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Title: Patterns of inter- and intra-regional differences in human capital and earnings : Evidence from Finland and Sweden 1987–2015

Year: 2021

Version: Published version

Please cite the original version:

Eliasson, K., Haapanen, M., & Westerlund, O. (2021). Patterns of inter- and intra-regional differences in human capital and earnings : Evidence from Finland and Sweden 1987–2015. Applied Geography, 135, Article 102539. https://doi.org/10.1016/j.apgeog.2021.102539

Applied Geography 135 (2021) 102539

Contents lists available at ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog

Patterns of inter- and intra-regional differences in human capital and earnings: Evidence from Finland and Sweden 1987–2015

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ARTICLE INFO

Keywords:
Regional disparities
Human capital
Skill intensity
Income
Intra-regional
Local labor market areas

ABSTRACT

In this paper, we examine the long-term patterns of geographical disparities in human capital and income in Finland and Sweden over the period 1987–2015. Using nationwide longitudinal population register data, we analyze disparities at different spatial scales, between and within functional labor market regions determined by observed travel-to-work patterns. Contrary to the findings from many other developed economies indicating inter-regional divergence in per capita income, we find indications of inter-regional convergence in per capita earnings among the functional labor market regions in both countries after 2000. However, small, and peripheral regions have not recovered from the macroeconomic shocks in the 1990s, in terms of per capita earnings. Our estimates indicate relatively small and statistically insignificant changes in the geographical dispersion of human capital at the inter-regional scale. At the intra-regional scale, the disparities in human capital and earnings between the core and hinterlands are relatively large and persistent, although some evidence of convergence is found for Finland. The largest intra-regional differences in human capital and earnings are found within the metropolitan labor markets.

1. Introduction

Research has identified a slower rate of convergence or even divergence in income and human capital levels in several developed economies since the turn of the millennium (Austin et al., 2018; Butkus et al., 2018; Ganong & Shoag, 2017; Iammarino et al., 2019). Country differences are substantial. OECD (2020) reports increasing regional economic gaps in half of the OECD countries between 2000 and 2018, including across the U.S. states. Among European countries, regional gaps in GDP per capita increased in large economies such as France, the UK, Spain, and Italy, but not in Germany (OECD, 2020, p. 55). The levels and dynamics of socioeconomic disparities may differ by spatial scales, e.g., between states, metropolitan areas, and counties in the U.S., or between geographical units within the size categories of the European NUTS classification (Dapena et al., 2016; He et al., 2017; Yamamoto, 2008). OECD (2020) finds larger within-country disparities in GDP per capita when measured across smaller regional units. Inter-regional analysis at a larger scale and intra-regional studies of urban/-metropolitan areas at a more disaggregated scale dominate this field of research. A smaller line of the empirical literature analyzes socioeconomic disparities at both scales within a national or larger federal framework (Liao & Wei, 2012; Partridge et al., 2009; Veneri & Ruiz, 2016).

Structural change in production and trade has for long induced the spatial concentration of labor and capital in developed economies, generally accompanied by regional income convergence (Barro & Sala-i-Martin, 2004). Theoretically, this development may be explained by the economies of agglomeration favoring urbanization (Duranton & Puga, 2004) and neo-classical adjustments reducing regional differences in real wages and per capita income, for example, by geographical labor mobility from smaller to larger and more populous regions and by increased concentration of labor supply to core areas within local labor markets. Externalities and spread effects from core cities may benefit economic activity in adjacent and fringe areas and contribute to regional convergence in per capita income, for example, by knowledge spillovers and commuting. However, "backwash" effects (e.g., net migration of people and relocation of retail from the hinterland to the core) could erode the advantages of proximity to the core (Barkley et al., 1996; Irwin et al., 2010; Wei, 2015). Generally, rural areas have experienced decreased population and employment; exceptions are mostly

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https://doi.org/10.1016/j.apgeog.2021.102539
Received 28 July 2020; Received in revised form 14 July 2021; Accepted 10 August 2021
Available online 7 September 2021

amenity-rich localities and rural areas close to core cities (Partridge et al., 2010). The concentration of highly educated people in or near core cities may also increase geographical disparities in income (Duranton & Puga, 2004). The cores of larger and dense regional labor markets are generally characterized by rising property prices and gentrification in various dimensions (e.g., Bereitschaft, 2020). These characteristics apply in broad terms to Finland and Sweden (Bernelius & Vaattovaara, 2016; Hedlund & Lundholm, 2015; Scarpa, 2016).[1]

Though many studies have investigated regional disparities in human capital and income levels, past research pertains primarily to administrative units within countries and/or data across countries with substantial dissimilarities in institutional contexts and data. The variables of main interest are usually measured either according to residential locations or workplaces, and the analysis is in most cases restricted to one regional scale.[2]

We contribute to past research on regional disparities in three main ways. First, we present comparable[3] estimates of inter-regional convergence in human capital and income across functional labor markets in two Nordic welfare states (Finland and Sweden) sharing important socioeconomic and institutional settings. Finland and Sweden differ in institutional and other socioeconomic aspects from the U.S. and many European economies, where – as noted above – tendencies toward increasing regional disparities have been observed in recent studies. A natural question is whether this trend applies to economies with different institutional environments and arrangements (Rodríguez-Pose, 2013). From a historical and international perspective, the Nordic countries were relatively late in terms of industrialization and urbanization. Agglomeration economies may have become more important relative to natural locational advantages more recently in Finland and Sweden than in many other developed economies. The two countries have experienced similar urbanization processes during the 20th century, although in quite different historical contexts up to the end of the Cold War. Finland and Sweden are "welfare states" with relatively narrow income distribution, high taxes, large public sectors, and extensive social security systems. Even though income inequality at the country level increased in Finland and Sweden after the 1990s economic crisis, it is still low compared to most countries other than the Nordic countries and has not been increasing during the 2000s, contrary to the U.S., for example (Kyyrä & Pesola, 2018; OECD, 2018). For further information on the regional economic history of Finland and Sweden, see Enflo (2018) and Enflo et al. (2018).

In both countries, the public sector provides comprehensive financing of education, including various forms of adult and university education free of charge, active labor market policies, and health care free or at low private cost. Redistributive tax and transfer systems, including regional tax-equalization schemes, work as automatic stabilizers when regional economies are negatively affected by long-term structural changes or short-term macroeconomic fluctuations. Increasing regional unemployment and decreasing income levels are counteracted directly by active labor market programs and access to education financed by the state. The tax and transfer systems automatically channel more funds from prosperous regions to economically depressed regions. In sum, the patterns of regional inequality and the economic relationships between the core and fringe regions may differ substantially between welfare states of the Nordic type and other developed market economies.

Second, we analyze long-term developments of intra-regional disparities in human capital and income within different size-categories of functional labor market regions (LMRs). We utilize two spatial scales mainly: i) inter-regional disparities between LMRs, defined by commuting patterns, and ii) intra-regional differences between the core and the hinterlands within the LMRs. The labor market is one of the most important arenas for socioeconomic interactions and the spatial distribution of important socioeconomic outcomes such as income, employment, and education. Therefore, we regard the functional LMRs as a preferred spatial unit of analysis, rather than administrative regions such as the municipalities or NUTS-3 regions (see, e.g., Martínez-Bernabeu et al., 2020, on the concept of functional regions and for further references). However, within LMRs, there are important socioeconomic inequalities between the core, adjacent, and fringe areas that must be acknowledged and understood. Therefore, we examine the heterogeneity between the core and the periphery within, e.g., large metropolitan labor markets and small regional labor markets. The intra-regional analysis is based on municipalities as an underlying administrative unit; in the Nordic context, these are crucial for the provision of welfare and implementation of policy. The analysis pertains to the long-term development of human capital and income levels, important socioeconomic attributes for policy and welfare. We use nationwide longitudinal population register data for estimation of inter-regional convergence across LMRs and analysis of intra-regional disparities over the period 1987–2015.

Third, we compare intra-regional differences in skilled labor and earnings based on the place of residence or place of work. This comparison is motivated by the increasingly important role of commuting, and because the two definitions provide complementary evidence for research and policy. The place of residence is directly related to local housing markets and intra-regional differences in local tax bases, which affect the ability of the local public sector to provide public service at sustainable tax rates.[4] The place of work is more relevant when spatial differences in productivity and growth are of primary interest.

We find that for both countries, changes in the regional dispersion of skill-intensity ratios over time are relatively small and statistically insignificant in most cases. The regional dispersion of income has decreased in Finland and remained fairly stable in Sweden. Further, our estimates indicate regional income convergence over time for Finland and (albeit less clearly) for Sweden from around the turn of the millennium up to the endpoint of our data in 2015. These income results are partially at odds with findings for recent decades in research for the U.S. and the EU.[5]

The intra-regional disparities between the core and fringe municipalities are substantial and, with few exceptions, persistent over time. While some changes in the inter-regional dispersion of human capital and income have coincided with macroeconomic recessions and

[1] Although there has been a population decline in some small and remote labor markets, Finland and Sweden have not experienced shrinking of medium-sized or larger cities as in some European countries and in the U.S. (Bagchi-Sen et al., 2020; Turok & Mykhnenko, 2007).

[2] In many cases these choices are due to availability of data. Further, identification of causal effects may require a narrower scope of analysis. In this study, we have chosen a broader, multi-dimensional and more descriptive analysis. We make no claims in terms of identification of causal effects.

[3] Both countries keep administrative registers with comparable longitudinal information on the total population.

[4] In both countries, the local public sector in municipalities (administrative units) plays a prominent economic role in terms of income taxation (of local residents) and provision of public services.

[5] Berry and Glaeser (2005) present patterns of regional convergence in wages and income across metropolitan statistical areas in the U.S. during the period 1970–2000. The results on wages indicate a shift from significant convergence in the 1970s to significant divergence in the 1980s and 1990s. The results on income indicate a substantial slowdown in convergence in the 1980s and no signs of convergence in the 1990s. Austin et al. (2018) study income convergence at a detailed geographical level (PUMA) in the U.S. and find only modest or insignificant income convergence in the period 1980–2010. Ganong and Shoag (2017) report a slowdown in income convergence among U.S. states in the period 1980–2010 and no indication of convergence for the period leading up to the Great Recession. Butkus et al. (2018) analyze regional convergence in GDP per capita at the NUTS-3 level in 26 EU member states during the period 1995–2014 and report increasing regional disparities in 21 countries.

recovery, intra-regional disparities remain relatively stable, with little trace of macroeconomic events. We find that patterns of intra-regional disparities show some interesting dissimilarities between the definitions of place based on residential locations or location of workplaces.

The following section presents the data, variables, and background statistics. We analyze inter-regional differences in skill-intensity ratios and earnings in Section 3 and the corresponding long-term developments at the intra-regional scale in Section 4. A summary and discussion are provided in Section 5.

2. Data and variables

Population-based data used in the analyses originate from various registers maintained by Statistics Finland and Statistics Sweden. By matching the unique personal identification codes across censuses and registers, the data provide detailed information regarding the individuals, including their education, earnings, labor market status, and locations of residence and workplace during the period 1987–2015. The analysis is restricted to the working-age population aged between 25 and 64. The data cover annually approximately 2.8 million individuals living in Finland and 5.0 million in Sweden.

We apply a data-driven approach based on commuting flows between all municipalities in the two countries to identify functional regional labor markets (LMRs). There are several aspects that are potentially relevant when considering how to group territorial units, such as municipalities, into LMRs. Martínez-Bernabeu et al. (2020) emphasize dimensions such as autonomy (minimizing commuting flows across the boundaries of the LMRs) and cohesion (maximizing commuting intensity within the LMRs). The applied definition of LMRs considers these two aspects and forms LMRs by joining a central municipality and surrounding municipalities from which a substantial proportion of the employed population commutes to the central municipality. We use the same criteria as developed by Statistics Finland and Statistics Sweden. In the first step, we identify core (or central) municipalities. A municipality is labeled as a core (central) municipality if at most 25% (in Finland; 20% in Sweden) of its employed population commute to other municipalities, and less than 10% (in Finland; 7.5% in Sweden) of its employed population commute to any specific municipality. In the second step, municipalities that are not defined as core municipalities are linked to the municipality to which the largest commuting flow is directed. The definition of LMRs is based on the share of commuters, rather than the absolute number of commuters. This is important because the population sizes of neighboring municipalities can vary greatly in the two countries.

Totally, there are 320 municipalities in Finland and 290 in Sweden. Using the commuting flows, we aggregate 236 Finnish municipalities into 42 LMRs. The remaining 84 municipalities that lie outside these travel-to-work areas are defined as self-contained (single-municipality) LMRs (126 in total). Correspondingly, we aggregate the Swedish municipalities into 69 LMRs, of which 46 LMRs contain two or more municipalities and 23 municipalities form self-contained LMRs.

The LMRs are the spatial units for analysis at the inter-regional scale (Table 1). To quantify the human capital in a labor market region (or area), we calculate the skill-intensity ratio (SIR) as the ratio of individuals with university-level education to those without a university degree as their highest level of attainment. Here, university education refers to bachelor's (or higher) degrees from polytechnics, colleges, or universities (i.e., with a program duration of at least three years). University education is arguably a relevant indicator of human capital and productive skills, influencing regional income and growth. Theoretically, SIR may be preferred to the share of university graduates as a measure, because, in the production context, SIR translates into the factor-intensity ratio of the two skill levels (Broxterman & Yezer, 2020a). Our measure of annual gross earnings includes annual income from employment (including self-employment income), which has been deflated to 2015 euros or Swedish kronas (SEK) by using the national consumer price indices. The earnings are not adjusted for spatial variations in prices. The advantage of using nominal instead of real earnings is that the former is more closely tied to regional differences in productivity (De la Roca & Puga, 2017). In Section 4, we also utilize alternative measures of SIR and earnings that pertain to individuals working in the local labor market area, irrespective of their residential location.

Table 1
Descriptive statistics for the labor market regions in Finland and Sweden, 1987 and 2015.

	Min	Max	Median	Mean	St. dev.
Panel A: Finland					
Skill-intensity ratio, 1987	0.026	0.192	0.023	0.061	0.023
Skill-intensity ratio, 2015	0.076	0.534	0.177	0.201	0.086
Per capita earnings (euro), 1987	11,515	25,800	15,714	16,101	2,595
Per capita earnings (euro), 2015	18,014	33,458	22,965	23,135	2,990
Panel B: Sweden					
Skill-intensity ratio, 1987	0.042	0.173	0.065	0.072	0.024
Skill-intensity ratio, 2015	0.108	0.520	0.200	0.220	0.085
Per capita earnings (SEK), 1987	116,670	189,826	148,343	146,571	14,618
Per capita earnings (SEK), 2015	183,958	319,844	255,722	252,451	24,641

Notes: Statistics have been computed for the 25–64-year-old population living in the 126 Finnish and 69 Swedish labor market regions. Annual per capita earnings have been deflated to 2015 euros and Swedish kronas (SEK) by using the consumer price indexes. The average exchange rate for one euro was 9.36 SEK in 2015.

For the analysis at the intra-regional scale, we first group the LMRs based on their resident population size (Table 2). We draw on Eliasson et al. (2020) to define *large LMRs* (i.e., metropolitan regions Helsinki in Finland and Stockholm, Göteborg and Malmö in Sweden), *medium-sized LMRs* with a minimum population of 100,000 (10 in Finland and 19 in Sweden), and *small LMRs* with a population of less than 100,000 (115 in Finland and 47 in Sweden, including the *single-municipality LMRs*, which are treated separately). The medium-sized LMRs typically have regional administrative centers and institutes of higher education. With a few exceptions, the small LMRs do not include regional administrative centers.

We then allocate the municipalities within the LMRs to core, adjacent, and fringe municipalities (i.e., areas), again based on the commuting flows. The definition of *core* (central) municipalities is based on the aforesaid criteria. Among the group of municipalities within the LMR not defined as core municipalities, a municipality is defined as an *adjacent* municipality if the largest commuting flow goes to the core municipality. Thus, a minimum of 10% (7.5% in Sweden) of its employed population commute to the core municipality. Finally, a municipality is defined as a *fringe* municipality if the largest commuting flow goes to an adjacent municipality. It belongs to the LMR of the core municipality through the adjacent municipality because at least 10% (7.5% in Sweden) of its workers commute to the adjacent municipality. Outside the metropolitan regions, the adjacent and fringe municipals are often peripheral areas in a geographical sense. Sweden and Finland are the 3rd and 5th largest countries by land area in the European Union. The classification of intra-regional labor market areas also captures the large variation in population density among different municipalities in Finland and Sweden. For example, the population density in the core municipality of the Stockholm LMR is 4,934 inhabitants per square kilometer, compared to an average of 28 inhabitants per square kilometer in the fringe municipalities of the Stockholm LMR.

Together, these regional classifications allow us to group the

Table 2
Intra-regional classification and population development.

Panel A: Intra-regional classification

Labor market region (LMR)	Intra-regional labor market area	Shortened name	Number of municipalities	
			Finland	Sweden
Large LMRs	Core	Large-Core	1	5
	Adjacent	Large-Adjacent	18	53
	Fringe	Large-Fringe	8	33
Medium-sized LMRs	Core	Medium-Core	10	22
	Adjacent	Medium-Adjacent	84	82
	Fringe	Medium-Fringe	3[a]	17
Small LMRs	Core	Small-Core	30	33
	Adjacent	Small-Adjacent	80	21
	Fringe	Small-Fringe	2[b]	1[b]
Single-municipality LMRs		Single municipality	84	23
Total			320	290

Panel B: Population development (1,000 inhabitants)

	Finland			Sweden		
Type of area	1987	2015	%Δ	1987	2015	%Δ
Large-Core	282	361	27.7	767	1,118	45.8
Large-Adjacent	369	508	37.6	952	1,243	30.6
Large-Fringe	25	26	5.2	258	314	21.8
Medium-Core	548	652	19.0	868	1,017	17.2
Medium-Adjacent	383	400	4.4	595	581	−2.4
Medium-Fringe	[a]	[a]	[a]	93	86	−7.6
Small-Core	487	427	−12.3	384	367	−4.4
Small-Adjacent	210	176	−16.2	115	107	−7.1
Single municipality	354	279	−21.1	206	175	−15.1
Total	4,962	5,378		8,270	9,842	

Notes: The regional classifications are from 2014 for Finland and 2015 for Sweden (see also Fig. 1). [a] Because very few individuals live in medium-fringe municipalities in Finland, these areas are merged into medium-adjacent areas in the analysis. [b] Small-fringe municipalities are merged into small-adjacent areas for the same reason (both countries). %Δ = Percentage change between 1987 and 2015.

municipalities into ten different types of intra-regional (local) labor market areas, as illustrated by the maps in Fig. 1. Table 2 shows the number of municipalities in each area and the change in population between 1987 and 2015. Within the large metropolitan LMRs, the working-age population has increased in all local labor market areas, but the increase was largest in the adjacent areas in Finland (38%) and core areas in Sweden (46%). Outside the metropolis, the working-age population has also risen substantially in the core areas of the medium-sized LMRs (19% in Finland and 17% in Sweden). A decline in the population has been most prevalent in single-municipality LMRs (−21% Finland and −15% in Sweden) and small-adjacent areas in Finland (−16%).

3. Inter-regional dispersion of human capital and earnings

Several measures have been used in the literature to analyze changes in the inter-regional dispersion of regional characteristics. In this paper, we utilize σ- and β-convergence measures that provide complementary information about relative convergence in the skill-intensity ratio (SIR) and per capita earnings across regions (see, e.g., Sala-i-Martin, 1996; Broxterman & Yezer, 2020b). Using earnings as an example, σ-convergence occurs when the relative dispersion in per capita earnings has fallen between two measurement points, and β-convergence occurs when the growth rate in per capita earnings correlates negatively with its initial level.

In practice, σ-convergence can be estimated using relative measures of dispersion, such as a standard deviation of logarithms, or coefficient of variation (CV), which is defined as the ratio of the standard deviation to the mean. We prefer the relative measures of dispersion (to absolute measures such as standard deviation) because the SIR and per capita earnings (and their variance) have increased significantly during the study period, as shown in Table 1. Absolute measures of convergence could simply reflect the overall growth in the share of highly educated persons over time, while relative measures are scale-invariant (Broxterman & Yezer, 2020a). This relativity implies that if we, for example, multiply all regional earnings by the scale (growth) factor τ, the standard deviation of log earnings (or CV in earnings) remains unchanged.

Following Sala-i-Martin (1996), we test for β-convergence by estimating the following growth equation with ordinary least squares (OLS):

$$\Delta(\log Y_{it}) = a + b \log Y_{i0} + \varepsilon_i \tag{1}$$

where Y_{it} is the SIR or per capita earnings in labor market region i in year t, $\Delta(\log Y_{it}) = \log Y_{iT} - \log Y_{i0}$, T is the end of a sub-period (e.g., 2015) and 0 is the start of a sub-period (e.g., 1987). If the estimate of $b < 0$, then it would imply β-convergence, and $b > 0$ would imply β-divergence. For example, β-convergence (divergence) in SIR would mean that initially higher levels of SIR had on average lower growth in SIR than regions with initially lower levels of SIR. As illustrated by Sala-i-Martin (1996), β-convergence is a necessary, but not sufficient, condition for the existence of σ-convergence. Regions with initially lower SIR (earnings) may be growing faster, but the dispersion in SIR (earnings) across regions may remain unchanged.

3.1. Human capital

Fig. 2 presents the development of the relative dispersion in the human capital intensity for Finland and Sweden over the period 1987–2015. Both countries show similar patterns over time. Relative dispersion in SIR increased during the study period regardless of the measure (i.e., standard deviation of log or CV). In Finland, for example, the standard deviation of log SIR increased from 0.32 to 0.36, and from 0.29 to 0.35 in Sweden, between 1987 and 2015. However, Levene's test does not reject the equality of the variances across time in any of the tests reported in Table 3 (although the test for Sweden 1987 vs 2015 is almost significant at the 10 percent level). Therefore, we do not find evidence to support significant σ-divergence during the study period in either country. Our robustness checks in the Supplementary Appendix suggest that the increase in the relative dispersion of SIR is more notable

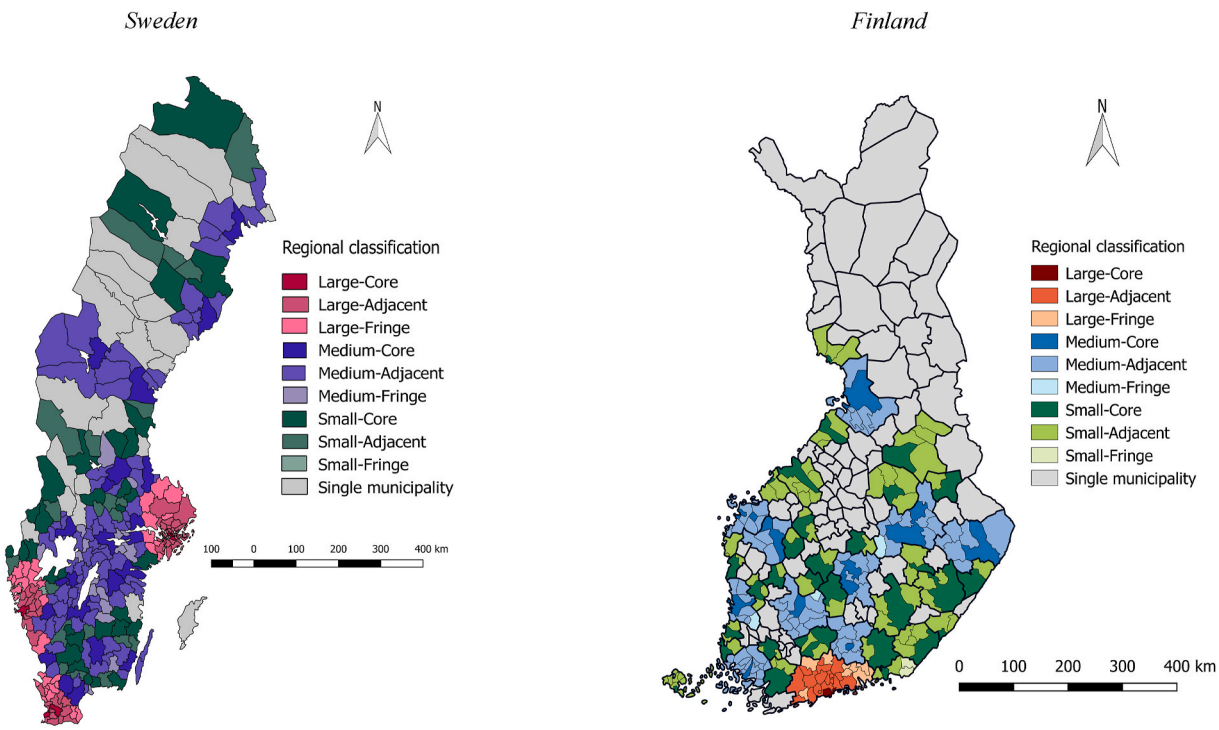

Fig. 1. Regional classifications with municipality borders.

when we measure it for smaller labor market areas (Fig. 2 and Fig. A.1) than for larger NUTS-3 regions (Fig. A.2). When dispersion is measured across NUTS-3 regions, figures even show some small (insignificant) decrease in relative dispersion during the study period (Fig. A.2).

Table 4 presents tests for β-divergence/convergence in human capital intensity for Finland (Panel A) and Sweden (Panel B). The estimates show the relationship between the initial SIR and the relative change in the SIR during the study intervals. Apart from the temporary β-convergence during the 1990s recession (1990–1995) and β-divergence during the recovery period (1995–2000), the estimates for Finland do not show statistically significant β-divergence or convergence in SIR across the labor market regions. Conversely, results for Sweden do show significant β-divergence in human capital between 1987 and 2015. However, the estimated annual β-divergence rate is only 0.3%, and the test for β-divergence is statistically significant only for sub-periods 1987–1990 and 1995–2000, with no significant β-divergence after 2000.

Additional analyses indicate that the results are sensitive to the level of analysis. We find significant β-convergence in SIR for both countries when the analyses were done at the NUTS-3 level (Table A.1). The convergence is stronger for Finland (-0.333; $p < 0.01$) than that for Sweden (-0.154; $p < 0.1$). Test results for *absolute* divergence in Table A.2 show a pattern consistent with earlier international evidence (Broxterman & Yezer, 2020b). All estimates are positive and of high statistical significance in both countries, indicating strong absolute divergence of SIR across LMRs over the period 1987–2015.

3.2. Earnings

Fig. 3 shows the development of relative earnings dispersion across LMRs for Finland and Sweden. Fluctuations in the dispersion of per capita earnings are pronounced in Finland. Immediately after the 1990s recession, the relative dispersion increased, but only for a short while. Relative dispersion in per capita earnings has decreased in Finland since 1996 (st. dev. of log dropped from 0.16 to 0.12). The declining trend has remained unchanged even in the aftermath of the 2008/9 financial crisis. The test results for σ-convergence reported in Table 5 show that the drop in the relative dispersion in per capita earning was statistically significant in Finland during the period 1987–2015 ($p < 0.01$).[6] On the contrary, relative changes in the relative per capita earnings across LMRs are small in Sweden (Fig. 3) and test results for σ-convergence/divergence are all insignificant (Table 5). Thus, we do not find a continuum of the long-run path toward inter-regional income convergence in Sweden, dating as far back as the end of the 19th century to the 1990s economic crisis (Enflo & Rosés, 2015; Persson, 1997). The patterns observed are similar when we measure relative dispersion using the standard deviation of log earnings and CV in earnings. The results also remain qualitatively intact when using data at the NUTS-3 level instead of LMR level data (Fig. A.3).

The estimates of the growth regressions in Table 6 show significant β-convergence in per capita earnings in both countries. In Finland, the annual β-convergence rate was approximately 1.3% between 1987 and 2015 (~2% during the 2000s). Thus, the long-run β-convergence trend in per capita income is continuing in Finland, which was observed by Kangasharju (1998) for the period 1934–1993 (~2% per annum). The period 1990–1995 alone shows temporary β-divergence in per capita earnings. In sum, relative earnings dispersion has decreased (i.e., σ-divergence in Fig. 3) in Finland during the study period, because the growth rate in the earnings has been relatively higher in the LMRs that had initially lower earnings. This conclusion also holds when we performed the analysis across NUTS-3 regions, though the rate of convergence is slightly lower between 1987 and 2015 (Table A.3).

Regarding Sweden, the estimates for the period 1995–2000 indicate the annual β-divergence rate in per capita earnings of about 2.2%. After the turn of the millennium, a period of β-convergence followed. Though the convergence estimates are not statistically significant in all the sub-periods, the estimate for the whole post-millennium period 2000–2015 (not reported in the table) is highly significant and indicates an annual β-convergence rate of 2% in per capita earnings. The corresponding

[6] Finland has substantially more LMRs than Sweden, which could influence our country comparison. However, the dispersion patterns remain qualitatively unchanged when we reduce the number of LMRs in Finland by aggregating single-municipality LMRs to form larger labor market regions (see Fig. A.4).

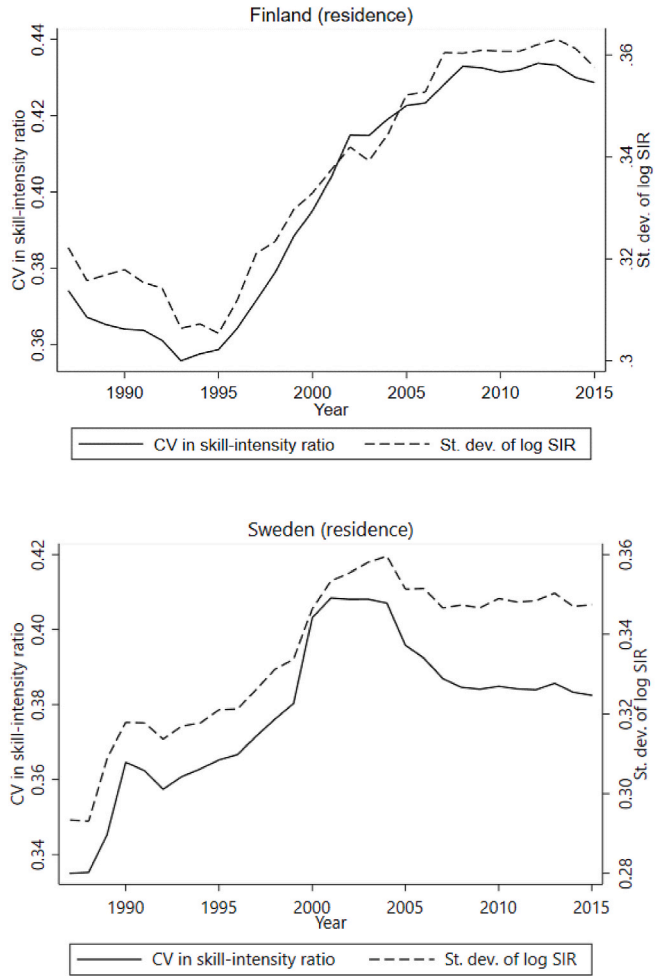

Fig. 2. Coefficient of variation (CV) in skill-intensity ratio (SIR) and standard deviation of log SIR, 1987–2015. *Notes*: Annual data for the 126 Finnish and 69 Swedish labor market regions.

annual β-convergence rate for the entire period 1987–2015 is approximately 0.9% (see also similar results for NUTS-3 regions in Table A.3, although the rate of convergence for 1987–2015 is lower). The results for Sweden illustrate that significant β-convergence rates do not necessarily imply significant σ-convergence. As shown in Table 5, we did not find a significant reduction in the relative dispersion in earnings for Sweden.

4. Intra-regional disparities in human capital and earnings

Table 7 presents the human capital intensity and per capita earnings of regions and local areas in 1987 and 2015. Figures show substantial heterogeneity in human capital intensity between the local labor market areas within Finland and Sweden. In both countries, the SIR values are particularly low in small-adjacent areas (and in single-municipality labor markets for Finland) and high in large-core areas. For example, the SIR values in 1987 ranged from 0.06 to 0.23 in Finland and from 0.05 to 0.18 in Sweden. Due to a substantial expansion of higher education, the human capital intensity increased substantially in all intra-regional labor market areas between 1987 and 2015, but geographical differences remain. By the end of the period, the SIR values in 2015 ranged from 0.20 to 0.53 in Finland and from 0.16 to 0.61 in Sweden.

In Finland, intra-regional differences in per capita earnings correspond to those in the SIR. Per capita earnings are the highest in the large-core areas and smallest in small-adjacent areas and single-municipality labor markets in both years. Even though per capita earnings have increased substantially at all geographical levels (by 22–54% during 1987–2015), the positive development has been particularly pronounced for those living in the adjacent areas, regardless of the LMR size.

In Sweden, intra-regional differences in earnings also tend to be quite large, although the relative differences are smaller compared to those for human capital intensity (Table 7). Per capita earnings are generally the highest in the core areas and diminish with distance to the core. Large-adjacent areas deviate from this pattern and show higher per capita earnings than the large-core areas in both periods. The growth rate in earnings has been similar across the intra-regional labor market areas. Exceptions to this are the large-fringe and small-adjacent areas, with a particularly high growth rate (about 75%). Despite the strong growth rate during the period, small-adjacent areas remain at the bottom of the per capita earnings ranking in 2015.

4.1. Human capital

Next, we investigate the development of intra-regional labor market differences in skill-intensity ratios (Fig. 4) and per capita earnings (Fig. 5) over time. In addition to country differences, we consider differences by the location of residences and workplaces.

The top two graphs in Fig. 4 show intra-regional labor market development in the skill-intensity ratio for Finland (see also Fig. A.5). Three clear observations emerge. Firstly, both figures for Finland illustrate that SIR is substantially larger in the core areas in all size categories of the labor markets. Intra-regional labor market differences are substantial in the large metropolitan region (Helsinki): the SIR in large-fringe areas is only about one-third of the SIR in large-core areas. Second, intra-regional labor market differences in the SIR among the resident population have been relatively unchanged during 1987–2015. Thus, the figure on the left for the resident population does not show intra-regional labor market convergence or divergence in the SIR. Third, intra-regional labor market differences in the SIRmeasured by workplace location show some divergence over time. The difference in the

Table 3
Testing for σ-convergence/divergence in log skill-intensity ratios across local labor markets, intervals from 1987 to 2015.

	1987–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	1987–2015
Panel A: Finland							
St. dev. at $t = 0$	0.322	0.318	0.305	0.333	0.352	0.361	0.322
St. dev. at $t = T$	0.318	0.305	0.333	0.352	0.361	0.358	0.358
Levene's test for equality of variances	0.036 (p = 0.850)	0.108 (p = 0.742)	0.550 (p = 0.459)	0.333 (p = 0.564)	0.005 (p = 0.944)	0.007 (p = 0.933)	0.601 (p = 0.439)
Panel B: Sweden							
St. dev. at $t = 0$	0.296	0.320	0.323	0.349	0.354	0.352	0.296
St. dev. at $t = T$	0.320	0.323	0.349	0.354	0.352	0.350	0.350
Levene's test for equality of variances	0.507 (p = 0.478)	0.006 (p = 0.937)	0.510 (p = 0.476)	0.006 (p = 0.940)	0.000 (p = 0.987)	0.002 (p = 0.964)	2.666 (p = 0.105)

Notes: Data are from 126 local labor markets in Finland (Panel A) and 69 local labor markets in Sweden (Panel B). $t = 0$ is the start of a sub-period (e.g., 1990) and $t = T$ is the end of a sub-period (e.g., 1995). Levene's test statistic for equality of variances (across time) is robust under non-normality.

Table 4
Testing for β-convergence/divergence in skill-intensity ratios across local labor markets, intervals between 1987 and 2015.

Outcome variable: $\Delta(log\ skill - intensity\ ratio_t)$	1987–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	1987–2015
Panel A: Finland							
log skill-intensity ratio$_0$	−0.043	−0.068**	0.064***	0.028	0.008	−0.027	−0.074
	(0.031)	(0.028)	(0.021)	(0.026)	(0.015)	(0.022)	(0.066)
R-squared	0.031	0.079	0.066	0.012	0.002	0.020	0.014
Annual β-convergence rate	−0.015	−0.014	0.012	0.006	0.002	−0.005	−0.003
Panel B: Sweden							
log skill-intensity ratio$_0$	0.068***	0.003	0.068***	0.004	−0.013	−0.009	0.102**
	(0.020)	(0.015)	(0.018)	(0.019)	(0.014)	(0.011)	(0.047)
R-squared	0.119	0.001	0.162	0.001	0.014	0.009	0.053
Annual β-convergence rate	0.022	0.001	0.013	0.001	−0.003	−0.002	0.003

Notes: Data are from 126 local labor markets in Finland (Panel A) and 69 local labor markets in Sweden (Panel B). The results are based on OLS estimates from Equation (1). Annual β-convergence rates have been calculated as: $log(1+b)/L$, where L is the length of the observation period. Heteroscedasticity-consistent standard errors are in parentheses. ***p < 0.01, **p < 0.05.

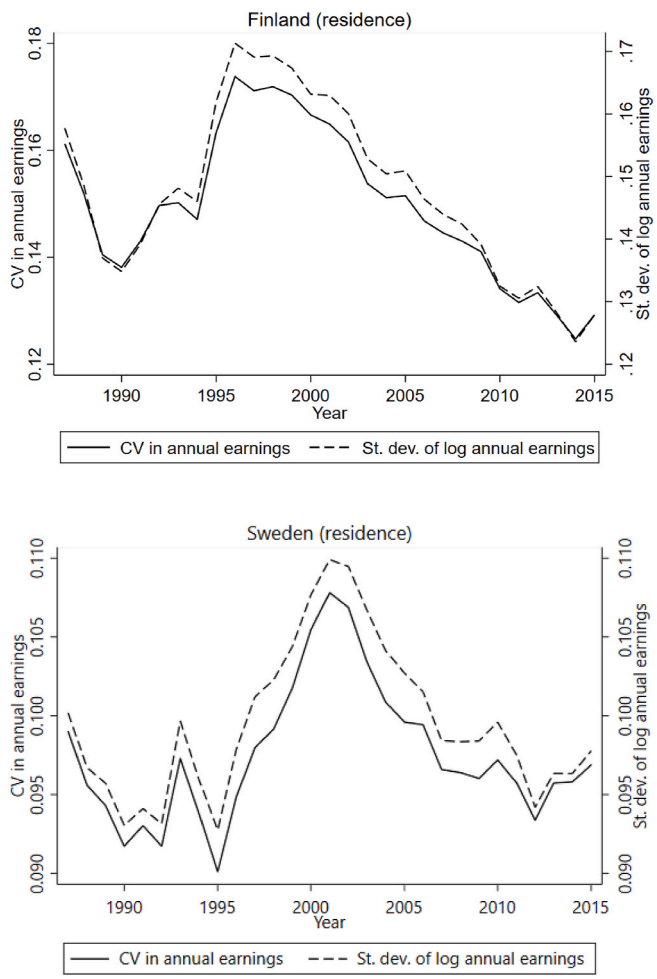

Fig. 3. Coefficient of variation (CV) in annual per capita earnings and standard deviation of log annual per capita earnings, 1987–2015. *Notes*: Annual data on the 126 Finnish and 69 Swedish labor market regions.

SIR between adjacent and core areas has increased in favor of core areas in all labor market size categories. That is, there has been an increased concentration of skill-intensive work in core areas. However, the skilled population is not located by residence in core areas in the same proportions. This may explain why out-commuting from adjacent areas has increased substantially, as illustrated by Fig. A.8.

The two graphs at the bottom in Fig. 4 display intra-regional labor market development in the skill-intensity ratio for Sweden. The key patterns evident for Finland apply to Sweden too, by and large. In all labor market size categories, SIR is higher in the core areas than in the surrounding intra-regional labor market areas. This holds when SIR is measured either by the location of residence or by the workplace. In both cases, intra-regional labor market differences are particularly large in the large metropolitan regions. By the end of the period, the SIR in large-adjacent and large-fringe areas is approximately 60% and 40% of the SIR in large-core areas, respectively. There is also a fairly clear pattern of increasing intra-regional differences in SIR over time in all labor market size categories, especially when SIR is measured by workplace location. The case in Sweden is like that in Finland: skill-intensive work is becoming more concentrated in core areas than nighttime populations of skilled workers.

4.2. Earnings

Fig. 5 depicts the evolution of intra-regional labor market differences in per capita earnings during the period 1987–2015 (see also Fig. A.6). For Finland, per capita earnings for the resident population show convergence of earnings within the labor market regions. Per capita earnings have grown faster in all areas outside the cores. Consequently, in 2015, individuals living in the large and medium-sized adjacent areas earn, on average, more than those living in the core areas. As discussed above, this development has been partially enabled probably by commuting to the core areas (Fig. A.8 and Table A.4).

In Finland, intra-regional labor market differences in per capita earnings do not show any positive or negative trend over time when the location is measured using workplaces. Thus, the convergence in earnings has occurred only in the earnings of the resident population. In addition, the intra-regional differences in earnings did not notably change due to the 1990s recession (Fig. 5) because per capita earnings dropped relatively equally in all local labor market areas (Fig. A.6).

The two graphs at the bottom of Fig. 5 depict intra-regional labor market development in per capita earnings for Sweden. Intra-regional labor market differences have remained rather stable during the period 1987–2015 in all labor market size categories, particularly when measured by the location of residence. Interestingly, there are no clear signs of the economic crisis in the 1990s in the intra-regional development of per capita earnings. This is in contrast with the inter-regional development, where we saw a clear β-divergence after the crisis, followed by β-convergence from the turn of the millennium (Table 6).

In the large Swedish metropolitan regions, we find large and persistent differences in the levels of per capita earnings measured by the place of residence. In large-fringe areas, per capita earnings tend to be 10–15% below those in the core areas, whereas per capita earnings in large-adjacent areas are approximately 5% higher than in the core areas. The gap between adjacent and fringe areas most probably reflects superior commuting opportunities in the former. This reasoning is supported by data on out-commuting rates for the resident population that are considerably higher, albeit decreasingly so, in large-adjacent areas

Table 5
Testing for σ-convergence in log annual earnings across local labor markets, intervals between 1987 and 2015.

	1987–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	1987–2015
Panel A: Finland							
St. dev. at $t = 0$	0.158	0.135	0.162	0.163	0.151	0.132	0.158
St. dev. at $t = T$	0.135	0.162	0.163	0.151	0.132	0.128	0.128
Levene's test for equality of variances	5.252	5.193	0.006	0.889	2.555	0.143	9.632
	($p = 0.023$)	($p = 0.024$)	($p = 0.940$)	($p = 0.347$)	($p = 0.111$)	($p = 0.706$)	($p = 0.002$)
Panel B: Sweden							
St. dev. at $t = 0$	0.101	0.094	0.093	0.108	0.103	0.100	0.101
St. dev. at $t = T$	0.094	0.093	0.108	0.103	0.100	0.098	0.098
Levene's test for equality of variances	0.442	0.013	1.534	0.051	0.216	0.102	0.260
	($p = 0.507$)	($p = 0.911$)	($p = 0.218$)	($p = 0.821$)	($p = 0.643$)	($p = 0.750$)	($p = 0.611$)

Notes: Data are from 126 local labor markets in Finland (Panel A) and 69 local labor markets in Sweden (Panel B). t = 0 is the start of a sub-period (e.g., 1990) and t = T is the end of a sub-period (e.g., 1995). Levene's test statistic for equality of variances (across time) is robust under non-normality.

Table 6
Testing for β-convergence in per capita earnings across labor market regions, intervals between 1987 and 2015.

Outcome variable: $\Delta(log\ per\ capita\ earnings_t)$	1987–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	1987–2015
Panel A: Finland							
log per capita earnings$_0$	−0.186***	0.103**	−0.033	−0.097***	−0.149***	−0.055***	−0.305***
	(0.026)	(0.042)	(0.033)	(0.021)	(0.019)	(0.017)	(0.036)
R-squared	0.335	0.045	0.013	0.192	0.326	0.072	0.347
Annual β-convergence rate	−0.069	0.020	−0.007	−0.020	−0.032	−0.011	−0.013
Panel B: Sweden							
log per capita earnings$_0$	−0.083***	−0.043	0.115***	−0.080***	−0.090*	−0.039	−0.229***
	(0.021)	(0.044)	(0.038)	(0.028)	(0.050)	(0.036)	(0.073)
R-squared	0.240	0.023	0.114	0.091	0.068	0.036	0.128
Annual β-convergence rate	−0.029	−0.009	0.022	−0.017	−0.019	−0.008	−0.009

Notes: Data are from 126 local labor markets in Finland (Panel A) and 69 local labor markets in Sweden (Panel B). The results are based on OLS estimates from Equation (1). Annual β-convergence rates have been calculated as: $log\ (1 + b)/L$, where L is the length of the observation period. Heteroscedasticity-consistent standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 7
Descriptive statistics for labor market areas, Finland and Sweden, 1987 and 2015.

Type of area	*Panel A: Finland*						*Panel B: Sweden*					
	Skill-intensity ratio			Per capita earnings (1,000 euro)			Skill-intensity ratio			Per capita earnings (1,000 SEK)		
	1987	2015	%Δ	1987	2015	%Δ	1987	2015	%Δ	1987	2015	%Δ
Large	**0.19**	**0.53**	**177.9**	**25.7**	**33.5**	**30.0**	**0.15**	**0.45**	**206.2**	**177**	**298**	**68.8**
Core	0.23	0.68	196.5	26.0	31.8	22.4	0.18	0.61	240.4	175	295	68.4
Adjacent	0.18	0.46	165.1	26.0	34.9	34.2	0.14	0.38	173.6	185	310	67.4
Fringe	0.07	0.22	232.8	18.8	28.5	51.6	0.08	0.23	199,1	149	262	76.2
Medium-sized	**0.10**	**0.41**	**295.2**	**19.4**	**27.1**	**39.9**	**0.09**	**0.29**	**220.6**	**159**	**265**	**67.2**
Core	0.12	0.48	287.9	20.1	26.5	32.3	0.11	0.36	228.7	166	274	65.1
Adjacent	0.08	0.31	302.6	18.4	28.0	52.4	0.07	0.20	193.0	150	253	68.6
Fringe	–	–	–	–	–	–	0.06	0.18	174.9	146	247	68.9
Small	**0.07**	**0.25**	**243.6**	**18.1**	**25.5**	**40.4**	**0.07**	**0.21**	**209.4**	**149**	**258**	**72.9**
Core	0.08	0.26	234.2	18.9	25.6	35.3	0.07	0.22	210.6	152	262	72.1
Adjacent	0.06	0.20	262.5	16.4	25.3	54.2	0.05	0.16	204.1	138	242	75.3
Single municipality	**0.06**	**0.20**	**236.7**	**16.2**	**23.2**	**43.8**	**0.07**	**0.19**	**193.1**	**141**	**246**	**74.2**

Notes: Figures have been computed for the resident population aged 25–64 years. Values shown in bold font are aggregates over the values for intra-regional labor market areas (core, adjacent, and fringe). Skill-intensity ratio is the ratio of individuals with at least a bachelor's degree to those with less education among the population aged 25–64. %Δ = Percentage change between 1987 and 2015.

(see Fig. A.8 and Table A.4). In the medium-sized and small labor market regions, per capita earnings in adjacent and fringe areas tend to be 5–10% below those in the core areas. This is also the case for single-municipality labor markets when compared to small-core areas. In sum, we do not find similar intra-regional convergence in (residence-based) earnings in Sweden that was found for Finland.

When per capita earnings are measured by the location of workplace instead of the residence, we observe substantially lower relative earnings in large-adjacent and large-fringe areas than in large-core areas in Sweden. For large-adjacent areas, the difference is equivalent to about 20 percentage points, from approximately 5% above the core areas (location of residence) to approximately 15% below the core areas (location of workplace). The corresponding difference for large-fringe areas is about 10–15 percentage points. In both cases, there is also a tendency for the gap relative to the large-core areas to increase over time. The large and growing intra-regional differences in per capita earnings in the metropolitan regions (measured by the location of the workplace) indicate that more productive (and more skill-intensive, see Fig. 4) workplaces are increasingly concentrated in the large-core areas in Sweden.

5. Summary and discussion

There are three major findings in this study. First, at the inter-

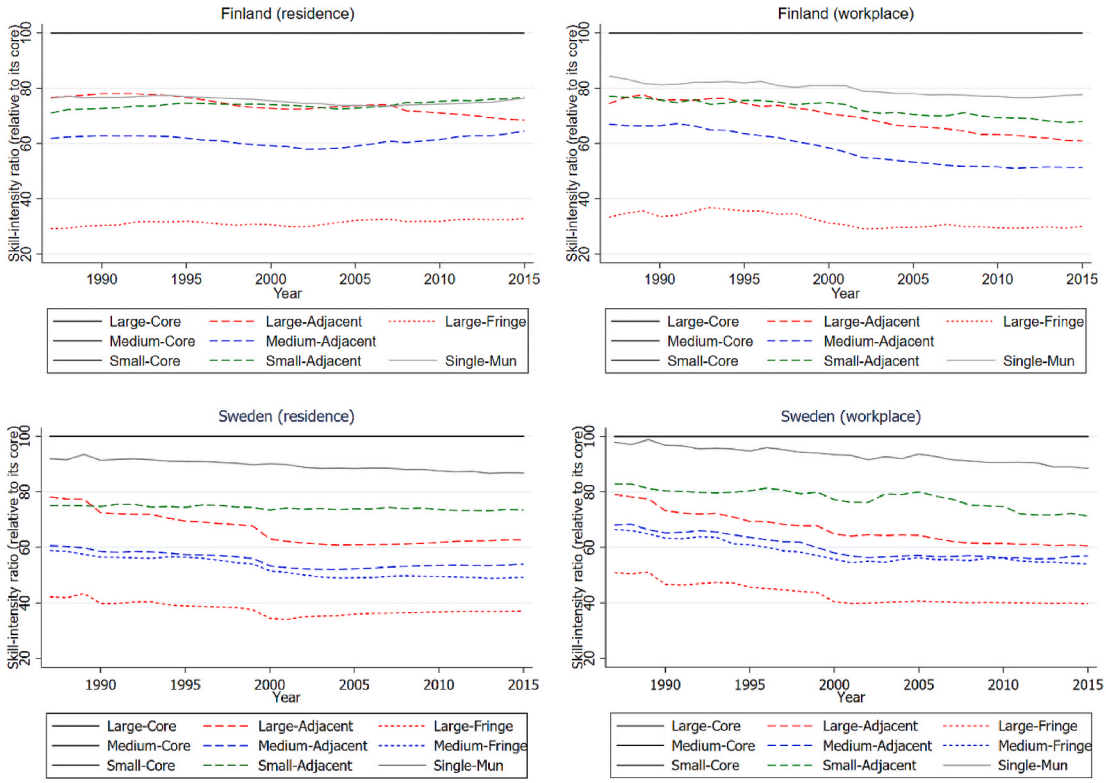

Fig. 4. Development of skill-intensity ratio by the type of intra-regional labor market area, relative to the values in the regional core. *Notes*: Figures have been given separately for the 25–64-year-old resident population and workers at workplaces in the area. Single-municipality LMRs are compared to the small-core areas.

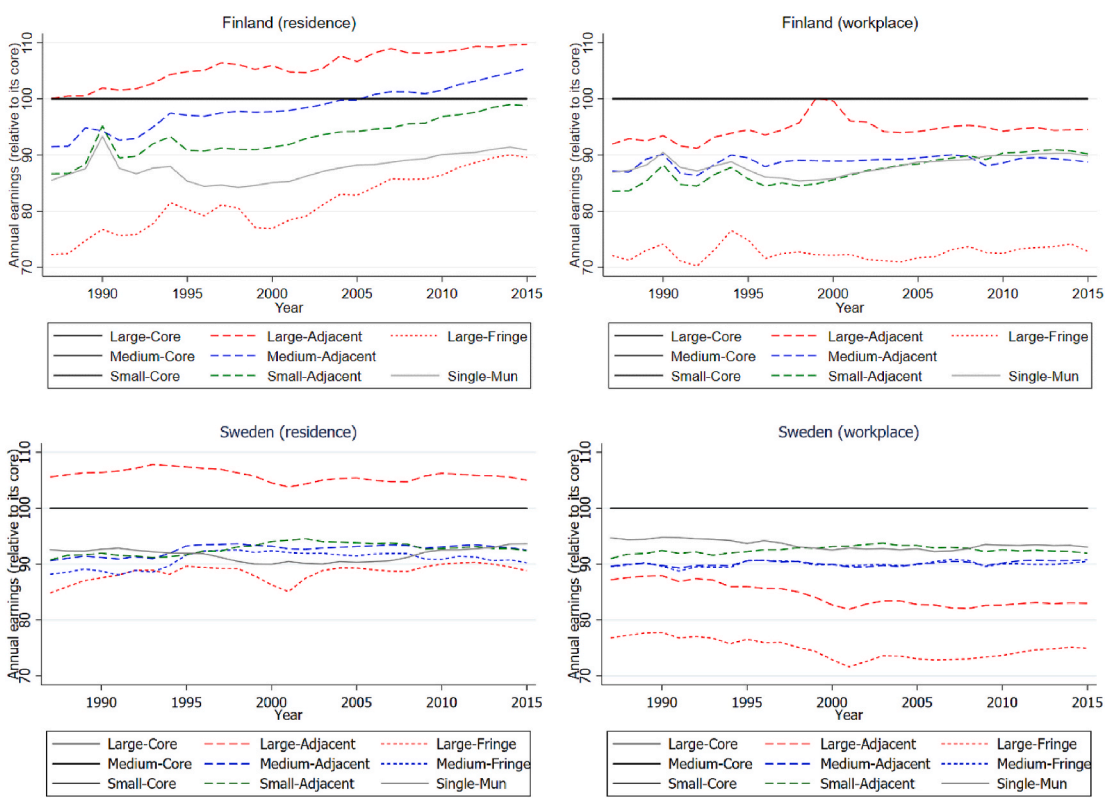

Fig. 5. Development of per capita earnings by the type of intra-regional labor market area, relative to the values in the regional core. *Notes*: Figures have been given separately for the 25–64-year-old resident population and workers in the area. Single-municipality LMRs are compared to the local core areas.

regional scale, we do not find consistent evidence of convergence in human capital intensity across functional labor market regions (LMRs). Although the regional dispersion in human capital has increased in *absolute* terms, we find only small and generally statistically insignificant changes in the skill-intensity ratio (SIR) over time when using a more appropriate relative measure (here, the standard deviation of log SIR). This pattern is consistent with earlier international evidence (Broxterman & Yezer, 2020b). At the same time, there is a clear trend toward inter-regional convergence in per capita income among LMRs in Finland and (but less pronounced) in Sweden from around the turn of the millennium up to the endpoint of our data in 2015. The latter result is at odds with the findings from the U.S. and the EU but in line with those for Norway (Rattsø & Stokke, 2014). Hence, the patterns of inter-regional income disparities in the three Nordic countries are different from those in many other developed economies.

Second, inequalities in human capital between the core and the hinterlands *within* functional labor markets are persistent and relatively stable over time, although some evidence of convergence is found for Finland. The largest intra-regional differences in human capital and earnings are found within the metropolitan labor markets. In Finland, per capita earnings in adjacent and fringe municipalities have grown more than the earnings in the core within LMRs when earnings are measured at the place of residence.

Third, measuring per capita income and human capital based on residential location or place of work matters for the results, which underscores the important role of commuting and housing markets. Residents in municipalities adjacent to the core of large LMRs have higher per capita income than the resident population in the core. In contrast, measuring income at the workplace location indicates the highest income for the core in all size categories of LMRs. Moreover, the intra-regional income differences are larger when measured at workplaces. An interpretation of these findings is that measuring income at the place of residence may not fully capture agglomeration economies (e.g., through matching and learning mechanisms) that emerge at workplaces concentrated to the core within LMRs. Increased commuting distances and increased distance work underscore the need for future research on the benefits and costs of commuting in agglomeration economies. A related issue is that the results at the inter-regional scale can be sensitive concerning whether the analysis is based on administrative or functional regions. Naturally, the choice of geographical units is often restricted by the available data and should be governed by the specific issues under investigation.

Although far from being conclusive evidence, the indications of inter-regional income convergence found in this study, and the results in Rattsø and Stokke (2014), are consistent with our speculation of stronger resilience to spatial income disparities in the Nordic welfare states than in other developed economies, due to institutional factors. Whether or not this is the case, and questions related to specific mechanisms in this context should be relevant avenues for further research.

Overall, we do not find intra-regional divergence in per capita earnings between 1987 and 2015, perhaps because of automatic stabilizers and compensating regional policy interventions, in combination with labor mobility through commuting and migration. However, population and employment growth have been slow or negative in small labor market regions and in areas outside the cores within the small and medium-sized regional labor markets (Table 2 and Fig. A.7; see also Eriksson & Hane-Weijman, 2017).

Related to the current discussions on the expected economic impacts of the COVID-19 crisis, our analyses for Finland and Sweden indicate increased inter-regional divergence in SIR and per capita earnings during the recovery from the 1990s recession. However, there is no indication of strong short-term impacts of the 1990s crisis on intra-regional differences. Instead, time trajectories of the intra-regional differences are characterized by long-term trends or stability over decades. Concerning policy, this stability underscores the importance of long-term structural factors behind intra-regional inequality. Considering intra-regional disparities in SIR measured at workplace locations, the growing gaps between adjacent and fringe areas relative to their cores may indicate an increased intra-regional concentration of productivity. Given the important role of human capital for socioeconomic development, our findings of growing disparities in human capital at the intra-regional scale imply serious challenges for social cohesion. The large disparities between the core and fringe areas within metropolitan labor markets reflect residential segregation and a socioeconomic periphery, despite the relatively short distances and high population densities.

Declaration of competing interest

None.

Acknowledgments

We are grateful for the financial support from Yrjö Jahnsson Foundation (no. 6621) and the Swedish Research Council (no. 2015-01706).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.apgeog.2021.102539.

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