tillväxtanalys

Regional agglomeration of skills and earnings
– from convergence to divergence?

DURING THE LAST THREE DECADES, we find a distinct pattern of skill divergence across regions. The uneven distribution of human capital is reinforced by the mobility of the highly educated population. This pattern coincides with declining or even reversed income convergence across Swedish regions, a development which could have potentially important implications for both national and regional economic policy.

Förord

Frågeställningarna inom tillväxtpolitiken är komplexa och kräver en djuplodande och mångsidig belysning för att ge kunskap om vad staten kan och bör göra. Tillväxtanalys arbetar därför med vad vi benämner ramprojekt. Ett ramprojekt består av flera delprojekt som bidrar till att belysa en viss frågeställning. Den här studien är ett av flera kunskaps-underlag för ett pågående ramprojekt med rubriken *Hur kan staten underlätta tillväxt i agglomerationsekonomier som samtidigt bidrar till utveckling i omkringliggande områden?* Ramprojektet kommer att avrapporteras under andra kvartalet 2020.

Det finns en omfattande internationell forskning som visar att arbetskraftens produktivitet tenderar att öka med regioners storlek och täthet. Bland ekonomer används begreppet agglomerationsekonomi för att beskriva det faktum att produktiviteten tycks stiga med antalet ekonomiska aktörer inom ett givet geografiskt område. I ramprojektet studerar vi frågor som: Vilka är mekanismerna bakom sambandet mellan arbetskraftens produktivitet och inkomster och regioners och städers storlek? Vilken roll spelar arbetskraftens geografiska rörlighet och individers utbildningsnivå och färdigheter? Vilken betydelse har kunskapsöverföring i form av arbetskraftsrörlighet från multinationella företag till lokala företag? Kan förbättrad funktionell integration av arbetsmarknader och ökad pendling bidra till geografisk spridning av agglomerationsvinster mellan regioner?

I denna studie analyserar vi den geografiska fördelningen av högutbildad arbetskraft och humankapitalinnehållet i flyttningsströmmar mellan svenska lokala arbetsmarknader under de senaste 30 åren. Studien är baserad på detaljerade longitudinella registerdata. Förutom att fokusera på personers formella utbildningsnivå analyserar vi också andra viktiga egen-skaper relaterade till individers förmåga och produktivitet, betyg från gymnasieskolan och familjebakgrund i termer av föräldrars utbildningsnivå och inkomster. Vi studerar också hur den regionala omfördelningen av humankapital sammanfaller med utvecklingen av regionala skillnader i inkomster i Sverige under de senaste tre decennierna.

Studien har författats av Kent Eliasson, fil.dr i nationalekonomi och analytiker vid Tillväxtanalys, och Olle Westerlund, professor i nationalekonomi vid Umeå universitet.

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Sammanfattning

I den här uppsatsen analyserar vi den geografiska fördelningen av högutbildad arbetskraft och humankapitalinnehållet i flyttningsströmmar mellan svenska lokala arbetsmarknader. Studien är baserad på detaljerade longitudinella registerdata. Under de senaste tre decennierna finner vi ett tydligt mönster av divergens i tillgången på högutbildad arbetskraft. Den ojämna fördelningen av humankapitaltillgångar förstärks av den högutbildade befolkningens geografiska rörlighet. Mönstret med växande skillnader i tillgången på högutbildad arbetskraft sammanfaller med avtagande eller till och med omvänd konvergens i inkomster mellan lokala arbetsmarknader. De humankapitalintensiva regionerna blir både mer humankapitalintensiva och rikare, medan regioner med sämre tillgång på högutbildad arbetskraft släpar efter. Denna utveckling har potentiellt viktiga konsekvenser för både regional och nationell ekonomisk politik.

Ökad regional divergens i humankapital och inkomster

Vi hittar en positiv och robust korrelation mellan den initiala andelen högutbildad arbetskraft och förändringen i andelen högutbildade under de senaste tre decennierna. Lokala arbetsmarknader med höga initiala andelar uppvisar genomgående en större ökning av andelen högutbildad arbetskraft. Vidare finner vi att den högutbildade befolkningens geografiska rörlighet förstärker den ojämna fördelningen av humankapitaltillgångar mellan regioner. Storstadsregionerna tar emot stora nettoinflöden av unga högutbildade samtidigt som medelstora och mindre regioner uppvisar betydande flyttningsförluster. De stora regionerna är emellertid inte bara nettomottagare av högutbildad arbetskraft i kvantitativa termer utan de framstår också som vinnare i kvalitativa termer. Våra resultat visar att andelen unga högutbildade som flyttar uppåt i den regionala hierarkin ökar betydligt i den övre delen av betygsfördelningen från gymnasiet. Ju högre gymnasiebetygen är, desto större är andelen unga högutbildade som flyttar från mindre till större regioner. Flyttningar uppåt i den regionala hierarkin visar sig också vara positivt förknippat med en gynnsam familjebakgrund mätt i termer av föräldrars utbildningsnivå och inkomster. Vidare kan vi konstatera att arbetsinkomsterna för både låg- och högutbildade stiger med andelen högutbildade i regionen och storleken på regionen. Avslutningsvis indikerar våra resultat att de ökade regionala skillnaderna i tillgången på högutbildad arbetskraft sammanfaller med avtagande eller till och med omvänd konvergens i inkomster mellan svenska regioner under de senaste 25 åren. Tendensen till ökad regional spridning i inkomster utgör ett avsteg från den långsiktiga historiska utvecklingen.

Bostadspolitik och infrastruktursatsningar viktiga policyåtgärder

Under stora delar av 1900-talet minskade de regionala skillnaderna men under senare år har de börjat öka igen. Denna utveckling gäller i USA och även i många europeiska länder, inklusive Sverige vilket framgår av denna studie. I många länder har vidgade inkomstklyftor och regional polarisering gått hand i hand med en polarisering av det politiska landskapet. Vissa forskare menar att de regionala klyftorna i Europa utgör ett hot mot ekonomisk utveckling, social sammanhållning och politisk stabilitet. Behovet av politiska insatser ökar i takt med att de regionala skillnaderna tilltar. Vilken typ av politik som behövs för att möta denna utveckling är dock långt ifrån givet. Den politik som utformas måste sannolikt vara platsspecifik och samtidigt kunna hantera svåra avvägningar mellan regional balans och ekonomisk effektivitet.

Sambandet mellan arbetskraftens produktivitet och inkomster och regioners och städers storlek är väl belagt i den ekonomiska forskningen. De deskriptiva resultat som presenteras i denna studie ger också stöd för ett sådant samband. Det faktum att produktivitet och inkomster verkar stiga med regioners storlek indikerar att ett ökat utbud av arbetskraft i de större regionerna kan bidra till produktivitet och tillväxt på nationell nivå. I det rådande ekonomiska läget är det många företag som uppger att det är svårt att hitta tillräckligt med arbetskraft med relevant kompetens. Det här gäller i många delar av landet men kanske främst i storstadsregionerna. Begränsningar på bostadsmarknaden och i transport-infrastrukturen utgör två potentiellt viktiga förklaringar till varför företag i storstads-regionerna upplever det allt svårare att rekrytera till lediga jobb. Även om arbetsmarknads-utsikterna i storstadsregionerna ter sig ljusa kan det vara svårt att hitta en överkomlig bostad med rimligt pendlingsavstånd till arbete. Sannolikt gäller detta särskilt för unga på arbetsmarknaden som har begränsade ekonomiska resurser. Politikinsatser som bidrar till ett ökat utbud av bostäder i storstadsregionerna skulle göra det möjligt för fler arbetstagare att dra nytta av den höga produktiviteten i dessa miljöer och därmed bidra till både regional och nationell produktivitet och ekonomisk tillväxt. Nyligen publicerade studier från USA tyder på att de ekonomiska vinsterna av ett ökat utbud av bostäder i storstadsregionerna kan vara relativt stora.

Ett annat potentiellt viktigt område för politikinsatser är investeringar i transportinfra-struktur som både underlättar effektiv inom-regional rörlighet i storstadsregionerna och samtidigt stimulerar ökad funktionell integration mellan storstadsområdena och omgivande mindre regioner. Sådana investeringar kan innefatta underhåll av befintlig infrastruktur och investeringar i ny infrastruktur och utbyggd kollektivtrafik. Detta skulle göra det möjligt för små och medelstora regioner att dra nytta av storstadsregionernas agglomerations-fördelar. Samtidigt skulle det bidra till att minska trycket på storstadsregionernas över-hettade bostads- och arbetsmarknader. Trots att de potentiella vinsterna av ökad funktionell integration mellan lokala arbetsmarknader sannolikt är störst runt storstadsområdena kan det också finnas förutsättningar för sådana vinster längre ner i den regionala hierarkin.

När det gäller frågan om hur arbetskraftsutbudet svarar på regionala obalanser är det viktigt att understryka att de regionala effekterna skiljer sig betydligt åt beroende på om anpassningen sker i form av pendling eller migration. Kostnaderna för sändarregionerna är i allmänhet mycket lägre när det gäller pendling. I motsats till migration kommer pendling inte att urholka lokala skattesatser och köpkraft. Därmed finns förutsättningar för att upp-rätthålla tillgången på offentliga tjänster och utbudet av privata tjänster i sändarregionerna. Till skillnad från migration kommer pendling inte heller att orsaka prispress nedåt på den lokala bostadsmarknaden. Från de mottagande regionernas perspektiv bidrar pendling till ett ökat arbetskraftsutbud utan att orsaka ytterligare tryck på redan överhettade bostads-marknader. Politikinsatser som uppmuntrar till pendling snarare än flyttning från regioner som släpar efter till mer expansiva områden har därmed potential att hantera den svåra avvägningen mellan regional balans och ekonomisk effektivitet.

Fortsatta studier

Denna uppsats har ett medvetet explorativt anslag och väcker kanske fler frågor än den besvarar. Baserat på resultaten i denna studie och resultat från annan forskning inom området identifierar vi tre områden som förtjänar mer uppmärksamhet. Ett viktigt område är att mer i detalj studera mekanismerna bakom det observerade positiva sambandet mellan arbetskraftens produktivitet och inkomster och regioners och städers storlek. Ett annat område är att analysera betydelsen av pendling för geografisk spridning av agglomera-

tionsvinster mellan regioner. Ett tredje område är att studera hur begränsningar på bostadsmarknaden påverkar arbetskraftens geografiska rörlighet och produktivitet.

Summary

In this paper, we analyse the geographical distribution of skills and the human capital content of migration flows between Swedish local labour markets. The study is based on detailed longitudinal population register data. During the last three decades, we find a distinct pattern of skill divergence across regions. The uneven distribution of human capital is reinforced by the mobility of the highly educated population. The pattern of skill divergence coincides with declining or even reversed income convergence across Swedish regions. The skilled regions become both more skilled and richer, while the less skilled regions lag behind. This development has potentially important implications for both regional and national economic policy.

Increased regional divergence of human capital and earnings

We find a positive and robust correlation across Swedish regions between the initial share of workers with a university degree and the change in this share during the last three decades. Local labour markets with high initial shares have consistently experienced a larger increase in the share of university educated workers. We further find that the migration behaviour of individuals with a university degree reinforces the pattern of skill divergence across regions. Metropolitan regions receive considerable net in-migration flows of young university graduates, the most prone to migration, while medium-sized and small regions experience large net out-migration flows. Larger regions are not only net attractors of young university graduates in quantitative terms, but we also find a distinct migration pattern in qualitative terms. Our results reveal that the share of university educated migrants moving upwards in the regional hierarchy increases sharply in the upper end of the ability distribution. The higher the grades in upper secondary school, the higher the share of university graduates that move from smaller to larger regions. Migration upwards in the regional hierarchy is also found to be associated with relatively strong family backgrounds of migrants in terms of parents' education and earnings. We further find that the earnings of both low-skilled and high-skilled workers increase with the share of highly educated workers in the region and the size of the region. Finally, our results show that the rising geographical segregation of the skilled is accompanied by declining or even reversed income convergence across Swedish regions during the last 25 years. The tendency for increased regional dispersion in earnings in recent decades departs from the long run historical development.

Housing and transport infrastructure can be important policy measures

Contrary to the development during large parts of the previous century, regional inequalities have been rising in more recent years. This is the case in the United States as well as in many European countries, including Sweden as this study show. In many countries, growing income disparities and regional polarization has marched side by side with political polarization. Some authors argue that regional economic divergence has become a threat to economic progress, social cohesion and political stability. The growing regional inequalities certainly call for some type of policy action but it is not obvious what the policy response to this development should be. Policy initiatives needs to be place-specific and will most likely involve difficult equity-efficiency trade-offs.

The positive relationship between worker productivity and earnings and the size of regions and cities is well documented in economic research. The descriptive evidence in this paper

also points clearly in this direction. The fact that productivity and earnings seem to increase with the size of regions implies that national productivity and economic growth can be stimulated by increased labour supply in larger regions. In the current economic situation, firms seem to have trouble finding sufficient numbers of workers with suitable skills. This is the case in many parts of the country but especially so in the metropolitan areas. Constraints in the housing market and the transport infrastructure are potentially important explanations for why firms in the metropolitan regions find it increasingly difficult to fill vacancies. Although labour market prospects look bright in the metropolitan regions, individuals may find it difficult to find affordable housing at acceptable commuting distances. Presumably, this is the case for young workers in particular, who have limited economic resources of their own. Policy initiatives that increase the supply of housing in the metropolitan areas would enable more workers to take advantage of the highly productive environments in these regions and thereby contribute to both regional and national productivity and economic growth. Recent studies from the United States suggest that the economic benefits from increased supply of housing in the metropolitan areas can be rather large.

Another important field for policy initiatives is investments in transport infrastructure that both facilitates efficient intra-regional mobility in metropolitan regions and stimulates increased functional integration between the metropolitan areas and surrounding smaller regions. Such investments could include maintenance of existing infrastructure as well as investments in new infrastructure and public transportation. This would allow small and medium-sized regions to tap into the agglomeration advantages of metropolitan regions. This could also offer some relief for the tight housing and labour markets in the metropolitan regions. Although the potential returns from increased functional integration of local labour markets probably are highest around the metropolitan areas, there is also potential scope for gains further down in the regional hierarchy.

When it comes to labour supply response to regional inequality, it is important to underline that regional effects are very different depending on whether the response is in terms of commuting or migration. The costs for the sending regions are generally much lower in the case of commuting. As opposed to migration, commuting does not erode the local tax base and purchasing power. This will contribute to upholding the supply of both local public and private services in the sending regions. In addition, commuting, unlike migration, does not cause downward pressure on local house prices. From the perspective of the receiving regions, commuting increase the labour supply without causing additional pressure on already tight housing markets. Policy reforms that encourage commuting rather than migration from lagging regions to more thriving areas thus have the potential to balance the difficult equity-efficiency trade-off between regional equality and national economic efficiency.

Future studies

This paper is purely exploratory in nature and perhaps raises more questions than it answers. Based on the findings in this study, and results from other research in the field, we identify three topics that merit additional attention. One involves attempting to further disentangle the exact mechanisms behind the observed positive relationship between worker productivity and earnings and the size of regions and cities. Another is to study the role of commuting for geographic spreading of agglomeration economies across regions. The third is to more carefully study how constraints in the housing market affect the geographical mobility and productivity of workers.

1   Introduction

In this paper, we analyse the geographical distribution of skills and the human capital content of migration flows between regions using detailed Swedish longitudinal population register data.[*] In addition to the commonly used indicator of human capital measured by educational attainment, we add information on school grades and parental background in terms of parents' education and earnings. We focus both on the current state and on long-term trends. We also pay attention to how the regional redistribution of human capital relates to income convergence across regions in recent decades.

The general phenomenon of urbanisation and agglomeration of human capital to larger, more densely populated, and more differentiated regional labour markets is evident in most countries (Iammarino et al. 2018, OECD 2018). A number of recent studies have documented the cumulative nature of skill agglomeration and its geographical consequences for economic development and various other socioeconomic outcomes in different regions.

In an analysis of the new geography of jobs in the United States, Moretti (2012) concludes that the level of education in the workforce has been the main predictor of the economic success of regions. An acceleration of globalisation in combination with skilled biased technological change has strengthened the labour markets of human capital-intensive regions and weakened the labour markets of regions with a less skilled workforce. This has resulted in a redistribution of jobs, people and wealth across metropolitan areas in the US. Berry & Glaeser (2005) and Austin et al. (2018) analyse evidence on skill divergence across US local labour markets during the last three decades and find a robust and strong positive correlation between the change in the percentage of adults with a college degree and the initial share of adults with a college degree. This skill divergence has been accompanied by declining or even reversed income convergence across US regions. A development that stands in stark contrast to the period between 1880 and 1980 when, with few exceptions, poorer states tended to grow faster than richer ones (Barro & Sala-i-Martin 1999).

Geographical concentration of economic activities is generally considered to be favourable for economic growth through different mechanisms giving rise to agglomeration economies (Marshall 1890, Duranton & Puga 2004). This is consistent with the positive correlation between average earnings and the size of regional labour markets observed in many developed countries. Figure 1 shows this relationship for local labour markets in Sweden in 2015. Workers in larger regions clearly receive higher annual earnings on average (the correlation coefficient is 0.71).
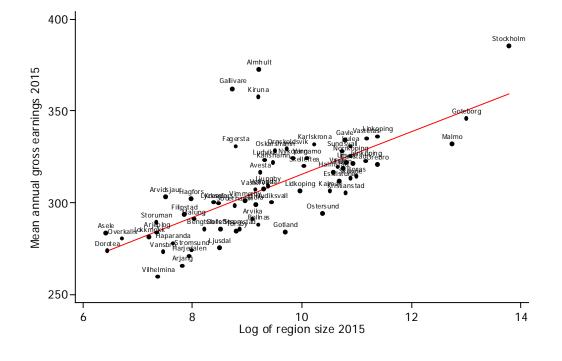

Figure 1 Region size and mean annual gross earnings 2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Region size in terms of number of prime-aged workers (aged 25–54). Annual gross earnings in SEK 1,000 for prime-aged workers.

The positive relationship between human capital and productivity is well documented in economic research, although the exact mechanisms for this relationship and identification of causal effects are still major subjects for further research. In applied research, measures of the educational attainment of the workforce are often used to quantify human capital. Figure 2 shows the share of workers with a university degree (at least three years tertiary level) plotted against the population size of regions in 2015. The figure illustrates an increasing concentration of highly educated workers by labour market size (the correlation coefficient is 0.85).

Although eyeball econometrics is dangerous, the similarity between figure 1 and figure 2 is striking, not only in terms of a positive correlation but also regarding each region's position in the diagrams. That is, there also seems to be a similarity in the rank of regions in terms of average earnings and share of skilled workers (Spearman's rank correlation coefficient is 0.71).
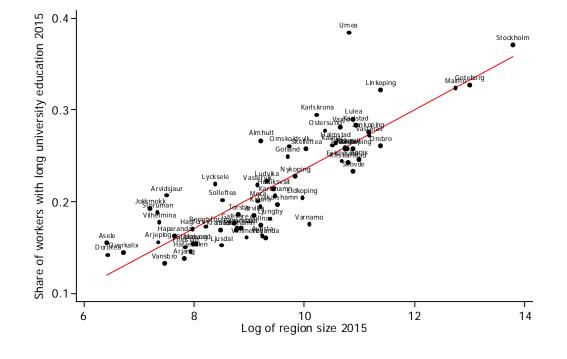
Figure 2 Region size and share of workers with long university education 2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Region size in terms of number of prime-aged workers (aged 25–54). Share of workers with long university education refers to prime-aged workers and defined as at least three years tertiary level of education.

Empirical estimates in early studies suggest strong positive effects of labour market size on labour productivity (consistent with figure 1), while recent studies indicate that the causal effect of agglomeration may be overstated because of residential self-selection, i.e., labour with relatively high productivity self-select into metropolitan areas and other larger/more dense labour markets (in line with figure 2). If this is the case, and if individual ability is not adequately controlled for, estimates of the effects of labour market size on productivity will be biased upwards, i.e., overstate the magnitude of agglomeration economies (e.g., Combes et al. 2008, Andersson et al. 2014).

The main contribution of this paper is to provide new descriptive evidence of systematic selection of productive skills into agglomerations and the role of migration in this process. Apart from the frequently used indicator of human capital measured by individuals' level of education, we add information on school grades and parental background in terms of parents' education and earnings. We also examine long-term changes in the regional distributions of human capital and per-capita incomes.

The paper is purely exploratory in nature. We make no attempt to identify the causal effects of human capital on earnings and productivity or to quantify the magnitude of residential selection bias on estimates of agglomeration economies. However, this study provides new empirical evidence on the systematic self-selection of human capital into agglomerations in terms of current location and in terms of population changes over time through migration flows upwards and downwards in the regional hierarchy. In general, this

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information confirms what is often assumed or considered indirectly in research using "black box" quantitative methods.[1]

To preview some of our results, we find a positive and robust correlation across Swedish regions between the initial share of workers with a university degree and the change in this share during the last three decades. Local labour markets with high initial shares have consistently experienced a larger increase in the share of university educated workers. We further find that the migration behaviour of individuals with a university degree reinforces the pattern of skill divergence across regions. Large local labour markets receive considerable net in-migration flows of young university graduates, the most migration prone, while medium-sized and small local labour markets experience large net out-migration flows. However, larger regions are not only net attractors of young university graduates in quantitative terms, but we also find a distinct migration pattern in qualitative terms. The data reveal that the share of migrants moving upwards in the regional hierarchy, i.e., from smaller to larger local labour markets, increases sharply in the upper end of the ability distribution. Migration upwards in the regional hierarchy is also found to be associated with a relatively strong family background of migrants in terms of parents' education and earnings. Finally, we find that the pattern of skill divergence coincides with a decline in income convergence across Swedish regions during the last three decades.

The descriptive statistics presented in this study provide support for results and argumentation in more recent studies on the causal effect of agglomeration on earnings and labour productivity. Our results indicate that residential self-selection needs to be taken seriously in attempts to estimate regional differences in earnings and productivity or almost any spatial difference in socioeconomic outcomes. In some situations, data on peoples' labour market history may reveal unmeasured ability, which allows us to address residential selectivity by studying changes in earnings before and after migration. However, a large share of migration between local labour markets pertains to young people with high education but with either no or very limited labour experience before migration. This makes the information content of pre-migration earnings less useful for corrections of residential self-selection. Direct measurement or relevant proxies of productive skills should therefore be of great interest for measurement of human capital stocks and skill composition of migration.[2]

Disposition

The structure of the paper is as follows. Section 2 gives a brief overview of the previous literature on agglomeration, the urban wage premium and systematic geographical sorting of human capital through migration. Section 3 provides a theoretical discussion on agglomeration economies and measurement of human capital. Data are presented in Section 4. The empirical part of the paper starts with Section 5, which provides a description of the geographical distribution of university graduates and the evolution of skill divergence over time. Section 6 focuses on the role of migration for the redistribution of human capital across regions. Migration patterns among recent college graduates are analysed in both

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[1] Black box refers to approaches using regression residuals as information to correct for selection bias. In many cases feasible and acceptable methods, but they usually rely on strong assumptions and no information on the nature of unobserved heterogeneity. Residuals (or fixed effects/selectivity coefficients) provide no specific information on human capital attributes.

[2] On the nexus between cognitive ability and school grades, see e.g. Spinath et al. 2006, and Weber et al. 2013. Strenze (2007) provides a review on intelligence, school grades and parental background as predictors of socioeconomic success.

quantitative and qualitative terms. Section 7 relates the findings on spatial sorting of skills to the important question of regional convergence in earnings. A summary and discussion are provided in Section 8.

2   Agglomeration, productivity, and residential self-selection

The positive association between human capital and growth is documented in numerous studies on aggregate data for regions and countries (see, e.g., Barro & Sala-i-Martin 1999, Östbye & Westerlund 2007 on Swedish and Norwegian data, and Crespo Cuaresma et al. 2018 on European data). Hanushek et al. (2017) use measures of average cognitive ability and educational attainment across states in the U.S. as indicators of knowledge capital. They find a roughly equal contribution between educational attainment and cognitive skills to the total estimate of 20–30 per cent of the interstate variation in per capita GDP.

The present study relates more closely to the research on agglomeration economies and systematic sorting of skills through migration. Spatial concentration of factors of production and economic activities is found to be positively correlated with productivity and economic growth. Several plausible mechanisms may explain this association and motivate causal effects on productivity. These may be classified into three categories: sharing, matching and learning (Duranton & Puga 2004).

Agglomeration economies can generally be attributed to the broad categories of factors of production – capital, labour and technology.[3] The primary concern in this study lies with agglomeration of human capital, i.e., not only with the quantities of labour but also quality in terms of productive skills/ability. Such skills may signal higher productivity in a static meaning but also learning and communication/interaction capabilities. Geographical concentration of labour in quantitative terms, i.e., at any given level of skill, may increase productivity because of firms' opportunities to exploit labour pooling or increased job search and job matching efficiency, for example (e.g., Gobillon et al. 2007). Moreover, concentration of jobs leads to a higher degree of specialisation and higher returns to investment in specialised human capital relative to general skills (Kim 1989).

Individuals benefit from agglomerations not only because of direct effects on employment and wage levels but also through human capital accumulation and therefore higher wage growth through matching and learning mechanisms. This is consistent with observations of higher returns to human capital in larger cities, especially for the highly educated (e.g., Glaeser & Resseger 2010).[4] Self-selection into more high-skilled jobs may contribute to higher returns. Both low-skilled and high-skilled job searchers benefit from being matched with highly skilled co-workers, but the beneficial effect is stronger for highly skilled workers (Venables 2011).[5] In all, these mechanisms imply a wage premium of agglomeration (urban wage premium).

Recent research has challenged the earlier consensus on large urban wage premiums. One of the earliest and most frequently cited studies is Ciccone & Hall (1996), who found for states in the US that a doubling of geographical density of employed workers was

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[3] Assuming technology is endogenous and subject to investment, e.g., in terms of research and education leading to a higher pace of innovation. Countries and regions may also increase production and productivity through in-migration of human capital. That is, workers with higher productivity are in the same sense as embedded technology in new capital goods.

[4] On Swedish data, Eriksson & Rodríguez-Pose (2017) report relatively higher productivity effects of labour migration to plants located in the large labour markets.

[5] When skills/abilities are not directly observed, housing prices may serve as a signalling device leading to systematic selection of the highly skilled into high-cost cities (Venables 2011).

associated with 5 to 6 per cent higher wages. Recent studies with better data and control for residential selectivity indicate a much smaller estimate of the urban wage premium, around 2 per cent (Combes et al. 2008, Mion & Naticchioni 2009, Andersson et al. 2014).

Combes et al. (2008) find that 40–50 per cent of aggregate regional wage differentials in France is accounted for by regional sorting of labour on observed and unobserved skills. Mion & Naticcioni (2009) report that spatial skill sorting of workers may explain 75 per cent of raw wage differences between Italian provinces.

Using Swedish data, Andersson et al. (2014) show that the effects of agglomeration on earnings are small in general but larger for workers in occupations characterised by non-routine tasks. They conclude that spatial sorting of labour is the main explanation of higher earnings in dense labour markets.

De La Roca & Puga (2017) use Spanish data and report estimates between 2 and 4 per cent and conclude that the higher estimate may not depend entirely on spatial sorting of abilities but represent at least partially dynamic effects (e.g., learning) of residing in larger cities.

Studies on internal migration show that moves over longer distances/between functional labour markets are mostly undertaken by young people and that the propensity to migrate increases with educational attainment (Greenwood 1997, Machin et al. 2012, Böckerman & Haapanen 2013). Although the relative contribution of migration as an explanation for the observed concentrations of human capital in large and dense labour markets is partially disputed (e.g., Costa & Kahn 2000, Compton & Pollak 2007, Brown et al. 2010), the spatial sorting of skills through migration is evident in most developed countries (Winters 2011 on US data; Faggian & McCann 2009 on data from Great Britain; van Venhorst et al. 2010 on data from the Netherlands; Haapanen & Tervo 2012 on Finnish data; Berck et al. 2016, and Tano et al. 2018 on Swedish data).

The present study provides a description of regional sorting on three main indicators: individuals' educational attainment, school grades, and parental background. The relevance of these indicators in this context is discussed in the following section.

3 Proxies for ability and agglomeration economies

The concept of human capital is multidimensional, including factors such as cognitive and non-cognitive skills and health. The various dimensions may be interrelated and come from nature and/or nurture.

A frequently used indicator of human capital or productive skills in studies of migration and regional productivity is educational attainment (level of education). It is arguably a relevant indicator with documented statistical power in quantitative research, e.g., in studies on earnings and internal migration. Educational attainment is also one of the indicators used in this paper.

However, there is substantial heterogeneity in ability within crude categories of educational attainment. Among students with a bachelor's or master's degree, for example, variation in academic performance can be anything between excellence and substantial difficulties in meeting minimum requirements for graduation. As indirect measures of this heterogeneity, we add two indicators – school grades and parental background.

School grades are not perfect measures of ability, but a portion of the variation in ability within categories of educational attainment is most likely reflected by school grades. Intelligence is shown to correlate with school grades but is far from the only factor since the ability to organise studies, motivation, time management and social competence are important factors. Both cognitive and non-cognitive skills may contribute to variance in school grades (e.g., Spinath et al. 2006, Roth et al. 2015).

Parental background is shown to correlate with children's socioeconomic outcomes through genetic and environmental factors. Strenze (2007) reviews and analyses previous research on intelligence as a predictor of socioeconomic outcomes. Intelligence is found to be a powerful predictor but not overwhelmingly better than parents' socioeconomic status or school grades.

We use parental income and education as indicators of socioeconomic status. The nature and nurture mechanisms explaining the predictive power of parental background are complex. In addition to parents' role in children's academic achievement, socioeconomic status may also have a direct impact on residential selectivity. In terms of migration and selective location choice of young people, parental income can be an important factor in a tight residential market in urban areas. Finding an affordable permanent contract/dwelling in high growth agglomerations without parental backing can be extremely difficult for young people. Job searchers with little or no parental backup may find it optimal to search for jobs and accept job offers in labour markets outside high cost agglomerations, e.g., outside Stockholm in the Swedish context.[6]

Individuals' ability can interact with agglomeration economies in various ways. One is through job search and quality of job matches. Economies of agglomeration may derive from efficiency of job matching (e.g., Gobillon et al. 2007, Wasmer & Zenou 2002).

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[6] This is in line with the residential-cost explanation of increased skill concentration in urban areas. Generally, increased productivity in agglomerations affects land rents, and only agents with high enough productivity will be able to locate themselves in agglomerations (e.g. Beherends et al. 2014). Inelastic housing supply would reinforce this selection mechanism. See also Berry & Glaeser (2005).

Larger local regional markets offer a larger variety of skills among job searchers, as well as a larger variety in firms' demand for skills (e.g., Wheeler 2001, Abel & Dietz 2015). The productivity returns of higher job finding rates and better quality of matches may increase with ability through higher efficiency in search, and via higher ability to process information in evaluation of alternative job offers.

Another possible interaction effect between ability and agglomeration on productivity may come from interaction with co-workers. Venables (2011) suggests that higher productivity can be due to self-selection into jobs where both low skilled and high skilled job searchers benefit from being matched with high skilled co-workers, with gains more pronounced for highly skilled job searchers.

Finally, new technologies are usually implemented in urban environments first. Complementarity between ability and technology (Acemoglu 1999, Caselli 1999) may increase the comparative advantage of highly skilled workers to locate in urban labour markets. Using Swedish data, Håkansson (2015) et al. report substantial skill sorting between firms, with high and increased ability concentration in modern sectors such as IT and telecommunications, while ability concentration is lower and decreasing in sectors such as construction, retail trade, and transportation. Given the relatively higher concentration of IT and telecommunications in urban areas, complementarity between technology and ability imply increased comparative advantage for a workforce with high ability to locate in agglomerations.

4   Data

The analysis is based on longitudinal micro data from Statistics Sweden, covering the entire Swedish population. The data are annual and cover the period 1986–2015. The data include information on age, level of education, employment status and annual gross earnings. We also have information on place of residence and place of work (if employed) each year.

When we focus on annual gross earnings we restrict our attention to prime-aged workers (aged 25–54) whom we would normally expect to work full-time, year-round. Given that annual earnings by definition are a function of wage per hour and the number of hours worked during a year, this restriction is imposed to reduce the effect of labour supply on annual earnings. It should also be noted that the annual gross earnings only include labour earnings; income transfers such as unemployment benefits are not included. This is important since average earnings per employee often are used as a proxy of labour productivity. The annual gross earnings are deflated by the national CPI, with base year 2015. The annual gross earnings of prime-aged workers will also be used in our analysis of convergence or divergence in per capita earnings over time.[7]

In the paper, we also use a specific dataset covering all graduates from university education during the period 2001–2010. In addition to information on the university/ university college, field/subject and level of the degree attained, these data also include information on the place of residence at age 17 (approximately one year prior to the earliest possible entry into university education) and the place of residence up to five years after graduating from tertiary education.[8] We restrict our attention to students graduating no later than at 32 years of age.[9] For this group, we have information on earlier school grades in terms of grade point average from upper secondary school. We are also able to link these individuals to their parents and obtain information on the parents' level of education and annual gross earnings. Data on parents' education and earnings refers to the year when graduates are 17 years of age.

For the regional dimension in the analysis we use 69 local labour markets. The local labour markets are defined on the basis of commuting patterns between Sweden's 290 municipalities in 2015. By construction, the local labour markets are defined to minimise commuting flows across regional borders. They are hence economically integrated regions where most people tend to both live and work. We use the same set of 69 local labour markets throughout the entire study period of 1986–2015.

In the analysis, local labour markets are sometimes grouped into three types of regions based on the size of the population in 2015: large regions (population over 500,000), medium-sized regions (population between 100,000 and 500,000) and small regions (population under 100,000). In the category of large regions, we find Sweden's three

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[7] Note that our measure of earnings does not capture regional variation in real earnings because of variation in e.g. costs for housing. However, deflation of earnings by regional costs for housing may not yield a better or more relevant measure of real earnings. Regional differences in housing costs partly reflect variation in factors such as local amenities and career prospects in different regions.

[8] While pursuing a university education, many students complete several degrees, e.g., first a bachelor's degree followed by a master's degree. We use information on the highest degree completed and the year of graduation pertains to this degree.

[9] During the period 2001–2010, approximately 80 per cent of all university education degrees were awarded to students 32 years of age or younger.

metropolitan areas – Stockholm, Göteborg and Malmö. In the medium-sized group, we find 19 local labour markets that typically include the regional administrative centres and contain the universities/university colleges located outside the metropolitan regions. The group of small regions consists of 47 local labour markets that, with a few exceptions, include neither regional administrative centres nor university colleges.
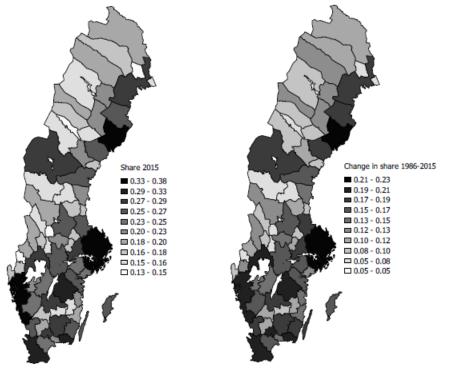
5   Geographical distribution of university graduates and skill divergence

In this section, we focus on the regional distribution of university graduates and the evolution of skill divergence over time. The map to the left in figure 3 shows the distribution of the share of university educated workers aged 25–54 across functional labour markets in Sweden in 2015. The map is a spatial representation of figure 2 in the introduction.

The overall pattern is as expected. The map shows higher concentrations of university graduates in the south, especially around the three biggest cities Stockholm, Göteborg and Malmö, and lower concentrations in the inland regions from mid-Sweden and further north. University graduates in the north are by and large concentrated in the coastal regions.

The map to the right displays the change in percentage points in corresponding shares between 1986 and 2015. The similarity in patterns between the two maps reveals a positive association between the current levels of highly educated workers and the long-term increase in the share of highly educated workers.

Figure 3 Share of workers with long university education 2015 and change in the share of workers with long university education 1986–2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Share of workers with long university education refers to prime-aged workers (aged 25–54) and defined as at least three years tertiary level of education.

The tendency for regional divergence in the shares of university educated workers over time is also evident in figure 4. The growth in the share from 1986 to 2015 increases with the baseline shares in 1986 (the correlation coefficient is 0.71).
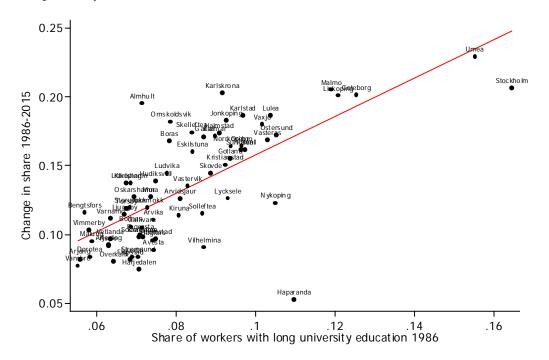
Figure 4 Initial share of workers with long university education 1986 and change in the share of workers with long university education 1986–2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Share of workers with long university education refers to prime-aged workers (aged 25–54) and defined as at least three years tertiary level of education.

Table 1 presents OLS estimates of the relationship between the change in the share of workers with a university degree and the initial share of university educated workers across local labour markets for six sub-periods. The table indicates divergence in all periods. The higher the initial share of workers with university education, the higher the growth in the share of university educated workers. The difference between the relatively weak indications of divergence for 1990–1995 compared with the high estimate for 1995–2000 is striking. To some extent, this is presumably a reflection of the deep recession during the former period, followed by a macroeconomic recovery with increased labour demand and higher mobility in the latter period. The magnitude of divergence also seems to be lower during the last decade up to 2015.

Table 1 Convergence in share of workers with long university education across local labour markets. Five-year intervals 1986–2015

	1986–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015
Initial share	0.197	0.125	0.287	0.186	0.111	0.090
	(0.037)	(0.024)	(0.034)	(0.029)	(0.016)	(0.017)
R-squared	0.30	0.30	0.52	0.38	0.40	0.31
Correlation	0.54	0.54	0.72	0.62	0.64	0.55

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Share of workers with long university education refers to prime-aged workers (aged 25–54) and defined as at least three years tertiary level of education. Standard errors in parentheses. The results are based on OLS estimates of the following form:

$$Share\ university_T - Share\ university_0 = \alpha + \beta * Share\ university_0 + \varepsilon$$

where T is the end of a sub-period and 0 is the start of a sub-period.

Summing up, the level of human capital measured by educational attainment increased substantially in Sweden during the period of observation from 1986–2015. The growth in the share of workers with long university education was positive in all local labour markets, but there is a large variation in growth rates. The overall pattern is higher growth rates of human capital in larger regions with an initial high share of highly educated workers. The tendency of long-run spatial concentration and regional divergence in human capital is also evident and consistent in estimates of medium-run changes. However, the rate of divergence seems to have tapered off somewhat during later periods of observation (2005–2015).

6   Migration and regional sorting of skills

In this section, we examine migration of human capital and show that the tendency of increased spatial concentration of skills in Sweden seems to be stronger than indicated above. We start out with some basic facts concerning migration by educational attainment. We then continue by focusing in greater detail on the migration pattern among recent university graduates. We consider not only the human capital content of migration flows in quantitative terms but also qualitative aspects related to migrants' ability.

6.1   Migration by educational attainment

Interregional migration rates across local labour markets in Sweden by age (one-year classes) and by educational attainment are shown in figure 5. In accordance with human capital theory, migration over longer distances is more frequent in the younger population. Migration rates peak around the age of 25, remain relatively high another five to ten years, and stabilise at fairly low rates from around age 40. Migration of university educated individuals dominates interregional migration flows within the age span with high mobility rates.
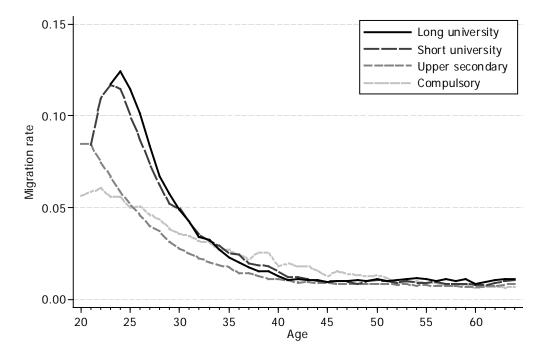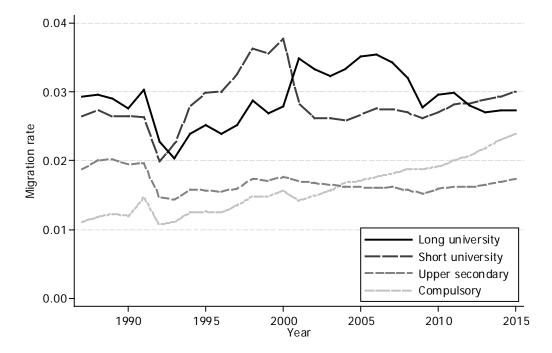
Figure 5 Migration rates across local labour markets by age and education 2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the residence. Migration rates calculated for individuals in one-year classes in the following age groups: 20–64 (compulsory and upper secondary), 21–64 (short university), and 23–64 (long university). Short university education defined as one or two years tertiary level of education. Long university education defined as at least three years tertiary level of education.

Figure 6 shows the evolution of migration rates across local labour markets over time and by education. The expected pattern of higher migration rates among highly educated individuals shown in figure 5 is replicated, but it also displays considerably short-term fluctuations and some interesting changes. The lower geographical mobility during the

macroeconomic recession in the early 1990s was followed by sharply increasing migration rates among the university educated. This was partially the result of increased supply and geographical decentralisation of university education, which increased migration to and from regions with universities and university colleges. The positive trend after the recession in the early 1990s in migration rates among individuals with only compulsory education is unexpected. To some extent the trend reflects internal migration of immigrants who relocate from their initial locations after arrival to Sweden but the trend is also clearly visible for people with only compulsory education born in Sweden.[10]

Figure 6 Migration rates across local labour markets by education 1986–2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the residence. Migration rates calculated for prime-aged individuals (aged 25–54). Short university education defined as one or two years tertiary level of education. Long university education defined as at least three years tertiary level of education.

Figure 7 shows the share of individuals with long university education among migrants across local labour markets plotted against the corresponding share among non-migrants. With only one exception, all observations are above the 45-degree line which means that migrants are better educated than non-migrants in the local labour market that they left. This is the case for all three size categories of local labour markets. The higher above the 45-degree line, the larger is the difference in the share of university educated between the migrant population and the non-migrant population. Local labour markets belonging to the group small regions tend to be particularly high above the 45-degree line. Whether this indicates spatial redistribution of human capital from smaller to larger regions is examined further below.

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[10] As shown in Figure 6, the migration rate for people with compulsory education has increased from 1.1 per cent in 1992 to 2.4 per cent in 2015. The corresponding numbers for compulsory educated individuals born in Sweden is 0.9 per cent and 2.1 per cent.
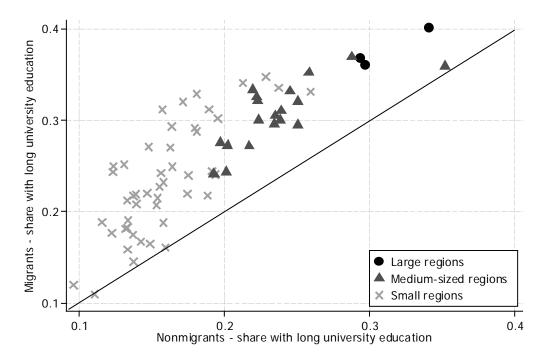
Figure 7 Share of individuals with long university education among non-migrants and migrants across local labour markets 2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the residence. Refers to prime-aged individuals (aged 25–54). The share with long university education among migrants across local labour markets is compared to the share with long university education among non-migrants. Long university education defined as at least three years tertiary level of education. The local labour markets are grouped into three types of regions based on their size of population in 2015 (see Section 4 for details of the grouping).

6.2 Migration patterns among recent university graduates

From the section above, it is clear that migration flows between local labour markets in Sweden are dominated by fairly young people with high education. Here, we will focus in greater detail on the migration pattern among recent university graduates. Different regions' ability to attract university graduates during the early part of their careers is important since mobility tends to decrease substantially with age. For this analysis, we use a dataset covering all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. For this group, we have information on school grades from upper secondary school and parental background in terms of parents' education and earnings. We will use this information to capture qualitative dimensions of the human capital content of migration flows.

In the discussion of recent research on the urban wage premium, we saw that as much as between 40 and 75 per cent of raw wage differences between regions may be explained by regional sorting of labour on observed and unobserved skills. When looking at the human capital content of migration flows between regions, it is therefore important to not only consider quantitative indicators, such as the level of education of migrants but also qualitative aspects related to migrants' ability and ambition.

Table 2 reports components of change in the number of university graduates during the period 2001 to 2010 across three types of regions.[11] Column (1) in the table presents the

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[11] The regions are aggregates of the 69 local labour markets based on their size of population in 2015. See Section 4.

number of graduates distributed according to their place of residence at age 17 (approximately one year prior to the earliest possible entry into university education). Columns (2) and (3) show gross migration flows after graduation by comparing the graduates' place of residence at age 17 with the place of residence five years after graduation.[12] Column (4) reports the net of internal in and out migration, and column (5) presents the total change in the number of university graduates. Panel A in the table reports counts while Panel B reports shares in relation to the number of starters.

The table shows the important role of migration for the long-term changes in regional stocks of highly educated workers. The gross flows are large and there is a substantial redistribution from small and medium-sized regions to large regions (the latter being Sweden's three metropolitan areas: Stockholm, Göteborg and Malmö). Net migration into the large regions amounts to more than 40 per cent of the graduates originating from the large regions. The total increase in the number of university graduates in the large regions amounts to 154,510, of which almost one third (45,175) is a contribution from net migration.

Table 2 Components of change in number of university graduates by type of region 2001–2010

	(1)	(2)	(3)	(4) = (2)-(3)	(5) = (1) + (4)
	Starters	In migrants	Out migrants	Net migration	Total change
Panel A: Counts					
Large regions	109,335	54,755	-9,580	45,175	154,510
Medium-sized regions	97,469	19,106	-42,428	-23,322	74,147
Small regions	41,670	5,150	-27,003	-21,853	19,817
Panel B: Shares (in relation to starters)					
Large regions		50.1	-8.8	41.3	141.3
Medium-sized regions		19.6	-43.5	-23.9	76.1
Small regions		12.4	-64.8	-52.4	47.6

Remark: Based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. The regions are aggregates of the 69 local labour markets based on their size of population in 2015 (see Section 4 for details of the grouping). Migration based on the location of the residence at age 17 relative to the location of the residence five years after graduation. See also Footnote 12 for additional details of the definition of migration.

The stock of university graduates also increased in the small and medium-sized regions despite large negative net-migration flows. Of the graduates who started out in small and medium-sized regions, 48 per cent and 76 per cent, respectively, remained in the regions in question five years after graduation. In the category medium-sized regions, we find local labour markets that host universities and university colleges that in many cases are quite large in relation to the size of the population and the labour market. The large net migration losses of graduates in medium-sized regions can therefore be explained both by students leaving after graduation to work in larger regions and by students leaving early to study and work in larger regions. In the category small regions, we typically find local labour markets that offer limited opportunities to pursue higher education in the home

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[12] Note that moves between local labour markets belonging to the same type of region do not count as migration (e.g., a move from a local labour market in the category large regions to another local labour market in this category), whereas moves between local labour markets belonging to different types of regions do count as migration (e.g., a move from a local labour market in the category small regions to a local labour market in the category large regions).

region. Thus, in this case, the large net migration losses of graduates predominantly reflect students moving early to study and work in larger regions.

From the analysis above, we can conclude that there is a considerable quantitative redistribution of university graduates over time from smaller labour markets towards larger labour markets. This finding is in line with previous studies on migration among university graduates (see, e.g., Faggian et al. 2007a,b, Faggian & McCann 2009, Venhorst et al. 2011, Haapanen & Tervo 2012).

We now turn to the qualitative dimension of migration flows among university graduates. As motivated in Section 3, we use school grades and parental background as proxies for ability and ambition. The two proxies are not perfect measures, but they are shown to be attributes that are valued on the labour market and are associated with more favourable socioeconomic outcomes in general. They are correlated with each other but not perfectly so. Two alternative measures of parental background are used – education and earnings. In addition to the influence on children's ability, parental background may affect migration through individuals' position on the housing market, a potentially extra important aspect for migration into high cost areas (Coulter 2017).

Figure 8 to figure 13 present the shares of university graduates moving upward and downward in the regional hierarchy distributed on either upper secondary school grade point average (GPA) or parents' level of education or earnings. Again, the analysis is based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. In total, 248,474 graduates. The denominator in the shares is the number of university graduates residing in a specific region at age 17 while the numerator is the number of graduates who, five years after graduation, have migrated from that region to another specific region (e.g., the number moving from small regions to large regions in relation to the number originating from small regions). Since the shares relate to destination-specific migration flows they cannot be aggregated.

Assuming that upper secondary school grades are positively correlated with productive skills, figure 8 indicates that the regional sorting on educational attainment shown in Table 2 represents an understatement of actual regional sorting of skills. There is an almost monotonic increase in the share of university graduates moving upwards in the regional hierarchy from the first to the tenth decile of the upper secondary grade distribution. Moreover, this association is especially evident at the top of the grade distribution, and for migration from small to large regions. Among university graduates in the top decile of the grade distribution, the share of graduates from small regions moving to large regions is 70 per cent. The corresponding figure for graduates in the lower end of the grade distribution is about 40 per cent.
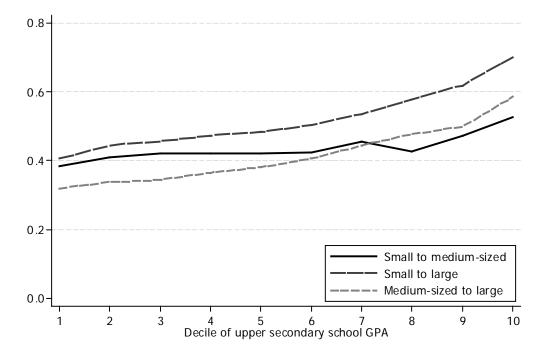
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Figure 8 Share of university graduates moving upward in the regional hierarchy, distributed on deciles of upper secondary school GPA, 2001–2010

Remark: Based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. The regions are aggregates of the 69 local labour markets based on their size of population in 2015 (see Section 4 for details of the grouping). Migration based on the location of the residence at age 17 relative to the location of the residence five years after graduation.

The share of university graduates moving in the reverse direction (figure 9), i.e., downward in the regional system, indicates a negative sorting on school grades for migration from large to small regions (measured on the right-hand axis). This is perhaps also valid for moves from large to medium-sized regions. Migration from medium-sized to small regions shows an opposite pattern. The difference between figure 8 and figure 9 regarding the scales of the vertical axis again indicates the large dominance of migration flows among university graduates upwards in the regional hierarchy over migration flows directed downwards towards smaller regions.
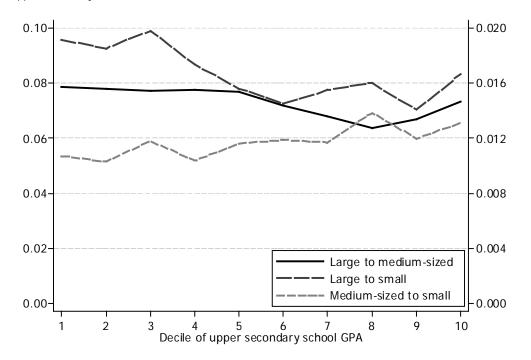
Figure 9 Share of university graduates moving downward in the regional hierarchy, distributed on deciles of upper secondary school GPA

Remark: Based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. The regions are aggregates of the 69 local labour markets based on their size of population in 2015 (see Section 4 for details of the grouping). Migration based on the location of the residence at age 17 relative to the location of the residence five years after graduation. Migration from large to small regions measured on the right-hand axis.

Turning to parental background of university graduates and migration flows between smaller and larger regions, our results indicate positive sorting on parents' education into larger regions (figure 10). The share of university graduates in each upward migration flow increases with parents' level of education. This association seems to be strongest for migration into large regions. For instance, 46 per cent of graduates without a university educated parent move from small to large regions, whereas 74 per cent of graduates with two highly educated parents do so.
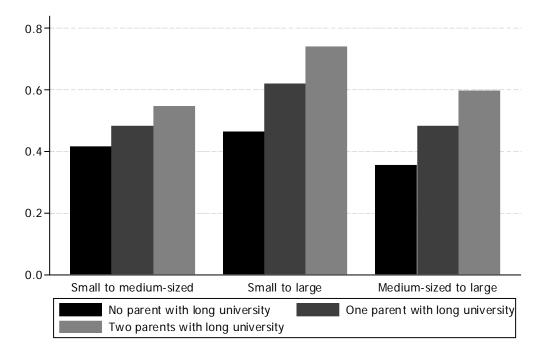
Figure 10 Share of university graduates moving upward in the regional hierarchy, distributed on parents' education

Remark: Based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. The regions are aggregates of the 69 local labour markets based on their size of population in 2015 (see Section 4 for details of the grouping). Migration based on the location of the residence at age 17 relative to the location of the residence five years after graduation. Long university education defined as at least three years tertiary level of education.

As for migration flows downward in the regional system, figure 11 indicates falling shares of university graduates by parents' education for moves from large to small regions and from large to medium-sized regions. Again, there is a different and reversed pattern for migration from medium-sized to small regions, similar to migration flows by school grades displayed in figure 9.
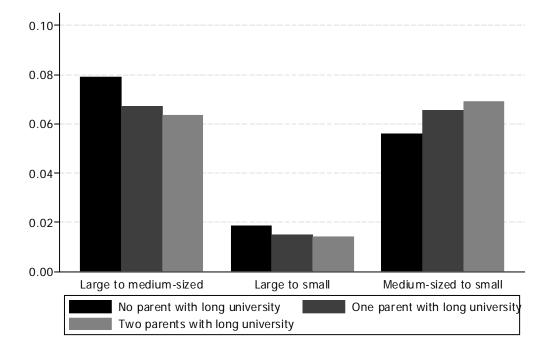
Figure 11 Share of university graduates moving downward in the regional hierarchy, distributed on parents' education

Remark: Based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. The regions are aggregates of the 69 local labour markets based on their size of population in 2015 (see Section 4 for details of the grouping). Migration based on the location of the residence at age 17 relative to the location of the residence five years after graduation. Long university education defined as at least three years tertiary level of education.

Examination of migration by parents' earnings yields roughly the same story as above – parents' socioeconomic position matter for patterns of migration. There is an apparent positive sorting on parents' earnings in migration flows from small to large regions (figure 12). This is particularly evident in the right tail of the (parental) income distribution.
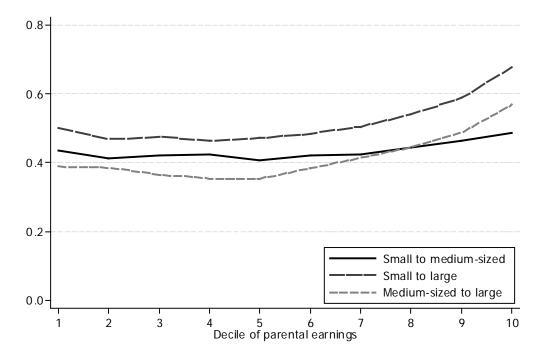
Figure 12 Share of university graduates moving upward in the regional hierarchy, distributed on deciles of parent's annual gross earnings

Remark: Based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. The regions are aggregates of the 69 local labour markets based on their size of population in 2015 (see Section 4 for details of the grouping). Migration based on the location of the residence at age 17 relative to the location of the residence five years after graduation.

Figure 13 presents the shares of university graduates in migration flows downward in the regional hierarchy. For higher earnings of parents, there are decreasing shares of university graduates in downward migration flows from large regions. This applies from the 4th decile regarding migration from large to small regions and from the 6th decile for moves from large to medium-sized regions. The share of university educated migrants from medium-sized to small regions does not seem to be associated with parental earnings.
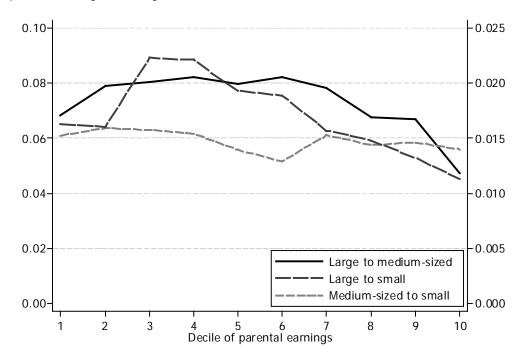
Figure 13 Share of university graduates moving downward in the regional hierarchy, distributed on deciles of parent's annual gross earnings

Remark: Based on all individuals 32 years or younger who graduated from at least three years of university education during the period 2001–2010. The regions are aggregates of the 69 local labour markets based on their size of population in 2015 (see Section 4 for details of the grouping). Migration based on the location of the residence at age 17 relative to the location of the residence five years after graduation. Migration from large to small regions measured on the right-hand axis.

In all, the examination of internal migration flows between local labour markets confirms some well-known features of internal migration over longer distances. Migrants are young, and migration rates increase with educational attainment. A majority of migrants between local labour markets in Sweden have either short or long university education.

In addition to these basic facts, we show that the gross-migration exchange of university graduates constitutes a large part of net changes in regional stocks of human capital. We also show that within the group of university educated migrants, there is substantial sorting on school grades and parental background. Migration upwards in the regional system is associated with higher school grades and more favourable parental backgrounds in terms of education and earnings. Although somewhat less clear, the reversed pattern is evident for migration downward in the regional hierarchy, i.e., higher school grades and more favourable parental background are negatively associated with migration from larger to smaller regions.

The broad picture outlined here is thus one of brain drain from small and medium-sized regions to metropolitan areas. The metropolitan areas are not only net receivers of human capital in the sense that university graduates tend to locate there, but also within the group of university graduates, metropolitan areas in particular attract those with the highest school grades and highly educated parents. Ahlin et al. (2016) argues that one important reason why university graduates with better school grades and a stronger parental background are overrepresented among migrants to metropolitan areas has to do with high entry requirements into top universities in Sweden and the fact that these universities are predominantly located in urban regions. However, sorting into metropolitan areas on

family background might also reflect restrictions and tightness on the housing market. Most migrants are young, with limited wealth from savings. Having parental back up by provision of cash deposits and security for loans (or by connections) may save hours of daily commuting times in metropolitan areas. This residential sorting mechanism is presumably the most important in metropolitan regions with large positive net-migration and excess demand for housing (e.g., Coulter 2017, Öst 2011).[13]
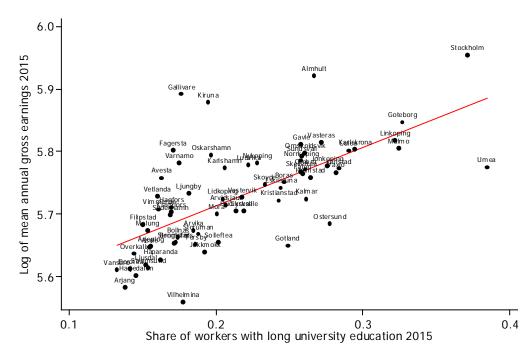
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[13] Theoretically, the importance of parental background in this context may partially be due to market imperfections on the capital and housing market.

7 Skill sorting, earnings and regional divergence

What are the implications of spatial sorting of skills for earnings and regional convergence in per capita incomes? While this important research question will not be pursued in depth here, we do continue on the explorative path and connect some of the descriptive statistics presented above with information on earnings and regional per capita incomes.

Figure 14 presents the relationship between the share of workers with a university degree and the log of mean annual earnings across local labour markets in 2015. The graph shows a clear positive association, indicating that the higher the share of university educated workers, the higher the mean annual earnings are (the correlation coefficient is 0.67). This pattern is expected given the positive correlation between regional size, on the one hand, and earnings as well as the share of highly educated workers, on the other hand (figure 1 and figure 2). Again, the metropolitan areas are found in the north-east corner of figure 14, although only Stockholm stands out above the regression line. Some other noteworthy outliers are the observations for Älmhult in the south of Sweden, one of the main locations for IKEA, and the northern mining regions Gällivare and Kiruna. Another outlier is the university and student dominated labour market region of Umeå in the north of Sweden.

Figure 14 Share of workers with long university education and mean annual gross earnings 2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Share of workers with long university education refers to prime-aged workers (aged 25–54) and defined as at least three years tertiary level of education. Annual gross earnings in SEK 1,000 for prime-aged workers.

Looking at the relationship between the share of highly educated workers and mean annual earnings for workers with upper secondary education, figure 15 shows a similar pattern as in figure 14. The average earnings of workers with lower educational attainment clearly increase with the regional share of workers with a university degree (the correlation coefficient is 0.41) and the location of the observations for different local labour markets

are quite similar in the two figures. A highly educated workforce not only seems to raise earnings in general but also the earnings of less skilled workers. This is a very interesting result. Given the very simplistic analysis, however, one should be cautious with interpretations of the finding. That said, the positive relationship between the share of skilled workers in a region and the earnings of their less skilled neighbours might reflect a complementarity between skilled and less skilled labour, as well as human capital externalities that raise the productivity of less skilled workers.

Figure 15 Share of workers with long university education and mean annual gross earnings for workers with upper secondary education 2015
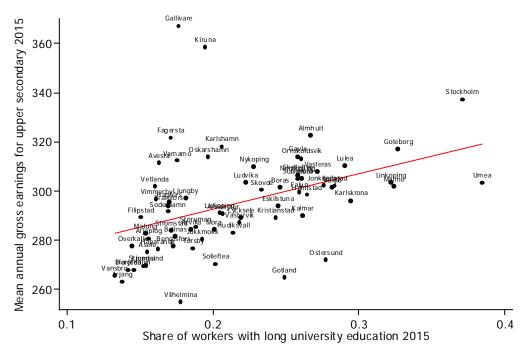

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Share of workers with long university education refers to prime-aged workers (aged 25–54) and defined as at least three years tertiary level of education. Annual gross earnings in SEK 1,000 for prime-aged workers.

Table 3 presents the five top and bottom local labour markets in terms of the share of workers with a university degree in 2015. At the top of the list, we find the metropolitan regions and regions that host large universities. The group at the bottom of the list includes small local labour markets in the north and south of Sweden. The difference in the share of highly educated workers is quite large. The regions at the top tend to have shares that are two to three times as high as the shares of regions at the bottom. Ranking regions by the share of skilled workers also restates the positive (but imperfect) correlation with earnings of university educated workers and workers with upper secondary education. Differences in educational levels are associated with large differences in annual earnings. University educated workers in the metropolitan areas have on average 20–45 per cent higher earnings than skilled workers in the bottom group. However, perhaps the most striking result is that the earnings of less skilled workers in the metropolitan regions are in parity with or even higher than the earnings of university educated workers in the bottom group in small local labour markets. Since the findings are based only on descriptive statistics we again remind that strong conclusions should not be drawn from the results. The table says nothing about

whether we are comparing comparable workers in the top and bottom regions of the table. From the previous section, we know that within categories of educational attainment there is substantial sorting between regions on attributes related to ability and ambition of workers.

Table 3 Mean annual gross earnings for workers with long university and upper secondary education 2015. Regions ranked by share of workers with long university education

	Rank	Share with long university	Earnings long university	Earnings upper secondary
Umeå	1	0.38	354.0	303.3
Stockholm	2	0.37	460.7	337.3
Göteborg	3	0.33	398.2	317.0
Malmö	4	0.32	387.5	302.1
Linköping	5	0.32	394.7	303.5
Härjedalen	65	0.15	314.6	267.8
Överkalix	66	0.14	329.2	277.6
Dorotea	67	0.14	319.8	267.8
Årjäng	68	0.14	301.3	263.1
Vansbro	69	0.13	316.6	265.7

Remark: Data are for five top/bottom local labour markets in Sweden and based on the location of the workplace. Share of workers with long university education refers to prime-aged workers (aged 25–54) and defined as at least three years tertiary level of education. Annual gross earnings in SEK 1,000 for prime-aged workers.

Finally, we turn to the issue of regional convergence or divergence in per capita earnings over time. We consider two different measures of convergence. The first measure refers to a situation where poor regions tend to grow faster than rich ones, so that poor regions over time tend to catch up with the rich ones in terms of the level of per capita earnings. This process is referred to as beta (β) convergence. A related but different measure focuses on the evolution in the cross-section dispersion of per capita earnings over time. According to this measure, convergence takes place if the cross-section dispersion declines over time. This process is referred to as sigma (σ) convergence.[14]

Figure 16 presents the relationship between the log of annual earnings for workers in 1986 and the average growth rate of earnings between 1986 and 2015 across local labour markets. There is no indication of either β convergence or divergence, i.e., no apparent association between regional earnings in 1986 and subsequent growth in earnings.

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[14] For our estimates of beta convergence we use OLS to estimate an equation of the form:

$$(1/T) * \log(y_{iT}/y_{i0}) = \alpha + \beta * \log y_{i0} + \varepsilon$$

where the left-hand side represents the annual growth rate in region i in per capita earnings between year 0 (the base year) and year T. The right-hand side includes a constant term α and the log of per capita earnings in region i in the base year. If the estimate of the slope parameter $\beta < 0$, this indicates unconditional (or absolute) convergence, whereas $\beta > 0$ indicates unconditional divergence. The expression "unconditional" convergence/divergence is distinct from "conditional" convergence/divergence (not employed in this study). The latter corresponds to an estimate of β when the growth equation includes other explanatory variables assumed to affect regional growth. For sigma convergence, we focus on the standard deviation of the log of regional per capita earnings (focusing instead on, for example, the coefficient of variation gives similar results). For more information on the two concepts of convergence, see Barro & Sala-i-Martin (1999).
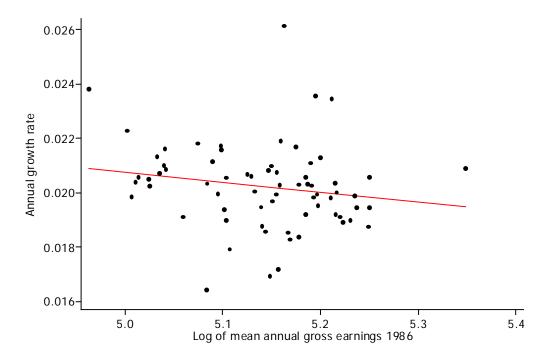
Figure 16 Convergence in annual gross earnings across local labour markets 1986–2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Annual gross earnings in SEK 1,000 for prime-aged workers (aged 25–54) deflated by the national CPI, with base year 2015.

Estimates on data for six sub-periods reveal no consistent pattern of either (unconditional) β convergence or divergence over time (Table 4). However, the statistically significant estimate for the first period, 1986–1990, indicates β convergence. Otherwise, there is no statistically significant association between initial regional earnings of workers and subsequent growth in earnings.

Table 4 Convergence in mean annual gross earnings across local labour markets. Five-year intervals 1986–2015

	1986–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015
Initial log mean earnings	-0.023	0.002	0.010	0.003	-0.006	0.007
	(0.006)	(0.007)	(0.008)	(0.005)	(0.006)	(0.005)
R-squared	0.17	0.00	0.03	0.01	0.02	0.02
Correlation	0.41	0.04	0.16	0.07	0.13	0.15

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Annual gross earnings in SEK 1,000 for prime-aged workers (aged 25–54) deflated by the national CPI, with base year 2015. Standard errors in parentheses. See Footnote 14 for specification of the regression.

Figure 17 shows the development of regional convergence for the period 1986–2015 using our second measure of convergence, namely, the standard deviation of the log of annual earnings for workers across local labour markets (σ convergence). The figure indicates evidence for the presence of σ convergence, i.e., decreasing dispersion, between 1986 and 1990 (the period where we also found statistically significant β convergence). This was a period with strong macroeconomic growth in Sweden. The figure reveals increasing regional dispersion in earnings during the following ten years (during the macroeconomic

crisis and recovery). The standard deviation of the log of annual earnings remains thereafter at a higher level, hovering around 0.08.

Figure 17 Dispersion of annual gross earnings across local labour markets 1986–2015

Remark: Data are for 69 local labour markets in Sweden and based on the location of the workplace. Annual gross earnings in SEK 1,000 for prime-aged workers (aged 25–54) deflated by the national CPI, with base year 2015. Dispersion measured by the cross-sectional standard deviation of log per capita annual gross earnings.

In all, the descriptive evidence presented here provides no convincing support for consistent (unconditional) convergence or divergence in regional earnings for the whole period. However, there are indications of convergence (β and σ) during the first period in the data (1986–1990). There is no sign of β convergence thereafter. In contrast, there is some indication of increased regional dispersion in incomes (σ divergence) after 1990.

Viewed in a longer historical perspective, the development of regional income differences in Sweden during the last 25 years deviates from the long-term trend. Persson (1997) finds robust evidence of both β and σ convergence in per capita incomes across Swedish counties during ten-year sub-periods from 1911 to 1993. With the exception of the interwar period from 1910 to 1940, Enflo et al. (2014) and Enflo & Ramón Rosés (2015) also find support for σ convergence in GDP per capita across Swedish counties from 1860 to 1980. The tendency for increased regional dispersion in incomes after 1990 thus seems to depart from the long run historical development.

8   Summary and discussion

In this paper, we have analysed the geographical distribution of skills and the human capital content of migration flows between Swedish local labour markets. During the last three decades, we find a consistent pattern of skill divergence across regions. The uneven distribution of human capital is reinforced by the mobility of the highly educated population. The pattern of skill divergence coincides with decreasing or even reversed income convergence across Swedish regions. The skilled regions become both more skilled and richer, while the less skilled regions lag behind. This development has potentially important implications for both national and regional economic policy.

We find a positive and robust correlation across Swedish regions between the initial share of workers with a university degree and the change in this share during the last three decades. Local labour markets with high initial shares have consistently experienced a larger increase in the share of university educated workers. We further find that the migration behaviour of individuals with a university degree reinforces the pattern of skill divergence across regions. Metropolitan regions receive large net in-migration flows of young university graduates, the most prone to migration, while medium-sized and small regions experience large net out-migration flows.

Larger regions are not only net attractors of young university graduates in quantitative terms, but we also find a distinct migration pattern in qualitative terms. Our results show that the share of university educated migrants moving upwards in the regional hierarchy increases sharply in the upper end of the ability distribution. The higher the grades in upper secondary school, the higher the share of university graduates that move from smaller to larger regions. Migration upwards in the regional hierarchy is also found to be related with relatively strong family backgrounds of migrants in terms of parents' education and earnings.

We further find that the earnings of both low-skilled and high-skilled workers increase with the share of highly educated workers in the region and the size of the region. Finally, our results show that the rising geographical segregation of the skilled is accompanied by declining or even reversed income convergence across Swedish regions during the last 25 years. The tendency for increased regional dispersion in incomes in recent decades deviates from the long run historical development.

The descriptive statistics presented in this study provide support for results and argumentation in more recent studies on the causal effect of agglomeration on earnings and labour productivity. Our results indicate that residential self-selection needs to be taken seriously in attempts to estimate regional differences in earnings and productivity or almost any spatial difference in socioeconomic outcomes. In some situations, data on peoples' labour market history may reveal unmeasured ability, which allows us to address residential selectivity by studying changes in earnings before and after migration. However, a large share of migration between local labour markets pertains to young people with high education but with either no or very limited labour experience before migration. This makes the information content of pre-migration earnings less useful for corrections of residential self-selection. Direct measurement or relevant proxies of productive skills should therefore be of great interest for measurement of human capital stocks and skill composition of migration.

During the last few decades, a combination of globalisation and technological change has resulted in a redistribution of jobs, people and wealth across regions. Contrary to the development during large parts of the previous century, regional inequalities have been rising in more recent years. This is the case in the United States as well as in many European countries including, as this study has shown, Sweden. In many countries, growing income inequalities and regional polarization have marched side by side with political polarization and the rise of populist parties. Iammarino et al. (2018) argue that regional economic divergence has become a threat to economic progress, social cohesion and political stability in Europe.

The growing regional inequalities certainly call for some type of policy action. But what sorts of interventions are most likely to be effective? This is of course a very difficult question lacking given answers. Kline & Moretti (2013), Austin et al. (2018) and Iammarino et al. (2018) discuss various aspects of place-based (or place-sensitive) development policies. Place-based policies are policies which target specific geographic areas for some type of treatment.[15] A first conclusion from these papers is that place-based policies must be tailored to the receiving regions' specific comparative advantages and challenges. One-size-fits-all policy will not work. This is the fundamental rational for place-based policies to begin with. Another important conclusion is that place-based policies most likely will involve difficult equity-efficiency trade-offs. While place-based policies may improve welfare in the receiving regions they may reduce the welfare of the nation as a whole. Thus, policy makers need to compare the marginal utility of different policy interventions in different regional settings, while at the same time keeping track of welfare consequences at the national level.

The positive relationship between worker productivity and earnings and the size of regions and cities is well documented in economic research. The descriptive evidence in this paper also points clearly in this direction. The fact that productivity and earnings seem to increase with the size of regions implies that national productivity and economic growth can be stimulated by increased labour supply in larger regions. In the current economic situation, firms seem to have trouble finding sufficient numbers of workers with suitable skills. This is the case in many parts of Sweden, but primarily so in the metropolitan regions. Constraints in the housing market and the transport infrastructure are potentially important explanations for why firms in the metropolitan regions find it increasingly difficult to fill vacancies. Although labour market prospects look bright in the metropolitan regions, individuals may find it difficult to find affordable housing at acceptable commuting distances. Presumably, this is the case for young workers in particular, who have limited economic resources of their own. Reforms that increase the supply of housing in the metropolitan areas would enable more workers to take advantage of the highly productive environments in these regions and thereby contribute to both regional and national productivity and economic growth.

Hsieh & Moretti (2017) quantify the effect of spatial misallocation of labour across US metropolitan areas due to constraints in the housing market. They conclude that restrictions to new housing supply in areas such as New York and the San Francisco Bay Area lowered US aggregate growth by over 50 per cent from 1964 to 2009. By tradition, land use and housing policy have primarily been the responsibility of the municipal level in the US

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[15] Place-based policies are in this sense different from people-based policies, which target particular groups of individuals depending on their circumstances (e.g. unemployment benefits and different types of welfare programs for households).

(which is also the case in Sweden). Given their findings, the authors argue that one possible way to minimize the negative externalities from housing supply constraints would be for the national level to limit the municipalities' ability to impose land use regulations. Based on the findings from the US, it seems that the economic benefits from increased supply of housing in the metropolitan areas can be fairly large.

Another important area for policy initiatives is investments in transport infrastructure that both facilitates efficient intra-regional mobility in metropolitan areas and stimulates increased functional integration between the metropolitan areas and surrounding smaller regions. Such investments could include maintenance of existing infrastructure as well as investments in new infrastructure and public transportation. This could reduce problems of spatial mismatch within the large metropolitan area labour markets. In combination with investments in education it could also facilitate employment and integration of immigrants in the metropolitan regions. Investments in transport infrastructure and public transportation would further enable small and medium-sized regions to tap into the agglomeration advantages of metropolitan regions. This could also offer some relief for the tight housing and labour markets in the metropolitan areas. Although the potential returns from increased functional integration of local labour markets probably are highest around the metropolitan regions, there is also potential scope for gains further down in the regional hierarchy, for instance between Sweden's many regional centres and adjacent smaller local labour markets. In these types of regions, the existing supply of transport infrastructure may be adequate. What stands in the way of improved functional integration is, in many cases, an insufficient supply of public transport on the existing infrastructure.

From a regional policy perspective, the observed skill divergence across regions is challenging. The fact that many small and medium-sized regions experience a net loss of university educated workers makes it more difficult for those regions to attract innovative firms. This reduces the supply of attractive jobs in these locations, which in turn makes it more difficult to keep and attract highly skilled people. However, it is not obvious what the policy response to this development should be. The fact that many workers with university degrees choose to locate in metropolitan regions presumably reflects increased utility on their part, and the agglomeration of skills into larger regions is also motivated from a national productivity perspective.

When it comes to labour supply response to regional inequality, it is important to underline that regional effects are very different depending on whether the response is in terms of commuting or migration. The costs for the sending regions are generally much lower in the case of commuting. As opposed to migration, commuting does not erode the local tax base and purchasing power. This will contribute to upholding the provision of both local public and private services in the sending regions. In addition, commuting, unlike migration, does not cause downward pressure on local house prices. From the perspective of the receiving regions, commuting increases the labour supply without causing additional stress on already tight housing markets. Policy initiatives that encourage commuting rather than migration from lagging areas to more prosperous regions thus have the potential to balance the difficult equity-efficiency trade-off between regional equality and national economic efficiency.

For lagging regions in the periphery, the potential to draw on the metropolitan areas' agglomeration advantages is obviously smaller. It is also in the remote regions that we find the largest negative net-migration rates. A minimum requirement of public policy in these settings is to maintain basic public services, such as compulsory and upper-secondary

education, health care and care for the elderly. Examples of more place-specific initiatives are active labour market policies in terms of vocational training and retraining that adapt the skill composition of labour supply to the requirements of the local production structure.

This paper has been purely exploratory in nature and perhaps raises more questions than it answers. Based on its findings, and the results from other research in the field, we identify three topics that merit additional attention. One involves attempting to further disentangle the exact mechanisms behind the observed positive relationship between worker product- ivity and earnings and the size of regions and cities. Another is to study the role of commuting for geographic spreading of agglomeration economies across regions. The third is to more carefully study how constraints in the housing market affect the geographical mobility and productivity of workers.

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