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Regional differences in productivity in Sweden: Insights from OECD regions

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REGIONAL DIFFERENCES IN PRODUCTIVITY IN SWEDEN: INSIGHTS FROM OECD REGIONS

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ABSTRACT/RÉSUMÉ

Regional differences in productivity in Sweden: insights from OECD regions

Regional inequality has increased in Sweden over the past decades, albeit from a low level. While redistribution and other public policies can narrow regional gaps in income, well-being and access to services, productivity growth is key to maintaining economic dynamism, creating job opportunities and attracting and retaining skilled workers. Against this background, this paper documents the performance of Swedish large regions (TL2) on the main productivity drivers identified by the literature. Panel regressions on a dataset covering up to 125 OECD regions in 17 countries identify the factors associated with high regional productivity, namely rail and road connectivity, knowledge-intensive employment and research and education. Investment in construction and finance is linked to somewhat weaker productivity. Even after taking these factors into account, the Stockholm region benefits from a sizeable productivity advantage, which likely reflects agglomeration effects.

This Working Paper relates to the 2021 OECD Economic Survey of Sweden (http://www.oecd.org/economy/sweden-economic-snapshot/)

JEL Classification: O47; P48; R11; R12; R58.

Keywords: Sweden; Productivity; Regional Studies; Regional economic activity; Regional development.

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Différences régionales de productivité en Suède : enseignements de l'analyse d'un échantillon de régions de l'OCDE

L'inégalité régionale a augmenté en Suède au cours des dernières décennies, bien qu'à partir d'un faible niveau. Alors que la redistribution et d'autres politiques publiques peuvent réduire les écarts régionaux de revenus, de bien-être et d'accès aux services, la croissance de la productivité est essentielle pour maintenir le dynamisme économique, créer des opportunités d'emploi et attirer et retenir les travailleurs qualifiés. Dans ce contexte, cet article documente la performance des grandes régions suédoises (TL2) en ce qui concerne les principaux moteurs de productivité identifiés par la littérature. Des régressions en panel sur un ensemble de données couvrant jusqu'à 125 régions de l'OCDE dans 17 pays identifient les facteurs associés à une productivité régionale élevée, à savoir la connectivité ferroviaire et routière, l'emploi à forte intensité de savoir et la recherche et l'éducation. L'investissement dans la construction et la finance est lié à une productivité un peu plus faible. Même après prise en compte de ces facteurs, la région de Stockholm bénéficie d'un avantage de productivité important, qui reflète probablement des effets d'agglomération.

Ce Document de travail a trait à l'Étude économique de l'OCDE de la Suède, 2021 (http://www.oecd.org/fr/economie/suede-en-un-coup-d-oeil/).

Classification JEL : O47; P48; R11; R12; R58.

Mots clés : Suède ; Productivité ; Études régionales ; Activité économique régionale ; Développement régional.

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Regional differences in productivity in Sweden: insights from OECD regions

By Christophe André and Mathilde Pak[1]

Productivity varies significantly across Swedish regions, even though differences are smaller than in many other OECD countries (Figure 1). Regional differences largely result from comparative advantages related to each region's uniqueness in terms of population, resource endowment and geography. However, factors influenced by public policies also matter, like connections to transport networks, broadband connectivity, the presence and strength of education and research institutions, and the availability of quality public infrastructure and services. This paper examines variations in productivity and related indicators across Swedish regions and investigates the factors most commonly associated with high productivity across OECD regions, using a dataset covering up to 125 large regions (OECD TL2) from 17 countries (depending on data availability for different specifications).[2]

The main findings are as follows:

- Productivity differences between Swedish regions are relatively small in OECD comparison. They are mainly observed in finance, ICT and manufacturing.
- Distance and low population density hamper transport connectivity in some regions. Digital connectivity is high across regions, although some rural areas lack access to high-speed broadband.
- Knowledge-intensive activities and employment are geographically concentrated, especially in the Stockholm region, which attracts R&D and the highly educated. Participation in lifelong learning is high throughout the country.
- In the sample of OECD regions covered in this paper, rail and road connectivity, knowledge-intensive employment, research and education are associated with high productivity. Investment in construction and finance is linked to somewhat lower productivity.
- The Stockholm region benefits from a sizeable time-invariant productivity advantage, which likely reflects agglomeration effects.

The literature has identified many factors associated with regional productivity, which are, however, often diffuse and difficult to quantify. They include R&D and technology, knowledge diffusion, business churning, human capital, institutions (both formal and informal, such as culture), policies and regulations, and demographic profiles and trends (Tsvetkova et al., 2020). Agglomeration effects are also becoming

[1] The authors are economists in the OECD Economics Department (ECO). They would like to thank Jinwoan Beom, Isabelle Joumard, Vincent Koen, Axel Purwin (ECO) and Alexandra Tsvetkova (Centre for Entrepreneurship, SMEs, Regions and Cities, OECD) for useful comments and suggestions. The paper has also benefitted from comments by Swedish officials and by members of the OECD Economic and Development Review Committee. Special thanks go to Natia Mosiashvili for statistical assistance and to Sisse Nielsen for editorial assistance.

[2] See Annex A for a map of Swedish TL2 regions.

increasingly important in knowledge-based economies. Bigger cities enjoy economies of scale, better labour market matching among a larger pool of workers and knowledge spillovers. International studies suggest that a doubling in population size raises the productivity level of a city by 2% to 5% (OECD, 2015). Recent OECD studies pointed to the role of specific productivity drivers in different countries. For example, weak transport links between and within cities outside London, insufficient spending on innovation and weak support for investment and skills were associated with regional productivity gaps in the United Kingdom (Gal and Egeland, 2018). High regional dispersion in education and job outcomes, compounded by low inter-regional mobility, were identified as key drivers of regional inequalities in Spain (Adalet McGowan and San Millán, 2019).

Against this background, this paper investigates associations between a set of productivity drivers identified in the literature and labour productivity across OECD regions, in order to get insights for Sweden. The paper is organised as follows: the next section documents differences in productivity and related indicators across Swedish regions. The following section uses panel regressions to investigate associations between labour productivity and a wide range of indicators across a large sample of OECD regions.

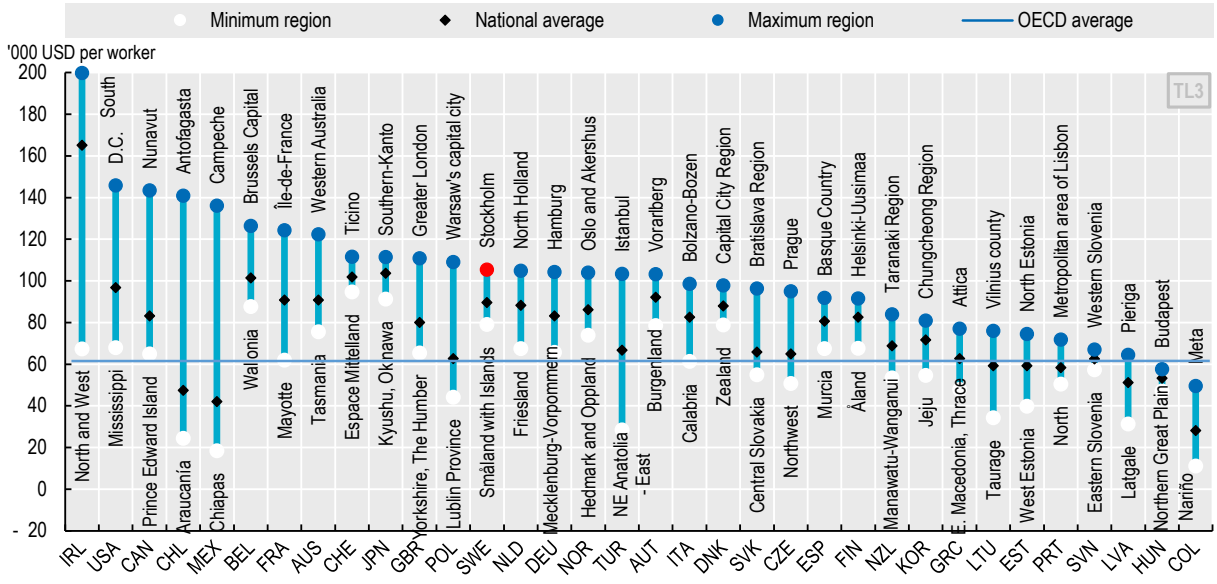
Productivity across Swedish regions

Regional differences in productivity are relatively small in OECD comparison

Productivity in the Stockholm region is higher than in the rest of the country. Nevertheless, the difference of 18% relative to the country average and 33% relative to the worst performing region is relatively small in OECD comparison (Figure 1). In that respect, Sweden is relatively similar to the other Nordics, some central European countries and Japan. Three sectors − finance, ICT and manufacturing − display wide regional productivity gaps, with very high productivity in the leading regions. In other services and construction, regional productivity differences are limited (Figure 2).

Figure 1. Labour productivity disparities across Swedish regions are moderate

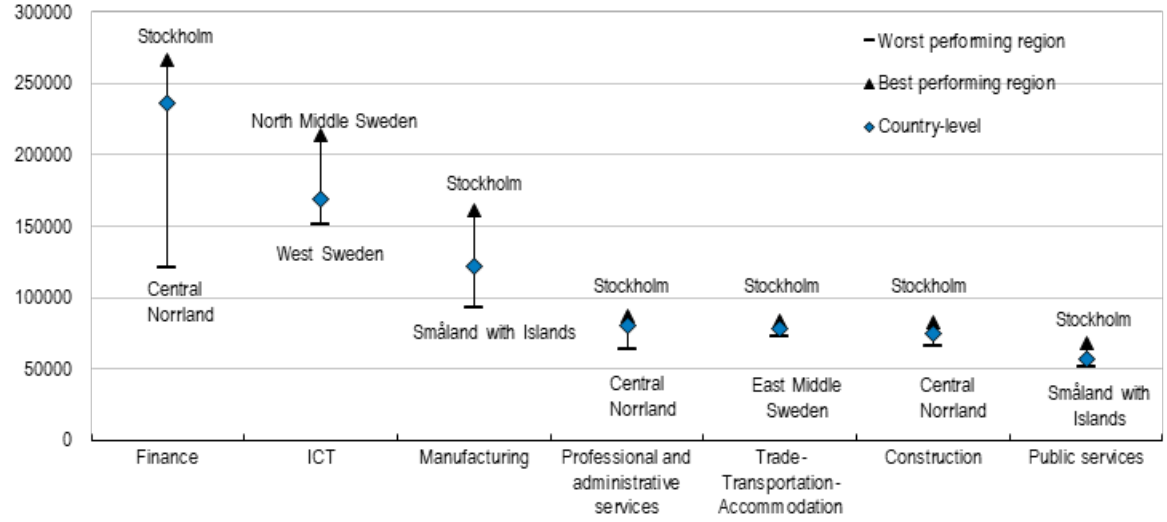
Gross value added per employee, TL2 regions, 2018



Source: OECD (2020), OECD Regions and Cities at a Glance 2020, OECD Publishing, Paris.

Figure 2. Productivity disparities between TL2 regions are wide in some sectors

In USD per worker, constant prices and constant PPP (base year 2015), 2017

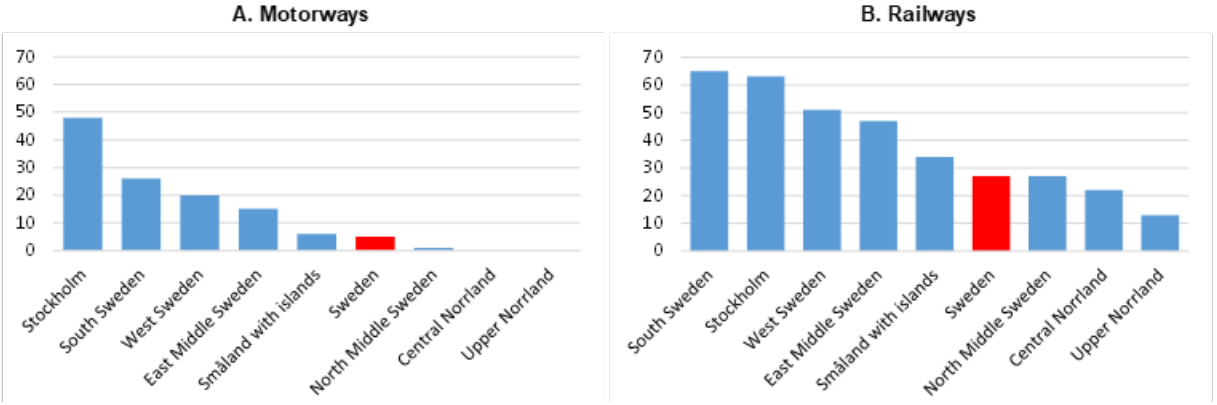


Source: OECD Regional Statistics Database.

Connectivity reflects wide variations in population density

Sweden is a vast country, with many sparsely populated areas and large variations in the density of transport networks across regions (Figure 3). Frequent, reliable and fast transport connections can enhance productivity by providing access to product markets and widening labour market areas. However, benefits have to be weighed against infrastructure costs and environmental footprint. The Swedish road network does not appear to be under-dimensioned (Braconier et al., 2013). High-speed rail lines linking Stockholm to Gothenburg and Malmö are currently being considered. The government has set a maximum of SEK 205 billion (EUR 20 billion, about 4% of annual GDP) for this purpose and the Swedish Transport Administration has presented four alternative plans in March 2021 (Trafikverket, 2021).

Km per thousand km^2, 2018



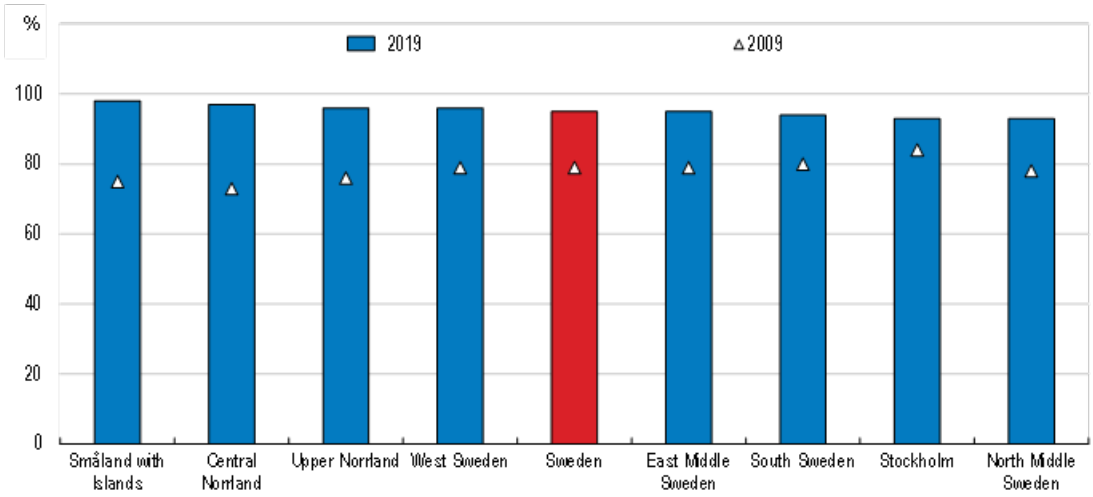
Source: Eurostat.

Digital connectivity is increasingly important to facilitate access to goods and services and to raise productivity. The COVID-19 pandemic has also boosted teleworking. Access to broadband is high in all regions (Figure 4). However, high-speed broadband remains limited in rural areas (Figure 5). Hence, the

government has allocated additional funding for the expansion of broadband over the coming years. The share of internet users who use the web to submit completed administrative forms or interact with public authorities is one of the highest among OECD countries and is high in all regions (Figure 6). Internet banking and online purchasing are also widely used (Figure 7).

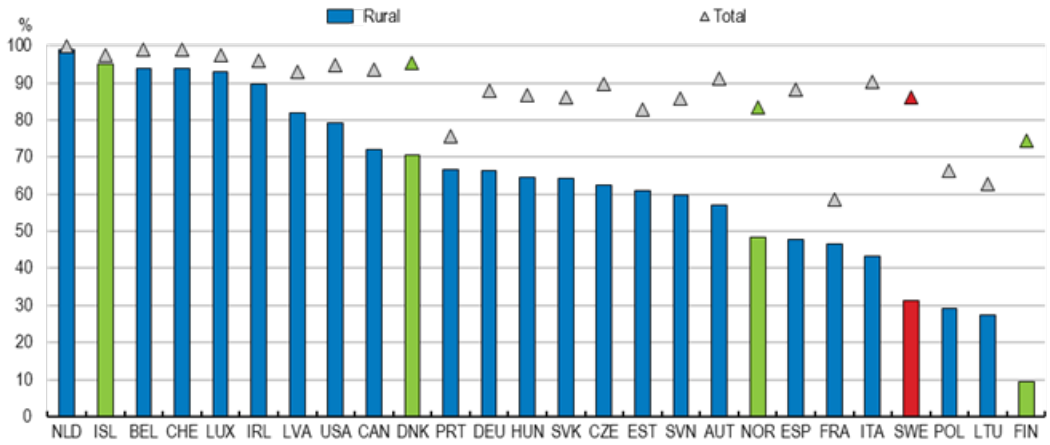
Figure 4. Broadband coverage is high across Swedish TL2 regions

As a share of total households



Source: Eurostat.

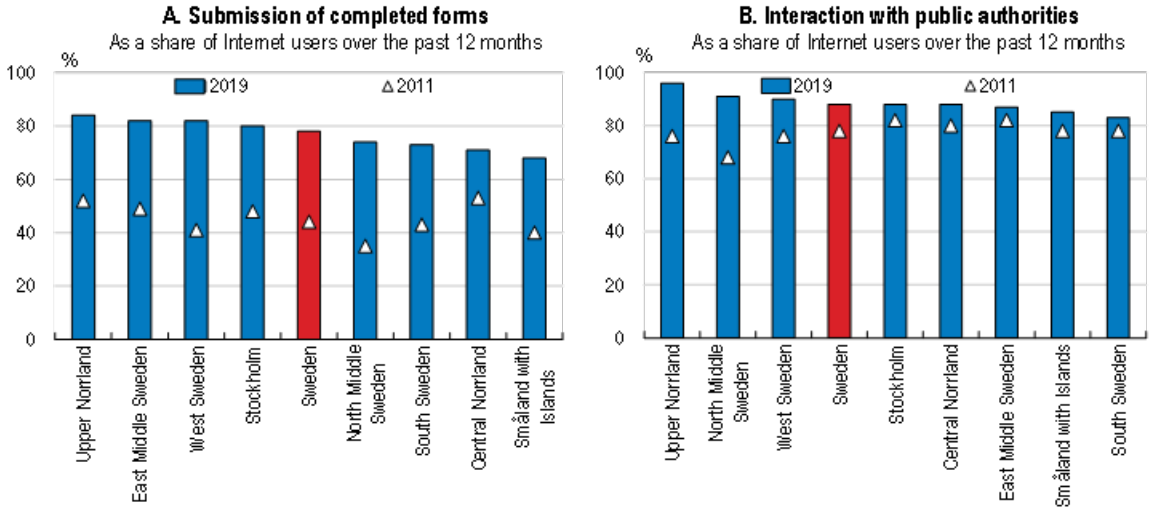
Figure 5. Access to high-speed broadband remains limited in rural areas



Note: 2019, or latest available year: EU countries (2018). Internet access is expressed as the percentage of households (population, for the United States) with access to fixed broadband technologies with download speed greater than 30Mbit/s (NGA technologies, for the EU). For EU countries, rural areas are those with a population density lower than 100 inhabitants per square kilometre. For Canada, rural areas are those with a population density less than 400 per square kilometre. For the United States, rural areas are those with a population density less than 1 000 per square mile or 386 people per square kilometre.
Source: Calculations based on OECD Regional Statistics database.

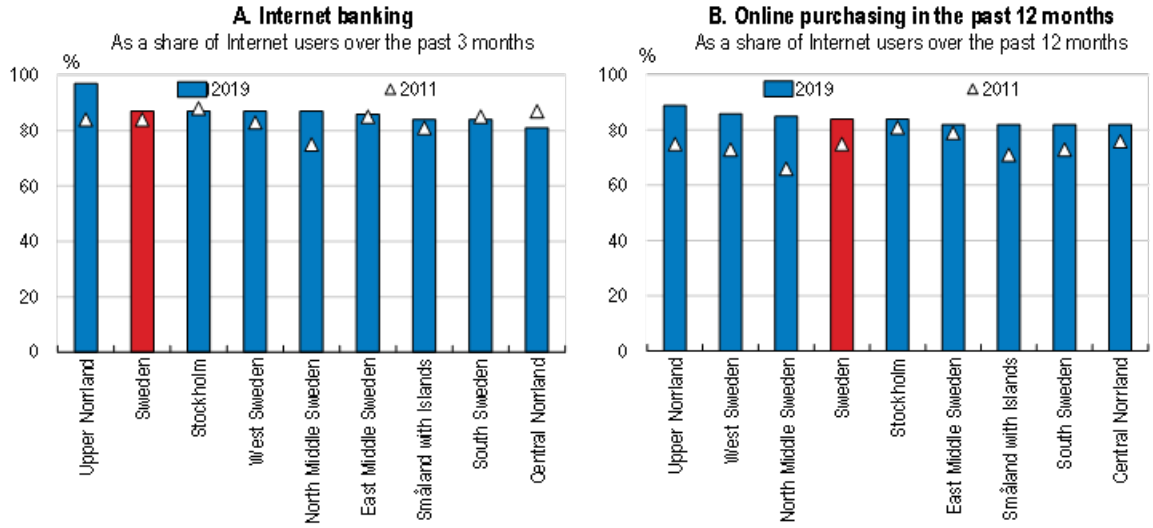
Figure 6. Internet is widely used to communicate with public authorities

TL2 regions



Source: Eurostat Digital Economy and Society Database.

Figure 7. Internet banking and e-commerce are widespread



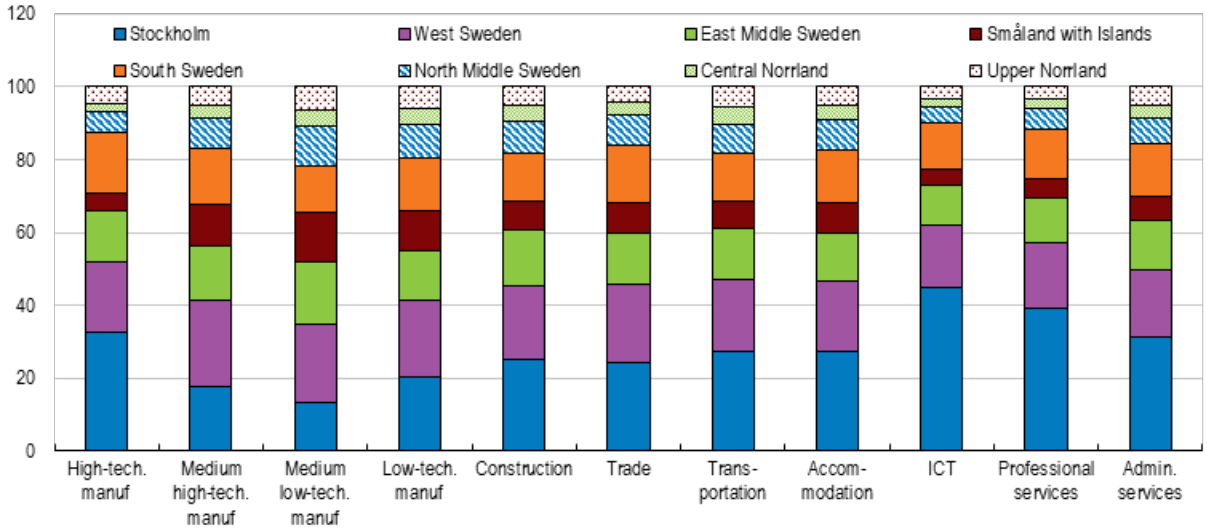
Source: Eurostat Digital Economy and Society Database.

Knowledge-intensive activities are geographically concentrated

high- and mid-tech manufacturing (Figure 8). Moreover, the number of firms in knowledge-intensive services has increased faster in Stockholm and West Sweden than in other regions since the 2008 global financial and economic crisis (Figure 9).

Figure 8. Highly productive sector firms concentrate in Stockholm and West Sweden

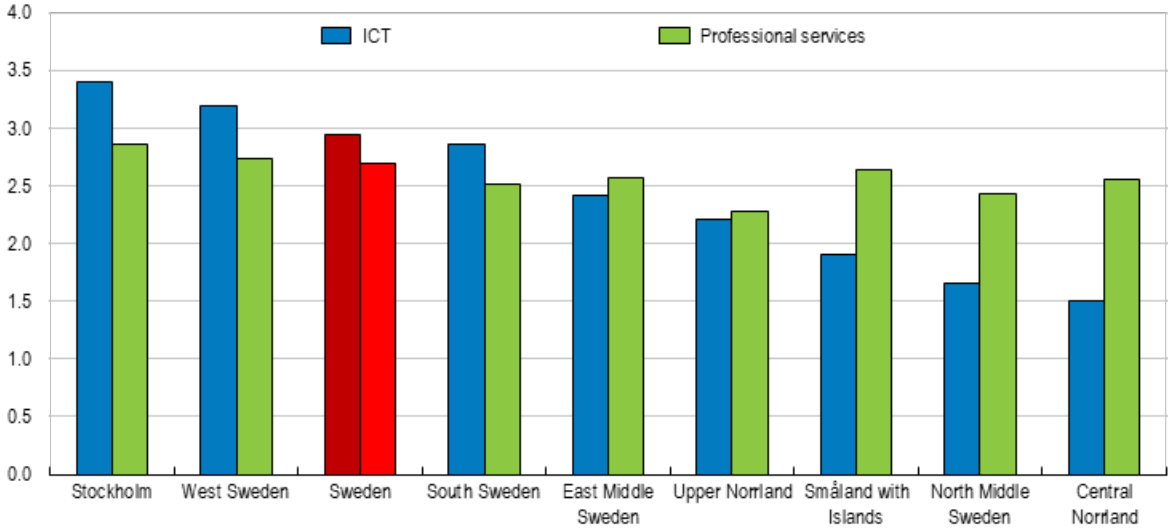
Share of firms in Sweden (%), TL2 regions, 2018



Note: High-tech manufacturing includes manufacture of pharmaceuticals (C21) and computer, electronic and optical products (C26); medium high-tech manufacturing includes manufacture of chemicals (C20), electrical equipment (C27), machinery (C28) and transport equipment (C29-C30); medium low-tech manufacturing includes manufacture of coke and refined petroleum products (C19), rubber (C22), other non metallic mineral products (C23), metals (C24-C25) and repair and installation of machinery and equipment (C33); low-tech manufacturing includes the remaining manufacturing sectors (C10-C18, C31-C32).

Figure 9. The number of firms in knowledge-intensive services increased faster in Stockholm and West Sweden

Average annual growth rate between 2008 and 2018, TL2 regions

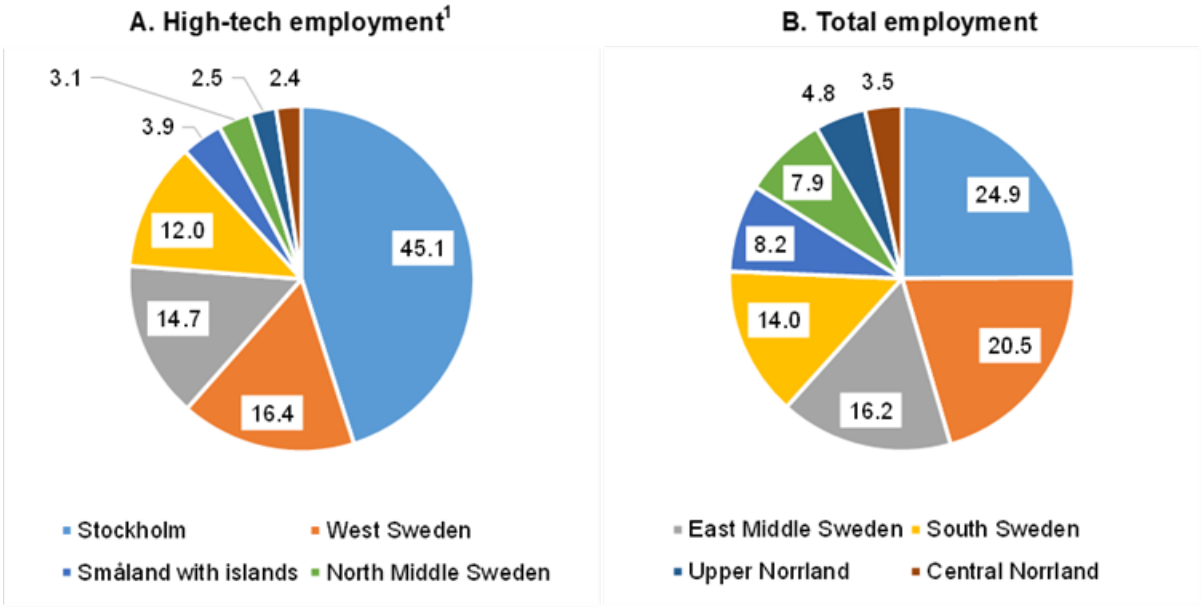


Source: Eurostat Regional Structural Business Statistics Database.

The distribution of industries across regions is reflected in employment patterns. About 45% of high-tech manufacturing and knowledge-intensive high-tech services employment is located in the Stockholm region (Figure 10). Beyond the obvious fact that more sophisticated firms are more likely to hire highly skilled workers, dynamic effects are at play. Start-ups are more likely to be created where a pool of highly qualified workers is available and existing firms can hire workers more easily to innovate and reinforce their growth potential. Highly educated workers are more likely to move to dynamic regions to study or to work.

Figure 10. High-tech employment is concentrated in the Stockholm region

Regional share of employment (%), TL2 regions, 2019



1. High-tech manufacturing and knowledge-intensive high-tech services employment.

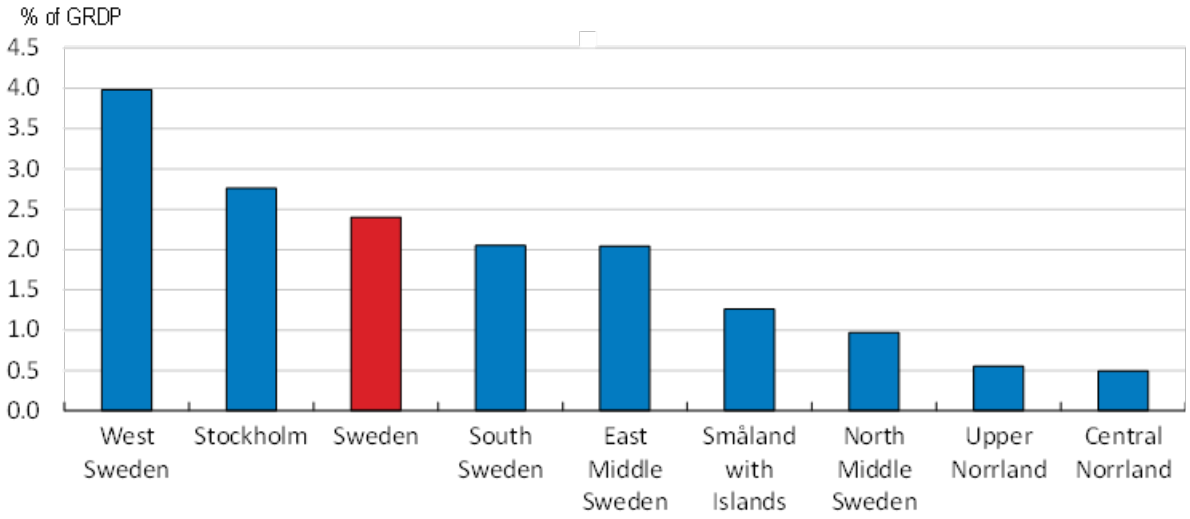
Research and education levels are higher in the large metropolitan areas

R&D expenditure is highest in West Sweden, which has a strong manufacturing base, and in Stockholm (Figure 11). However, it is also relatively high in South and East Middle Sweden, at about 2% of gross regional domestic product (GRDP). R&D spending is relatively low in more sparsely populated regions, although innovative projects are currently taking place in Northern regions' mining, metal and car battery manufacturing industries (*OECD Economic Survey of Sweden*, 2021).

The share of adults with tertiary education varies significantly across regions. In 2019, 53% of the population aged 25 to 64 had tertiary education in the Stockholm region, while this share was only 34% in North Middle Sweden (Figure 12). Meanwhile, participation in lifelong learning is on average the highest in the OECD and regional differences are narrow (Figure 13).

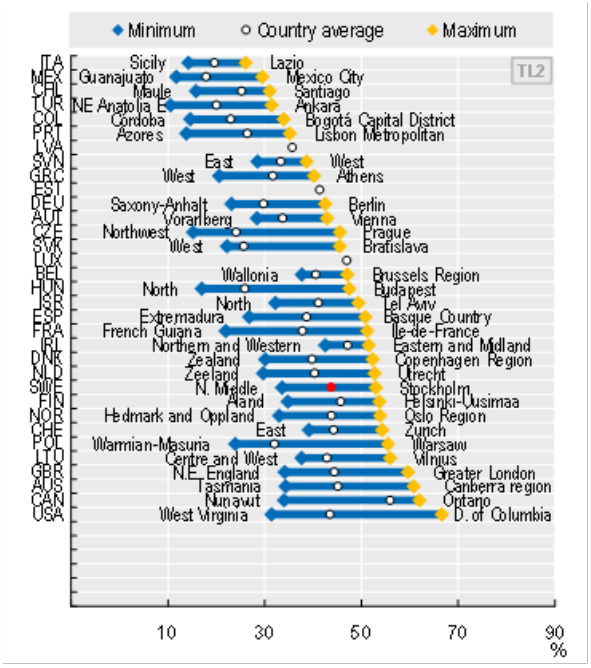
Figure 11. R&D expenditure in the business sector is higher in highly productive regions

TL2 regions, 2017



Source: Eurostat Regional Science and Technology Statistics Database.

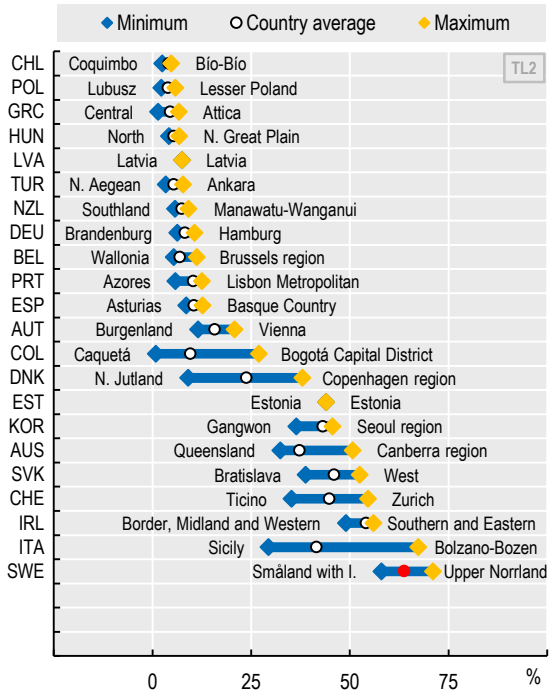
Population aged 25-64 with tertiary education, TL2 regions, 2019



Source: OECD (2020), OECD Regions and Cities at a Glance 2020, OECD Publishing, Paris.

Figure 13. Participation in lifelong learning is high throughout the country

Population aged 25-64 in formal and or non-formal training, TL2 regions, 2017



Source: OECD (2020), OECD Regions and Cities at a Glance 2020, OECD Publishing, Paris.

Data

Regional data at the OECD TL2 (Eurostat NUTS2) level have been collected from several databases from the OECD (Regional productivity, Value-added and employment, Regional innovation and Regional social indicators) and Eurostat (Internet use, Digital economy and society, Regional structural business statistics, IT Employment, GFCF, Training and Transportation). The sample used in the regressions includes up to 125 OECD regions in 17 countries (depending on data availability for different specifications). The analysis uses OECD TL2 level, which divides Sweden into 8 regions, rather than the finer county level to ensure wider indicator coverage across the sample.

Panel regressions

The model is a traditional fixed-effect model, which can be written as:

$$\text{Log } y_{it} = \delta + \alpha_i + \mu_t + \beta x_{it} + \varepsilon_{it}$$

where y_{it} is labour productivity, δ is a constant term, α_i is a regional fixed effect, μ_t is a time fixed effect, x_{it} is a matrix containing variables related to connectivity, knowledge-intensive employment, research and education and investment, and ε_{it} are random errors.

As the right hand side variables are expressed as ratios, only the endogenous variable is in logarithm. Hence, the coefficients are semi-elasticities. The regional fixed effects account for time-invariant heterogeneity across regions. The time fixed effects capture common shocks.

As data coverage varies across regions, more observations are dropped in the regressions including more variables. Alternative regressions with different variables and regions also serve as robustness checks. Except for the percentage of the population with tertiary education, the coefficients remain broadly similar as the variables included and the country coverage change.

These regressions uncover and measure associations between productivity and a number of factors, which the literature identified as potential drivers. Nevertheless, they do not imply causality, as high productivity regions are likely to attract inputs that can in turn raise productivity, such as skilled workers, firms and research institutions. Hence, causality is likely bi-directional.

The first column of Table 1 displays a relatively general panel equation, including statistically significant variables selected from a broader set of indicators (see Annex B). In subsequent columns, some variables are dropped to extend the sample, as data are missing for some regions.

Table 1. Panel regressions for labour productivity

Dependent variable: 100*Log(labour productivity)[1]					
Density of motorways (km per thousand km^2)	0.11***	0.14***	0.16***	0.09***	0.09***
Density of railways (km per thousand km^2)	0.08**	..	..	..	..
High-tech employment (% of total employment)[2]	0.87**	0.83**	0.97***	0.89**	0.96***
Mid-tech employment (% of total employment)[2]	1.26***	1.04***	0.98***	0.89***	0.84***
Employment in non-high tech knowledge intensive market services (% of total employment)[3]	0.60***	0.49***	0.50***	0.32***	0.44***
R&D expenditure (% of GDP)	0.64**	0.56*	..	..	..
Tertiary education (% of population)	0.87***	0.27***	0.13*	..	..
Investment in construction (% of value added)	-0.06**	-0.07***	-0.05**	-0.06**	..
Investment in financial services (% of value added)	-0.10***	-0.12***	-0.13***	-0.10***	..
R^2 (within)	0.54	0.48	0.44	0.43	0.44
Total number of observations	548	619	694	785	971
Period	2008-17	2008-17	2008-17	2008-17	2008-18
TL2 Regions	70	81	81	95	125
Countries	9 (1)	11 (2)	11 (2)	13 (3)	17 (4)

1. The regression includes both region and time fixed effects. The coefficient are semi-elasticities (e.g. in the first column, an increase of one km per thousand km2 in the density of motorways is associated with an increase in the level of productivity by 0.11%). (1) Czech Republic, Spain, Finland, Hungary, Italy, Norway, Portugal, Slovak Republic and Sweden are included; (2) Countries in (1) plus Austria and Poland; (3) Countries in (2) plus Denmark and Slovenia; (4) Countries in (3) plus Ireland, Lithuania, Switzerland and Turkey. ***, ** and * denote statistical significance at the 1%, 5% and 10% confidence level, respectively.
2. The classification of economic sectors into high-technology, medium high-technology, medium low-technology and low-technology industries is based on R&D intensity at the European Community (NACE) 2-digit level.
3. Services are mainly aggregated into knowledge-intensive services on the basis of the share of tertiary educated persons at the NACE 2-digit level.
Source: Authors' calculations.

The results suggest the relevance of the following factors for regional productivity:

- Connectivity: a higher density of motorways or railways is associated with higher productivity. The share of households with access to broadband is not significant in panel regressions. This likely reflects the high coverage reached in most of the regions in the sample. Nevertheless, a cross-section regression on OECD regions for 2018 clearly shows that regions with low broadband coverage exhibit low productivity (Figure 14).
- Knowledge-intensive employment: although representing a small share of total employment on average (respectively around 1% and 5%), high and mid-tech manufacturing is tightly linked to

overall regional productivity, suggesting strong spillover effects. The relation between productivity and non-tech knowledge-intensive market services, which employ on average about a quarter of the workforce, is also robust.

- Research and education: higher R&D expenditure is associated with higher productivity, even after controlling for the regional industrial structure and despite the potential disconnection between research and production sites. The share of the population with tertiary education also correlates with productivity, although the coefficients are less stable across specifications than for other variables, presumably reflecting complementarities with other factors.
- Investment: higher investment rates should boost productivity through capital deepening. However, this effect could not be identified in the panel regressions. Conversely, high investment rates in construction and financial services are associated with somewhat lower regional productivity, suggesting that these sectors may divert resources from more productive industries.

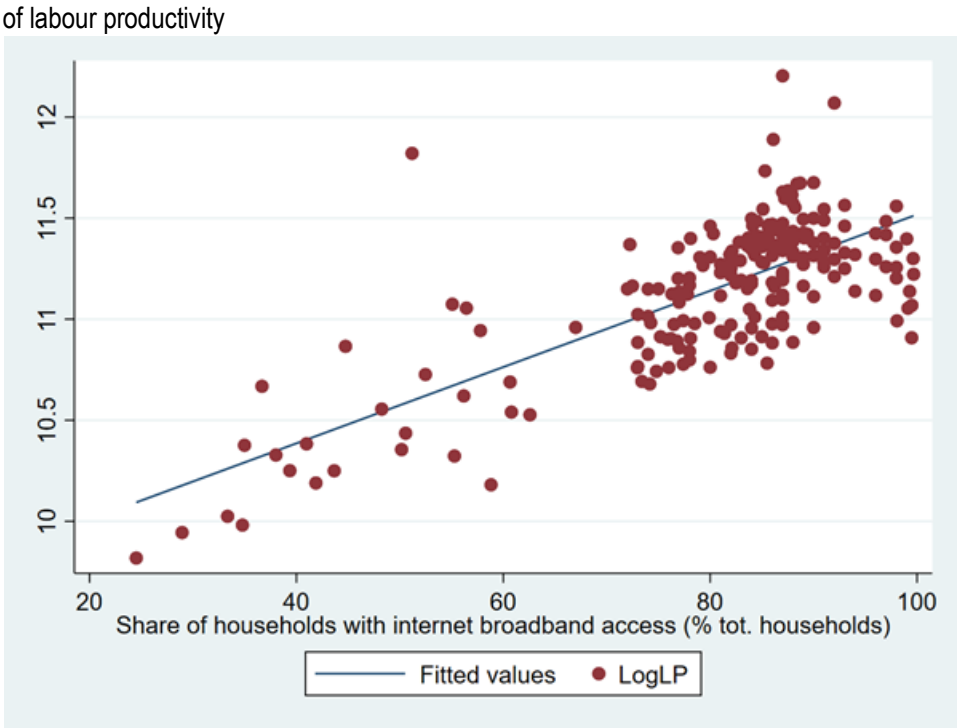
The model's fixed effects measure time-invariant heterogeneity across regions (Table 2). They capture a number of factors affecting productivity that cannot be incorporated in the model because relevant indicators are not available. For example, agglomeration effects can be partly captured by connectivity indicators, but associated labour market matching effects and knowledge spillovers are difficult to measure. The Stockholm fixed effect, which represents more than 20% of the region's productivity level is likely to largely account for this kind of mechanisms. This effect amounts to nearly half of the productivity difference between Stockholm and the average OECD region in the sample. Fixed effects for Upper Norrland and North Middle Sweden may reflect high capital intensity in mining and heavy industry, as the model is not able to account for capital deepening.

Table 2. Fixed effects for Swedish regions

Region (TL2)	Fixed effect (% of productivity)	Productivity difference to OECD sample average (2017)
Stockholm	21.5	47.2
Upper Norrland	12.8	21.3
North Middle Sweden	12.1	12.0
West Sweden	3.5	21.1
Småland with Islands	2.4	8.9
East Middle Sweden	2.2	16.6
South Sweden	-4.4	14.7

Note: Central Norrland is omitted due to missing data for some indicators.
Source: Authors' calculations.

Figure 14. OECD regions with low broadband coverage are at a disadvantage



Note: The sample covers 219 TL2 regions in 18 countries. LP denotes labour productivity.
Source: Authors' calculations.

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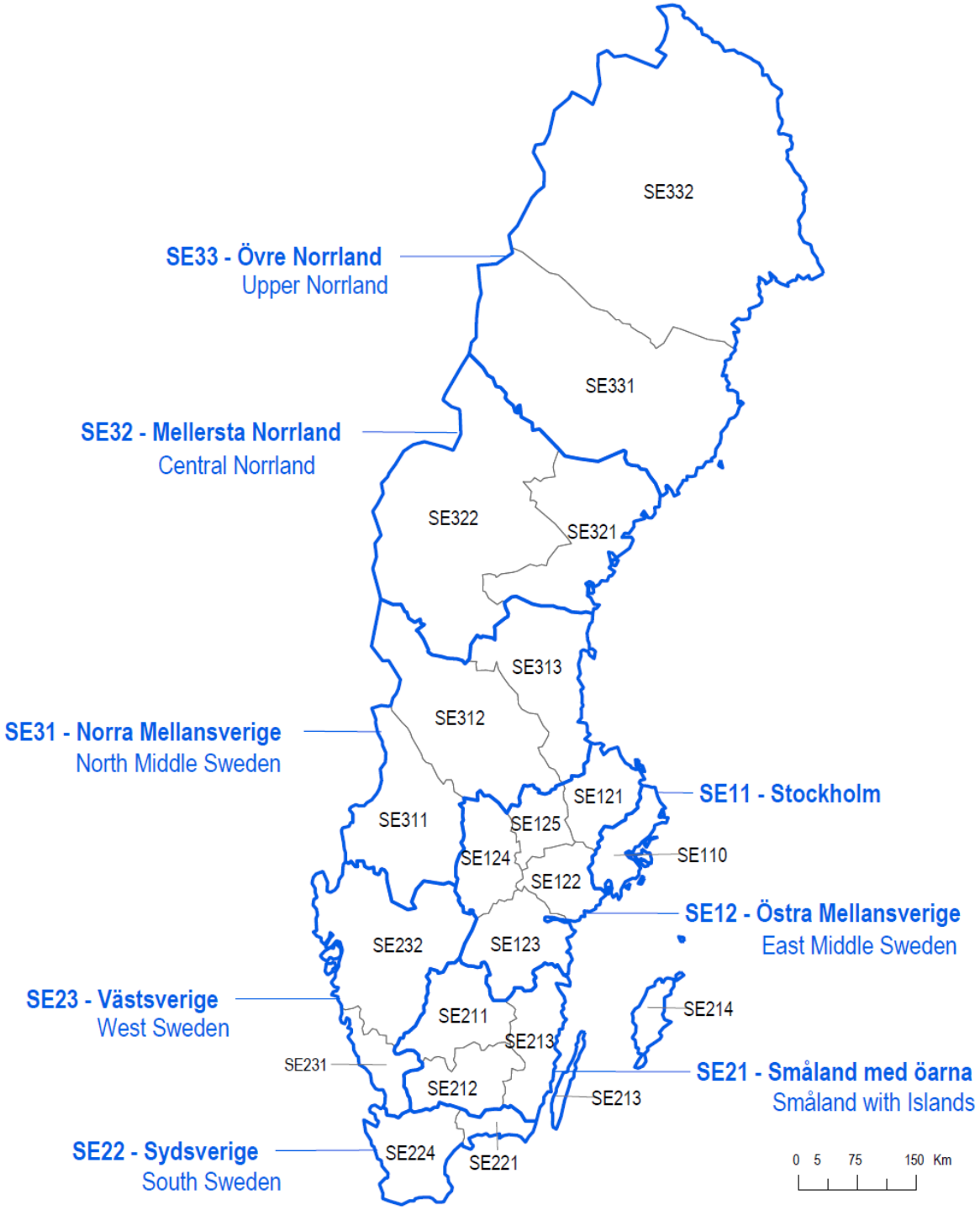
Annex A. Swedish TL2 regions



Note: TL2 (large regions) are outlined in blue. Smaller regions (TL3) refer to counties.
Source: *OECD Territorial grids*, March 2020.

Annex B. Variable selection and multicollinearity check

The model variables are selected from a wide dataset derived from OECD (Regional productivity, Value-added and employment, Regional innovation and Regional social indicators) and Eurostat (Internet use, Digital economy and society, Regional structural business statistics, IT Employment, GFCF, Training and Transportation) databases. We do not use an automatic routine to select the variables, partly because we let the sample adjust to the availability of data (i.e. an observation is dropped when the corresponding value of a variable is missing). Economic judgment also helps determine the indicators that are most relevant to the analysis when variables are correlated. Missing values for some variables in some regions imply trade-offs between the variables included and the sample of regions covered. Table A B.1 describes the main steps of the variable selection process, in which non-significant variables are gradually removed, controlling for the overall fit of the model and the stability of the coefficients of the remaining variables. Only significance levels are shown for simplicity. Additional regressions were run, in particular with alternative variables likely to be correlated (e.g. total R&D and its public and private subcomponents). In the case of correlated variables, the one with the highest explanatory power or the least correlated with other variables of the model was selected.

Table A B.1. Main steps of variable selection

	Step				
	1	2	3	4	5
Density of motorways (km per thousand km^2)	***	***	***	***	***
Density of railways (km per thousand km^2)	**	**	**	**	**
High-tech employment (% of total employment)	**	*	*	**	**
Mid-tech employment (% of total employment)	***	***	***	***	***
Employment in low tech manufacturing (% total employment)	n.s.	n.s.			
Employment in middle-low tech manufacturing (% of total employment)	n.s.	n.s.			
Employment in knowledge intensive high tech services (% tot. employment)	***	***	***	*	
Employment in non-high tech knowledge intensive market services (% of total employment)	***	***	***	***	***
Investment in manufacturing (% of value added)	*				
Investment in construction (% of value added)	n.s.	n.s.	*	**	**
Investment in ICT services (% of value added)	n.s.				
Investment in financial services (% of value added)	***	***	***	***	***
Investment in professional services (% of value added)	n.s.				
R&D expenditure (% of GDP)	n.s.	n.s.	n.s.	**	**
R&D personnel employed (% of total employment)	n.s.	n.s.	n.s.		
Tertiary education (% of population)	***	***	***	***	***
Share of households with internet broadband access (%)	n.s.	n.s.	n.s.		
R^2 (within)	0.54	0.53	0.53	0.54	0.54
Total number of observations	507	507	507	547	548
TL2 regions	69	69	69	69	70

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% confidence level, respectively, n.s. denotes non-significant variables. Blanks correspond to omitted variables.

Multicollinearity between exogenous regressors could bias the coefficients of the equations. To make sure this is not the case, we display the variance inflation factors (VIFs) for the all the panel regressions shown in Table 1 in the main text (Table A B.2). The VIFs are all well below the conventional benchmark of 10 in all cases, indicating the absence of multicollinearity.

Table A B.2. Variance inflation factor (VIF) for panel labour productivity regressions

Density of motorways (km per thousand km^2)	1.71	1.52	1.47	1.20	1.15
Density of railways (km per thousand km^2)	1.15	..	..	..	
High-tech employment (% of total employment)[2]	1.50	1.34	1.25	1.24	1.15
Mid-tech employment (% of total employment)[2]	2.02	1.91	1.80	1.91	1.57
Employment in non-high tech knowledge intensive market services (% of total employment)[3]	2.60	2.41	2.28	1.44	1.24
R&D expenditure (% of GDP)	1.72	1.68	..	..	..
Tertiary education (% of population)	2.68	2.52	2.06	….	..
Investment in construction (% of value added)	1.19	1.17	1.10	1.07	..
Investment in financial services (% of value added)	1.12	1.10	1.09	1.05	..
Average VIF	**1.74**	**1.71**	**1.58**	**1.32**	**1.28**
Total number of observations	548	619	694	785	971
Period	2008-17	2008-17	2008-17	2008-17	2008-18
TL2 Regions	70	81	81	95	125
Countries	9 (1)	11 (2)	11 (2)	13 (3)	17 (4)

Note: A VIF below 10 is widely accepted as indicating an absence of multicollinearity.