European Planning Studies

ISSN: 0965-4313 (Print) 1469-5944 (Online) Journal homepage: https://www.tandfonline.com/loi/ceps20

The City as a Focus for Human Capital Migration: Towards a Dynamic Analysis of University Human Capital Contributions

Paul Benneworth & Mikolaj Herbst

To cite this article: Paul Benneworth & Mikolaj Herbst (2015) The City as a Focus for Human Capital Migration: Towards a Dynamic Analysis of University Human Capital Contributions, European Planning Studies, 23:3, 452-474, DOI: 10.1080/09654313.2013.868869

To link to this article: https://doi.org/10.1080/09654313.2013.868869

European Planning Studies, 2015
Vol. 23, No. 3, 452–474, http://dx.doi.org/10.1080/09654313.2013.868869

The City as a Focus for Human Capital Migration: Towards a Dynamic Analysis of University Human Capital Contributions

PAUL BENNEWORTH* & MIKOLAJ HERBST**

*Center for Higher Education Policy Studies, University of Twente, Enschede, The Netherlands, **Centre for European Regional and Local Studies (EUROREG), University of Warsaw, Warsaw, Poland

(Received October 2012; accepted November 2013)

Abstract *Universities' contributions to urban development frequently focus on their micro- or macro-scale effects, ignoring the meso-scale effects they have on inter-territorial relationships. Although universities are seen as an essential part of the recipe for successful urban development, there is a lacuna to understanding how they make places and shape urban hierarchies, and this article addresses this question. This article focuses on one university–urban development process, the creation and embedding of highly skilled graduates, to explore what the aggregate effects of universities on places are; it develops a set of indicators to measure graduate attraction and retention as well as the overall composite place effect. The article develops a typology based on these three indicator sets, and tests this using a data set developed from a Polish social media website. It finds that these indicators are a good way of measuring the effects of human capital creation and mobility at the urban scale. The article concludes by arguing that a greater focus is required in studying the roles that universities play in fostering through-flow in places, changing these places' nature as nodes within wider urban systems and hierarchies, in the context of university–regional development.*

Introduction

What makes a city an economic growth centre and social hub? Clearly, the social and economic roles of cities have evolved over the last century. In the era of heavy industry, resource-intensive manufacturing located itself to access resources, near water power or ports, and workers located near those industries. Cities emerged both as sites for manufacturing, and also as centres of co-ordination of the economic distribution networks that underpinned those industries. As summarized by Bradshaw and Blakely (1999), in the

Correspondence Address: Paul Benneworth, Center for Higher Education Policy Studies, University of Twente, Postbus 217, Enschede 7500AE, The Netherlands. Email: p.benneworth@utwente.nl

past there existed three key factors of urban development: location, location, and … location: city growth was determined by exogenous factors. However, the role of endogenous factors (i.e. factors independent of location) in local economic growth has steadily increased over time.

Some of these factors originate from the very nature of a city: cities strongly benefit from the economies of scale, which stimulates their further development (Krugman, 1991). More generally, economists argue that a city creates important positive externalities related to the access to public services, reduced transaction costs, the presence of dense social networks, and a diversified labour market. Certainly in the post war period, cities have also acted as foci for total factor productivity growth, given increasing returns to scale on knowledge capital investments (Romer, 1994; Temple, 1998). All these provide strong incentives for an individual to settle down and make a city grow (Glaeser, 2010), but until the mid-1990s these issues were ignored in favour of the availability of natural resources and a transportation network. And increasingly it is the stock and quality of human resources that determine the growth potential of a region, rather than its physical proximity to markets, natural resources or suppliers. But at the same time, individuals make their locational decisions regarding where to live on the basis of the territory's economic success, reinforcing existing patterns. This makes it hard to understand whether human capital leads or lags urban development.

Our starting point is to argue that there has been a tendency for research to assume that locational decisions are entirely shaped by the existing economic structure: human capital is therefore assumed to reflect existing economic structures and hierarchies, or to lag, economic development. But at the same time, human capital is by its very nature formed in particular places, and not just through economic activity, but through education, with human capital formation leading economic development. Here, we seek to redress this balance and explore how one such leading characteristic, mobility within the higher education system, affects where human capital forms. Using a modified Hoare and Corver (2010) student mobility classification we develop a set of measures for "city performance" in terms of how well they perform in the attraction and retention of students and graduates (activity that "leads" economic activity). We use this classification to develop a typology of Polish cities based on student movement data, and relate it back to the more usual indicators used in socio-economic performance. This enables us to explore the extent to which cities' attractiveness for highly mobile individuals is shaping a new urban hierarchy in a country undergoing economic transition.

Human Capital and Urban Development

Economic theory suggests at its most basic that human capital affects regional (and urban) development by improving territorial labour productivity or by enhancing an economy's capacity to generate and absorb innovations (Nelson & Phelps, 1966; Lucas, 1988). Empirically, the correlation between education levels and both economic wealth and productivity growth levels is well established. Mankiw *et al.* noted in *American Economic Review* (1992) that differential *per capita* GDP levels between various countries can largely be explained by educational differentials. Their model, the so-called augmented Solow model, considerably enhanced GDP per capita forecast qualities over models explaining growth via factors such as labour resources and physical capital (OECD, 2012).

Their results influenced a wave of researchers who verified this influence of human capital on economic growth (*inter alia* Benhabib & Spiegel, 1994; Barro, 1999; Bils & Klenow, 2000; Bernanke & Gurkaynak, 2001). Subsequent research confirmed that this relationship holds at the regional as well as national levels with both *growth rates* and GDP levels being influenced by the education level (*inter alia* Di Liberto & Symons, 2001 for Italy; Badinger & Tondl, 2002 for 128 EU regions in 10 member states; Herbst, 2007 for Polish sub-regions post-1989). De La Fuente (2002) demonstrated the importance of converging educational levels in driving Spanish regional convergence. Persson and Malmberg (1996) likewise demonstrated US regions' long-term correlation of education and growth levels (1920–1990).

Existing urban structures reflect past locational pressures in the traditional manufacturing economy, but with contemporary urban evolution increasingly based on knowledge and specialised services, mobility from "rustbelt" to "sunrise" locations can drive sometimes profound changes in urban hierarchy. This is most recently exemplified by Detroit's spectacular bankruptcy—a classic booming industrial city of the early 1900s, which lost 25% of its population 2000–2010. Conversely, a number of cities have built their economic position on human capital investments, including Eindhoven (the Netherlands), Malmo (Sweden) or San Diego (US). These cities are fast-growing metropolises, leading world rankings of innovative cities according to OECD statistics based on patent intensity (cf. *Forbes* magazine, 9 July 2013).

A key ingredient in the recipe for knowledge-based urban growth is the university (OECD, 2007; Perry & May, 2010; Goddard, 2011; Goddard & Vallance, 2013). A range of literatures have sought to understand how universities contribute to territorial development. A first wave sought to calculate universities' economic impacts (*inter alia* Cooke, 1970; Brownrigg, 1973; McNicoll, 1995; Hermansson *et al.*, 2012). A second wave highlighted the range of benefits which universities bring (*inter alia* Arbo & Benneworth, 2007; OECD, 2007; Bramwell & Wolfe, 2008), including the roles they play as:

- pipelines to global knowledge sources (Bathelt *et al.*, 2004),
- drivers of regional industrial clusters (Malecki, 2011),
- sources of new high-technology firms (Siegel, 2011),
- sources of experts improving regional governance (Gunasekara, 2006; Healey, 2008).

A third wave explored the contributions which universities make to territorial innovation networks, whether conceptualised as territorial innovation systems or ecologies, or technological innovation systems (Asheim & Coenen, 2005; Edquist, 2005; Hekkert *et al.*, 2007). More recently, the emphasis has been placed on universities as drivers of knowledge-based urban development processes, providing place leadership and creating spatial frameworks encouraging co-operation and knowledge overspill (Yigitcanlar, 2010). And it is through this latter lens that universities' contributions to urban development have been understood, providing place leadership, supporting innovation and creating graduates (cf. Goddard & Vallance, 2013). However, a knowledge economy characterised by highly mobile individuals, where skills are exploited where they are needed rather than where they are created (cf. Florida, 2004) calls into question how universities contribute to urban knowledge capital stocks. This demands a dynamic and comparative form of analysis, not just looking at one particular place, but looking at how these

spatial mobility preferences are changing places' function simultaneously in the context of a wider urban system.

We conceptualise the individual perspective around the notion that universities attract talent to a place for a period of study after which time that talent might not be retained (*inter alia* Delisle & Shearmur, 2010; Corcoran *et al.*, 2011; Haapanen & Tervo, 2011; Di Maria & Lazarova, 2012). At its worst, "brain-drain" may see universities equipping their localities' brightest individuals to leave, undermining regional human capital levels (*inter alia* Franco *et al.*, 2010; Venhorst *et al.*, 2010; Oosterbeek & Webbink, 2011). We therefore argue that it is necessary to develop a framework for universities' human capital formation effects which captures both these potential positive and negative effects. This needs to be understood at the level of the national system, and which places are "winning" or "losing" need to be understood beyond simplistic narratives of world cities acting as "escalator regions" (cf. Fielding, 1992).

Cities as Attractors and Producers of Human Capital

The most significant contribution that universities make to human capital is delivered through migration (Abel & Deitz, 2012). Our starting point is to stylise the flow of human capital between regions emphasising individual decisions at two points in the mobility process (following Hoare & Corver, 2010). Firstly, cities attract students to a region at the point study commences, changing student location. Secondly, graduates then choose where to work on the basis of available job opportunities. This influences where human capital is absorbed, and the overall pattern shapes the evolving urban hierarchy; different regional characteristics influence where universities' human capital is eventually absorbed. A university study is a human capital upgrading process where students take courses and examinations which improve their later employability. Universities clearly have an upskilling effect on the individuals, but this has little influence on where those students eventually end up using their human capital, and hence on the overall national urban system.

Bound *et al.* (2004) found no significant relationship between the production of degrees in US states and their shares of highly skilled workers. With regions competing for human capital, various push and pull factors affect individual students' and graduates' decisions on migration at the start and the end of tertiary education. Much of the change in observed stock of young, skilled labour force (human capital) is accounted for by education decisions. In this paper, we focus on the possible effect of human capital mobility on urban hierarchy. At the heart of Hoare and Corver's model is that initially all potential students live at home, they then make two choices, one where to study and then where to live and work following graduation. They use a 2×2 classification based on whether to study and then work locally or externally; the four classes are locals (study and work locally), settlers (who migrate to study then settle), returners (who migrate to study then return home), and outsiders (study locally but migrate to work). Hoare and Corver use a simple 2 region model, and therefore for the sake of completeness it is necessary to add a mobile class (those who migrate to study, then migrate to 3rd region to work, Marinelli, 2013). This would suggest that there is a relatively simple four-way classification of cities that can be made with respect to their benefits from human capital mobility:

- *Winning cities* attract many students, even from distant localities and successfully absorb graduates on the labour market (high values in all areas)
- *Supra-regional centres* perform well in attracting students (high numbers of locals and returners), but suffer from a net outflow of tertiary graduates;
- *Post-university migration destinations* do not have an important higher education function but nevertheless perform well in attracting and absorbing graduates;
- *Local academic centres* have both a low ability to attract students (especially from outside the region) and low attractiveness as a place of graduate residence.

We acknowledge that the mobility effect has a number of degrees of complexity and nonlinearities that hinder generating simple stylised facts concerning human capital formation in regions (Delisle & Shearmur, 2010). Graduates are more mobile nationally and internationally than non-graduates (*inter alia* Hensen *et al.*, 2009; Venhorst *et al.*, 2010). Graduate mobility is also affected by a locality effect: graduates tend not to move when studying in large cities with high wage rates and GDP levels, and low unemployment levels (Faggian *et al.*, 2006; Faggian & McCann, 2009; Ishitani, 2011). Graduates studying in their home region tend to be less mobile than those who move to study (Franco *et al.*, 2010). Gibbons and Vignoles (2010) find that in England, although distance to the nearest institution does not affect the choice regarding study, it does affect the location of study, disadvantaging more rural areas in particular. Venhorst *et al.* (2010) find significant graduate migration between peripheral areas rather than a one-way flow from periphery to core regions. Comunian *et al.* (2010) find that "bohemian" creative graduates typically accept much lower salaries than their human capital would suggest, questioning the Floridian relationship.

Mainstream economic theory explains population flows in terms of moving from poorer to economically flourishing areas, blending two theoretical fields, namely human capital and job competition. Within human capital theory, migration flows result from individuals' higher expected returns to human capital investments (Faggian & McCann, 2009). Job competition theories propose that regional labour markets allocate a given job to the candidate with the best applicable skills (Venhorst *et al.*, 2010). Thus, human capital approaches emphasize individuals' personal characteristics, while the job-competition model focuses on the economic characteristics of both origin and destination. Recent decades have seen mainstream economic theory being systematically broadened to include softer factors, like quality of life and various amenities (cf. Florida, 2002) or a notion of migration as a collective rather than individual decision (Stark, 1991).

Baryla and Dotterweich (2001), Faggian and McCann (2009), or Mosca and Wright (2010) all demonstrate how higher education institutions' (HEIs) characteristics may have significant impact on student and graduate mobility, and consequently, urban hierarchy. In this article, we draw on the argument that universities and their places should be studied as a single entity (cf. Lawton Smith, 2007; Benneworth *et al.*, 2010; Goddard & Vallance, 2011; Martin, 2011). We argue that universities play important role in driving human capital migrations, but the academic function of a city should be considered jointly with other territorial characteristics affecting young, skilled individuals' migration decisions, certainly when considering impacts on human capital formation processes. We use a modified concept of absorptive capacity (Cohen & Levinthal, 1990; Vang & Asheim,

2006), "urban absorptive capacity" to refer to the ways in which cities positively contribute to human capital flows comprising both elements of educating students but equally importantly, retaining those graduates. Our operational research question is "how can the 'urban absorptive capacity' be defined, operationalized and its urban hierarchy effects typologised?", as a first step towards understanding how university-city systems' characteristics affect economic development.

Operationalising Urban Absorption Capacity for Human Capital

In the previous section, we identified three important processes relating human capital upgrading/mobility and the changing urban hierarchy. We therefore seek to operationalize these three processes, namely the attraction of students to an area, the retention of those individuals as graduates, and the aggregate effects this has in terms of the urban hierarchy. Migration brings both benefits but also costs. The benefits are the attractiveness of different destinations (the quality of the university, expected wages on the local labour market, career opportunities, and Floridian quality of life aspects. The cost of migration includes monetary and mental elements; the monetary elements include price differentials and travel costs to see family, whilst the mental cost comes through reduced familial support, the loss of social networks,[1] and the loss of symbolic value invested in places. The net benefits of migrating to a given city from a student's perspective is therefore the difference between the expected benefits and the costs, and we conceptualise attractiveness as this net difference. In this research and following Ghatak *et al.* (2008) migration distance is used as a proxy for value—the further people move to a city, the more valuable the city is to them, and likewise, the two costs of migration, travel and mental costs are positively correlated to origin-destination distance (whilst data on inter-urban differences in living costs are frequently unavailable).

If the cost of migration is proportional to distance, then an individual considering two destination cities offering similar benefits will always choose the one located closer to the existing residential location. Based on this assumption, we regard a city's attractiveness as a human capital migration destination as its capacity to attract people from distant localities. We can alternatively measure a city's attracting power by verifying its success in attracting migrants from outside its own region. Our two attraction variables are as follows:

- Attraction 1: How far are students willing to travel to study in a city?
- Attraction 2: How many students does the city attract from outside its own administrative region?

The second set of indicators relates to the extent to the second step of the process, namely how far the city is able to retain these graduates, and consequently does not suffer from brain drain. We operationalize this in terms of three indicators, firstly the proportion of graduates that settle in a city (Hoare and Corver's locals and settlers), secondly, the proportion of non-local students that stay (to work, settlers, outsiders and mobiles), and thirdly, the mean distance that graduates settle from a city (as a value proxy using the argument above).

- Retention 1: What proportion of local university graduates settle in the city?
- Retention 2: What proportion of graduates originating from outside the city settle there after graduation?
- Retention 3: How far from the city do departing graduates go after they complete higher education?

The third set of measures are a pair of indices which map two dimensions along which the composite urban effect emerges, attempting in different ways to combine these attraction and retention effects, in two separate ways. The first is a gravity effect, namely do cities attract students from far afield and embed them locally (high gravity) or vice versa? The second is a net effectiveness of migration, as the net number of mobile students who eventually stay in a region, as a proportion of all the mobile students attracted.

- Composite 1: What is the ratio of the mean distance of attraction for study over the mean distance of departure after graduation?
- Composite 2: What is the ratio of the net number of mobile students attracted and embedded in the region?

We use these questions as the basis of a set of performance measures for "academic places" with respect to the attraction and absorption of human capital. We have operationalized them into a set of performance measures, and those operationalizations are explained here as a formula with explanation (Table 1).

We acknowledge that at least some of the human capital attraction indicators might theoretically underrate cities located close to border regions which may have limited capacity to attract students from outside the province. Although this seems a serious limitation, in reality contemporary universities attract large numbers of foreign students, with a border location being perceived of as an asset rather than a burden. In the European University Viadrina located in Frankfurt an der Oder, around 40% of students origin from outside Germany (mostly Poland); likewise the Medical University of Bialystok (eastern Poland, close to the Belarussian border) has a foreign student enrolment of around 15%.

Methodology and Study Approach

In this paper, using these indicators we have attempted to assess the ability of 18 Polish cities to attract and absorb human capital in the context of educational and post-educational migration. We have used Poland primarily because of the availability of a rich data source. The Polish public statistics system does not allow in-depth analyses, saying nothing about the past of the students studying in various cities, the secondary schools they attended or distances they are willing to travel to study. Such data can be found in the USOS software now being widely introduced by Polish universities, but access is given rather reluctantly due to data-protection fears or technical difficulties. However, data for one HEI is insufficient evaluate the "academic attractiveness" of the whole city or to compare cities. This is reflected in previous studies on student attraction capacity in Poland being either monographs which analyse individual HEIs' situations (Wasielewski, 2004) or relying on estimates based on very general Central Statistical Office

Table 1. Measures of human capital attraction and retention

Label	Formula	Description	Rationale
Measures of human capital attraction (N = number of students) for City i			
Student attractiveness	$AT_{1i} = \overline{d}_{i\text{sec\_tert}}$	Mean distance from secondary school to tertiary school in *i*	Large "catchment area" of a city reflects its high performance in attracting students
Supra-regional attractiveness	$AT_{2i} = \frac{N_{i\text{stud\_outreg}}}{N_i}$	Share of tertiary students coming from outside of *i*'s region in the total student population of *i*	As regional capital hosts a variety of HEIs, the ability to enroll students from outside the own administrative region is a sign of city's attractiveness
Measures of human capital retention (N = number of graduates)			
Job attractiveness	$AB_{1i} = \overline{d}_{i\text{tert\_resid}}$	Mean distance from tertiary school in *i to graduate's place of residence*	Graduates settling down close to the city confirm its ability to absorb human capital
Settlers	$AB_{2i} = \frac{N_{i\text{settlers}} + N_{i\text{local}}}{N_i}$	Share of *i*'s university graduates (both locally born and incoming) settling down in *i*	Shows the attractiveness of the local labour market and residential areas for degree holders
Settling incomers	$AB_{3i} = \frac{N_{i\text{settlers}}}{N_{i\text{grad}} - N_{i\text{local}}}$	Share of tertiary students settled in *i among those who* came from outside the *i*'s region	Measures the attractiveness of the city for those graduates, who are not locally rooted
Measures of overall urban absorption capacity (N = number of graduates)			
Gravity measure	$CI_{1i} = \frac{\overline{d}_{i\text{sec\_tert}}}{\overline{d}_{i\text{tert\_resid}}}$	Ratio of mean distance from secondary school to tertiary school (for all students in city *i*) and the mean distance from city *i* to the current residence of *i*'s graduates	A composite measure of human capital absorption returning high values for the cities attracting students from even distant localities and retaining graduates within the agglomeration
Net human capital benefit	$CI_{2i} = \frac{N_{i\text{settlers}} - N_{i\text{outsiders}}}{N_{i\text{settlers}} + N_{i\text{outsiders}}}$	A difference between the number of students incoming to the city *i* to receive education and eventually settling down in *i*, and the number of locally born students who studied in *i* and eventually left to another region, divided by the sum of the two categories.	A measure based on the concept of migration effectiveness. The numerator can be interpreted as *i*'s net gain of human capital, while denominator represents the sum of mobile students. Values significantly exceeding zero indicate permanent destinations for skilled migration, whilst below zero indicates only temporary (intermediate) destinations, where students tend not to stay.

data (Chojnicki & Czyż, 1997). Likewise, graduate destination data is even scantier (unlike countries like the Netherlands, the UK or Italy), typically conducted by individual HEIs, by university career bureaus, promotional bureaus or graduates' associations (cf. Losy absolwentów—raport, 2008). These studies differ in terms of numbers and methodologies and are difficult to meaningfully combine, and usually lack an explicit spatial mobility dimension.

Our study circumvents these problems by using data harvested from *nk.pl*, a social networking website where users voluntarily register in the list of their current or past class or student group to maintain or renew social contacts. In order to find classmates, the potential user needs to virtually register in real schools and classes which he or she attended, and cases of fabrication (as a joke or for commercial purposes) are easy to uncover and subsequently can be omitted in research.[2] This increases the overall reliability of the data. At the same time what distinguishes the *nk.pl* website as a scientific tool is its mass popularity at particular point in time. At the end of 2008, the website had over 11 million registered users, meaning over one-third of web-active Polish citizens were registered in *nk.pl* at the time of our research. We expect our proportional study population coverage to be much higher because young people are considerably overrepresented among the website's users. This research uses *nk.pl*'s registered users in January 2009, defining users as being virtually "enrolled" to any tertiary school as either a student or former student, restricting the sample to individuals who graduated after 1990. This produced 2.0 m observations, (1.3 m graduates (65%) and 0.7 m (35%) students at the time of data gathering). The average user age (only those users who revealed their age) was 28 years, and women accounted for 62% of the sample.

Using social network data does impose a number of limitations, including the bias towards younger users, those with access to the internet (according to the Polish Central Statistical Office in 2010 about 39% of households did not use the Internet), and there may be a self-selection of successful individuals willing to make their career progress public. These are not fatal flaws in the dataset: given that the research seeks to assess the current capacities of cities to attract students and retain young graduates in the local labour market, even a considerable overrepresentation of young people in the research sample is not an adverse feature. We assume a *de minimis* significance of internet access regarding the population of students and university graduates. Finally, self-selection on nk.pl is restricted by its relatively limited scope, only allowing users to register their attended schools, therefore not serving as a platform for self-promotion.

Human Capital as Factor of Urban Transition in Poland

Poland was chosen for this study not only because of the availability of data but because of the relative speed at which Poland transformed from an industrial into a knowledge economy following communism's collapse. In 1989, 29% of the Polish labour force were employed in manufacturing, and 28% in agriculture, the following years saw the service sector mushroom alongside closures of inefficient state enterprises shrinking the agricultural and manufacturing base. In 2011, 56% of all employees worked in the service sector, and 17% in agriculture (predominantly in private enterprise), with the economy now being predominantly private (62.9% of employment, 77.5% of GDP). Poland is divided into 16 administrative provinces, each having a provincial capital, although in the provinces kujawsko-pomorskie and lubuskie, capital functions are

divided between two cities (Bydgoszcz and Toruń, and Gorzów Wielkopolski and Zielona Góra, respectively), giving 18 major cities in total.

Today, Poland is a country with a population of 38 m and a GDP per capita of €15,300 PPS, 65% of EU average compared to 51% at EU accession (2004). Urban areas played a crucial role in the transformation period: new jobs were mostly created in large cities, alongside rural-metropolitan migration exacerbated by rising unemployment in rural and declining industrial regions. The shifting hierarchy has been hallmarked by traditionally industrial cities losing population, as multifunctional metropolises attracted migrants from elsewhere. Meanwhile, the other metropolitan cities experienced positive net migration rates to both their inner cities and surrounding areas. Between 1995 and 2011 the total population of the five largest metropolitan areas (Warsaw, Cracow, Katowice, Wroclaw, and Gdansk) increased from 9.8 m to 10.1 m, 26% of the total population (GUS 2012), with individual growth rates corresponding to Greater Warsaw (9.2%), and the metropolitan areas of Gdansk (7.8%), Poznan (7.8%), and Cracow (5.8%). Conversely, the metropolitan area of Lodz, a leading textile area since the nineteenth century, lost 8% of its population 1995–2011, its inner city losing 12% of residents, and the city falling from being Poland's second city to its fourth. Upper Silesia, specializing in mining and heavy industries, was similarly affected, with the whole population falling by 8.3% (1995–2011), and some cities such as Katowice or Bytom losing more than 10%.

Industry's collapse led young people to shun vocational training (directed to the needs of the centrally planned economy) and invest in general education. This is visible in secondary school figures—whilst in 1990–1991, 76.5% of secondary students attended various types of vocational schools, a decade later, 62.3% of secondary students were enrolled at vocational program, including a 20% point drop at basic vocational schools. This produced a student body well-equipped to attend university. Since transition, higher education has expanded dramatically from 400,000 to almost 2 m students, a shift in participation rate from 10% to 40% (Herbst & Rok, 2011) whilst the number of tertiary schools has increased from 112 to 456 (Główny Urząd Statystyczny 2009).

Large cities clearly attracted young people by offering opportunities for tertiary study. More than 300 (mostly private) HEIs were founded between 1990 and 2010, inducing migration of youth people to large and middle size cities in search for education. Each major city hosts universities, but the distribution is uneven: Warsaw hosts 20% of all Polish students. Although many smaller cities also perform academic functions in Poland, in this work we focus on the 18 major cities with the status of provincial capitals, as the academic function in Poland is concentrated in these major metropolises. (Some research shows that medium-sized cities may also play important roles in regional economies, cf. Adam, 2006 for the case of Germany). One important argument for considering metropolitan cities rather than smaller towns is that they usually host a mix of different HEIs, differentiated in terms of study fields and quality. This makes cities more comparable to each other with respect to their academic functions. A map of Poland indicating the 18 Polish academic cities, including population and GDP information, is shown in Figure 1.

Characterising the Human Capital Effects of Polish Cities

The first part of the research question concerns the indicators developed to measure the attraction and retention of students and graduates in the respective provinces. The

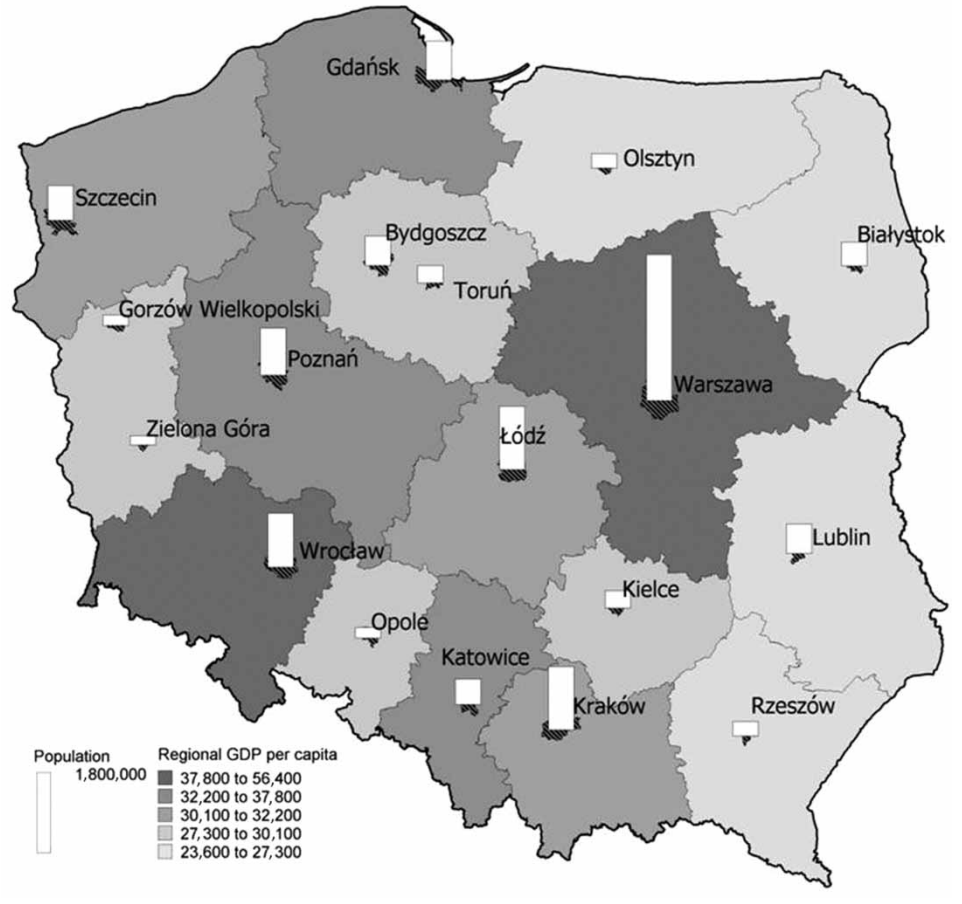

Figure 1. The 18 Polish academic cities, their relative populations, and provincial GDP per capita (in Polish Zloty, 2009).
Source: Based on data from Central Statistical office.

values of these indicators (AT and AB) for the 18 academic cities in Poland are shown in Table 2. They reveal substantial variability in different academic cities' capability to attract and absorb students from outside the local province.

Attractiveness Indicators

When measured with the Student Attractiveness indicator (average distance from secondary to tertiary school), the attracting power of the cities is expressed in kilometres, and is independent of the city's location with respective to provincial borders and provincial size. According to this measure, Warsaw is the top-performing city in attracting students from distant localities (92.4 km on average). The catchment area of Poland's other largest metropolises—Poznań, Wrocław and Kraków–is also large, with a value of AT1

Table 2. The values of attraction and retention of human capital for 18 academic cities

City	Student attractiveness, km (AT_1)	Supra-provincial attractiveness (AT_2) (%)	Job attractiveness, km (AB1)	Settlers (AB_2) (%)	Settling incomers (AB_3) (%)
Białystok	53.9	18.5	64.4	44.2	15.7
Bydgoszcz	56.7	23.8	58.9	38.7	17.0
Gdańsk	73.6	31.6	57.6	37.2	26.0
Gorzów Wielkopolski	54.4	29.0	78.1	35.4	10.3
Katowice	38.3	15.5	43.7	14.9	9.5
Kielce	49.8	29.2	64.7	30.1	7.8
Kraków	79.7	42.3	63.4	42.5	28.3
Lublin	69.0	26.5	80.1	35.4	15.0
Łódź	46.6	20.5	45.7	47.8	20.3
Olsztyn	83.3	38.8	80.5	30.1	16.3
Opole	57.7	36.3	61.1	24.7	11.8
Poznań	85.5	32.7	71.5	39.6	24.8
Rzeszów	47.9	18.4	60.9	29.4	16.0
Szczecin	87.0	23.4	86.0	42.7	21.2
Toruń	79.6	37.7	78.3	29.3	17.2
Warszawa	92.4	38.0	58.2	52.4	35.4
Wrocław	82.0	35.4	66.1	42.5	27.7
Zielona Góra	67.2	42.5	77.3	24.5	8.7

Notes: (AT_1), mean distance from home to school; (AT_2), percentage of extra provincial students; (AB1), mean distance from university to graduate's place of residence); (AB_2), share of local university graduates settling down locally. (AB_3), share of settling local university graduates among those who came from outside the province.

ranging from 79.7 to 85.5 km, although two medium-sized cities—Szczecin and Olsztyn–perform at a similar level (87.0 and 83.3 km, respectively).

A striking exception from the rule that the largest cities are most successful in attracting students is the city of Łódź—the third largest metropolis in Poland. The city has one of the lowest share of students from outside the province and the radius of its catchment area is below 50 km—the second lowest. One possible explanation of this phenomenon is that Łódź—from the nineteenth century an important textile manufacturing centre—has never been a recognized academic centre. Transformation towards a free market economy saw most state owned enterprises collapse with Łódź entering a period of high structural unemployment. The proximity of Warsaw (142 km, 90 min by train), home to higher ranked and more attractive universities, appears to drain the city of valuable human resources.

There is a different situation in Katowice, Upper Silesia province's capital, which is the centre of Poland's mining and steel industries. Like Łódź, Upper Silesia experienced a severe decline during transformation, but Katowice's poor performance in attracting students from distant locations, observed in Table 2 ($AT_1 = 38$ km), results less from the city's HEIs's weaknesses, and more because Katowice is a part of a densely populated multi-city agglomeration, 1000 km^2 of urban sprawl (25 linked cities) with 2 m population. This agglomeration is a natural catchment for Katowice's HEIs but its lower Student Attractive-

ness indicator values should not be interpreted as sign of underdevelopment in Katowice's academic function.

In low-performing cities, such as Białystok or Rzeszów, incoming students account for less than 20% of the total student population. Meanwhile, in the highest ranked cities, more than 40% of students finished secondary school outside the province. Surprisingly, the cities with the highest value of Supra-provincial Attractiveness indicator (AT_2) include Zielona, Góra and Opole, average-sized western cities. Unlike other high-rated cities (such as Warsaw, Kraków, or Wrocław) they are not known for their well-developed academic function, possibly suggesting that AT_2 is influenced by the size of province in which a city is located (ceteris paribus universities in small provinces attract more extra-provincial students than in large provinces).

On the basis of this attractiveness we hypothesise a four-way division in urban functions; there are well-developed academic cities with a national function, universities embedded within metropolitan centres, important academic cities which have a large hinterland because of their relative distance from other university cities, and local centres in the shadow of important academic cities and metropolitan centres. We also argue that of these two measures, Student Attractiveness and Supra-provincial Attractiveness appear to be the most directly useful for classifying the ability to attract students.

Retention/Absorption Indicators

Columns 3–5 in the Table 2 measure cities' performance in absorbing university graduates of HEIs. City size is a decisive factor in determining cities' residential attractiveness for educated employees. Poland's largest metropolises—Warsaw, Kraków, Poznań, Wrocław, Gdańsk and Łódź—all rank top for all three measures (see Table 3). Comparing the measures of human capital attraction and absorption in Table 2 we notice that the pre-

Table 3. The ranks of Poland's 18 cities for retention indicators

Indicator	Job attractiveness, km (AB1)	Settlers (AB_2)	Settling incomers (AB_3)
Warszawa	4	1	1
Łódź	2	2	7
Kraków	8	5	2
Gdańsk	3	9	4
Wrocław	11	6	3
Bydgoszcz	5	8	9
Białystok	9	3	12
Poznań	12	7	5
Szczecin	18	4	6
Rzeszów	6	14	11
Katowice	1	18	16
Opole	7	16	14
Toruń	15	15	8
Gorzów Wielkopolski	14	10	15
Kielce	10	12	18
Lublin	16	11	13
Olsztyn	17	13	10
Zielona Góra	13	17	17

ference for large cities is more prevalent among university graduates (when choosing a place to live and work) than among students (choosing a place of study). Łódź is once again influenced by Warsaw's proximity, the short distance between the two cities allowing graduates to live in Łódź while working in Warsaw thus minimizing living costs. Warsaw's proximity appears to improve Łódź perceived performance in terms of graduate absorption. The results also confirm that the case of Katowice should be considered separately and it is not really comparable to other cities, retaining only 14.9% of local school graduates (the lowest score among the 18 cities), and with poor rates for settlers and settling incomers, but those that do graduate stay locally—43.7 km, leaving the city but staying in the agglomeration, Wrocław, Opole and Łódź all being within commuting distance.

Composite Urban Absorption Effects

The third set of indicators are related to the composite migration effects on the city within the wider national urban system, and these are shown in Table 4 (along with their ranks). High values of performance indicators referring to both attracting students and absorbing graduates may be interpreted jointly as a sign of a city's ability to benefit from its academic function (by creating and accumulating human capital and thus stimulating economic growth). Meanwhile, high performance in just one of the considered areas (student attraction or graduate absorption) indicates limited benefits from the university. A city with a low ability to attract students and a low rate of graduate absorption suggests that hosting HEIs has little influence on the city's development potential.

Looking at the rankings for both variables, we end up with five large metropolises strongly outperforming other cities (see Table 4 according to both used indicators). Not

Table 4. The values of composite absorption effect indicators for 18 Polish cities

City	Gravity (CI1)	Gravity rank	Net human capital benefit (CI2)	NHCB rank
Warszawa	1.59	1	0.85	1
Gdańsk	1.28	2	0.70	3
Kraków	1.26	3	0.79	2
Wrocław	1.24	4	0.67	4=
Poznań	1.20	5	0.67	4=
Olsztyn	1.03	6	0.52	6
Toruń	1.02	8	0.49	7
Szczecin	1.01	9	0.41	8
Opole	0.94	11	0.35	9
Bydgoszcz	0.96	10	0.31	11
Łódź	1.02	7	0.10	14
Katowice	0.88	12	0.33	10
Zielona Góra	0.87	13	0.24	13
Rzeszów	0.79	16	0.25	12
Lublin	0.86	14	0.08	15
Białystok	0.84	15	−0.10	17
Kielce	0.77	17	−0.09	16
Gorzów Wielkopolski	0.70	18	−0.20	18

surprisingly Warsaw is at the top of the ranking, followed by Gdansk, Krakow and Wroclaw. Again, Łódź performs worse than other cities with a similar population number. The bottom of the list is occupied by the relatively small cities of Gorzów Wielkopolski and Kielce.

In Figure 2, we directly compare cities' capacities to attract and absorb human capital, decomposing the CI_1 (gravity) indicator to show separately the average distance to tertiary school (CI_1's numerator) and the distance from HEI to labour market (CI_1's denominator). The black ring around a city represents the average distance from which the secondary school graduate is attracted to study at the city's university (AT_1). The grey ring in turn shows the average distance at which the local university graduate settles down after completing the education (AB_1). Cities where the black ring is outside the grey ring are net attractors, and for the other three cities (Katowice, Rzeszow and Kielce) they are net losers, although for a very limited catchment. For most of the observed cities the pre-university attraction range exceeds the post university diffusion distance, although the opposite holds for Katowice, Kielce, and Rzeszow in the south-east of Poland.

The Net Human Capital Benefit measure refers to the migration effectiveness or composite capacity to accumulate human capital, calculated as the ratio between the number of

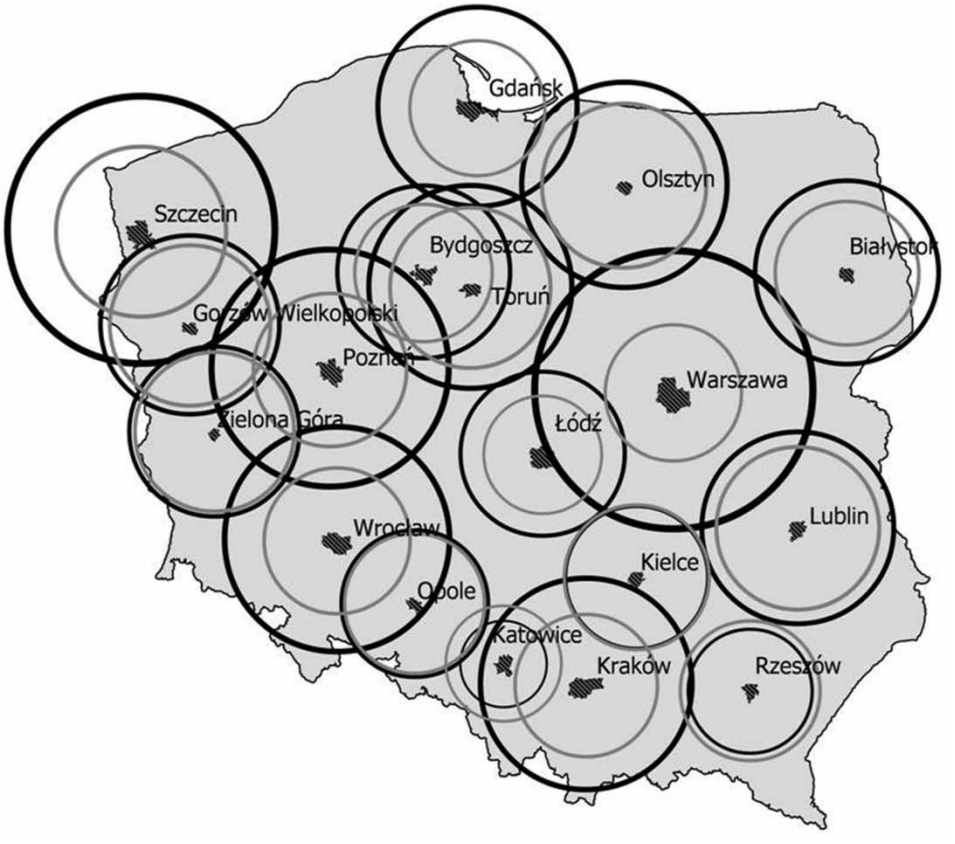

Figure 2. The gravity variables (AT1 and AB1) for 18 academic cities.

externally attracted students who stay and local students who then leave. Table 3 reveals substantial differences between cities with respect to their ability to accumulate human capital. The large metropolises (Warsaw, Kraków, Wrocław, Poznań, and Gdańsk) form a pentagon characterised by high CI_2 values. The scores of cities in the periphery, especially in the east, are much lower, covering Białystok, Lublin, Rzeszów, and Kielce, east of Warsaw as well as Gorzów Wielkopolski, in the west. Despite its central location (in the middle of the pentagon) Łódź also achieves a very low value of Net Human Capital Benefit indicator (0.10).

Typology of Cities

Using the evidence from the composite indicators above, and relating it to the theoretical typology identified above, we sketch a three-fold distinction between academic cities and their capacity to benefit from their universities' human capital outputs.

- A core pentagon of *winning cities*, leading metropolises that are able to attract undergraduates and retain graduates, and where universities and labour market are well aligned, creating a self-reinforcing virtuous circle ($CI1 > 1$; $CI2 > 0$).
- A penumbra of *regional higher education centres*, which act as focal points for the attraction and retention of human capital but at a less substantial scale than these leading cities ($CI1 \approx 1$; $CI2 \geq 0$).
- A set of *peripheral university-cities*, both peripheral in terms of their location as well as their economic centrality—with some of these losing both undergraduates and graduates to other more attractive locations($CI1 < 1$; $CI2 < 0$).

In the following section, we turn to look at how these various characteristics come together in particular places to try to understand in more detail the underlying drivers of this human capital hierarchy of Poland's university-cities. To provide more resolution to the distinction sketched above, we revert to the first order variables used above to better understand them in terms of the typology set. We use the Student Attractiveness indicatory (AT_1), and the Settling Incomers indicator (AB_3). The values of these two variables for 18 cities are plotted in Figure 3. This let us clearly distinguish three clusters of cities. The "Winning Cities" are located in the upper right quadrant, and achieve high performance in both attracting and absorbing human capital (marked with a solid black oval). Warsaw can be distinguished within this group as the highest ranking city for both measured aspects of human capital accumulation. In addition, the cluster includes Kraków, Wrocław, Poznań and Gdańsk—all large metropolises with more than half a million population.

The second group are Supra-Regional Centres, within the thick dotted line, cities whose tertiary school catchment areas go beyond the immediate locality, but fail to retain a substantial portion of attracted students after graduation (Szczecin, Toruń, and Olsztyn). Although their wide catchment area must be considered as an asset, in the end these cities act as providers of formed human capital to other, more attractive destinations. All these cities have a relatively high Net Human Capital Benefit (CI_2) score—also true for Opole and Katowice. These two cities attract from a much more localised catchment but are effective at retaining those students, whilst supra-regional academic centres attract from across Poland, and correspondingly lose graduates to winning academic cities.

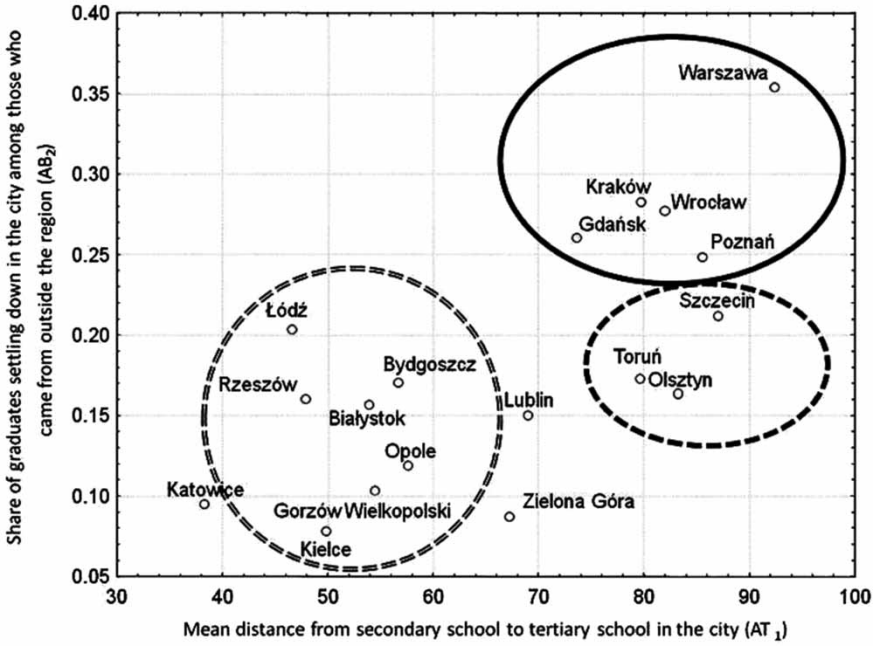

Figure 3. Classification of 18 cities according to the proposed typology.

The third group are the Local Academic Centres, in turn located close to the bottom left quadrant on Figure 3, covering the largest number of Polish cities. These are characterized by both a limited catchment area of their universities and low graduate mobility. Within this group, it is possible to see both some cities that have a relatively high migration effectiveness from this limited catchment area, as well as net losers (Białystok, Kielce, and Gorzów Wielkopolski). It therefore might be justified to divide this category—Local Academic Centres, into two groups, distinguishing those which function in a reasonably coherent labour market situation ("Regional Enclaves") and those which see a relative outflow of their graduates after completion ("Regional Centrifuges"). Perhaps unsurprisingly, given the regional labour market composition, we were unable to identify post-university migration destinations corresponding to the upper-left quadrant. One would to find these regions where there was strong economic growth creating considerable graduate employment but no corresponding local HEI provision. Two features of Poland's transition have worked against this situation. Firstly, higher education opportunities are relatively well distributed across Polish territory: no significant employment centres are without a university. Secondly, economic growth has been concentrated in a limited number of larger cities, precisely those corresponding to our "Winning City" category.

It is important to note that universities are not exclusively responsible for the flow, and with respect to individuals already holding a degree: they are not even particularly important determinants of migration decisions. Our analysis shows that the best performing cities, particularly in terms of human capital retention, are the largest metropolises, such as Warsaw, Poznan, Wroclaw, and Gdansk. Although they all host several HEIs, these are employment opportunities and offer widely understood quality of life that

play crucial role in attracting skilled individuals. This leads to the conclusion that the empirically proven importance of human capital for urban development, and the increasing mobility of students and graduates favour large cities and strengthens the position of metropolises in urban hierarchy. As mobility of students in search for the university is limited by various costs of migration, some smaller cities are able to attract individuals from neighbouring areas. The cities best performing in these terms—Szczecin, Torun, Lublin, and Olsztyn, belong to the category of supra-regional centres. They manage to draw students nationally, but perform much weaker when it comes to retaining human capital after graduation.

Of the two old industrial cities in the sample—Lodz and Katowice, the former can be classified as a regional enclave, and the latter rather as a regional centrifuge with very low ability to attract students from outside the region, but at the same time, having limited mobility of graduates. The relative attractiveness of Lodz as a destination for graduates seems to result more from the proximity of Warsaw and its labour market than from the local opportunities. The emergence of the knowledge-based economy and increasing migration of skilled labour force appear to be other challenges for the old industrial centres in Poland, as they make valuable resources to concentrate in the large multifunctional metropolises, draining smaller cities and former manufacturing hubs of human capital.

This taken together suggests that Poland's urban hierarchy has evolved in reflection of the emerging pressures of the knowledge economy, with substantial rebalancing taking place reflecting inefficiencies that had previously emerged, as well as those driven by emerging opportunities in large urban economies. Although there has been a massification of higher education in Poland in the last two decades, and every province is relatively well provided for in terms of education, the effects of that higher education have become intertwined with a growing regional inequality between places. The mere production of students is not sufficient for universities to contribute to processes of more balanced urban development; rather, the human capital contributions remain locked-in with places' existing path trajectories, reflecting in the Polish case the trauma of transition and deindustrialisation as well as the emergence of a buoyant private sector service economy. There is potentially a mutual reinforcement at work here, with the five core cities forming a growth pentagon where new economic opportunities will emerge, with universities across Poland continuing to feed a divergence between this pentagon and the more isolated outlying regions.

Conclusions: A New Urban Hierarchy?

Our overarching research question was "how can the 'urban absorptive capacity' be defined, operationalized and its urban hierarchy effects typologised?" On the basis of our analysis, it is possible to both reflect on the typology of academic cities developed earlier in this paper, and on what this tells us about how human capital migration contributes to urban development trajectories. . In this article, we proposed two indicators of city performance in attracting students and three indicators of achievement in absorbing graduates, defined on the basis of the universities to which students were affiliated. In addition, we defined two composite indicators, capturing both aspects of human capital accumulation, in particular regions, showing the aggregate effect on cities, and allowing the overall effect on urban hierarchy to be mapped. From the original seven indicators,

Table 5. Typology of academic cities and the values of selected indicators

	Student attractiveness (AT_1)	Settling incomers (AB_3)	Net human capital benefit (CI_2)
"Winning cities"	High: students drawn nationally	Good retention of externally originating students	High: students drawn nationally, graduates retained
"Supra-regional centres"	High: students drawn nationally	Medium: students are highly mobile after graduation	Medium: students drawn nationally offset by low retention
"Regional enclaves"	Very low: students recruited from nearby	Good: retention is good, graduate mobility is low	Very low: primarily local students recruited, good retention
"Regional Centrifuge"	Medium: students draw sub-nationally/supra regionally	Low: graduates leave region to succeed	Low: regional recruitment with poor retention rates

three of them appear to be of greatest value in classifying the cities (Student Attractiveness AT_1, Settling Incomers AB3, and the Net Human Capital Benefit CI_2). Using these three indicators, it is possible to refine and better specify the original typology (see Table 5).

Our analysis enables two further steps addressed in the remainder of the conclusion, namely the academic and policy consequences of our findings. The first is a reflection on how our findings further academic debate about the role of human capital in urban development and in particular, understanding how the characteristics of university-urban systems affect local development prospects. Our first finding relates to territorial economic models of human capital and growth that clearly show that the relationship between universities and cities' growth has a more complex dynamic than simplistic human capital models suggest. Cities are nodes in networks and mediate flows of people through them—the net balance of these flows may be positive or negative, and various factors (including the presence of universities, and labour markets) influence both the city-as-node characteristics, and hence the net balance of those flows. There is a need to rethink how universities contribute to urban competitiveness and development not merely in terms of the current static situation, but how they change the relationships between cities. A practical consequence of this would be that "league tables" of urban competitiveness should find a way to include universities' contributions to better reflect the attractiveness, stickiness and centrality of these places for students. There therefore appears to be more research necessary to understand these urban networks following Malecki (2002), and in particular the micro-scale processes (such as the production of students) that affect the meso-scale node characteristics within that, which in turn shape the topologies of urban networks. As well as tangible characteristics such as labour power, this might also be useful to consider the intangible elements such as place leadership that are critical to understand how places function as "nodes" (Gibney *et al.*, 2009; Fernandez-Maldonado & Romein, 2010).

In parallel to this, our research also provides an insight into understanding how horizontal policies without specific urban dimensions (e.g. higher education policies) influence university-city relationships through variations in the nature of those relationships. As an example, one could imagine that a policy change substantially increasing tuition fees

might, through the labour market, (and the need to find a high-paying job after graduation) have highly spatially differentiated effects (Holdsworth, 2009). It could potentially greatly benefit winning academic cities (where final pay is higher), and slightly benefit regional centrifuges (more pursue cheaper non-residential HE), whilst hurting supra-regional centres (more have to leave to find post-qualification employment that pays sufficiently to service student debts). Although more research is needed to be able to give a definitive pronouncement on this issue, our research is therefore also of relevance for those wishing to use their national education policies to achieve particular territorial goals. Likewise, more research is needed into what drives graduate retention beyond simplistic narratives of labour market matching, possibly incorporating Marinelli's (2012) distinction between those who move to improve their human capital and those who move to exploit their human capital.

This research also highlights the fact that non-conventional data sets can provide useful data, which can complement national public data, especially in countries like Poland where public statistics provide very limited information on resident mobility around university and employment choices. At the same time, the contingency and limited reproducibility of the data (particularly given nk.pl's falling popularity with Polish users) underscore the need for reliable and comparable human capital data for better understanding, with more nuances, the apparently straightforward question of whether universities benefit their territories. Data should ideally track the human capital creation and absorption process, and relate it to the structures which both create it (the universities) as well as those that absorb it (the territories) to create better empirical insights into this complex relationship between human capital and regional development.

Our article has reported an experimental analysis based on a highly contingent data set, and yet we believe that the findings are sufficiently interesting to warrant further exploration. Whilst universities are seen conceptually and politically as helping to serve specific territorial ends, their effects appear far more to be shaped by the location of their cities within wider urban hierarchies. This creates unexpected barriers to action but also potential future avenues for helping cities to switch their path-dependent trajectories within these overall urban hierarchies. Understanding this is clearly an important next step in understanding the "flow-through" roles of universities in shaping regional development trajectories (Faggian *et al*., 2006; Felsenstein, 2011). In the context of the increasingly important knowledge economy, universities and cities should surely be able to find effective ways of accommodating each other's needs, and maximising both the private and social benefits of higher education.

Acknowledgements

We would like to acknowledge the constructive comments of three anonymous referees. Any errors or omissions remain the responsibilities of the authors.

Funding

The research was carried under the project "Human capital mobility and regional growth in Poland. Theory, empirical model and the implications for public policy", funded by the National Science Centre (NCN), [UMO-2011/01/B/HS4/04727].

Notes

1. Dasgupta (2003) claims that one's position within a social network is transferable into monetary benefits.
2. The *nasza-klasa.pl* website has already been used for spatial analyses of higher education (although on a smaller scale), for example in the PhD dissertation by A. Bajerski submitted at the Adam Mickiewicz University in Poznań (Bajerski, 2009).

References

Abel, Jaison R. & Deitz, Richard. (2012) Do colleges and universities increase their region's human capital? *Journal of Economic Geography*, 12(3), pp. 667–691.

Adam, B. (2006) Medium-sized cities in urban regions, *European Planning Studies*, 14(4), pp. 547–555.

Arbo, P. & Benneworth, P. S. (2007) Understanding the regional contribution of higher education institutions: A literature review OECD education working paper 2007/09, Paris: OECD.

Asheim, B. T. & Coenen, L. (2005) Knowledge bases and regional innovation systems: Comparing Nordic clusters, *Research Policy*, 34(8), pp. 1173–1190.

Badinger, H. & Tondl, G. (2002) Trade, human capital and innovation: The engines of European regional growth in the 1990s. Research Institute for European Affairs, University of Economics and Business Administration.

Bajerski, A. (2009) Przekształcenia struktury przestrzennej szkolnictwa wyższego w Polsce po 1989 r., unpublished PhD dissertation, Poznań: Instytut Geografii Społeczno-Ekonomicznej i Gospodarki Przestrzennej Uniwersytetu im. Adama Mickiewicza.

Barro, R. J. (1999) Human capital and growth in cross-country regressions, *Swedish Economic Policy Review*, 6(2), pp. 237–277.

Baryla Jr, Edward A. & Dotterweich, Douglas. (2001) Student migration: Do significant factors vary by region? *Education Economics*, 9(3), pp. 269–280.

Bathelt, H., Malmberg, A. & Maskell, P. (2004) Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation, *Progress in Human Geography*, 28(1), pp. 31–56.

Benhabib, J. & Spiegel, M. (1994) The role of human capital in economic development, *Journal of Monetary Economics*, 34(2), pp. 143–173.

Benneworth, P. S., Charles, D. R. & Madanipour, A. (2010) Building localized interactions between universities and cities through university spatial development, *European Planning Studies*, 18(10), pp. 1611–1629.

Bernanke, B. S. & Gurkaynak, R. S. (2001) Is growth exogenous? Taking Mankiw, Romer and Weil seriously. National Bureau of Economic Research, NBER Working Papers, No. 8365, Cambridge, MA.

Bils, M. & Klenow, P. J. (2000) Does schooling cause growth? *American Economic Review*, 90(5), pp. 1160–1183.

Bound, John, Jeff, Groen, Gábor, Kézdi & Sarah, Turner. (2004) Trade in university training: Cross-state variation in the production and stock of college-educated labor, *Journal of Econometrics*, 121(1), pp. 143–173.

Bradshaw, T. K. & Blakely, E. J. (1999) What are "third-wave" state economic development efforts? From incentives to industrial policy, *Economic Development Quarterly*, 13(3), pp. 229–244.

Bramwell, A. & Wolfe, D. A. (2008) Universities and regional economic development: The entrepreneurial University of Waterloo, *Research Policy*, 37(8), pp. 1175–1187.

Brownrigg, M. (1973) The economic impact of a new university, *Scottish Journal of Political Economy*, 20(2), pp. 123–139.

Chojnicki, Z. & Czyż, T. (1997) *Struktura przestrzenna nauki w Polsce* (Poznań: Bogucki Wydawnictwo Naukowe).

Cohen, Wesley M. & Levinthal, Daniel A. (1990) Absorptive capacity: A new perspective on learning and innovation, *Administrative Science Quarterly*, 35(1) pp. 128–152.

Comunian, Roberta, Faggian, Alessandra & Li, Qian Cher. (2010) Unrewarded careers in the creative class: The strange case of bohemian graduates, *Papers in Regional Science*, 89(2), pp. 389–410.

Cooke, E. D. (1970) Analyzing university student contribution to the economic base of the community, *Annals of Regional Science*, 4(1), pp. 146–153.

Corcoran, J., Stimson, R. J. & Li, T. (2011) Locational patterns of new graduate employment and regional economic performance in Australia, *International Journal of Foresight and Innovation Policy*, 7(1/2/3), pp. 44–55.

Dasgupta, P. (2003). Social capital and economic performance. Analytics, in: E. Ostrom & T. K. Ahn (Eds) *Foundations of social capital*, pp. 309–343 (Cheltenham: Edward Elgar).

Delisle, F. O. & Shearmur, R. (2010) Where does all the talent flow? Migration of young graduates and nongraduates, Canada 1996–2001, *Canadian Geographer/Le Geographe Canadien*, 54(3), pp. 305–323.

Di Liberto, A. & Symons, J. (2001) *Education and Italian Regional Development* (London: London School of Economics and Political Science, Centre for Economic Performance).

Di Maria, C. & Lazarova, E. (2012) Migration, human capital formation, and growth: An empirical investigation, *World Development*, 40(5), pp. 938–955.

Edquist, C. (2005) Systems of Innovation. Perspectives and Challenges. in: J. Fagerberg, D. C Mowery, & R. R. Nelson (Eds) *The Oxford Handbook of Innovation*, pp. 181–208 (New York: Oxford University Press).

Faggian, A. & McCann, P. (2009) Human capital, graduate migration and innovation in British regions, *Cambridge Journal of Economics*, 33(2), pp. 317–333.

Faggian, A., McCann, P. & Sheppard, S. (2006) An analysis of ethnic differences in UK graduate migration behaviour, *The Annals of Regional Science*, 40(2), pp. 461–471.

Felsenstein, D. (2011) Human capital and labour mobility determinants of regional innovation, in: P. Cooke, b. Asheim, R. Boschma, R. Martin, D. Schwartz & F. Tödtling (Eds) *Handbook of Regional Innovation and Growth*, pp. 119–131 (Cheltenham: Edward Elgar).

Fernandez-Maldonado, Ana Maria & Romein, Arie. (2010) The role of organisational capacity and knowledge-based development: The reinvention of Eindhoven, *International Journal of Knowledge-Based Development*, 1(1), pp. 79–96.

Fielding, Anthony J. (1992) Migration and social mobility: South East England as an escalator region, *Regional Studies*, 26(1), pp. 1–15.

Florida, R. (2002) *The Rise of the Creative Class: And how it's Transforming Work, Leisure, Community and Everyday Life* (New York: Perseus Book Group).

Florida, Richard. (2004) *Cities and the Creative Class* (New York, London: Routledge).

Franco, M., Haase, H. & Lautendchäger, A. (2010) Do universities impact regional employment? A cross-regional comparison of migration effects, *Actual Problem of Economics*, 7(109), pp. 301–312.

de la Fuente, A. (2002) On the sources of convergence: A close look at the Spanish regions, *European Economic Review*, 46(3), pp. 569–599.

Ghatak, S., Mulhern, A. & Watson, J. (2008) Inter-regional migration in transition economies: The case of Poland, *Review of Development Economics*, 12(1), pp. 209–222.

Gibbons, S. & Vignoles, A. (2012) Geography, choice and participation in higher education in England, *Regional Science and Urban Economics*, 42(1–2), pp. 98–113.

Gibney, John, Copeland, Stuart & Murie, Alan. (2009) Toward anew'strategic leadership of place for the knowledge-based economy, *Leadership*, 5(1), pp. 5–23.

Glaeser, Edward L. (Ed.) (2010) *Agglomeration Economics* (Chicago, London: University of Chicago Press).

Goddard, J. & Vallance, P. (2011) Universities and regional development, in: A. Pike, A. Rodriguez Pose & J. Tomaney (Eds) *Handbook of Local Economic Development*, pp. 425–437 (London: Routledge).

Goddard, J. & Vallance, P. (2013) *The University and the City* (London: Routledge).

Goddard, J. B. (2011) *Conencting Universities to Practical Growth: A Regional Guide* (Sevilla, Spain: IPTS JRC). Available at http://ec.europa.eu/regional_policy/sources/docgener/presenta/universities2011/universities2011_en.pdf (accessed 22 November 2013).

Gunasekara, C. (2006) Universities and associative regional governance: Australian evidence in non-core metropolitan regions, *Regional Studies*, 40(7), pp. 727–741.

Haapanen, Mika & Tervo, Hannu. (2009) Cumulative inertia or cumulative stress? Migration behaviour of Finnish graduates, *Migration Letters*, 6(1), pp. 83–90.

Healey, P. (2008) Knowledge flows, spatial strategy making, and the roles of academics, *Environment and Planning C: Government and Policy*, 26(5), pp. 861–881.

Hekkert, M. P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S. & Smits, R. (2007) Functions of innovation systems: A new approach for analysing technological change, *Technological Forecasting and Social Change*, 74(4), pp. 413–432.

Hensen, M. M., de Vries, M. R. & Cörvers, F. (2009) The role of geographic mobility in reducing education-job mismatches in the Netherlands, *Papers in Regional Science*, 88(3), pp. 667–682.

Herbst, M. (2007) Wpływ kapitału ludzkiego i społecznego na (krótkookresowy) wzrost gospodarczy w polskich podregionach, in: idem (red.), *Kapitał ludzki i kapitał społeczny a rozwój regionalny*, pp. 166–203 (Warsaw: Scholar).

Herbst, M. & Rok, J. (2011) Equity in an educational boom: Lessons from the expansion and marketization of tertiary schooling in Poland. MPRA Paper 33795, University Library of Munich, Germany, *European Journal of Education*. Available at http://mpra.ub.uni-muenchen.de/33795/ (accessed 11 December 2013).

Hermannsson, K., Lisenkova, K., McGregor, P. & Swales, J. K. (2012) The expenditure impacts of individual higher education institutions (HEIS) and their students on the Scottish economy under devolution: Homogeneity or heterogeneity? *Environment & Planning A*. Available at http://www.strath.ac.uk/media/departments/economics/researchdiscussionpapers/2010/10-16REVISEDfinal.pdf (accessed 11 December 2013).

Hoare, A. & Corver, M. (2010) The regional geography of New Young graduate labour in the UK, *Regional Studies*, 44(4), pp. 477–494.

Holdsworth, Clare. (2009) "Going away to uni": Mobility, modernity, and independence of English higher education students, *Environment and planning. A*, 41(8), p. 1849.

Ishitani, T. T. (2011) The determinants of out-migration among in-state college students in the United States, *Research in Higher Education*, 52(2), pp. 107–122.

Krugman, Paul R. (1991) *Geography and Trade* (Cambridge, MA: MIT press).

Lawton Smith, H. (2007) Universities, innovation, and territorial development: A review of the evidence, *Environment and Planning C: Government and Policy*, 25(1), pp. 98–114.

Losy absolwentów—raport, (2008) Available at http://www.absolwent.com.pl/strona.aspx?id=134,8 (accessed 1 October 2010).

Lucas, R. E. (1988) On the mechanics of economic development, *Journal of Monetary Economics*, 22(1), pp. 3–42.

Malecki, E. (2011) Technology clusters, in: P. Cooke, b. Asheim, R. Boschma, R. Martin, D. Schwartz & F. Tödtling (Eds) *Handbook of Regional Innovation and Growth*, pp. 315–333 (Cheltenham: Edward Elgar).

Malecki, Edward J. (2002) Hard and soft networks for urban competitiveness, *Urban Studies*, 39(5–6), pp. 929–945.

Mankiw, N. G., Romer, D. & Weil, D. (1992) A contribution to the empirics of economic growth, *American Economic Review*, 107(2), pp. 407–437.

Marinelli, Elisabetta. (2013) Sub-national graduate mobility and knowledge flows: An exploratory analysis of onward-and return-migrants in Italy, *Regional Studies*, 47(10), pp. 1618–1633.

Martin, R. (2011) Regional economies as path-dependent systems: Some issues and implications, in: P. Cooke, b. Asheim, R. Boschma, R. Martin, D. Schwartz & F. Tödtling (Eds) *Handbook of Regional Innovation and Growth*, pp.198–211 (Cheltenham: Edward Elgar).

McNicoll, I. H./COSHEP. (1995) *The Impact of the Scottish Higher Education Sector on the Economy of Scotland* (Glasgow: Committee of Scottish Higher Education Principals).

Mosca, Irene & Wright, Robert E. (2010) National and international graduate migration flows, *Population Trends*, 141(1), pp. 36–53.

Nelson, R. & Phelps, E. (1966) Investment in humans, technological diffusion, and economic growth, *American Economic Review: Papers and Proceedings*, 51(2), pp. 69–75.

OECD. (2007) *Higher Education and Regions: Globally Competitive, Regionally Engaged* (Paris: OECD/IMHE).

OECD. (2012) *What are the Returns on Higher Education to Individuals and Countries? Education Indicators in Focus, 2012/06* (Paris: Organisation for Economic Co-operation and Development).

Oosterbeek, H. & Webbink, D. (2011) Does studying abroad induce a brain drain? *Economica*, 78(310), pp. 347–366.

Perry, B. & May, T. (2010) Urban knowledge exchange: Devilish dichotomoies and active intermediation, *International Journal of Knowledge-Based Development*, 1(1/2), pp. 6–24.

Persson, J. & Malmberg, B. (1996) Human capital, demographics and growth across the U.S. States 1920–1990, Stockholm University, Institute for International Economic Studies, Seminar Papers, No. 619.

Romer, P. M. (1994) The origins of endogenous growth, *Journal of Economic Perspectives*, 8(1), pp. 3–22.

Siegel, D. S. (2011) The rise of university technology transfer and academic entrepreneurship: Managerial and policy implications, in: D. B. Audretsch, O. Flack, S. Heblich & A. Lederer (Eds) *Handbook of Research on Innovation and Entrepreneurship*, pp. 300–315 (Cheltenham: Edward Elgar).

Stark, O. (1991) *The Migration of Labor* (Cambridge, MA: Blackwell).

Temple, J. (1998) The new growth evidence, *Journal of Economic Literature*, 37(1), pp. 112–156.

Vang, J. & Asheim, B. (2006) Regions, absorptive capacity and strategic coupling with high-tech TNCs: Lessons from India and China, *Science Technology Society*, 11(1), pp. 39–66.

Venhorst, V., Van Dijk, J. & van Wissen, L. J. G. (2010) Do the best graduates leave the peripheral areas of the Netherlands? *Tijdschrift voor economische en sociale geografie*, 101(5), pp. 521–537.

Wasielewski, K. (2004) Młodzież wiejska na UMK w Toruniu, *Wieś i Rolnictwo*, 122(1), pp. 126–138.

Yigitcanlar, T. (2010) Making space and place for the knowledge economy: Knowledge-based development of Australian cities, *European Planning Studies*, 18(11), pp. 1769–1786.