates for the 16 Polish regions are shown in Table 2. The results prove that the Warsaw region outperforms all other Polish regions with respect to conversion rates within all four pathways. The country's capital successfully converts into the local labour force about 96% of locals, 63% of individuals locally born but studying elsewhere, 50% of in-migrating students and 4% of those raised and educated outside the Mazowieckie region.

The dominance of Warsaw is clear, but the identification of the runner-up is less obvious. The Wrocław region (Dolnośląskie) performs strongly in convert-

Table 2. Regional conversion rates for 16 regions of Poland

Region name	Central city	Locals	Returners	Stayers	Outsiders
1	2	3	4	5	6
Mazowieckie	Warszawa	96.0%	62.8%	50.5%	4.1%
Dolnośląskie	Wrocław	93.8%	57.4%	44.4%	0.9%
Pomorskie	Gdańsk	93.6%	58.0%	49.4%	0.8%
Śląskie	Katowice	92.7%	53.4%	32.2%	0.7%
Wielkopolskie	Poznań	92.7%	54.7%	42.4%	1.0%
Małopolskie	Kraków	92.2%	61.2%	44.2%	1.1%
Zachodniopomorskie	Szczecin	90.7%	43.7%	33.4%	0.4%
Łódzkie	Łódź	89.8%	47.1%	34.5%	0.4%
Kujawsko-pomorskie	Bydgoszcz-Toruń	89.5%	44.7%	31.5%	0.5%
Podkarpackie	Rzeszów	89.2%	44.4%	30.5%	0.3%
Opolskie	Opole	88.0%	46.8%	24.0%	0.2%
Podlaskie	Białystok	87.0%	41.3%	28.7%	0.2%
Lubuskie	Gorzów-Zielona Góra	86.6%	46.0%	20.8%	0.2%
Warmińsko-mazurskie	Olsztyn	85.3%	42.5%	27.8%	0.3%
Lubelskie	Lublin	83.1%	39.5%	26.1%	0.3%
Świętokrzyskie	Kielce	82.9%	36.4%	15.1%	0.3%

Source: own calculation; based on data for students graduating between 2000 and 2008.

ing local students (ranks 2nd), but it is not equally successful in pulling back students who moved out to receive education in other regions (4th). Gdańsk does almost as well as Warsaw in converting in-migrating students (49%), but it ranks only 5th with respect to attracting late migrants through the outsider pathway. Kraków (Małopolskie) is in turn very attractive for locally born students educated elsewhere (returners) and for late migrants. In both these categories the region ranks just behind the capital region.

The lowest conversion rates are noted in the Świętokrzyskie region, located in central Poland, between two strong metropolises – Warsaw (Mazowieckie region) and Kraków (Małopolskie region). Relatively poor conversion performance can also be observed in most regions of eastern Poland, including Podlaskie, Lubelskie, and Warmińsko-Mazurskie.

The weak performance of Łódzkie – a centrally located region with the third largest city in Poland (Łódź) – needs closer examination. The city's economy, in the past reliant on the textile industry, suffered heavily from economic transformation. Following the collapse of local industry and rising unemployment, the city population began to fall in the 1990s and this process continues to the present. Low conversion rates reflect poor job opportunities in the local labour market. The second reason behind the relatively low attractiveness of Łódź for graduates is its proximity to Warsaw (133 km). Better employment prospects and higher wages make Warsaw intercept some of the graduates who might potentially come to Łódź (cf. Herbst, 2010).

The application of the same framework (conversion rates) in the assessment of regional performance in absorbing human capital in Poland and the UK (in Hoare and Corver, 2010)³ allows us to compare the average values of indicators in the two countries, and to seek similarities and differences with respect to the nature of interregional migrations. As shown in Table 3, the average conversion rates in corresponding pathways are similar for the two countries, although slightly higher for Poland with respect to locals, returners and stayers. Regarding dispersion measures, the standard deviations are higher for the UK, which indicates a higher degree of spatial polarization, with London and Northern Ireland marking the two extremities.

Table 3. Mean values and standard deviations of conversion rates for the UK and Polish regions

Mean	Locals	Returners	Stayers	Outsiders
1	2	3	4	5
UK	84.9% (6.2%)	47.9% (9.0%)	29.8% (13.5%)	2.0% (2.5%)
Poland	89.6% (3.9%)	48.7% (8.1%)	33.5% (10.2%)	0.7% (1.0%)

Source: Hoare and Corver (2010) and own calculations.

³ The sample consists of the four cohorts of UK-domiciled first-degree graduates from higher education institutions (graduating between 1998/99 and 2001/02) who are in full-time employment in the UK (sample size: 225,000). Twelve UK regions (incl. Scotland, Wales, and Northern Ireland) were used as a spatial framework.

Analysis of conversion rates in Polish regions leads to the conclusion that, despite minor differences, the stronger regions generally perform well with respect to all migration schemes, while the poorer ones exhibit low rates of conversion in all categories. This suggests that the aggregated differences between the top performing and worst performing regions are substantial, and migrations may further aggravate the unequal distribution of human capital stock between voivodships. Moreover, the geography of conversion rates shows that low attractiveness for graduates is characteristic predominantly in the regions of eastern Poland. This may cause massive brain drain from the whole eastern macroregion to the benefit of the metropolitan areas in central and western Poland. To illustrate this problem the authors propose a measure of brain drain at the regional level based on the sequential migration typology introduced by Faggian et al. (2007) and applied earlier in this article (see section 4.2). From the perspective of a region potentially exposed to brain drain, its scale can be measured as:

$$BD_i = \frac{US_{i \rightarrow o} + RM_{i \rightarrow o} + RE_{i \rightarrow o} + OUT_{i \rightarrow o}}{US_{i \leftarrow o} + RM_{i \leftarrow o} + RE_{i \leftarrow o} + OUT_{i \leftarrow o}}, \text{ where.}$$

$US_{i \rightarrow o}$ denotes the number of university stayers leaving region i to begin studies and eventually settle down outside i .

$RM_{i \rightarrow o}$ denotes the number of repeat migrants leaving region i at any stage of their career (university or labour).

$RE_{i \rightarrow o}$ denotes the number of return migrants leaving region i after graduation.

$OUT_{i \rightarrow o}$ denotes the number of outsiders leaving region i after graduation and settling down outside i .

$US_{i \leftarrow o}$ denotes the number of university stayers coming to region i to begin studies and eventually settling down in i .

$RM_{i \leftarrow o}$ denotes the number of repeat migrants settling down in region i after graduation.

$RE_{i \leftarrow o}$ denotes the number of return migrants settling back in region i after graduation elsewhere.

$OUT_{i \leftarrow o}$ denotes the number of outsiders settling down in region i after graduation.

The BD_i equal to zero (hypothetically possible although non-existing in reality) means that region i does not lose any human capital, as all future graduates passing through the region at any stage of their education are eventually absorbed by the local labour market. BD_i between 0 and 1 suggests that there is some outflow of skilled individuals from the region, but the net effect of human capital migrations is positive. A BD_i value above 1 indicates that the region is subject to brain drain. The higher the BD_i value, the larger the human capital loss relative to its inflow to the region.

The values of the brain drain measure for the 16 Polish regions, shown in Figure 5, reveal that two eastern regions – Lubelskie and Świętokrzyskie – experience particularly severe drainage. In both cases the outflow of graduates exceeds the inflow more than twice. The proximity of Warsaw combined with the lack of large metropolitan cities inside the regions are the two major factors responsible



Figure 5. Regional brain drain in Poland

Source: own calculation.

for such an adverse situation. Three other regions, of which two – Podlaskie and Podkarpackie – are located in the east, are also subject to severe brain drain, with the BD ratio between 1.5 and 2.

In turn, there are five regions clearly benefiting from the mobility of skilled individuals, i.e. Mazowieckie, Małopolskie, Dolnośląskie, Wielkopolskie, and Pomorskie. Not surprisingly, all five host the largest and most flourishing Polish cities – Warsaw, Kraków, Wrocław, Poznań, and Gdańsk, respectively. In line with earlier considerations, Łódź remains the only metropolis which seems to lose more talent than it attracts.

Determinants of the interregional flow of human capital (empirical model)

The investigation of human capital mobility between regions should involve the identification of major determinants of regional success or failure in attracting educated migrants. As shown in the introductory part of this article, such issues are often addressed by estimating models of individual migration decisions, using micro data. The dataset applied in this study provides too little information at

the individual level to build such a model. Instead, an empirical model of human capital flow between regions is proposed, using aggregate data on human capital flows between the 16 regions of Poland. A similar attempt was made earlier by Ghatak et al. (2008), but without the focus on highly educated individuals.

The empirical model of human capital flows between regions has the following form:

$$M_{ij} = \alpha + \beta X_i + \phi X_j + \varepsilon_{ij} \text{ where:}$$

M_{ij} is a measure of human capital migration from region i to j .

X_i and X_j are vectors of explanatory variables, characteristics of i and j .

α, β are model parameters.

ε_{ij} is the estimation error.

The coefficients assigned to the characteristics of a donor region (i) can be interpreted as measures of the importance of push factors, while the parameters referring to a destination region (j) describe the strength of particular pull factors.

Drawing on the literature review (section 2), five groups of push and pull factors potentially determining the attractiveness of different regions for skilled individuals were identified. Two aspects of migration were considered separately, i.e. (1) the migration of secondary school graduates to university, and (2) the mobility of university graduates, related to entering the labour market. The push and pull factors are expected to work differently for these two populations.

The five groups of factors are defined as follows:

- Physical distance between the home and destination region;
- Economic prosperity and the quality of life in the home/destination region;
- Living costs in the home/destination region;
- Specific service availability in the home/destination region.

The endogenous variable is the natural logarithm of the share of students (graduates) migrating from any region i (home region) to any region j (destination region) in the total population of students (graduates) registered in the home region over the researched period. The data cover students enrolling in universities between 2005 and 2008 and graduates completing their tertiary education between 2001 and 2005. Therefore both samples include four year cohorts. The reason why we chose to investigate an earlier period for graduates than for students is that we acknowledged some graduates do not decide on their place of residence immediately after graduation, but hesitate and try different possibilities before settling down somewhere. The analysis of migration behaviour based on the *nk.pl* database shows that the shares of different migration patterns in the population become stable only if we consider graduates observed 3 years after graduation or later. Thus, since the observation took place in January 2009, we chose to ignore individuals graduating after 2005. In turn, with respect to migration related to university admission, we wanted to consider the most recent available data, which implied choosing the 2005–2008 period.

Every record in the dataset represents one combination of a home (donor) region i and destination region j . As there are 16 regions in Poland, the dataset contains 240 observations (16×15).

The regional characteristics that are used as explanatory variables in the model specification are listed in Table 4.⁴ The physical distance between regions is calculated using data on the road distance between their central cities, extracted from the Google Maps service. The main cities are key attractors in each region both for students (most universities are located there) and graduates. Road distance gives a realistic view on the effort required to travel from one place to another. A square distance is added to capture the fact that the marginal cost of moving one kilometre further is lower at greater distances. The strength of a regional economy is measured by Gross Regional Product per capita (calculated by the Central Statistical Office, data for 2009), adjusted with regional deflators, to reflect the real output of regional economies and account for differences in the living costs in particular regions. The level of unemployment reflects the labour market opportunities in a given region. Central city size may be considered as a proxy measure of the access to cultural amenities (assuming better access in large cities), or more broadly, as a measure of the region's metropolitan character. In turn, the share of regional population with tertiary education is assumed to be linked to the knowledge intensity of a regional economy, but it may be

Table 4. Description of explanatory variables

Variable name	Description
<i>Distance between regions</i>	
Distance_km	Road distance between the central cities in home and destination regions
Distance_km ²	Squared distance between the central cities in home and destination regions
<i>Socio-economic conditions of donor/destination region</i>	
GRP per capita (price adjusted)	Gross regional product per capita in home and destination region, adjusted by regional deflators to reflect the differences in living costs
Unemployment	Unemployment rate in home and destination region
Central city size	Population of region's central city
Share_higher_edu	Share of regional population with a university degree
<i>Service availability in donor/destination region</i>	
Preschool availability	Share of 3–5 years old children enrolled in preschools
Housing availability	Number of apartments per capita

⁴ The model has been tested for standard data or specification features which might lead to biased estimates of regression coefficients or standard errors. The Breusch-Pagan test showed no heteroscedasticity in the analyzed data. The Shapiro-Wilk test proved that the normality of residuals cannot be rejected. The 'Collin' procedure run in STATA reported multicollinearity in the early specifications, resulting in dropping some of the explanatory variables and replacing different indicators of living costs with one regional deflator.

also interpreted in terms of the networking nature of human capital migration. In both cases one would rather expect regions with high level of human capital stock to be more attractive as destinations for skilled migration. Regarding service availability, two variables are included. Housing has proved to be an important determinant of general migration flows in Poland (e.g. Ghatak et al., 2008) and preschools provide a service of particular importance for young adults, with a relatively low level of provision in Poland (compared to other EU countries). Characteristics of regional economy and service availability are included both for the donor and destination regions. The source of all the data, except for road distances between the regions, is Poland's Central Statistical Office.

The results of the model estimation are shown in Tables 5 and 6, for students and graduates respectively. The first observation concerning mobility from home to university is the striking importance of physical distance. Despite the increasing number of available options and growing competition for enrollees between higher education institutions, students tend to choose schools located close to their place of residence. An increase in distance to a potential destination by 10 km is associated with a 16% drop in the measure of migration propensity.

As expected, migration for education is unlikely in the case of students originating from large metropolitan areas. Interestingly, however, the level of regional human capital is positively associated with student outflow. A possible explanation is that students raised in a more educated environment are generally more mobile when it comes to seeking an optimal university or faculty, while those originating from a less academic environment tend to choose education opportunities closer to the family nest.

When choosing where to study, migrating students prefer large metropolitan cities, but they do not attach particular importance to the economic performance of a region. Regional income per capita has an insignificant effect on migration, and unemployment prospects are not decisive, as the statistical impact of the destination region's unemployment rate on migration turns out to be positive.

The role of service availability in directing migration flows from home to university is unequivocal. Students tend to choose regions with better developed preschool care, but at the same time they are – unexpectedly – willing to migrate to regions with lower apartment availability. The latter might be attributed to students' willingness to accept sub-standard quality of housing (e.g. living in over-crowded conditions), in order to satisfy their preference for studying and living in larger metropolises. Another possible interpretation is that, given the scarcity of beds in student houses, permanent migration to the place of studies is conditioned on student income (wealth). In other words, those who cannot afford to rent a room or flat tend to study near their family homes, which results with no effect of apartment availability on student mobility.

The determinants of university graduates' interregional migration, observed between 3 and 8 years after graduation, are shown in Table 6. Despite the fact that graduates entering the labour market are definitely more mobile than students choosing a university, the distance to travel still plays an important role in degree holders' decision about where to settle. It is very likely that this effect is partly

Table 5. The model estimation results for migration to study

log_migr_stud	Coef.	Std. Err.	T	P > t
<i>distance between regions</i>				
distance_km	-0.016300	0.001	-11.64	0.000
distance_km ²	0.000012	0.000	6.93	0.000
<i>socio-economic conditions of donor region</i>				
log GDP per capita (price adjusted)	0.132	0.671	-0.20	0.844
log unemployment	0.072	0.413	0.17	0.862
log central city size	-0.506	0.168	-3.02	0.003
share_higher_edu	17.820	6.054	2.94	0.004
<i>service availability in donor region</i>				
log preschool availability	-1.455	0.543	-2.68	0.008
log apartment availability	0.827	1.154	0.72	0.474
<i>socio-economic conditions of destination region</i>				
log GDP per capita (price adjusted)	0.020	0.671	-0.03	0.977
log unemployment	1.510	0.413	3.65	0.000
log central city size	1.756	0.168	10.47	0.000
share_higher_edu	-4.622	6.054	-0.76	0.446
<i>service availability in destination region</i>				
log preschool availability	1.637	0.543	3.01	0.003
log apartment availability	-6.043	1.154	-5.23	0.000
N	240			
Adjusted R ²	0.78			

Source: own calculations.

driven by the return migration of students who move back to their hometowns after graduating from university. In fact, since circular mobility is included in our analysis of student migration, some individuals whom we consider as moving after graduation are those who just commuted to the university location on a daily basis, but have never changed their place of residence.

With respect to home region characteristics (push factors), graduates are more willing to leave areas with poor employment prospects and a high share of degree holders in the population. A reason for the latter is the fact that academic centres act as gathering points for students enrolled at universities who eventually decide where to settle for work. Thus, a human capital 'donor' function is natural for big academic centres. Note that by focusing on the flows of graduates between regions (pair-wise), the considered sample does not cover graduates settling down in the region of studies after graduation.

In the case of pull factors, the picture is quite clear. Degree holders prefer to migrate to affluent regions with large central cities. The coefficient by unemployment variable is negative as expected, but statistically insignificant, which suggests that although employment prospects may play a role as a push factor, they

are not decisive in graduate decisions on migration destination. When seeking new destinations, graduates tend to choose regions with a high level of human capital. There are two ways of explaining this phenomenon. The first refers to the notion of herd behaviour, where individuals tend to follow the decisions of other members of a given group (in this case, diploma holders). Secondly, the share of people with higher education reflects the structure of a regional economy (its knowledge intensity) and indicates the demand for highly skilled labour force.

The role that availability of specific services plays in graduate location choices is not clear. A shortage of apartments in a donor region acts as a push factor, but simultaneously it seems to attract migrants to a given destination. A possible way of explaining this phenomenon is by considering migration as a highly selective process. Those who decide to re-settle after their studies are usually more affluent than their peers. Thus, they are less sensitive to price differentials on the housing market. Their choices are rather influenced by the opportunities provided by a given locality than costs resulting from such a move.

Table 6. The model estimation results for migration of graduates

log_grad05_stu	Coef.	Std. Err.	T	P > t
<i>distance between regions</i>				
distance_km	-0.01360	0.0010	-14.03	0.000
distance_km^2	0.00001	1.21e-06	8.83	0.000
<i>socio-economic conditions of donor region</i>				
log GDP per capita (price adjusted)	-0.2074	0.4626	-0.45	0.654
log unemployment	1.2119	0.2847	4.26	0.000
log central city size	0.2000	0.1155	1.73	0.085
share_higher_edu	9.0121	4.1702	2.16	0.032
<i>service availability in donor region</i>				
log preschool availability	0.2435	0.3745	0.65	0.516
log apartment availability	-2.4371	0.7953	-3.06	0.002
<i>socio-economic conditions of destination region</i>				
log GDP per capita (price adjusted)	2.0810	0.4626	4.50	0.000
log unemployment	-0.4019	0.2846	-1.41	0.159
log central city size	0.2684	0.1155	2.32	0.021
share_higher_edu	8.5849	4.1701	2.06	0.041
<i>service availability in destination region</i>				
log preschool availability	-1.4634	0.3744	-3.91	0.000
log apartment availability	-3.0748	0.7951	-3.87	0.000
N	240			
Adjusted R ²	0.802			

Source: own calculations.

Differences in living costs between regions are not included in the regression specifications as separate variables, but only through regional deflators used to calculate real GDP per capita. Therefore, in order to verify the impact of living costs on migration flows, we estimated alternative specifications (not shown in the tables) with nominal GDP per capita values used as a proxy of regional economic performance. We did not observe notable differences between the 'real' and 'nominal' model results in either the student or graduate specification. This suggests that regional differences in living costs have no significant effect on the direction of human capital migration in Poland.

Conclusions

The goal of this paper was fourfold: to measure the mobility of students and graduates within a transforming economy using the case of Poland, to discuss the typology of skilled migration, to identify the winning regions and those which are subject to brain drain, and to identify major push and pull factors determining interregional flows of human capital. Different datasets were combined, but the crucial and unique data on mobility were collected from the social networking website *nk.pl*.

The mobility of Poland's human capital is low. Graduates seeking employment are more prone to migrate than students when choosing where to study, but still only 24% of graduates move to another region after completing tertiary education, and almost two thirds of those who move actually come back to their domicile region.

Despite increasing returns from education, the average mobility of students, proxied by the average distance between the secondary school and the chosen university, decreased during the 1990s and 2000s, following a long-term trend. Clearly, the supply effect (a fast developing network of tertiary schools outside large metropolises) has offset the effect of an increasing demand for education. In turn, there is no clear trend in the mobility of graduates. Growing interregional economic disparities should encourage their mobility (cf. Venhorst et al., 2010), but graduates' propensity to migrate seems to be strongly affected by the socio-economic situation in Poland at the time they were entering the labour market (e.g. unemployment level, impact of opening labour markets in EU countries).

The decreasing mobility of tertiary students in a transforming economy may also reflect students' lack of clear preferences with respect to the field of studies or even the school in which to enrol. In line with earlier findings of Herbst and Rok (2014), the educational boom accompanying economic reforms relied more on the negative choices of students trying to escape from the vocational track that led to unemployment than on positive and conscious decisions to follow their own interests and ambitions. Such an attitude, combined with limited housing opportunities outside the home region, necessarily leads students to choose universities close to their places of residence (to minimize costs) and faculties which are easily accessible and offer general rather than highly specialized courses. Note that following the rapid development of tertiary schooling in the 1990s,

the study field structure in Poland became significantly skewed towards social sciences and humanities, as compared to both student distribution prior to 1989, and the present-day structure observed in EU countries. The key role of distance to university in explaining migration flows confirms that factors pertaining to the quality of studying are still underdeveloped in Poland (cf. Long, 2004).

The most common strategy among young Poles, according to the typology of sequential migration behaviour, is non-migration (27%). However, repeat and return migrations are almost equally common (26% and 25% respectively). Although the difference in the type of analyzed data makes direct comparison between countries difficult, it seems that Polish graduates are less mobile than those in the UK. Lower mobility might result from less pronounced interregional economic disparities, i.e. the incentive to move is rather weak. And the striking importance of distance in explaining the migration behaviour of young Poles indicates that costs of migration are high. Thus lower mobility may be due to the high level of dependence on family resources, both in respect to housing opportunities, and to the role of family-based social networks in searching for employment.

Only regions with large metropolitan cities experience net gain of human capital in consequence of skilled migration. Meanwhile, the most severe brain drain is observed in the economically peripheral eastern Poland. On the one hand, this process reduces the endogenous potential of less developed regions, aggravating interregional economic disparity. But, as pointed out by Marinelli (2013), graduates are less often able to find employment matching their skills in their home regions. A certain level of local techno-economic development is required to allow a region to fully benefit from highly skilled graduates, and this is found in the metropolitan regions. Indeed, our study finds that graduates tend to leave regions with higher unemployment rates and move to larger cities, characterised by more diverse and knowledge-intensive labour markets.

The results of this study add to our understanding of the polarization processes taking place in transition economies. Despite the growing dispersion of higher education institutions, fuelled by the marketization and privatization of this sector, highly skilled individuals tend to cluster in the largest metropolitan areas. This reflects the growing inclusion of Poland in global economic trends, where the new division of labour and accelerating pace of innovation define the capacity of a region to attract and retain skills (Boschma et al., 2013).

The level of spatial concentration rises systematically with home-to-study and then study-to-work transitions. This finding corroborates the modern approach to agglomeration economies, which emphasizes the tendency of highly skilled labour to be concentrated in specific cities, rather than cities in general (cf. Faggian et al., 2013, Consoli et al., 2013). The relatively high levels of return migration observed in Poland are not sufficient to counteract the concentration of skills in core regions. In respect to human capital potential, polarization seems to outweigh diffusion processes. Given the role of human capital in regional development and the inability to fully benefit from high skills in the labour markets of

lagging regions, the question of rethinking, enabling and facilitating diffusion processes arises.

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