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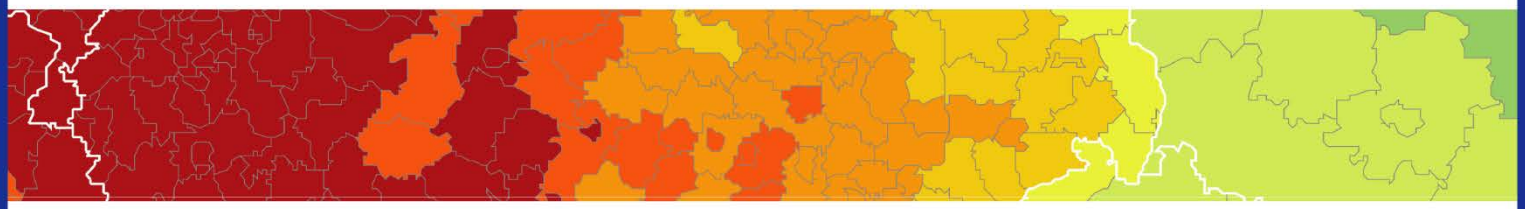

MISTA
Metropolitan Industrial Spatial Strategies & Economic Sprawl

Targeted Analysis

Annex 2
Background Report

Annex 2: Background Report

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Annex 2: Background Report

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Abbreviations

AA	Agglomeration Area
AMECO	Annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs
ARDECO	Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy
B2B	Business-to-Business
EC	European Commission
ELFS	European Labour Force Survey
ESA	European Space Agency
ESPON EGTC	European Territorial Observatory Network ESPON European Grouping of Territorial Cooperation
EU13	Countries that joined the EU after 2004: Bulgaria (BG), Croatia (HR), Cyprus (CY), Czech Republic (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Romania (PL), Slovakia (SK) and Slovenia (SI)
EU15	European Union (1 January 1995 - 30 April 2004): Belgium (BE), Denmark (DK), France (FR), Germany (DE), Greece (EL), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PT), Spain (ES), United Kingdom (UK), Austria (AT), Finland (FI) and Sweden (SE)
EU28	European Union (1 July 2013 - 31 January 2020): EU-15 + Cyprus (CY), Czechia (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Slovakia (SK) and Slovenia (SI), Bulgaria (BG), Romania (RO) and Croatia (HR)
Eurostat	Statistical office of the European Union
FDI	Foreign direct investment
FUA	Functional Urban Area
GVA	Gross value added
ICT	Information and communications technology
ILO	International Labour Organization
ISCO	International Standard Classification of Occupations
JRC/EC	Joint Research Centre of the European Commission
KIBS	Knowledge intensive business services
LAU	Local Administrative Unit
Metro region	Metropolitan region, including the core city and its functionally intertwined environs
MISTA	Metropolitan Industrial Spatial Strategies and Economic Sprawl
MR	Metropolitan region
NACE	Statistical Classification of Economic Activities in the European Community ("Nomenclature statistique des Activités économiques dans la Communauté Européenne")
NUTS	Nomenclature of Territorial Units for Statistics
NUTS2	Nomenclature of Territorial Units for Statistics: Basic regions for the application of regional policies
NUTS3	Nomenclature of Territorial Units for Statistics: small regions for specific diagnoses
OECD	Organisation for Economic Co-operation and Development
PP	Percentage point
R&D	Research & development
SBS	Structural business statistics
SMEs	Small and medium-sized enterprises
TFP	Total factor productivity

Executive summary

This is the first background report of the ESPON project MISTA (Metropolitan Industrial Spatial Strategies and Economic Sprawl). It outlines the results of task 1 of this project, which among other things, aimed to provide an empirical overview of the development of industrial activities in European urban agglomerations over the last 30 years.

This analysis is motivated by an important recent shift in the focus of the literature on industrial development: Up until the “Great Recession” of 2008/09 de-industrialisation and tertiarisation were mostly seen as an unavoidable side effect of economic development and a large manufacturing sector was considered as more or less obsolete in a fundamental change towards a post-industrial, service-oriented economy. However, based on new evidence the speed of de-industrialisation over the last decade has been slowing. Furthermore, experience of countries and regions with a strong industrial base seem to have emerged better through the "Great Recession" of the late 2000s (Fingleton et al. 2012), leading to a reassessment of the role of manufacturing in highly developed countries and regions. Since then, a dynamic manufacturing sector is again considered a prerequisite for innovation and growth not only in countries and regions, but also cities (e.g., *Van Winden et al*., 2011; *Baily – Bosworth*, 2014).

The report therefore addresses the following central research questions:

- How has industry in urban agglomerations developed in aggregate over the last 30 years?
- To what degree has the general trend to de-industrialisation differed across different types of cities and time periods?
- To what degree have different sectors of industry experienced different development trends in the major European agglomerations?
- To what degree is the more recent trend to a reindustrialisation of cities reflected in empirical data and which industrial sectors are most strongly affected by changing trends in the location of productive activities in Europe.

In addition, we analysed the developments of the structure of employment in city regions within the productive sector. Here we ask how the education and occupation structure of employment in industry in European city regions differs from that in other regions and what have been the central trends in employment in industries in European city regions in the last decade.

Aggregate Developments

We document a number of stylised facts that highlight the importance of industry for the economic development of urban agglomerations. In particular, we show that industry serves as a nucleus for research and innovation in the local economic systems, is a main driver of productivity and also wage growth and has important input-output linkages to the service sector. Thus in 2018, manufacturing alone accounted for over 60% of total business R&D in the EU and Norway. Similarly, labour productivity levels were by far higher in industry than in the European economy total in 2017 in all EU regions, and the compensation of employees in industry was some 31% higher than in the economy total.

The data also impressively confirms the role of industry as a "productivity machine" for metropolitan regions. While cumulative productivity gains in industry over the period 1995-2017 (measured in constant prices and per employed person), amounted to +70.1% in the major metro regions, +64.4% in the other metro regions and +59.7% in all NUTS-3 regions of the EU and Norway, the corresponding figures for the respective economies as a whole (including services) were much lower at +24.3%, +27.1% and +28.7%. The resulting advantage of the (larger) metro regions in their current industry productivity level is impressive: A GVA per employed person of € 94.776 (2017) at constant prices in the major metro region's industry and of € 79.321 in other metro region's industry is contrasted by € 72.935 in the industry of all NUTS-3 regions.

Further, the production sector of metropolitan regions remains to be of central importance to the European production system as a whole. More than half (54%) of the workforce in European industry (or 19.8 million people) is employed in metropolitan regions and almost two thirds (64%) of the industrial output of the whole European Union is generated in these regions.

The empirical research undertaken in this project also corroborates previous results indicating a substantial decline in the employment and GVA share in cities since the 1970's and a much more stable development since the "Great Recession" in 2008/09. It, however, extends these findings by demonstrating that:

a) Despite a clear downward trend in industry employment in most European urban areas since the 1990s, developments in terms of GVA were much more favourable although far from uniform and strongly influenced by specific metropolitan characteristics.
b) As shown by a novel decomposition analysis of employment growth of industry in European metro regions, the bulk of the decline in employment in industry has been due to a substantial increase in labour productivity and thus industrial upgrading rather than "true de-industrialisation". Indeed, productivity increases can explain the total employment loss in this sector, while the effects of "true de-industrialisation" (i.e., a decline of production in cities), although mostly negative, are often balanced out by additional effects stemming from the growth of metropolitan areas or countries in general.
c) Trends in both the employment and GVA share in industry have been markedly more stable since the "Great Recession" than before. In particular in the period 2008 to 2017, the negative impact of "real de-industrialisation" lost much of its significance and made hardly any negative contribution to industry employment change in the metro regions.
d) There is some evidence of a return of certain forms of production to city regions. Recent growth trends suggest that some sectors of production activities have been growing more rapidly in urban regions than in the European average. Although this tendency starts from a rather low level, indicating a return of certain production to urban regions (as more rapidly growing sectors account only for 14% of total employment).
e) This return of production to cities is not restricted to logistics, utilities and some high-tech industries, but also applies to some divisions in consumer goods production and other less technology intensive sectors. In conjunction with the results of the literature survey, these sectors are mainly affiliated with the hand-crafted, design-oriented, high-quality production for local high-income markets.
f) Next to this, urban regions in Europe have been affected by a shift of the employment structure within industry to more highly qualified and service-oriented employment. This

change is still ongoing and affects urban regions more strongly than others. As a consequence, an increasing share of jobs in urban production are service or white-collar jobs, and in 2016 just below half (47.2%) of the employed in industry in urban regions of the EU were working in such jobs.

Differentiation of developments

A further central contribution of the current report is that it provides a more detailed and in-depth analysis of the heterogeneity in the development of productive activities than has hitherto been available. In particular, the report highlights a number of differences that apply to the heterogeneity within and across metropolitan regions as well as to the differences within and across individual sectors of productive activities.

Differences within and between metro regions

For example, with respect to differences within metropolitan regions we find that in the last 30 years production has in general favoured the urban fringes as industry developed more favourably in the wider metro environs than in the metropolitan core. Over time, intra-metropolitan specialisation apparently increases alongside the advantages of the metro centres for knowledge-intensive services and of the wider environs for industry production. This to a large degree reflects better location conditions (such as lower land prices and fewer congestion effects) for (large-scale) productive activities in the wider metro areas.

Despite this, core metro regions remain central locations for modern industrial activities. On the one hand, this is because of the increasingly integrated nature of service and manufacturing functions in industrial value chains, based on "hybrid" and servo-industrial production methods. This leads to a situation where although industry (and within industry in particular manufacturing) is more attracted to the wider metro regions that depends on complementary industry-related services located in the metro cores for market success.

On the other hand, this is also due to changing tastes and lifestyles (such as e.g., increased environmental concerns in urban cores and increased tastes for customisation and individualisation through consumption) and the still growing population in urban cores. This leads to a larger demand for activities related to the implementation of the circular economy and supply of public goods in urban cores as well as to an increasing demand for largely small-scale customised productions in city centres, that also has to be satisfied by nearby producers.

With respect to differences between metro regions**,** this study indicates that – next to substantial variation between individual cities, that highlight the economic importance of institutions, history and policy – the aggregate picture of the development of productive activities in cities is strongly driven by large metropolitan regions, capital city regions and by metropolitan regions located in the EU15 countries and Norway. By contrast, the patterns of industrial development differ markedly in smaller metro regions, as well as in regions that are not capitals or are located in EU13 countries. These developments in industrial activities across metropolitan areas reflect different locational (dis-)advantages and suggest that:

- Small and medium-sized metropolitan areas did not experience declining employment in production as radically as large metro areas and thus provide a broader industrial base (in terms of localised branches) than large cities. In addition, these cities were also less strongly affected by the shift of the employment structure to high-skilled employees and to white collar and service occupations than larger cities.
- Metro regions that are not capital cities have also been less strongly affected from employment losses and also differ markedly in terms of industrial specialisation from capital cities. Capitals are more strongly specialised on utilities (e.g., electricity, gas and water provision, remediation of waste materials) and logistics (e.g., wholesale trade, warehousing, water transport, air transport). By contrast, in metropolitan areas that are not capitals there is a disproportionately strong localisation of the machinery and equipment industries as well as of car production and basic metals, textiles and leather products. This is due to larger population sizes in capital cities leading to more pressing concerns with respect to environmental issues, as well as the different functions of these cities in the European city system. In addition, due to the path dependence of industrial activities, this is likely to also impact on the future development of different cities.
- Cities located in EU13 countries – in part for historic reasons and in part due to generally lower income levels in EU13 countries as well as substantial inflows of foreign investments in the last three decades – are much more "production affined" than cities located in EU15 countries and Norway. This is documented by a larger share of production (and manufacturing) in value added and employment, a larger number of localised branches in particular in manufacturing, and an occupational structure of the employed in industry that is much more strongly focused on medium qualification levels and above all on medium-skilled production occupations. This last fact also suggests that functional specialisation of production (on service functions) within metro regions has progressed much less in metro regions of EU13 countries than in metro regions located in EU15 countries and Norway.

This vast heterogeneity between city types, paired with the equally huge differences between individual metro regions, warns about an overgeneralisation of the results of aggregated data based on the averages of all metro regions. It also highlights the importance of city specific, idiosyncratic factors that may be rooted in specific policies, institutional differences or history affecting industrial development (e.g., the presence of the headquarter of a large industrial enterprise), that have to be considered when designing industrial policy for a specific city.

Differences within and between industry groups

The heterogeneity of the production sector in metropolitan regions be carefully considered in terms of the products produced, geographic extent of markets, size of enterprises and technologies used. From a theoretical perspective, heterogeneity leads to an expectation that cities in general are unlikely to present equally favourable conditions for the production of all of these parts of industry and may provide differentiated locational advantages for certain activities within production. It also leads to the expectation that there may be substantial heterogeneity among cities with respect to their locational advantages.

These expectations are largely confirmed by the results of the current study. This applies to both the specialisation of metro regions on specific production branches as well as the

functional specialisation within branches. Thus, with respect to individual sub-sectors, the evidence of this study suggests that many of the negative developments observed in the production sector in aggregate (such as a low localisation of production, long-term declining employment and a long-term loss in production shares) are closely linked to the development of manufacturing activities (such as NACE sector C in the international classification of economic activities).

The production sector as understood by the MISTA project, however, covers a much larger set of activities (including logistics, construction, utilities and wholesale trade). In these activities, metro regions have experienced a much better development than in the manufacturing sector, which drives the aggregate picture of production. On average a larger share of the employed work in logistics, utilities and wholesale trade and storage in European metro areas. These sectors are consequently more strongly localised in urban regions than elsewhere. Similarly, employment growth in recent years (2012 to 2018) has been higher or at par with growth in other regions in all of these sectors except for manufacturing.

In addition, our results do not support a complete loss of locational advantages for metro regions for manufacturing per se. Rather, growth trends suggest that some sectors of manufacturing activities have been growing more rapidly in urban regions than in the European average. Interestingly, these sectors correlate less strongly with high-technology and qualifications and more strongly with consumption close production. Indeed, this study finds, next to some high-skilled product activities, in particular consumption-close branches of manufacturing (such as furniture, food and beverages or the manufacture of leather products) have grown more strongly in urban areas than elsewhere even in terms of employment. While these branches are still small in urban employment shares, this suggests that some parts of production may indeed be returning to metropolitan regions. However, this production differs vastly in nature from the large-scale (and often environmentally burdensome) mass production that is usually associated with the term “industry”, as it is usually related to small-scale production of highly customized goods with low or even favourable environmental impact.

Irrespective of whether this trend will hold out in the future or not, the results of our research also suggest a markedly different occupational and educational structure in production in metro areas as compared to other regions. Recent employment trends across production sectors in metro areas shows an increasing share of high-skilled employment, a trend also observed in other sectors (e.g., construction). One of the outstanding observations of the employment structure of urban manufacturing is a lower share of jobs for medium level (upper secondary or vocational) workers, such that in urban regions both the share of both highly skilled and low-skilled workers exceeds that of manufacturing in other regions. Thus, in urban regions manufacturing is a more important employer for both high-skilled and low-skilled workers than in other EU regions.

In parallel, also the occupational structure of manufacturing in metro regions is much more ‘tertiarised’ than in other regions. As a result of increasing functional specialisation, in the

European Agglomeration Areas (AAs) industrial employment is therefore much more strongly focused on service occupations than in other regions and it is to be expected that a substantial share of the jobs in manufacturing in European AAs are actually office jobs than are associated with demands for office spaces. Furthermore, recent trends suggest that the increased tertiarisation of the employment structure still continues to this day.

Policy

From an economic policy perspective, these empirical results therefore allow a cautiously optimistic view on the further development of industry in European city regions and also highlight the need to adopt new lenses when trying to grasp the nature of contemporary manufacturing. They also suggest that there may be a fertile ground for industrial policies aiming to strengthen the metropolitan industrial base. Our results indicate that the decreases in industrial employment in city regions were primarily triggered by the particularly high productivity gains in metropolitan industry. At the same time, however, it is precisely these productivity advantages that will determine the competitiveness of city regions despite high incomes, especially in technology- and knowledge-intensive productive activities. Maintaining high productivity levels will therefore be of central importance in order to retain production in cities, even if this implies slower employment growth in this sector.

“One-size-fits-all" solutions are unlikely to yield success here, given the large heterogeneity in industry evolutions in both regional and sectoral terms. In a structural policy view this will mean building on existing sectoral strengths of the respective city region and expanding these towards cognitively "related" but new activities that are particularly accessible to knowledge spill-overs (such as through encouraging spin-offs). To promote productive activities in cities in the long run, it is essential to understand the nature of the manufacturing that has remained in a specific city and why it has done so. Also, promoting an economically healthy environment for the total local economy, that fosters innovation and entrepreneurial activities is conducive to productive activities in the long run. This requires:

- *City-specific solutions based on intensive dialogue between policy makers, businesses, economists and urban planners and a change in perspective from factories, capital equipment and technology towards a people-based view of cities as productive platforms.* Developing and maintaining such platforms, that require intensive personal contact, is therefore one important element in designing successful industrial policies in metro regions.
- *Tools for supporting productive activities. While some cities are conscious of the value of their industrial land and manufacturing businesses, few actively support these activities.* In the past, manufacturing and industrial land operated with relative independence of public planning regimes and were driven by standard market dynamics, only requiring support for the development of new infrastructure. Since productive activities have become the ‘weaker’ activity (compared with housing, recreation, offices and commercial activities), public authorities have been poorly equipped to prioritise manufacturing activities over other activities. Therefore, there is relatively little contemporary experience with how to manage or support productive activities. Some cities have released development strategies to encourage

densification. Other cities have supported financing for education or through financial incentives for businesses to address certain urban issues (such as the circular economy and resource management).

- *Resources for monitoring policy success (or failure) including the development of data sources that allow for an improved evidence base for policy making.* In the context of the current project, the most pressing needs would be to provide comparable regionally and granular sector data on employment, GVA and the number of enterprises in all EU countries. In addition, there is also a need for an increased harmonisation of basic statistical definitions.

1 Introduction

Since the end of the 1970s, the production of physical goods in developed countries has lost considerable importance in terms of output and employment. The extent of this erosion of industry is quite impressive. In highly developed countries, according to recent *United Nations* (2019) data, the industry shares of value added at current prices fell from 28,3% to 18,2% in the USA and from 39.5% to 29.5% in Japan in the period 1985-2017. In Europe, the UK (from 33.3% to 19.8%), France (28.8% vs. 19.7%), Belgium (31.4% vs. 21.9%), the Netherlands (32.7 vs. 19.7%), and to a lesser extent Spain (34,9% vs. 23,5%), Italy (33,0% vs. 24,0%) and Sweden (33,7% vs. 24,4%) have lost considerable manufacturing potential. The development in Germany (from 39.4% to 30,9%), some of the smaller EU15 countries (e.g., Austria 34.5% vs. 28.3% or Finland 35,1% vs. 27,3%) and since the 1990s the new Member States (e.g., Poland 1995-2017 from 37.4% to 33,5%, Latvia 30,3% vs. 21.6%, Slovakia 36,8% vs. 34,4%; Slovenia 347% vs. 32,4%, Romania 38,4% vs. 33, %) seem somewhat more favourable. However, also here the industry share has been noticeably reduced, except for Ireland (30,6% vs. 38,5%), Hungary (30.4% vs. 30.4%) and Bulgaria (25.6% vs. 28.3%) respectively.[1])

This weak manufacturing development in both the USA and Europe, was particularly noticeable in urban areas, although these areas recorded more favourable employment dynamics overall. *Helper et al.* (2012a), for example, calculate clearly above-average rates of shrinkage in manufacturing employment for the 366 largest USA metropolitan regions and the period 1980-2011. Thereby, the disadvantage compared to the other USA regions was considerable at –8.8 percentage points for all metro regions and –10.0 pp for the 100 largest ones.

Recently, however, the experience that countries and regions with a strong industrial base seem to have been more resilient to the "Great Recession" (*Fingleton et al*., 2012) has led to a reassessment of the role of manufacturing in highly developed countries and regions: While previously de-industrialisation and tertiarisation have been seen as an unavoidable side effect of economic development and a large manufacturing sector as more or less obsolete in a fundamental change towards a post-industrial, service-oriented economy, a dynamic manufacturing sector is now again seen more as a prerequisite for innovation and growth in countries and regions, but also cities (e.g. *Van Winden et al.,* 2011). Furthermore, a growing body of empirical evidence suggests that some parts of industry may be returning to urban agglomerations in Europe.

In terms of economic policy, this increased recognition of the importance of industrial activities for urban (respectively regional) development has manifested itself in a renaissance of concepts that aim for a turnaround in manufacturing development ("re-industrialisation"). At the EU-level, the *EU-Commission* stated that “a vibrant and highly competitive EU manufacturing sector can provide the resources and many of the solutions for the societal challenges facing

[1] In contrast, the manufacturing share in China has remained largely constant at around 32 to 33% since 1990, and in Korea it has risen from 18.5% to 31.2% since 1980.

the EU, such as climate change, health and the ageing population, and the development of a healthy, safe and secure society and thriving social market economy" (2010, p. 4), and subsequently launched the target to bring back the industry share in GDP to 20% in 2020 (*European Commission*, 2012). Although this target is clearly very ambitious[2] also the recently published industrial strategy of the new Commission (*European Commission*, 2020) assigns a central role to industry in leading the change that Europe embarks on its twin transition towards climate neutrality and digital leadership, while coping with increasing global competition.

Against this backdrop, the current background report of the MISTA (Metropolitan Industrial Spatial Strategies and Economic Sprawl) project, aims to provide an empirical overview of the development of industry in European urban agglomerations over the last 30 years. Our aims are primarily empirical: we ask how industry in urban agglomerations has developed in aggregate over the last 30 years, to what degree the general trend to de-industrialisation has differed across different types of cities and time periods and to what degree sectors of industry have shown different development trends in the major European agglomerations. Further, we ask to what degree the more recent trend to a reindustrialisation of cities is visible in the data and which of the industrial sectors are most strongly affected by changing trends in the location of productive activities in Europe.

The next Chapter motivates the analysis by presenting some stylised facts highlighting the importance of industry for the economic development of urban agglomerations. In particular we show that industry serves as a nucleus for research and innovation in the local economic systems, is a main driver of productivity and also wage growth and has important input-output linkages to the service sector. It is thus a sector causing substantial indirect effects on employment and value-added growth in urban agglomerations. Chapter 3 then discusses methodological and data issues that had to be resolved to conduct the empirical analysis presented in the current report, while Chapter 4 presents a short overview over the empirical and theoretical literature on the development of industry in urban agglomerations, that is used to formulate the main hypotheses of the subsequent research.

Chapter 5 and 6, by contrast, present the empirical results focusing on the aggregate trends of industrial development in urban agglomerations over the last 30 years, while Chapter 7 presents results on recent developments from a disaggregate perspective. These results corroborate previous findings of a substantial decline in the employment and GVA share in cities since the 1970's. They, however, also extend these findings by demonstrating that the bulk of this decline has been due to a substantial upgrading of industrial production within cities caused by a substantial increase in labour productivity rather than "true de-industrialisation" (such as a decline of production in cities). Further, we demonstrate that there has been a

[2] In 2019, the industrial share in GDP is 16,7% in the EU28 and 16,2% in the EU15, a further slight decrease from 2012 when the target was set (17,2% and 16,7%). Among the countries of the case study cities of the current project, Norway (22.9%), Poland (22.0%) and Germany (21.8%) exceed the target, while Austria (19.6%) is slightly below, followed by Italy (17.5%) and Latvia (13.3%).

marked decrease in the speed in the de-industrialisation of urban agglomerations since the early 2000's, some industries (mostly consumption goods and high technology industries as well as industries related to the supply of the growing populations of cities) returning to urban agglomerations. While most of these sectors are still rather small in terms of employment and GVA shares, this suggests a modestly optimistic perspective on the future development of industry in cities.

Chapter 7, finally, summarises the main lessons learnt that from the analysis and also highlights some main policy conclusions drawn from this.

2 Development of "productive activities" in city regions: Why bother?

2.1 Theoretical starting points

Implicitly, recent policy concepts emphasizing the importance of industry for regional development are based on the idea that certain characteristics of the industrial sector make it particularly important for growth and transformation (also) in highly developed economies. As far as this idea is connected with the hope of a "re-industrialisation" – and thus a reversal of a structural trend that has dominated the last 30 years – it is therefore based on the assumption of new technological and organisational possibilities that make industrial activities viable in highly developed and high-income countries and regions.

From an economic theory perspective such an argumentation must be based on the assumption, that the industrial sector is a source of important externalities for overall economic development. In traditional neoclassical growth theory (*Solow*, 1956; *Swan*, 1956) with its assumption of constant returns to scale, long-term economic growth is determined solely by capital accumulation such as the investment ratio (which in the closed model is equal to the savings ratio). It is thus "sector-neutral" in the sense that the sector composition of a region has no lasting effect on its economic growth and development[3]). This, however, rapidly changes if the unrealistic assumption of constant returns to scale at the macroeconomic level is abandoned and intra- and inter-sector externalities are allowed for. First approaches to such an analysis, particularly relevant for industry, can already be found in *Kaldor's* (1966, 1978) analysis on international growth differences. In this he identified three empirical regularities and theoretically explained them through returns to scale and learning curve effects in manufacturing:[4]

- Higher growth in manufacturing is ceteris paribus linked to higher growth in the total economy ("Kaldor's law");
- Manufacturing labour productivity growth is positively correlated with manufacturing output due to learning effects ("Kaldor-Verdoorn Law"); and
- Productivity growth in the total economy is positively linked to growth in manufacturing output and negatively linked to employment in non-manufacturing sectors (see: *Kaldor*, 1975; *Thirlwall*, 1980).

More recently such empirical approaches have been generalized and embedded into standard general equilibrium macro models by the works in the tradition of economic geography models of regional development (e.g.: *Fujita et al.*, 1999). Based on these theoretical arguments, some

[3] While this theory does expect (sectoral) specialization in trade along the lines of comparative advantages this trade leads to an equalization of factor proportions and thus also factor price equalization (*Krugman et al.,* 2017).

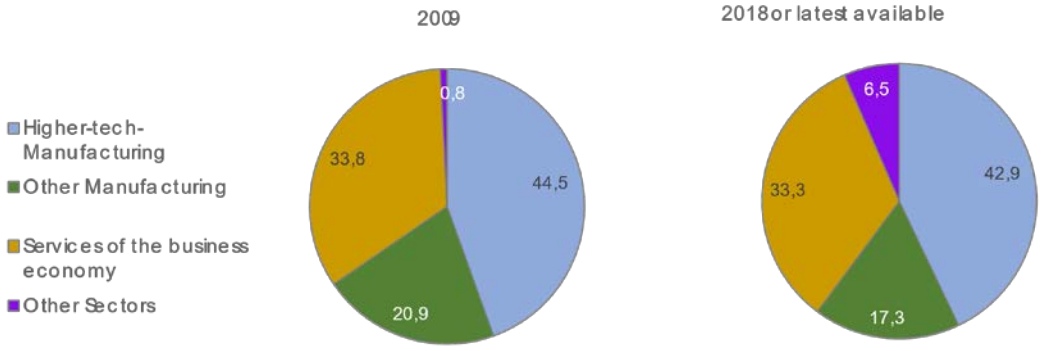
[4] These relationships were later confirmed in numerous empirical studies at the national (e.g., *Necmi*, 1999; *McCausland – Theodossiou*, 2012*; Marconi et al*., 2016; *Gabrisch*, 2019) as well as the regional level (*Bernat*, 1996; *Hansen – Zhang*, 1996; *Fingleton – McCombie*, 1998; *Pons-Novell – Viladecans-Marsal*, 1999). Overall, this supports the assumption that the industrial sector has special (growth-stimulating) characteristics that are not found to this extent in other (primarily service) activities.

specific features of industry can be cited, which suggest a special role for the sector in the economic development of even highly developed locations and may thus legitimise sector specific economic policies towards this sector on a metropolitan scale.

2.2 Industry as a nucleus of research and innovation

The first of these is that - as demonstrated by ample empirical evidence - industry and especially manufacturing plays a central role in corporate research and innovation and thus in technological progress (*Baumol*, 1967; *Aiginger* – *Sieber*, 2006). In this respect, a look at the input side of the European innovation system through Eurostat data from the European R&D survey is rather telling (Figure 2.1).

Figure 2.1: Business expenditure on R&D in EU manufacturing and the European Economy total 2009 and 2018



Source: Eurostat, ESPON MISTA 2020. – Note: Without Greece, Luxembourg and Sweden.

According to this survey, manufacturing (NACE C) accounts for more than 60% of total business R&D expenditure in the European Union (plus Norway) in 2018, with higher technology industries[5] alone accounting for some 43% of total expenditure. This means that the manufacturing share in R&D currently exceeds that of value added by a factor of 4 on average, a ratio that can be shown on a similar scale for the US or South Korea as well. In addition, this great importance of manufacturing in European innovation input proved largely stable over the last decade: The manufacturing share in R&D spending declined by about 5 percentage points (pp) between 2009 and 2018. However, this was exclusively to the benefit of the "Other Sectors" grouping, in which in turn the 2-digit industries D (electricity, gas, steam and air conditioning supply) and E (water supply, sewerage, waste management and remediation activities) were the main drivers – sectors that both are part of industry in a broader sense[6].

[5] This comprises the manufacture of fabricated metal products, computers, electronic and optical products, electricity equipment, machinery, motor vehicles and other transport equipment (Nace-2-digits C25 to C30).

[6] As far as the output side of the innovation system is concerned, empirical findings are limited due to data constraints. For Europe, however, information from Eurostat's Community Innovation Survey -

2.3 Industry as a productivity driver

Related to this, there is also much evidence of a more dynamic productivity development in manufacturing compared to the service sector total[7]). This can be explained by greater (technical) possibilities for (static) economies of scale in goods production, which often fail to materialise in the provision of services due to a lack of standardisation and replication (*Baumol*, 1967). For similar reasons, dynamic returns to scale from learning-by-doing (*Arrow*, 1962) should also play a greater role in industry. In addition, the greater tradability of industry goods leads to greater international competitive pressure, thus creating incentives for productivity improvements.

Against this background, empirical evidence for the EU member states (*European Commission*, 2013) indicates significantly higher growth in total factor productivity (TFP) in industry than in market or business services for almost all EU countries for the period from the mid-1990s to the "Great Recession". Data from the ARDECO database show a similar picture also for the post-crisis period, with advantages of industry in both productivity growth and productivity levels (Figure 2.2). According to these data, labour productivity levels measured by (real) GVA per employed were by far higher in industry than in the European economy total in 2017 (left panel), in all EU regions. In addition, efficiency advantages also increase with metropolisation, which points to (productivity-enhancing) agglomeration effects in metro regions, but may also indicate selection effects, as (especially in industry) only the most productive firms may be able to cope with the higher land and labour costs typically found in dense urban areas.

In a dynamic view, this was accompanied also by a much higher productivity growth in European industry (right panel) in the last quarter century: While industrial productivity in constant prices rose by between 70% (metro regions) and 60% (all EU regions) from 1995, efficiency gains were strikingly lower in the total economy, ranging from +29% (all EU regions) to +24% (major metro regions). Industry is therefore something like a "productivity machine", also in the EU member states, a role that leads to further efficiency advantages even in this highly developed country group[8]). This applies even more strongly to metropolitan regions, in

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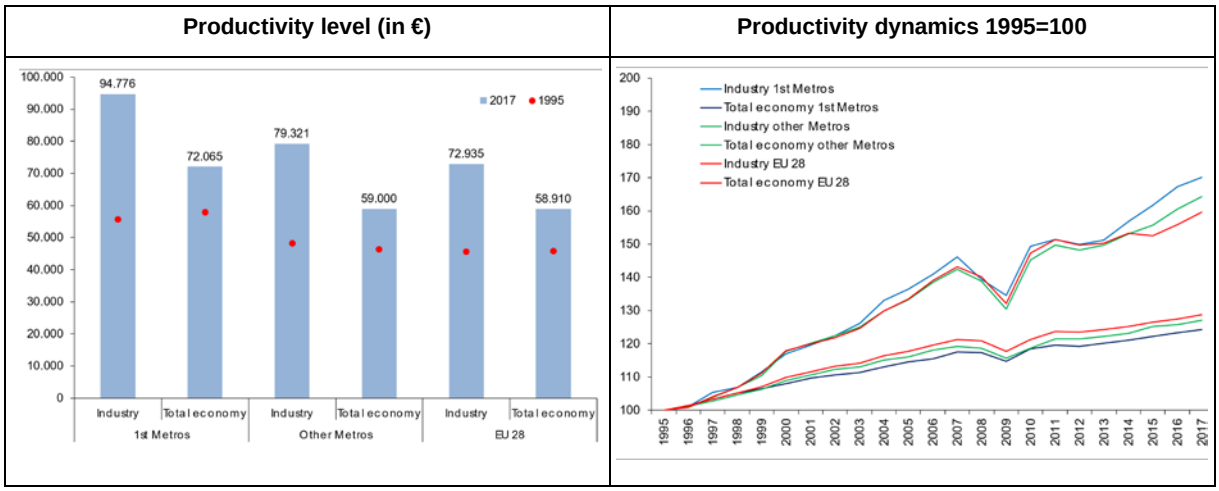
although incomplete and impaired by small sample sizes – indicate that the innovation ranking of manufacturing is clearly above sectoral standards on the basis of several indicators (e.g., percentage of enterprises that introduced an innovation; percentage of enterprises with technological contracting out; percentage of innovative firms with intellectual property rights) and for most EU member states. In the services sector, manufacturing is only surpassed by ICT in some cases (e.g., percentage of market introduction of innovation), and in general by knowledge-intensive business services and/or finance and real estate. For the United States, Boroush (2010) based on survey data shows that the number of product and process innovations in all manufacturing sectors (including those in "low-tech") is higher than the average for the other sectors of the US's economy.

[7] Some service sectors do, however, show a productivity development comparable or even superior to that of industry. For a more detailed sectoral analysis on this topic see, for example, Garcilazo et al. (2013).

[8] In developing countries, this characteristic makes industrialisation strategies particularly promising: shifting labour from traditional, low-productivity sectors to higher-productivity manufacturing lifts overall productivity – an effect that accelerates with the employment share in manufacturing (*Kaldor*, 1966, *Chenery et al*., 1986).

which manufacturing productivity growth has been even stronger than in other European regions.

Figure 2.2: Productivity Levels and Productivity dynamics in EU Industry and the European Economy total.
GVA per employed person, constant prices.



Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

2.4 Manufacturing and industry as an inflation dampener

An important implication of these higher efficiency gains in manufacturing is that the prices of manufactured goods should decline relatively to services (*Baumol*, 1967), an expectation that is impressively confirmed by data on sectoral producer prices in the EU28 countries from Eurostat's AMECO database (Table 2-1). According to this, the upward trend in the GVA deflator for manufacturing (NACE C) and to a lesser extent for industry in a broader sense (NACE B-E) has been much weaker in 1995-2018 than in the other sectors of the EU economy (upper panel). Compared to the development of the GDP deflator for the total economy, the relative producer prices for manufacturing goods (in relation to those in most services sectors) have fallen significantly from 1995 (bottom panel), notably professional & support services, ICT and financial services (not shown), but also the public sector. By continuously supplying cheaper and more diverse products, manufacturing and industry therefore also play an essential role in limiting price buoyancy and therefore securing overall purchasing power and welfare (*Marsh*, 2012) [9].

[9] At the same time falling manufacturing (industry) prices cause the manufacturing (industry) share in nominal value added to decline ceteris paribus. Thus, as discussed in more detail below a shrinking share in nominal GVA is not in itself an indication of "de-industrialization" or a dwindling competitiveness of manufacturing (industry).

Table 2-1: Development of Producer Prices by NACE Sectors
Value added, gross, EU28, Price index (implicit deflator), 2010=100, Euro

	Agriculture (A)	Manufac-turing (C)	Industry (B-E)	Distributive Services (G-I)	Professional & Support Services (M-N)	Public Services (O-Q)	All NACE Activities
Price Index 2010=100							
1995	104.7	91.9	85.8	77.4	73.9	64.9	76.8
1998	105.1	97.4	90.9	84.2	81.5	71.5	82.7
2001	110.7	99.6	93.8	90.4	88.9	80.1	88.6
2004	102.3	98.9	94.1	92.8	93.9	87.8	92.8
2007	105.8	100.8	99.4	97.2	98.5	96.8	99.4
2010	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2013	110.1	104.2	105.3	102.1	103.7	103.9	103.7
2016	106.1	109.0	107.9	105.8	107.9	108.4	107.5
2018	114.6	108.5	108.2	107.3	109.1	112.0	109.1
Intersectoral Price Shift (Total=100)							
1995	136.2	119.5	111.6	100.7	96.1	84.5	100.0
1998	127.2	117.8	109.9	101.8	98.6	86.5	100.0
2001	124.9	112.4	105.9	102.1	100.3	90.3	100.0
2004	110.2	106.6	101.4	100.0	101.2	94.7	100.0
2007	106.5	101.4	100.0	97.9	99.1	97.4	100.0
2010	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2013	106.2	100.4	101.6	98.5	100.0	100.2	100.0
2016	98.7	101.4	100.3	98.4	100.4	100.8	100.0
2018	105.0	99.4	99.2	98.3	100.0	102.7	100.0

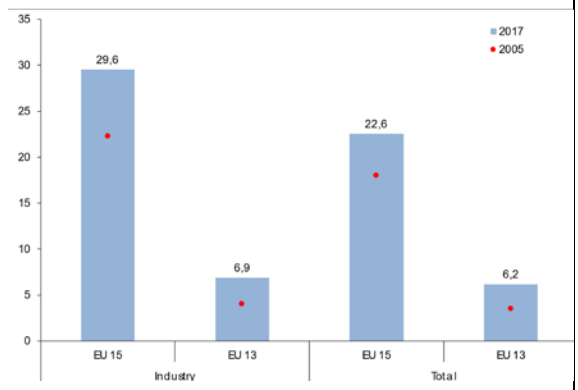
Source: Eurostat (AMECO); ESPON MISTA 2020.

2.5 Industry as a well-paying employer

In addition, a role for industry and especially manufacturing in promoting purchasing power and thus regional consumption can also be assumed by the fact their higher efficiency should also be reflected in higher sectoral wages – an expectation that is also supported by arguments from efficiency wage theory[10]. Empirically, available evidence for both the US (e.g., *Helper et al*., 2012) and the EU (e.g., *European Commission*, 2013) supports the hypothesis of higher manufacturing wages after controlling for individual characteristics like gender, education or occupation. For industry, even a simple comparison of hourly compensation per employee from our ARDECO database is rather telling.

[10] According to this, the wage rate in manufacturing should be higher on the one hand because the costs of production losses are higher here compared to other sectors. Manufacturing will therefore pay comparatively high wages to ensure high motivation and thus keep the probability of production losses low. On the other hand, a similar conclusion can be drawn from the typically higher company sizes in manufacturing: they make the costs of controlling work processes more expensive, so a higher wage rate to ensure high intrinsic motivation seems a more cost-effective alternative (*Krueger – Summers*, 1988; *Woodcock*, 2008).

Figure 2.3: Wages in industry and the total Economy Compensation per Working Hour
Compensation per Working Hour, Current prices

Wage level (in € per hour)	Wage development (2005=100)
	

Source: ARDECO database (JRI/Eurostat); ESPON MISTA 2020. – Without Poland.

As shown in Figure 2.3 (left panel), the compensation of employees in industry was € 29,6 per working hour in 2017 in the EU15 countries, some 31% higher than in the economy total. In the EU13, this sectoral wage edge was smaller (around 11%), whereby the wage differences between old and new member states in common currency are in any case still striking. However, an analysis of wage growth since 2005 shows a noticeable catching-up process of the EU13 from 2005 as the first year covered in the data base. In this development again, industrial wages rose faster than those in the economy total in both country groups, although more pronounced in the EU15[11].

2.6 Significance of merchandise trade for the balance of payments and as a "carrier" for exports of services

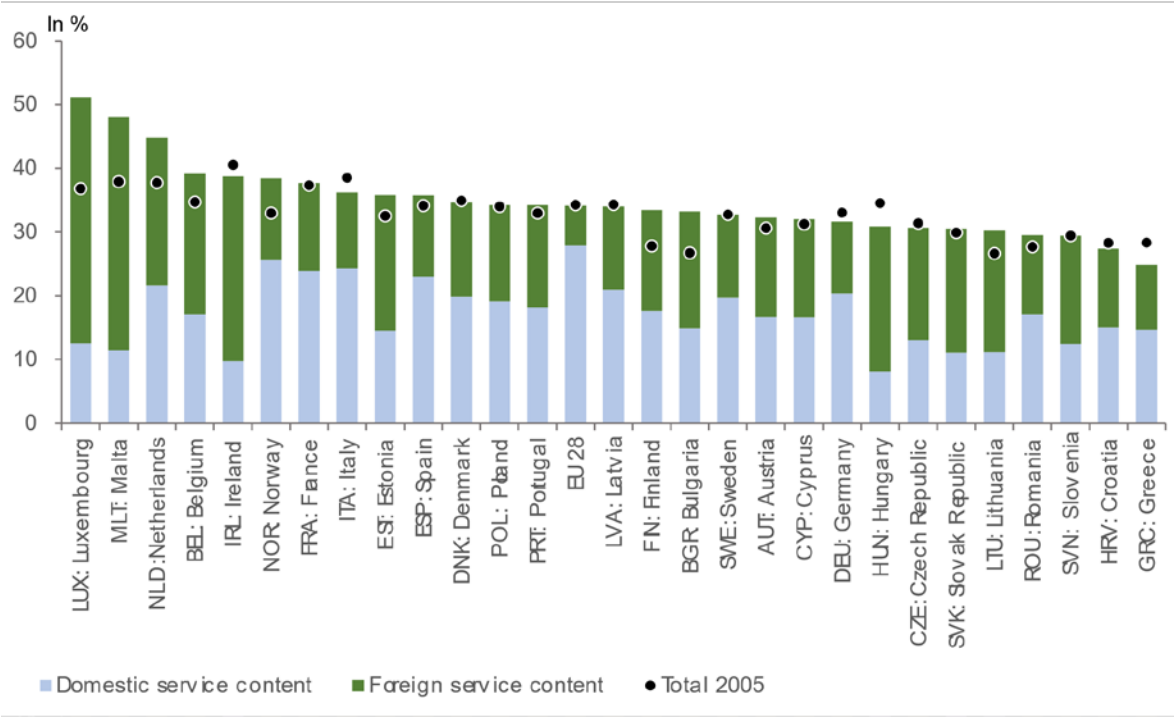
While industry is thus important for securing regional purchasing power and domestic consumption, the same applies to its role in easing balance-of-payments restrictions in 'open' urban economies. This property arises from advantages of manufactured products over services in distance trade, largely due to some goods characteristics of services)[12] and the resulting higher trade costs in the latter from a "proximity burden" (as the necessity of suppliers and consumers of services to be in close physical contact). Although these disadvantages are recently losing in importance due to the spread of digital technologies and lower trade barriers, they have by no means disappeared: while services currently account for more than half of world GDP and around three quarters of GDP of the developed economies, a worldwide trade

[11] There is also ample evidence that manufacturing, and industry have a favourable influence on the wage distribution: while manufacturing pays wages around or slightly above average, the service sector is much more strongly segmented into high and low wage activities. Increasing de-industrialisation thus leads to a greater spread in income levels and thus to income polarisation (*Tregenna*, 2013).

[12] Services are mostly intangibles that cannot be transported and/or stored. Consequently, for them time and place of production and consumption coincide such that foreign markets can only be developed by complex and capital-intensive forms of market entry (e.g., foreign branch offices). This imposes considerable export barriers given the firm size structure in services (e.g., *Knight*, 1999).

volume of 18,9 trillion US$ in goods still compares to only 6 trillion US$ in services in 2019 according to traditional measurement. Even if the (estimated) supply of services through commercial presence (i.e., trade by foreign affiliates; GATS mode 3) is added, services trade does not match that in goods at present[13].

Figure 2.4: Services Value-Added embodied in Manufacturing Exports, EU countries, 2016



Source: OECD, 2018a (TiVA Indicators), ESPON MISTA 2020.

This means that an export-based manufacturing sector is also likely to be of considerable importance for the development of metro regions with their usually strong service orientation – even more so if one considers the increasing importance of services as intermediates and the resulting "servitisation" of manufacturing output. As new data from the OECD TiVAT database indicate, in the context of these developments components of the service sector are "embodied" in manufacturing exports to a high degree, and therefore are exported "indirectly" with them (Figure 2.4).

According to this value added in services accounts for between 30% and 40% of the content of manufacturing exports in most EU countries (EU28 34,2%), with Luxembourg (51.2%) and Greece (24.8%) at either ends[14]). Thereby, a relevant foreign share of services value added may be an indication of the role that services play in the integration of the manufacturing sector

[13] In its current World Trade Report, the *World Trade Organisation* (2019) estimates total service trade at about 13.3 trillion US$ in 2017 with an increase of +5,4% in 2005-2017.

[14] In the countries of the case study cities of the MISTA project the service content of goods exports is typically close to the EU average, with a maximum at 38.5% in Norway and a minimum at 31.6% in Germany.

in global value chains (*OECD*, 2018a). Nonetheless, the domestic services share dominates in all large and highly developed EU member states, including all countries of our ESPON project's case study cities.

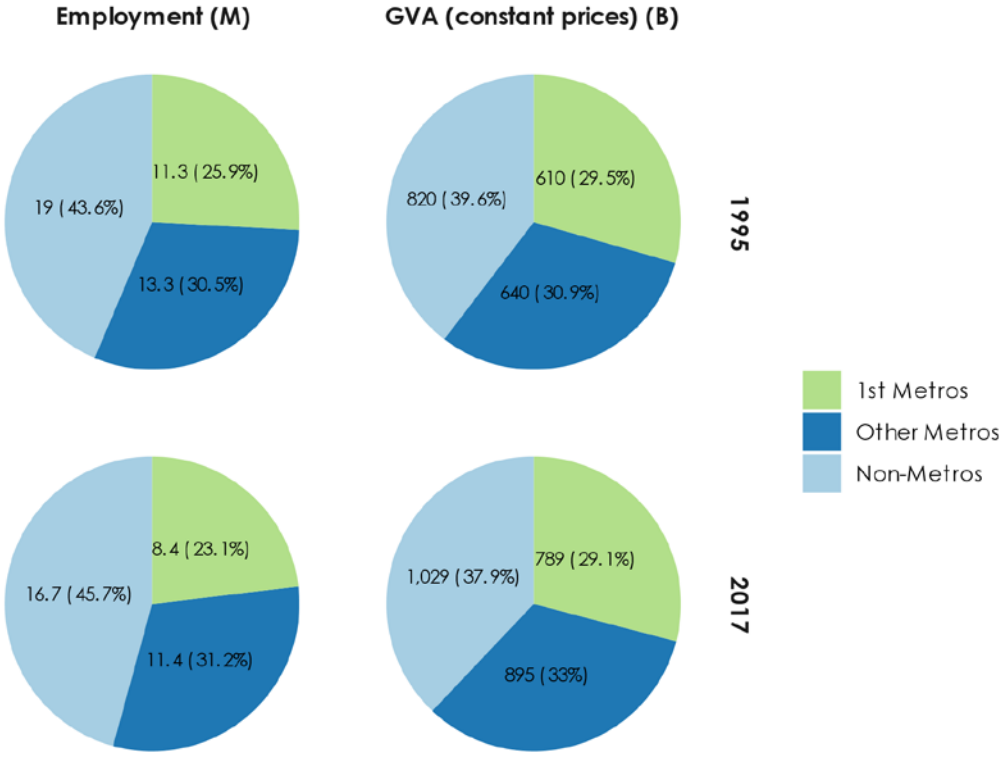
This means that tangible production (and their export) may have an important "carrier function" in foreign trade for services that, by their nature, are in principle only tradable to a limited extent. Thus, with its exports, manufacturing undoubtedly makes a decisive contribution to building up international competitive advantages also in many services (*Nordas – Kim*, 2013).

2.7 Metro regions as key locations for European industry

Last but not least, a further argument justifying a special focus on industrial development and its future prospects in metropolitan regions is that contrary to what is often implicitly assumed in economic policy debates, urban regions are by no means locations that only have disadvantages for industrial production and are therefore necessarily condemned to de-industrialisation and/or the outmigration of productive activities. Rather, an analysis based on the new ARDECO dataset shows that the majority of European industry is still located in metropolitan regions (in a functional definition), both in terms of employment and value added (see Figure 2.5).

More than half (54%) of the workforce in European industry (NACE B-E) is employed in metropolitan regions, which is a total of around 19.8 million people. They generate a value added of some € 1,516 billion, almost two thirds (64%) of the industry output of the whole European Union. Within these metro regions, even the largest and most densely populated cities, which are the reference group for our case study cities are key locations for industrial production – 8.4 million industrial workers generate 30% of European industry output. Moreover, the importance of metropolitan regions as industrial locations seems to have hardly diminished in the last quarter century: While the metro region's share in European industry employment has fallen by 3 pp since 1995, its share in industry output has risen slightly (+1 pp).

Figure 2.5: Importance of Metropolitan Regions in European Industry
1995 and 2017



Source: ARDECO database (JRC/EC), ESPON MISTA 2020.

2.8 Main take-aways

- **There are a number of empirically and theoretically well-founded economic arguments that suggest that industry is an important sector for economic development in urban centres.** Among these, the special role of industry in the innovation system and in triggering productivity and thus wage growth as well as the strong forward and backward (input-output) linkages provided by industry, highlighted in this Chapter are arguably the most important ones.
- **Industry is an important nucleus for research and innovation.** In 2018, manufacturing alone accounted for over 60% of total business R&D in the EU and Norway. This means that the R&D share in manufacturing exceeded its value-added hare by a factor of 4 on average.
- **Industrial development also drives productivity and wage growth in most developed countries and regions.** Labour productivity levels were by far higher in industry than in the European economy total in 2017, in all EU regions and the compensation of employees in industry was some 31% higher than in the economy total. Productivity and wage advantages of industry also increase with metropolisation, and from a dynamic perspective industrial productivity in constant prices rose by between 70% (metro regions) and 60% (all EU regions) in the EU in the period 1995 to 2017, while efficiency in the total economy ranged from +29% (all EU regions) to +24% (metro regions).
- **Even abstracting from inter-sectoral spillovers and externalities urban regions play an important role in the production system of the EU in general.** More than

half (54%) of the workforce in European industry (or 19.8 million people) is employed in metropolitan regions and almost two thirds (64%) of the industrial output of the whole European Union is generated in these regions.

3 The city and productive activities: A literature survey

3.1 The changing role of industry in highly developed economies

Given the high importance of industrial development many recent publications have been devoted to describing and analysing industrial development in metropolitan regions. These contributions focus on the causes and effects of de-industrialisation, the role of city regions in industrial development or on the appropriate policies to influence effective urban industrial development, respectively. Thus, a substantial part of this literature is concerned with documenting and explaining the substantial de-industrialisation process since the end of the 1970s. It often considers de-industrialisation and tertiarisation to be an unavoidable side effect of economic development and a large manufacturing sector as more or less obsolete in a fundamental change towards a post-industrial, service-oriented economy. Although this literature is mostly concerned with the national level and thus provides few insights into the potentials for industrial production in metropolitan regions, it does present a number of important stylised fact that are highly relevant for understanding industrial development in these regions, too. In particular, the literature suggests that:

a) The trend towards de-industrialisation is particularly evident in the USA, Europe and Japan, but also affects many low- and middle-income countries, especially in Latin America and Sub-Saharan Africa (*Rowthorne – Ramaswami*, 1997; *Pilat et al.,* 2009; *Rodrik*, 2016)[15]. Even in the two decades before the "Great Recession" of 2008/09, the industry share in employment had already declined in 23 of 28 high- and middle-income countries. In 17 of these – including most high-income countries – this was also the case for the value-added share (*Tregenna*, 2011).
b) The trend was even stronger for manufacturing and for employment compared to (real) gross value added. For instance, according to Eurostat, the share of people employed in manufacturing decreased from 18.9% to 13.7% in the EU28 and from 17.9% to 12.9% in the EU15 between 1995 and 2019.
c) The process of de-industrialisation was more pronounced in metropolitan areas than at the country level, with empirical evidence mainly focusing on the USA (e.g., *Friedhoff et al*., 2010; *Helper et al*., 2012). *Helper et al.* (2012a), for example, calculate clearly above-average rates of shrinkage in manufacturing employment for the 366 largest US metropolitan regions and the period 1980-2011. Thereby the disadvantage compared to the other US-regions was considerable at –8.8 pp for all metro regions and –10.0 pp for the 100 largest ones.

More recently, however, newly arising evidence on a slower speed of de-industrialisation in the decades since the change of millennium, as well as the experience that countries and regions with a strong industrial base seem to have emerged better through the "Great Recession" of the late 2000s (*Fingleton et al*., 2012), have led to a reassessment of the role of manufacturing

[15] A declining manufacturing share before reaching a fully developed manufacturing base ('premature de-industrialization') is attributed to the simultaneous entry of many (and large) developing countries into international competition. It is seen as particularly problematic from a development perspective (*Dasgupta – Singh*, 2006; *Palma*, 2008; *Naudé – Szirmai*, 2013; *Rodrik*, 2016; *Filipe – Mehta*, 2016; *Filipe et al*., 2019).

in highly developed countries and regions. Since then, a dynamic manufacturing sector has again been seen more and more as a prerequisite for innovation and growth in countries and regions, but also cities (e.g., *Van Winden et al*., 2011; *Baily – Bosworth*, 2014). Against this background, arguments for an "industrial imperative" (*Rodrik*, 2012) have been rediscovered, and the interest in a "new" industrial policy has undoubtedly increased among scholars (e.g., *Aghion et al.*, 2011; *Pisano – Shih*, 2009; *Aiginger – Rodrik*, 2020) as well as at the EU level (*European Commission*, 2010, 2012, 2020). The potential of automation and new digital technologies for returning manufacturing to Europe (see below) have fuelled the debate further (e.g., *Eurofund*, 2019)[16]. Also, the disruption in international trade caused by the current COVID-19 crisis is likely to reinforce the ambitions for a solid European and national industrial base and shorter international value chains.

3.2 The causes of de-industrialisation

According to the literature, de-industrialisation trends can be explained by internal (domestic) and external (global) factors. Among internal factors, declining shares of productive activities can be attributed to i) decreasing relative prices due to higher average productivity growth in productive industries compared to services (e.g. *Baumol*, 1967; *Saeger*, 1997); ii) changes in consumption patterns towards services with rising incomes (e.g. *Falvey – Gemmel*, 1996; *Echevarria*, 1997; *Peneder – Streicher*, 2018); iii) increasing interdependence between and hybrid forms of industry and services, increasing demand for knowledge intensive business services (KIBS) with increasing complexity of productive activities (e.g. *Ciriaci – Palma*, 2016; *Di Berardino – Onesti*, 2020); and iv) purely statistical effects ("artefacts") from the outsourcing of former in-house service departments of large industry companies to legally independent service companies (e.g. *Tregenna*, 2009, 2010) that shift employment and output from industry to service branches in economic statistics. In addition, the increasing importance of external factors in globalisation is stressed to explain structural change towards services in highly developed economies, in particular i) the offshoring of production stages and longer value chains in increasingly fragmented production networks (e.g. *Baldwin – Venables*, 2010; *Baldwin*, 2011) leading to a relocation of activities and knowledge transfer towards regions with lower costs of production; and ii) emerging alternative export bases, other than manufacturing such as knowledge intensive and financial services (urban regions) or tourism (rural regions) (e.g. *Palma*, 2005, 2008).

Studying national input-output tables, *Peneder and Streicher* (2018) illustrate that the overwhelming part of the decline in industry value-added shares is mirrored by an according decline in the domestic final expenditures on manufactured products. According to *Rodrik* (2016) previous empirical evidence suggested that both globalisation and labour-saving technological progress (leading to productivity growth) in manufacturing have been behind the

[16] See also the ongoing ESPON project "Technological Transformation & Transitioning of Regional Economies at https://www.espon.eu/transregecon

developments of de-industrialisation. At the regional level, *Dauth and Suedekum* (2015) illustrate that the degree of de-industrialisation in German regions since the late 1970s has been driven to a large extent by the initial size and the differential in import and export exposures of the local manufacturing sectors. Regions with low degrees of de-industrialisation typically started with a large manufacturing share (thus reinforcing this specialisation) and with a highly export-oriented local structure of manufacturing, implying that these regions benefited substantially from the rise of new markets in recent decades.

3.3 City regions and their role in industrial development

Since the very beginning, cities have not only been a place of trade, but also a place of production. During the 19th and early 20th century factories increasingly moved to the outskirts of the city and beyond, with functions of living, working and recreation increasingly kept apart in urban planning (*Brandt et al*., 2017). In the more recent past, the mechanisms explaining de-industrialisation in city regions are the same as those behind de-industrialisation trends in highly developed countries. In fact, cities are particularly exposed to each of the internal and external factors discussed above: Large cities are typically hubs for tradable services in which they enjoy agglomeration advantages rather than for large-scale manufacturing production because of high land and labour costs as well as unfavourable conditions for the transport of bulky physical goods. This has led to an increasing specialisation in knowledge intensive tradable services in many city regions (see *Fujita – Thisse*, 2002 and *Duranton – Puga*, 2004 for comprehensive surveys).

With respect to industry, decentralisation and offshoring of productive processes of manufacturing from urban to suburban or peripheral locations is a process that is driven by capital and labour costs as well as land prices, with less productive activities moving to cheaper locations of production. This process leads to activities with higher productivity (growth) remaining in urban centres rather than in surroundings of metros or other regions (*Mistry – Byron*, 2011). This in turn leads to relative productivity-driven declines in industry employment shares and again to an increase in local demand for complementary knowledge intensive business services. Similarly, the outsourcing of highly productive servo-industrial activities of larger companies (e.g., Headquarter-, R&D- or ICT-functions) to independent service companies seems particularly common in metropolitan regions, making the above-mentioned "statistical artefact"-effect of outsourced holdings and subsidiaries a particularly relevant factor for urban centres. In addition, income levels in urban regions are typically higher (*OECD*, 2018), implying a higher relative local demand for services rather than manufacturing goods.

The same mechanisms also provide for an explanation of differences in de-industrialisation between different cities. In particular, the literature expects disadvantages of large cities compared to smaller ones for (large-scale) industrial production, due to higher land prices, unfavourable conditions for the transport of bulky physical goods and generally rising congestion costs relative to agglomeration advantages (*Fujita – Thisse*, 2002; *Duranton – Puga*, 2004). Similarly, lower levels and dynamics of industry can be expected for high-income

metro regions (compared to those with a lower level of economic development), as consumer preferences change to services with rising incomes (e.g., *Falvey* – *Gemmel*, 1996; *Peneder* – *Streicher*, 2018), and the higher complexity of production in high-income cities increases the demand for complementary business services (e.g., *Di Berardino* – *Onesti*, 2020). Last but not least (and above all), higher incomes also mean higher (labour) costs for industrial companies, which increases the incentives to offshore production stages (e.g., *Baldwin*, 2011). Furthermore, under the assumption of agglomeration advantages (also) within sectors ("localisation economies"; *Marshall*, [1920], 1994) industry-based metro regions should show a more favourable Industry development than service centres. Thereby capital cities may have particular disadvantages for industry due to their specialisation in public services (competing with industry for limited space), but also from the fact that Capitals usually are the largest cities in their respective national city systems.

However, the past processes of de-industrialisation and its differentiation among cities illustrated above have been primarily of a relative rather than an absolute scale, with industry shares declining mainly because services have grown more quickly than productive activities and not so much due to declining absolute industry output and employment (*Ferm* – *Jones*, 2017).

In addition, there are several arguments which justify a more optimistic view of the future development of industry in cities that make a further decline of the productive base quite unlikely. First, large factories that could do so have already moved away from high value city locations to the urban hinterland, peripheral regions or abroad. Those factories that have remained are the ones that benefit from their specific urban location (*Ferm* – *Jones*, 2017). Second, while there are no essential arguments for changes with respect to productivity differences between industry and the service sector[17] – leading (ceteris paribus) to a further decline in the employment share of manufacturing – changes in preferences among consumers and the disruptive effects of modern information and communication technology (ICT) and ICT-infrastructure are likely to have strong effects on the location of economic activities which may favour urban regions.

Among these, ICT in particular keeps facilitating the unbundling of individual parts of the production process. According to *Baldwin and Evenett* (2015), this may lead to a “reshoring” and thus a return of productive activities to city regions. By contrast, some sectors for which urban areas previously held comparative advantages (such as managerial and dispositive functions) offshoring may become feasible and some jobs may be lost. However, the part of the bundle of activities for which cities have comparative advantages could well expand. Further the lower cost for the parts/stages moved out of the city might boost that sector's exports, with

[17] While the productivity paths in the service sector are by no means uniform, no general catching-up process in efficiency levels can be identified for the tertiary sector as a whole (e.g., *Maroto-Sanchez* – *Cuadrado-Roura*, 2009).

all of this leading to increased employment. Similarly, previously non-traded sectors could begin to both export and import due to shrinking transport and transaction costs. Thus, globalisation and ICT may cause job gains in previously non-competitive sectors of cities, and job losses in previously competitive urban sectors.

Baldwin and Forslid (2020) refer to recent developments in ICT, big data and artificial intelligence as the phase of "globotics" – globalisation and robotics – and as the third grand economic transformation with respect to the geographic distribution of economic activities[18]. Globotics implies a geographic separation of labour and labour services characterized by automated and robotic large-scale industry production, vanishing face-to-face communication costs and increased telemigration (foreign-based online service work). This leads to a decrease in the impact of wage differentials between countries and regions as production becomes increasingly jobless and, for instance, a robot in Germany can be controlled and maintained by a teleworker based in India. The vanishing importance of wage differentials will lead to a relocation of manufacturing to consumer locations in high-wage countries. However, while this kind of industry production will increase value added it is not likely to create many additional jobs. At the same time globotics also implies that the vanishing communication costs over distance may move comparative advantages in many (knowledge intensive) services from cities in highly developed countries to low-wage countries, with potentially significant consequences for European cities[19].

While the scenario in *Baldwin and Forslid* (2020) is highly stylised and the consequences of globotics do not affect all productive activities to the same extent (think of automotive industry vs. hand-crafted bakery), it illustrates both the opportunities and challenges for the development of productive activities in metropolitan regions posed by digitisation. The declining role of labour cost differentials, because of mainly automated production, increases the importance of proximity to demand as a locational factor. This will facilitate the (re-)location of production back to the metropolitan areas. However, even in the age of globotics, the limited availability of land as a production factor as well as the higher transportation costs of bulky physical goods will continue to disadvantage large-scale production in large cities. However, if understood as functional urban areas in which the core cities are economically integrated with their hinterland, metropolitan regions are and will even more so continue to be a fertile ground for large-scale production in higher-technology industries that benefit from proximity to urban agglomerations.

[18] Specifically, *Baldwin and Forslid* (2020) describe three phases of unbundling, with the industrial revolution as the first (factories unbundled from consumers), globalization as the second (production stages unbundled across nations) and globotics as the third (in which labour and labour services are geographically separated).

[19] *Baldwin and Forslid* (2020) conclude that with increasing ICT and artificial intelligence, high-wage regions may become "sheltered service societies" with jobs mostly remaining in service industries, sheltered from international competition.

3.4 Main trends in productive activities of city regions

While typically not having locational advantages for large-scale production, large city regions are specialized in skill-intensive productive activities. On the one hand this is because of agglomeration advantages and skill-abundance (*Davis – Dingle*, 2020), giving them locational advantages in dispositive functions in the value chain such as R&D, innovation and design. On the other hand, cities have increasingly seen growth in new specifically "urban" manufacturing activities. This includes customised small-scale production at the end of the value chain such as hand-crafted consumer products, because of high local demand among the urban population for high-quality, sustainable and regionally produced design-oriented products (*Brandt et al*., 2017). In addition, *Riha* (2016) underlines that cities provide unique opportunities and advantages to manufacturers with respect to sustainability benefits, availability of capital, material supply, cultural access, and brand origin. *Jofre-Monseny et al*. (2014) have analysed the location decisions of new manufacturing firms at the city level in Spain. They have illustrated that industries with the highest benefits from urban agglomeration are mainly knowledge intensive or creative industries[20].

Hernández-Murillo and Marifian (2013) as well as *Burggräf et al*. (2019) stress that cities provide a large pool of workers of varying skill levels (especially highly educated workers) to manufacturing firms. In this sense, universities and science parks (localised in cities) are becoming more clearly incorporated into business strategies. This is especially true for manufacturing firms which invest in R&D and who benefit from knowledge spillovers via the R&D activities of other companies and public-sector research in close spatial proximity (*Belitz – Schiersch* 2018). Physically close, collaborative relationships are of general importance for innovative manufacturers (particularly for SMEs). This was less important when firms were vertically integrated (i.e., their supply chain was provided within the firm). To become more competitive in today's fragmented value chains, manufacturers choose locations that best support early stages of production (*Schmidt*, 2014). As highlighted by *Mistry and Byron* (2011) and *Belitz and Schiersch* (2018) such knowledge spillovers in urban collaborative networks make manufacturers in urban areas more productive than those in less dense areas. Also, the closeness to firms in similar or related industries, and to knowledge intensive (business) services such as financial, ICT, legal and educational services provide crucial locational advantages for urban regions (*Daniels – Bryson*, 2002; *Westkämper*, 2014; *Helper et al*., 2012).

In this context an increasing part of the literature casts doubt on the usefulness of the standard dichotomy of services and production for both analytic and policy purposes: On the one hand this is because, as a consequence of functional specialisation of manufacturing in cities, even the employed in manufacturing enterprises are increasingly performing service tasks. Thus, empirical evidence for Denmark (*Hummels et al*., 2014; *Bernard et al*., 2020) and Norway (*Bøler*

[20] For creative industries *Coll-Martínez et al*. (2019) illustrate a particularly high degree of agglomeration with a narrow spatial extent of agglomeration externalities (within 1 kilometre in Barcelona).

et al., 2015) illustrates that offshoring some parts of the production process did not lead to a decline in domestic production in offshoring firms but rather to an expansion of the product lines along the quality dimension, to a shift of domestic workers into innovation and product-development activities, and to an increase in the wage premium of domestic high-skilled workers. On the other hand, this is because of a strong complementarity between manufacturing and parts of the service sector. According to these results many knowledge-intensive services such as R&D or B2B services – regardless of their own productivity level - also increase productivity in productive activities (*Andersen et al*., 2000; *Wood*, 2002; *Evangelista et al*., 2013). Therefore, the continuing boom in these services is likely to further increase relative productivity in industry, with the consequences shown for relative prices and the industrial share in value added and employment.

The concept of proximity can also be viewed in terms of closeness to markets. Transport connections have always been key for manufacturing. *Cohen* (2000, for Chicago) and *Friedhoff et al.* (2010, for other US metros) found that for high-tech companies the (higher) cost of a "brownfield" renovation in a depressed inner-city location was often more than offset by the proximity to good amenities and convenient transportation. By studying ten cities across the globe, *van Winden et al*. (2011) finds that executives stressed the growing importance of international air and train connections for their businesses. An increasingly important factor in manufacturers' urban site selection choice is the speed of delivery to customers (*Hatuka et al*., 2017). Moreover, proximity to final consumption is crucially important for the integration of production and design (customisation) and of "just in time" production, allowing firms to serve urban niche markets (*Marsh*, 2012; *Ferm – Jones*, 2017).

As *Helper et al*. (2012) illustrated for the United States, metropolitan manufacturing plants were already relatively small in the past. Future primary costs for small-scale manufacturer's will be machine tools (like 3D printers or robots) rather than labour or land. This will increase opportunities for producing prototypes by only using computers and 3D-printers, which will further empower small to medium-sized firms or even individual entrepreneurs in urban agglomerations (*Hatuka et al.,* 2017) because in many industries new technology enables quiet and space-efficient manufacturing without burdening the environment (*Erbstösser*, 2016).

Gornig and Werwatz (2018) investigate the location patterns of start-ups in Germany, concluding that more industrial start-ups were created in cities than in other regions between 2012 and 2016. They found that urban agglomerations with relatively low property prices and well-developed research infrastructure, such as Berlin, Leipzig or Dresden, attract more start-ups in high-tech industries. Their results suggest that proximity to research institutions as well as to customers makes cities attractive start-up locations. Also, for Germany, *Audretsch et al*. (2011) found that, distinguishing 3 types of cities according to their functional specialisation, cities with integrated smaller industrial firms are more conducive for manufacturing entrepreneurial activities than cities dominated by large stand-alone production plants in one sector or by headquarters and service firms.

3.5 Economic, social and environmental effects of the changing relationship between cities and productive activities

By the late 1960s respectively early 1970s, European cities had begun a long process of de-industrialisation, which increased intra-city inequality, since higher job losses were concentrated in the poorest neighbourhoods (*Clark et al*., 2019). Although the European labour market and social security system are different from North American ones, it seems justified to report findings from studies on US-cities: *Doussard et al*. (2009) studied the impacts of de-industrialisation in a large US-metropolis, Chicago, during the 1970s-80s. They highlight the profound implications both for socioeconomic sustainability and for the distribution of jobs and incomes. The shrinking of urban manufacturing led to the decline of job security, and to an increase of both poverty rates and income inequality[21]. Another study by *Strait* (2015) on US-metropolitan areas confirms these results. During the 1970s, metropolitan areas which experienced a decline in manufacturing and construction employment exhibited the greatest increases in extreme poverty. This resulted in a racial divide with the 'white-flight' to the new suburbs and new jobs, while African Americans remained in old heavily neglected neighbourhoods. Recently, *Lee and Rodriguez-Pose* (2020) illustrated that particularly entrepreneurship in tradeable (but not in non-tradable) activities reduces poverty and increases incomes of non-entrepreneurs in US-cities.

Friedhoff et al. (2010) found empirical evidence that, among the 114 deindustrializing metropolitan areas in the US, the economies which are more economically (sectorally) diversified at the outset of de-industrialisation experienced faster wage growth than the less diverse economies. *Ostry et al*. (2001) focused on the long-term consequences of de-industrialisation on Canadian workers, finding that workers who are not re-employed or re-employable over the long term were at higher risk for ill health.

Several studies analyse the economic, social and environmental impacts of emerging re-industrialisation trends. Since the early 1990s, a sequence of innovations (such as automation and artificial intelligence) and the rise of new business models (e.g., the "servitisation" of manufacturing) have transformed the landscapes of the inner-city districts. *Hutton* (2009) identified the following impacts of these industry developments within the core city: i) Economic impacts, such as new investment, business start-ups and entrepreneurship, employment training and relations (complementary, competitive or conflictual) with traditional or established industries; ii) social impacts, such as new occupational opportunities and income benefits, reformation of social class, displacement tendencies and the re-imaging of local areas; iii) environmental impacts, such as adaptive re-use of heritage buildings, the redevelopment of heritage urban landscapes, stimulus for innovation in urban design and the reconfiguration of the built environment, creating a positive re-imaging of areas previously abandoned.

[21] In particular, African-American workers experienced a dramatic deterioration in both their chances for and conditions of employment as a result of de-industrialisation.

Riha (2016) specifies some additional benefits of urban manufacturing. Firstly, smaller and locally well-integrated manufacturers can quickly identify and respond to changing customer trends and preferences. Urban manufacturers typically employ high-skilled workers from the surrounding neighbourhoods and offer middle-income job opportunities. Secondly, they often create linkages with other local industries, boosting knowledge spillovers, innovation and leading to new products and new businesses. *Croxford et al*. (2020) identified four key areas for urban manufacturing that need the city and which conversely the city needs. Firstly, urban manufacturing supports a thriving economy in terms of providing a vital service for the local economy, helping replace imports, develop tradable goods and helping cities to adapt to the future. Secondly, manufacturing helps stimulate innovation by producing solutions to urban problems which involve design, capital and local production capabilities. Thirdly, manufacturing can help cities address climate change and environmental impacts by helping achieve the most efficient use of available resources. Finally, manufacturing helps provide economic and social inclusion through offering alternative types of work to predominant service-related jobs and provides jobs that are easily accessible.

Freeman et al. (2017) explore the role of the so-called "re-distributed manufacturing" (such as manufacturing done at a small-scale, often using new production technologies). The potential benefits of this manufacturing type include i) an improvement in cities' productivity; ii) the use of new materials, or existing materials used in a new way; iii) the reduction of the region's dependence on the global supply networks; iv) the improvements in the economic sustainability of a region through increased diversity of economic activity. *Kostakis et al*. (2016) refer to the "design global, manufacture local" model, also known as "glocalism". *Hatuka et al*. (2017) found that bringing manufacturing back to the city core offers a chance "to locate living-wage jobs where people live". It may also have some environmental benefits through shortening commutes and reducing the delivery distances, reducing traffic emissions (*Westkämper*, 2014). In addition, it raises the potential for the formation of local value chains and higher resource efficiency (*Schonlau et al*., 2019). Similarly, *Ciaramella and Celani* (2019) discuss the reuse of spaces for technology-driven industry in modern cities and increasing opportunities to develop industrial intensification through vertical production, since some modern production systems allow space-saving and low-emission production.

3.6 How cities are accommodating new forms of production

Cities that are undergoing growth are likely to experience development pressure on land that is either currently zoned industrial or functions as mixed-use area. Few cities have the capacity to intervene against market forces or are capable of considering the impact of land use changes on the long-term economy. Cities that have considered manufacturing and productive activities as essential to the local economy have shown three approaches for managing change.

Some cities have selected stronger zoning on specific areas. These have been considered "opportunity zones" or in some cases they have been branded as "innovation districts" by *Katz and Wagner* (2014). These zones may get additional public investment, branding or support

and therefore attract a cluster of public and private activities. Sites may be focused on a particular kind of theme or topic which help them cluster business or improve branding (*Tadjar*, 2019). For cities struggling with pressure to provide affordable housing (or housing in general) and additional social services, industrial land is often the 'least-worst' site for development considering possible political consequences. This gives public authorities two other obvious pathways. One of them is industrial intensification, whereby industrial land is so expensive that multi-story buildings become viable. Industrial intensification could include a mix of business types (such as heavier manufacturing on the ground floors and lighter functions on the upper floors) or it could be a mix of activity types (such as a mix of manufacturing and logistics). The other option is referred to as industrial co-location, whereby a traditionally industrial activity co-habits the same building or block as other non-industrial activities (such as housing, social services such as a school or commercial activities). While traditional manufacturing could be accommodated in both industrial intensification and co-location projects, modern norms, development costs and assumed real estate values have meant that there are few built contemporary examples. Furthermore, private developers will aim to avoid the mix. Both options are being explored in a number of cities (notably New York and London) and have been documented in detail by *Rappaport* (2015).

3.7 Policy implications from the existing literature: emerging challenges

Retaining and attracting manufacturing and productive activities helps the city to be more economically diverse and therefore more resilient (*Ferm – Jones*, 2017). High-wage manufacturing industries matter for metropolitan wages as a whole. Therefore, retaining such industries should be part of a strategy of local policy makers to maintain high wages in general. However, for efficient structural policy and to promote growth of such industries, it is key to identify productive activities that have remained and/or are growing in a specific city as well as to understand the nature of these activities and why they were successful (*Friedhoff et al.*, 2010; *Ferm – Jones*, 2017). Industrial policy is therefore a search process in unknown territory, which should be open to new solutions, experiments, and learning. Therefore, policy makers and businesses should engage in an intensive dialogue, screening decentral information (*Aiginger – Rodrik*, 2020). The results will be city-specific, targeted approaches rather than a "one-size-fits-all" approach. Furthermore, higher-tech manufacturing and advanced services have a complex and interdependent relationship. Thus, policymakers should not ignore or try to repel one of these two sectors, even if their development strategy favours the other one (*Friedhoff et al.*, 2010). In addition, there is a growing similarity and interdependence between various sectors, going beyond the traditional definitions of product and statistical classifications. The desired size of manufacturing or any other technologically advanced sector has to be in line with general policy goals and strategy with respect to resources and living conditions (*Aiginger – Rodrik*, 2020). Hence, structural policy must consider the strategic importance of the organisation of the economy as a whole (*Di Berardino – Onesti*, 2020).

According to the results in *Peneder and Streicher* (2018), some of the major causes for de-industrialisation in highly developed economies lie outside the reach of meaningful policy interventions. These include the decline in the domestic final expenditures on (local) manufacturing value added and the higher growth of productivity in manufacturing. Thus, policy makers should rather focus on factors that are fundamental to the economic health of the area as a whole and on promoting the competitiveness of existing industries in the area (e.g., workforce skills, infrastructure, excellence in advanced high schools, tertiary education and R&D, an innovation system fostering radical innovations, etc.). A sound economic ecosystem is more relevant for growth in the long-run than sectoral composition (*Friedhoff,* 2010; *Aiginger – Rodrik*, 2020). This becomes even more relevant in the future, with employment in productive activities moving towards more small-scaled production and entrepreneurial or even single-person companies, with less stable jobs compared to larger-scale factories. For reasons highlighted by *Baldwin and Forslid* (2020, p. 35), it is necessary to stop thinking factories, but to "start thinking cities, people and training, … [and cities as] productive platforms".

Finally, from an urban planning perspective, identifying and developing sites that are appropriate for manufacturers at various stages (e.g., the prototyping stage, the start-up stage, the scale-up stage, the small and medium-sized enterprise stage) based on regional strategic objectives could encourage the return of industry to the city. However, first cities should update their regulatory regimes, which currently encourage the conversion of industrial land into other uses (*Hatuka et al*., 2017). From a planning perspective, models of mixed use of urban spaces compete with issues such as affordable housing and new housing construction are currently high on the political agenda (*Schonlau et al*., 2019). *Curran* (2007) and *Kunk et al*. (2014) explore the effects of gentrification on urban industrial displacement, illustrating that, as urban neighbourhoods gentrify, manufacturers are faced with displacement because their space has become attractive to higher-paying businesses or developers seeking to convert industrial spaces into residences.

3.8 Main take-aways

1. **Interlinkages between industry and services are increasing.** In general, de-industrialisation is a process that affects all developed economies, albeit to varying degrees. While the literature mentions a variety of factors driving de-industrialisation, there is a broad consensus that increasing service shares seem to be particularly important in consumption, technological progress and globalisation (trade and outsourcing). While there was a very clear trend at the end of the 20th century to decouple production and consumption, the 21st century is showing that services and production are becoming increasingly interlinked.
2. **Incompatible industrial activities have already left European cities.** The mechanisms for de-industrialisation in cities are basically the same as at the global level. However, cities are particularly affected by high land and labour costs. Furthermore, the burden for relocation at the regional level (from the city to the periphery) is lower than at the national level (from a highly developed to a developing economy). Accordingly, employment-intensive, land-intensive and emission-intensive production companies have largely moved away from the big cities. In this way, a close

functional relationship has developed between large cities and their surrounding regions.

3. **A future for creative, knowledge intensive and customised production.** In general, knowledge-intensive tasks (such as headquarters, R&D, design), creative industries and consumer-oriented (individualized, high quality, hand-crafted) small-scaled production have remained or are even growing in cities. So do industries with local supply functions. In addition, there are also historical qualities of particular industries growing in specific cities.
4. **Strengthening links between industry and cities offers socio-economic opportunities.** Emerging re-industrialisation trends have the potential to change the landscapes of inner-city districts. These developments within the core city have economic impacts: new investment opportunities, increasing numbers in industry business start-ups and entrepreneurship, training and relations with traditional or established industries. Potential social impacts come from new occupational opportunities and income benefits in disadvantaged neighbourhoods, increased social upward mobility, displacement tendencies and the re-imaging of local areas. Finally, re-industrialisation also affects cities' environments, in terms of adaptive re-use of heritage buildings, reconstruction of heritage urban landscapes, stimulus to innovation in urban design and reconfiguration of the built environment, creating a positive re-imaging of areas previously abandoned.
5. **Urban manufacturing offers choice and responsive production.** There is a lot of speculation about future developments, but analysts are almost unanimous in expecting profound changes: on the one hand, because technological developments are changing the spatial distribution of locational advantages (due to a decreasing role of labour costs and an increasing role of web-based production such as 3D-printing, both resulting in a growing importance of geographical proximity to demand); on the other hand, because consumer preferences and consumption habits are changing (with a trend towards individualised, local products, and an increasing importance of ecological aspects). These trends may be permanently reinforced by the current COVID-19 crisis. All this can contribute to a certain re-industrialisation of cities. The secular trend towards services is, however, likely to continue due to high productivity increases in industry compared to services and because of the increasing importance of services in consumption with increasing welfare levels.
6. **Cities need clear tools for managing productive activities.** While some cities are conscious of the value of their industrial land and manufacturing businesses, few actively support these activities. In the past manufacturing and industrial land operated with relative independence of public planning regimes and were driven by standard market dynamics, only requiring support for the development of new infrastructure. Since productive activities have become the "weaker" activity (compared with housing, recreation, offices and commercial activities), public authorities have been poorly equipped to prioritise manufacturing activities over other activities. Therefore, there is relatively little contemporary experience with how to manage or support productive activities. Some cities have released development strategies to encourage densification. Others have supported financing for education or through financial incentives for businesses to address certain urban issues (such as the circular economy and resource management).
7. **Productive activities should grow from historical processes.** To promote productive activities in cities in the long-run, it is essential to understand the nature of the manufacturing that has remained in a specific city and why it has done so. Also promoting an economically healthy environment for the total local economy that fosters

innovation and entrepreneurial activities is conducive to productive activities in the long-run. This requires city-specific solutions based on intensive dialogue between policy makers, businesses, economists and urban planners, and a change in perspective from factories, capital equipment and technology towards a people-based view of cities as productive platforms.

4 Data issues and definitions of urban typologies for a European comparison

As illustrated by the last Chapter there is quite sizeable empirical and theoretical literature that focuses on various aspects of the de- (and potential re-industrialisation of European economies. However, in comparison to the literature focusing on the national level, the specific impact of this process on (in particular European) cities is still less developed. One aim of the MISTA project was therefore to provide an empirical, descriptive overview of the spatial trends in productive uses in EU city regions and the economic, social and environmental impacts of these trends including:

- A comparative description of the spatial evolution of the industrial and manufacturing base of European cities and their functional regions for the EU over the last two decades.
- Indications on the evolution of different manufacturing branches (such as transport and logistics, wholesale trade, storage, competitive manufacturing of traded material goods, production for the local market and material services) in the last decade.
- A discussion of the potential causes for the heterogeneity among cities.
- A first empirical assessment of the potential social and environmental impact of these trends.

The available data bases that allow to empirically address these research questions are subject to considerable constraints. This Chapter shortly describes the main conceptual and data challenges faced by the project and how they were approached in the course of the project.

4.1 The ideal dataset

Ideally, an empirical implementation of the tasks specified above requires statistical information which features all of the following characteristics:

1. **Data at a regionally disaggregated level for functional metropolitan regions:** A central starting point of the analysis is a growing spatial mismatch between the administrative boundaries and the economic extension of urban areas documented in much of the literature. "Functional" urban regions as economic entities (in terms of commuting relationships, input-output-linkages and the like) typically exceed or fall short of the political-administrative boundaries of local authorities. Since this is the case to varying degrees from city region to city region, comparisons based on data in an administrative delineation can be massively distorted and thus misleading. As statistical data are almost exclusively collected at the administrative level, it is necessary to compile the necessary information for the functional urban region by merging administrative data at the small-scale level (LAU, NUTS-3).
2. **Data at a disaggregated sector level:** As also discussed in the literature survey, new business models, a progressive fragmentation of value chains and the rise of "hybrid" goods based on manufactured and service content lead to an increasing interpenetration between firms and activities in the secondary and tertiary sector. The boundaries between productive sectors and services hence become blurry and the economy as a whole – the manufacturing sector included – is tending towards a more mixed (and “service-led”) identity. However, comparable data at the sectoral level are

collected (and available) only at the NACE industry classification[22], which is very much based on the traditional production-services-dichotomy. In order to grasp the mentioned evolutions and their consequences for the sectoral profiles and the ongoing structural change at the metropolitan level also empirically, it would therefore be necessary to use sectoral information at highly granular (NACE) level as this would allow us to compile comparable data more closely related to the hybrid activities of metropolitan enterprises.

3. **Longitudinal data for the medium and long term:** Since the MISTA project is mainly concerned with structural change in the metropolitan regions and their producing sectors, its analysis must go beyond a comparison of the current structural profiles and/or the analysis of short-run structural developments in the urban economies. As structural change is a long-term phenomenon, time series data for a longer timespan are needed to understand its nature.
4. **Data comparable across EU-countries:** Given the comparative nature of the MISTA project, which looks at a broad set of metropolitan regions in different EU member states, empirical data used should be strictly comparable across Europe. This restricts the available data space to information based on harmonised survey methods and nomenclatures at the European level. Thereby, data on value added is particularly important in our context, also because data (only) on the development of the number of economic entities and/or their employees are not enough to allow insights into the character of structural change processes and their causes. Given this, data from the ESA-based Regional Economic Accounts as well as from European Surveys (like Structural Business Statistics, Labour Force Survey etc.) are core tools in our empirical analyses.

As expected, it was found that no database available and/or "ready to use" meets all these requirements. Moreover, the possibilities for constructing a comprehensive database meeting all requirements from available sources seem rather limited, given the severe trade-offs between these requirements in the data sources at hand. Thus, for example:

- While many countries (e.g., Austria, Sweden, Norway, Denmark and others) provide deeply granulated regional data that may go down to below the community level, such data usually lacks comparability across countries (i.e., there is a trade-off between points 1 and 4 above),
- While data at a disaggregated sector level is available in most countries it is typically not available in longer time series not least because of the continued revisions of the relevant internationally comparable NACE codes the last of which occurred in 2008 (trade-off between 2 and 3) and which in themselves reflect the massive structural and technological change leading to the continuous emergence of new products and activities in modern economies.
- And – most problematic in our case – the availability of finely disaggregated sector data strictly decreases with rising regional granulation throughout the EU (i.e., a trade-off between 1 and 2).

As a consequence, the project team decided for a flexible use of different data sets at different regional aggregation levels according to the specific research topics analysed. So, for example, in the analysis of structural change at the European level conducted in this study with its high

[22] NACE (Nomenclature statistique des activités économiques dans la Communauté européenne) is the classification of economic activities in the European Union (EU).

demands on sectoral depth and temporal length, the option is to compromise on regional granulation and thus on the accuracy of the delineation of the metropolitan area.

4.2 Delineation of metropolitan regions

In principle, the search for a meaningful delineation of the metropolitan areas must consider that the MISTA project aims to compare the 7 urban areas involved in the study (Berlin, Oslo, Riga, Stuttgart, Torino, Wien, Warsaw) with each other, but also with (all) other comparable urban areas in the European Union and Norway. Thereby an urban area is classified as "comparable" if it is either a capital city and/or a city region with more than 1.5 million inhabitants in the agglomeration area. This leads to a sample of (58) "major" metropolitan regions in the EU (see Table 5.1 for a list), which will be the benchmark in our comparative analyses. Against this background, only delineations of metropolitan areas can be considered, which can be applied in a harmonised form to all these urban regions. Table 4.1 shows the possibilities of regional delineation of the metropolitan areas and their differences.

The most spatially precise delineation of the urban region is without doubt Eurostat's typology of "Functional Urban Areas" (FUA; left panel). Based on population data at the (1 km²) grid-cell level this typology delineates the functional city region at the Local Administrative Unit (LAU) level, thereby distinguishing between the core city and the surrounding travel-to-work area (commuting zone)[23]. Applied to the urban areas participating in our study, this typology leads to a FUA-population between slightly more than 900,000 in Riga and 5.1 million in Berlin, with slightly more than 600,000 (Oslo, Stuttgart, Riga) and 3.5 million inhabitants in the core cities of these FUAs in between. The FUA delimitation, however, places great demands on data availability. It is not available for all regions by far and can thus only be approximated in the in-depths analyses of individual case study-cities.

Table 4-1: Definition of city regions in this report

Delineation used	Defining criterion	Source	Use in this report
Functional Urban Areas (FUA)	City and its surrounding travel-to-work-area (commuting zone), defined at the grid-cell and/or LAU level	Guidelines from Eurostat (2019: 49-60), implementation by case study cities	Detailed analyses for the case study cities (Case studies); Ch.4
Metropolitan Regions (MR)	One or more NUTS-3 regions with at least 50% of their population living inside a FUA; at least 250.000 inhabitants; Approximation of FUA at the NUTS-3 level	Eurostat (2019: 83-88)[24]	Comparative analyses of general long-term trends in industry in all European MRs and MR sub-groups; Ch. 3.2.2
Agglomeration Areas (AA)	NUTS-2 region(s) that constitute (or include) the Metropolitan Region of interest; Approximation of MR at the NUTS-2 level	Own definition; see annex table A.3.1 for NUTS-2 correspondence	Analyses of disaggregated industry specific developments; Ch. 3.2.3

[23] A city is the LAU where a majority of the population lives in an urban centre of at least 50.000 inhabitants, while the commuting zone is the area where at least 15% of employed residents work in the city.

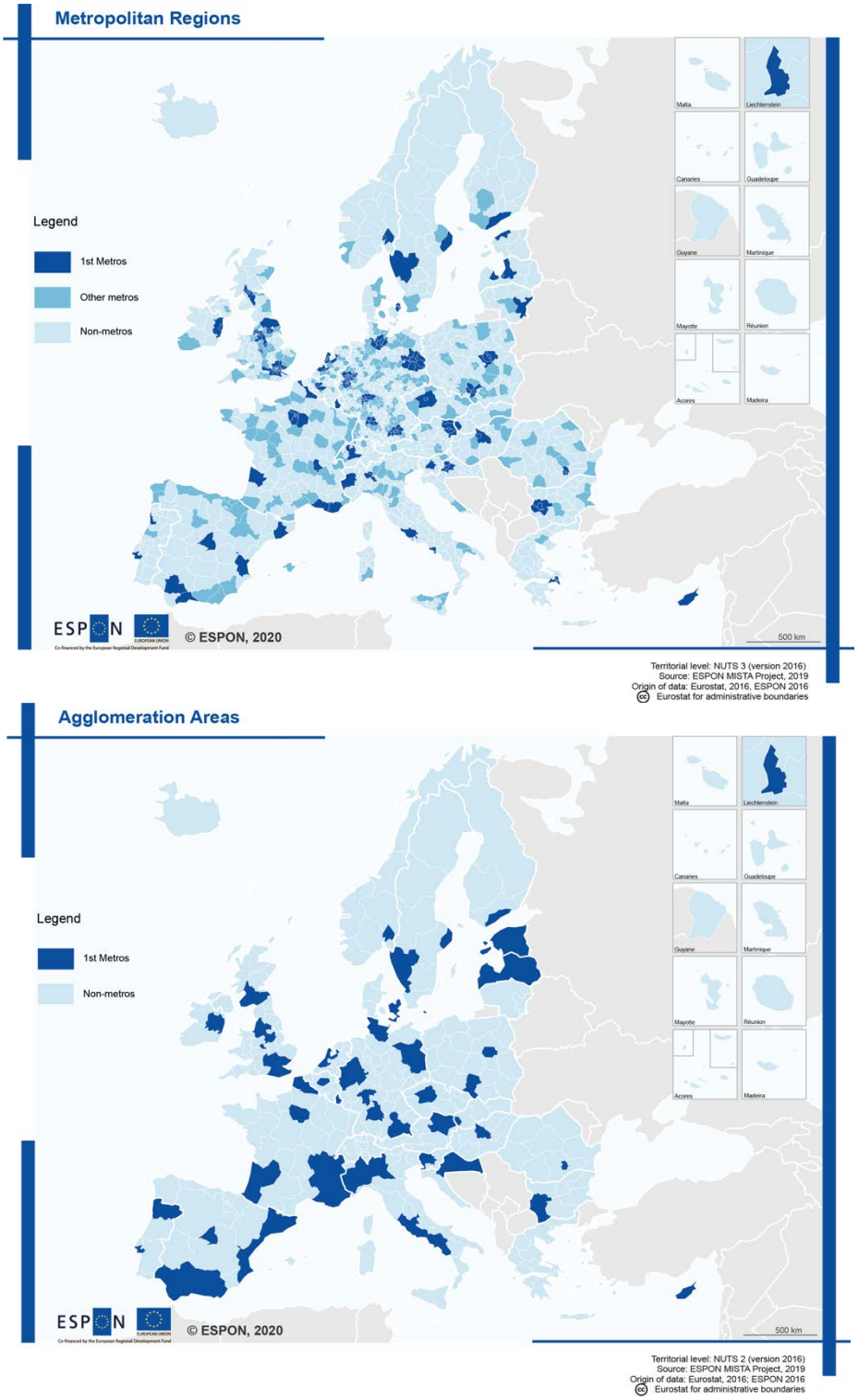
[24] See http://ec_europa.eu/eurostat/cache/metadata/en/reg_typ_esms.htm for methodological details and https://ec.europa.eu/eurostat/web/metropolitan-regions/background for NUTS-3 correspondence.

Source: ESPON MISTA 2020.

A somewhat coarser, but less data-demanding delineation of urban areas is provided by Eurostat via the typology of "Metropolitan Regions" (MR; middle panel). This works at the more aggregated regional (NUTS-3-) level and defines metropolitan regions as urban agglomerations (NUTS-3 regions or groups of NUTS-3 regions) where at least 50% of the population lives inside a functional urban area that is composed of at least 250,000 inhabitants. As a comparison of the population results for both typologies show, this regional delineation for the MRs hardly differs from the (more precise) local delimitation of the FUA typology or is even congruent with it[25]. Therefore, it seems feasible to use the NUTS-3-based delineation of "Metropolitan Regions" from Eurostat as the "workhorse" in our analysis.

[25] Table A3.2 in the appendix shows which NUTS-3 region(s) of our case study cities make up these metropolitan regions. In the case of multi-NUTS-3 metropolitan regions the central NUTS-3 (core) approximates the city of the FUA definition and is highlighted accordingly.

Map 4-1: Metropolitan Regions and Agglomeration Areas in the EU and Norway.



Source: ESPON 2020.

As a consequence, the comparative analyses of general long-term developments of industry in a broader sense (i.e. NACE B-E) are implemented at the NUTS-3 level (MR definition) and will be based on harmonised NUTS-3 time series data on essential economic accounts indicators (incl. employment and GVA) measured at the establishment level from the new Annual

Regional Database of the European Commission's DG Regio (ARDECO), released by the Joint Research Centre of the European Commission (JRC/EC) in February 2020 [26].

However, in cases where even data at the (regional) NUTS-3-level are not available, it is necessary to base empirical analyses on an approximation of this "Metropolitan Region" area by using data for the respective NUTS-2 region(s) that constitute (or include) the Metropolitan Region of interest. For these analyses, in a rather pragmatic approach, we assign those NUTS-2 regions to an "Agglomeration Area (AA)" that contain NUTS-3 regions in the respective metropolitan region (MR) definition, but exclude those of these NUTS-2 regions, in which "metropolitan" NUTS-3 regions make up only a minor part (< 50%) of the population in the NUTS-2 region in question[27]. This applies in particular to the detailed industry specific analyses of all productive activities at the NACE 2-digit and NACE 3-digit level where we use NUTS-2 level data from Eurostat's Structural Business Statistics (SBS) on (40 of a total of 68) NACE 2-digit industries and WIFO's Regional Structural Database at the NACE 3-digit level[28] for the 58 first-metro regions at the AA level for the time period 2010 to 2016. The regional manifestations of the MR and AA level are illustrated in Map 4-2. The results of an application of this approach to the broader agglomeration area of our case study city regions show that even this broad delineation may be a feasible approximation of the city region total in the majority of cases: In comparison to the NUTS-3-based regional typology no (Warsaw, Oslo) or still justifiable (Berlin, Wien) deviations appear for four urban regions measured by population. This means that an application of the (broad) NUTS-2-based typology is a feasible option. However, in case of Agglomeration Areas represented by only one (very) large NUTS-2 region (Stuttgart, Riga, Torino), discrepancies between the NUTS-3-based "Metropolitan Region" typology and the broader "Agglomeration Area" delineation are rather large. This has (at least) to be considered in the interpretation of empirical results based on the latter.

4.3 Delineation of production activities or industry

With respect to the delineation of production activities the project team explored to what degree the sectors in the terms of reference to the MISTA project can be analysed with the data

[26] In detail we combined this dataset with Eurostat's typology on (functional) metropolitan regions with more than 250.000 inhabitants (Eurostat, 2019: 83-88) in order to construct data on the (289) metro regions in the EU and Norway, covering the longest period possible with complete data, i.e., 1995-2017. The resulting project dataset allows to distinguish different metro region types, including (58) major metropolitan regions (major metro regions) as a suitable benchmark for the project's (7) case study city regions), as well as a rough distinction into 6 economic sectors, including industry (NACE sectors B-E)

[27] Table-A 1 and Table-A 2 in the Appendix also include a NUTS-2-based typology ("Agglomeration Areas" – AA) that has been developed by us. Obviously, conclusions for the narrower urban region core cannot be drawn from such a (broad) delineation (unless the city itself is a NUTS-2 region such as is the case for Wien and Berlin). In addition, we assigned a threshold in population density to exclude NUTS-2 regions with a very thin settlement structure. However, this second criteria are not biting in any case in the city regions mentioned in the table.

[28] This data was estimated by the Austrian Institute of Economic Research (WIFO) based on SBS and geocoded Amadeus firm-level data provided by Bureau van Dijk. A previous version of this was used in earlier EU-projects (e.g., *Unterlass et al*., 2015)

available. According to this, the following sectors (and NACE groups) will have to be analysed: Transport and logistics (mostly NACE H), wholesale and storage (NACE 46 + 45), competitive production (NACE C), production for local markets (NACE C), material services including building sector (NACE F), general workshops, repair services (NACE 95). The review of the European data situation conducted by the service providers suggested that these groups can be well analysed on the level of the AAs for all European cities, but that their analysis at a smaller regional level hinges on the collection of additional data from the stakeholder cities. As a consequence, it was decided to use available data at a more aggregated sectoral and regional level for the European wide comparative analysis of the project, but to augment this analysis with a sectorally and regionally more disaggregated view based on national data, in the case study analyses.

Further, given the limitations of the NACE classifications, we also explored the potential to consider additional data sources which provide the possibility to augment the analyses based on NACE industry classification, with additional data that allows for an analysis of occupational codes (such as ISCO) or other typologies more closely related to the activities of enterprises. Here, the European Labour Force Survey proved to be an interesting source that can be analysed at the level of the AAs. We therefore also analyse this data in the current analysis, as it allows for additional insights into the progress of regions in servo-industrialisation, the functional division of labour and potential risks originating from technological changes such as (digitisation).

4.4 Data sets used and data development

As Table 4-2 makes clear, a flexible use of all the regional and industry typologies mentioned is nonetheless necessary. The table lists the data bases available at the different urban region typologies mentioned above, whereby we concentrate on data for employment and gross value added as the core indicators of the empirical analysis scheduled. What catches the eye is a clear trade-off between data availability and the regional accuracy of the respective urban delineation. As a matter of fact, data available for an application of the LAU-based FUA typology (left panel) are rather scarce. No data for GVA are available here at all, and the few data on employment available from the Urban Audit project – though providing a certain sectoral disaggregation – are far from complete, with a bulk of missing values in the sectoral as well as (and above all) the time dimension.

While these problems clearly devalue the LAU-based typology as a starting point for an EU wide comparison, data issues definitely speak in favour of the NUTS-3-based MR typology as the major basis for comparative analyses of the (broad) structural evolutions in the European city regions, especially from a longitudinal perspective. Here, harmonised data from the Regional Accounts and Regional Business Demography are available for employment and GVA in a rather broad sectoral delineation. These data can be combined with a large

longitudinal data set from the EC Joint Research Centre[29]. This allows us to track sectoral evolutions in the Metropolitan Regions (and their core regions) for a quite long period of time (1991-2017), whereby the data are complete (no missing values) and also comprise additional variables (e.g., on working hours or compensation).

By contrast, when it comes to analyses at a disaggregated sectoral level, the NUTS-2-based "Agglomeration Area" typology is the only option if information on all EU cities is called for. Aside from the databases mentioned above (that are of course also available at NUTS-2 level) data from the European Labour Force Survey, the European Structural Business Statistics and the WIFO NUTS-2 Sectoral Database allow a larger information base on employment.

[29] This database was set up by Cambridge Econometrics (UK) and changed over to the Joint Research Centre in 2016. It will be replaced by a new database called ARDECO (Annual Regional Database of the European Commission) in the near future.

Table 4-2: Data availability in terms of employment and output in different city-region delineations

	LAU-based typology: Functional Urban Areas (Eurostat)		**NUTS-3-based typology**: Metropolitan Regions (Eurostat)		**NUTS-2-based typology**: Agglomeration Areas	
Data sources	- City statistics (collected in the Urban Audit & the Large City Audit project)		- Regional economic accounts - Regional business demography - JRC European regional database - WIFO NUTS-3 sectoral database (to be checked)		- Regional economic accounts - Regional business demography - JRC European Regional Database - European Labour Force Survey - Structural business statistics (SBS) - WIFO NUTS-2 sectoral database	
	Employment	GVA	Employment	GVA	Employment	GVA
Data coverage						
Of 7 case study cities	All	None	All	All	All	All
Of 56 largest metropolitan regions	46/56	None	All	All	All	All
Sectoral coverage	10 sectors (aggregates of NACE industries), missings: *	No data	11 sectors (aggregates of NACE industries, Eurostat), missings: ** 6 sectors (CE), missings: ***	11 sectors (aggregates of NACE industries, Eurostat), missings: ** 6 sectors (CE), missings: ***	11 sectors (aggregates of NACE industries, Eurostat), missings: ** 6 sectors (CE), missings: *** NACE 2-digit-level (SBS), missings: ** NACE 3-digit-level (WIFO), missings: **	11 sectors (aggregates of NACE industries, Eurostat), missings: ** 6 sectors (CE), missings: ***
Time coverage	2000-2017 (cities; completeness: *) 2008-2017 (FUA; missings: *)	No data	2000-2017 (Eurostat), completeness: ** 1991-2017 (CE), completeness: ***	2000-2017 (Eurostat), missings: ** 1991-2017 (CE), missings: ***	2000-2017 (Eurostat), coverage: ** 1991-2015 (CE), missings: ***; 2008-2017 (SBS), missings: **; 2000-2016 (WIFO), missings: **	2000-2017 (Eurostat), missings: **; 1991-2015 (CE), missings: ***

*Source: ESPON MISTA 2020. * stands for a weak completeness of the data available (many missing values), ** for a fairly well completeness with only few missing values, *** for full completeness (no missing values).*

From a sectoral point of view, the latter two databases are particularly relevant, as the SBS provides employment data for the disaggregated NACE 2 sectoral level, while the WIFO sectoral database even offers information on the deeply disaggregated 3-digit level of the NACE classification, albeit at the basis of estimates derived from a link with the Amadeus database at the enterprise level.

In detail we therefore use the following additional data sets at NUTS-2 level on account of the substantial additional insights they are likely to provide for the project:

- Eurostat SBS data and the WIFO regional structure database constructed from this as this provides data on employment at the NACE 3-digit level for all NUTS-2 regions: This allows scrutinizing the development of the sectoral employment structure of the Agglomeration Areas for the period from 2012 to 2018 from a European perspective. It also provides the opportunity to use existing typologies of industries (that e.g., group NACE 3-digit industries according to their human capital content and factor intensities or their use of ICT technologies) that are defined at the NACE 3-digit level. This also provides for additional insights as to the economic structure of AAs according to an economically meaningful terminology-
- The European Labour Force Survey (ELFS): this is a Europe-wide Survey conducted by the national statistical offices which is the main source information for the EU employment and labour market statistics. This can be used to provide information on the occupational and industrial structure of the employed in industry in European AAs located in most EU countries and Norway.

4.5 Main take-aways

- **The data situation for empirical analyses as those undertaken is rather difficult.** Data sets that combine the requirement of long time series with a high granularity at the regional and sectoral level exit only in some EU countries, and as a consequence the MISTA project (as well as most other comparative research on urban development) often has to compromise on data quality to address issues of interest.
- **Aside from other policy measures development of data sources that allow for an improved evidence base for policy making should therefore be a core policy priority**. In the context of our project the most pressing needs would be to provide comparable regionally and sectorally granular data on employment, GVA and the number of enterprises in all EU countries. In addition, increased harmonisation of basic statistical definitions across countries for many administrative datasets that do not follow standard international statistical norms would also be of high value added for comparative research on industrial development in urban regions.

5 Baseline empirical analysis of major trends in European metro regions

Given the data described in the last Chapter and the fact that existing work points to a strong de-industrialisation trend in metro regions over the last decades but also to a more recent return of some parts of industry to metros, this Chapter empirically analyses the following key research questions:

- To what extent were the last 3 decades marked by a (stronger) de-industrialisation trend in European metropolitan regions than in other regions and to what degree did this trend differ across metro regions?
- Were there significant differences in the development of industry between metropolitan core regions and their wider environs?
- And to what degree are there indications of an end to the secular erosion of employment in industry in European metro regions?

To address these questions, we use data taken from the Annual Regional Database of the European Commission's DG Regio (ARDECO), recently released by the Joint Research Centre of the European Commission (JRC/EC) in February 2020. This database harmonised NUTS-3 time series on the key economic accounts indicators (including employment and GVA) measured at the establishment level for the time period from the 1980s for the EU15 countries and the mid-1990s for the EU13 countries. As discussed in more detail in Chapter 3, we combine this dataset with Eurostat's typology on (functional) metropolitan regions with more than 250.000 inhabitants (*Eurostat*, 2019, p. 83-88) to construct data on the (289) metro regions in the EU and Norway, covering the longest period possible that allows for a comparison of all 28 EU countries and Norway (such as 1995-2017). The resulting project dataset allows to distinguish different metro region types, including (58) major metro regions as a suitable benchmark for the project's (7) stakeholder metro regions, as well as a rough distinction into 6 economic sectors, including industry (NACE sectors B-E) which is the core object of our analysis.

5.1 Development of industry in metropolitan regions:

5.1.1 General trends

Figure 5.1 presents a first overview of the main trends in the development of industry in the European metropolitan regions. It shows the development of employment and GVA at constant and current prices in industry (NACE sectors B-E) in the (58) major metropolitan regions (1st metro regions), all (289) metropolitan regions and all (1348) EU (NUTS-3) regions since the mid-1990s, with the year 1995 normalized to 100.

Irrespective of the regional level considered, this indicates a clear long-term de-industrialisation trend for employment in industry but not for gross value added. Since 1995 employment decreased in terms of both volumes (upper panel) and shares (lower panel). By contrast, gross value added (GVA) increased significantly in volume both in nominal and real terms, (with increases in nominal terms being somewhat stronger than in real terms than in real terms based on 2015 prices) but decreased in terms of GVA shares (with this decline somewhat stronger in

nominal than in real terms). On the one hand the more pronounced de-industrialisation in terms of employment than GVA implicitly points to higher productivity gains in industry than in other sectors. On the other hand, this also points to lower price increases for industrial goods than for services, as already discussed in Chapter 2.

Figure 5.1: Development of industry in European (metro) regions due to different performance indicators, 1995-2017; Index 1995 = 100

Source: ARDECO (JRC/EC); ESPON MISTA 2020.

These basic patterns are also rather similar across metropolitan regions and all EU regions, suggesting that the general development of the industrial base of metro regions and other regions followed similar patterns in the time period considered. However, irrespective of the indicator used, industry developments in the 1st metro regions (i.e., the comparison group for the case study regions) are somewhat weaker than in all metro regions. Similarly, metro regions overall show a less favourable development of industry in terms of all indicators than all EU regions in average. This confirms that over the entire period de-industrialisation was stronger in metro regions than other regions and also stronger in large metros than in small ones. This is in all likelihood due to specific locational disadvantages for some (land and wage cost sensitive) industries in conurbations and a greater general exposure of metros to the drivers of de-industrialisation tendencies.

Figure 5.2, however also shows that the downward trend of industry in all regional types considered has flattened out over the observation period in both GVA shares and employment (levels) and has ultimately been largely stable since the mid-2000s, except for the years of the "Great Recession"[30]. This accords with previous literature arguing for a possible end to de-industrialisation in urban areas. The only indicator that contradicts this hypothesis is the continued decline of the employment share.

Indeed, over the entire period 1995 to 2017, the employment share of industry declined in all major European metro regions. On a weighted average, some 10.4% of total employment still work in industry in this group in 2017 (see Table 5-1). This indicates a noticeable locational disadvantage of major metro regions for industrial production, that is also greater than in all (289) metropolitan regions in the EU. In this broader group of metro regions, the industrial employment share still amounts 13.0%. This is only slightly lower than in the EU regions in total (15.3%), but higher than in major metros.

Such an averaging approach, however, also masks the considerable differences in industrial development among the individual major metro regions. Although this metro group consist only of capitals and large agglomerations and should therefore be reasonably homogeneous the industry share in employment varies between more than a quarter of the regional workforce in Katowice and Stuttgart and less than 5% in Oslo and London[31], with the individual metro's position in 2017 highly correlated to the initial conditions in the mid-1990s. We therefore find a positive and strong correlation between a metro's industry share in 2017 and its change from the mid-1990s (r = +0,42), whereby the range of the latter extends from -10% of the 1995 share in Praha and more than half of it in some British metros, but also in Ljubljana, Madrid, Valetta and Bucuresti. Concerning the case study metros of the MISTA project, Stuttgart, Torino, Riga and Warszawa managed to further improve an above-average industrial orientation compared to the (weighted) average of the major metro regions since 1995, while Wien, Berlin and Oslo continued to lose ground.

Table 5-1: Industry in European 1st metropolitan regions: Employment Industry employment share; 57 major metro regions; 2017

	Industry Employment Share						
	In %	**1995=100**	**Growth Rank**		**In %**	**1995=100**	**Growth Rank**
Katowice	29.7	70.1	12	Lille	10.9	55.8	39
Stuttgart	*25.0*	*83.2*	*3*	Manchester	10.6	46.9	51
Porto	23.0	66.3	17	**Major Metros**	**10.4**	**58.9**	
Torino	*19.7*	*63.1*	*24*	Sevilla	10.1	86.0	2
Praha	18.1	91.2	1	Lyon	9.9	59.2	29

[30] The 2008/09 recession was by far more pronounced in GVA than in employment on account of the usual labour hoarding tendencies in recessions and also on account of the short-time work schemes and other measures to stabilise employment in industry implemented by many countries at that time.

[31] Even greater differences can be found in the industrial share of value added (Stuttgart 38.8%; London 5.4%) and its development (Bratislava 172.7% of the 1995 share; London 47.2%); see Table-A 5. in the Annex. In this perspective, however, in as many as 14 of the major metro regions the output share of industry increased since 1995, with this group also including some cities from EU13 countries, northern Europe and from France and Germany (including Stuttgart).

	Industry Employment Share						
	In %	1995=100	Growth Rank		In %	1995=100	Growth Rank
Tallinn	17.6	69.8	13	Helsinki	9.8	62.9	25
Grad Zagreb	16.7	60.6	28	Dublin	9.4	50.8	50
Barcelona	14.9	56.6	36	Lefkosia	9.0	56.9	35
Milano	14.9	61.5	26	Rotterdam	8.9	71.1	9
Göteborg	14.8	66.3	16	*Wien*	*8.6*	*53.6*	*43*
Valencia	14.8	63.6	22	*Berlin*	*8.6*	*63.6*	*21*
Ruhrgebiet	14.6	58.5	32	Leeds	8.6	57.6	33
Bratislava	13.7	75.1	5	Luxembourg	8.5	51.2	49
Düsseldorf	13.7	60.9	27	Athina	8.4	52.4	45
Alicante	13.7	64.9	18	Glasgow	7.9	51.3	48
Riga	*13.6*	*75.9*	*4*	Bordeaux	7.8	70.6	10
Ljubljana	13.5	46.7	52	Lisboa	7.8	51.8	47
Vilnius	13.3	64.3	19	Marseille	7.2	71.2	8
Sofia	12.7	54.4	42	Madrid	7.0	45.2	54
Warszawa	*12.7*	*67.0*	*15*	København	6.7	67.6	14
West Midlands	12.4	44.6	55	Bruxelles	6.5	56.4	37
München	12.2	73.9	6	Amsterdam	6.5	64.2	20
Frankfurt	12.2	59.0	30	Paris	6.2	55.3	41
Budapest	12.1	55.6	40	Stockholm	5.9	53.5	44
Napoli	11.9	70.3	11	Roma	5.4	57.6	34
Valletta	11.9	42.6	57	Málaga	5.1	58.8	31
Köln	11.8	56.3	38	*Oslo*	*4.7*	*52.4*	*46*
Hamburg	11.5	71.5	7	London	4.2	45.4	53
Bucuresti	11.1	44.3	56				
Liverpool	11.0	63.5	23				
All Metro Regions	13.0	66.1					
All EU Regions	15.3	72.3					

Source: ARDECO database (JRC/EC); ESPON MISTA (2020). – No data for Zurich. Case study metros in italics.

This wide range of results, even within the group of (fairly similar) major metro regions[32], suggests that specific influences on the development of industry in the individual metro regions are of great importance – be it the respective economic policy stance, the topography of the metroscape, the geographical location of the metro region in relation to major trading partners, and/or its centrality in interregional value chains. Aside from this there are also important differences between different metro types (Table 5-2 and Figure-A 1(for employment) and Figure-A 2 (for output) in the Annex. In particular there are clear disparities in the (average) industry shares of metros of different sizes (11.6% in large vs. 17.1% in large metro regions), income levels (10.9% in high vs. 16.0% in low-income metro regions) and industrial orientation (7.6% in service based vs. 22.9% in industry-based metro regions). These differences are accompanied by similar (and significant) gradients in the development of these shares from the mid-1990s. Measured by the industry GVA share (right panel), similar, albeit less pronounced differences appear in quantitative terms. Most notably, on the output side we find some metro groups in which the industry share has remained almost stable (lower-tier, low-income and

[32] For all (289) metropolitan regions as well as the case study metros of the MISTA project the development of the industrial shares in the period 1995 to 2017 is shown in Figure-A 1 (for employment) and Figure-A 2 (for output) in the Annex. According to this, the development paths of the individual city regions were very heterogeneous in the period observed, but also show long-term similarities, with a tendency towards decreasing industry shares in terms of employment and towards stable industry shares in terms of (real) gross value added.

EU13 metro regions) or even increased (small and industry-based metro regions) in the period 1995 to 2017[33].

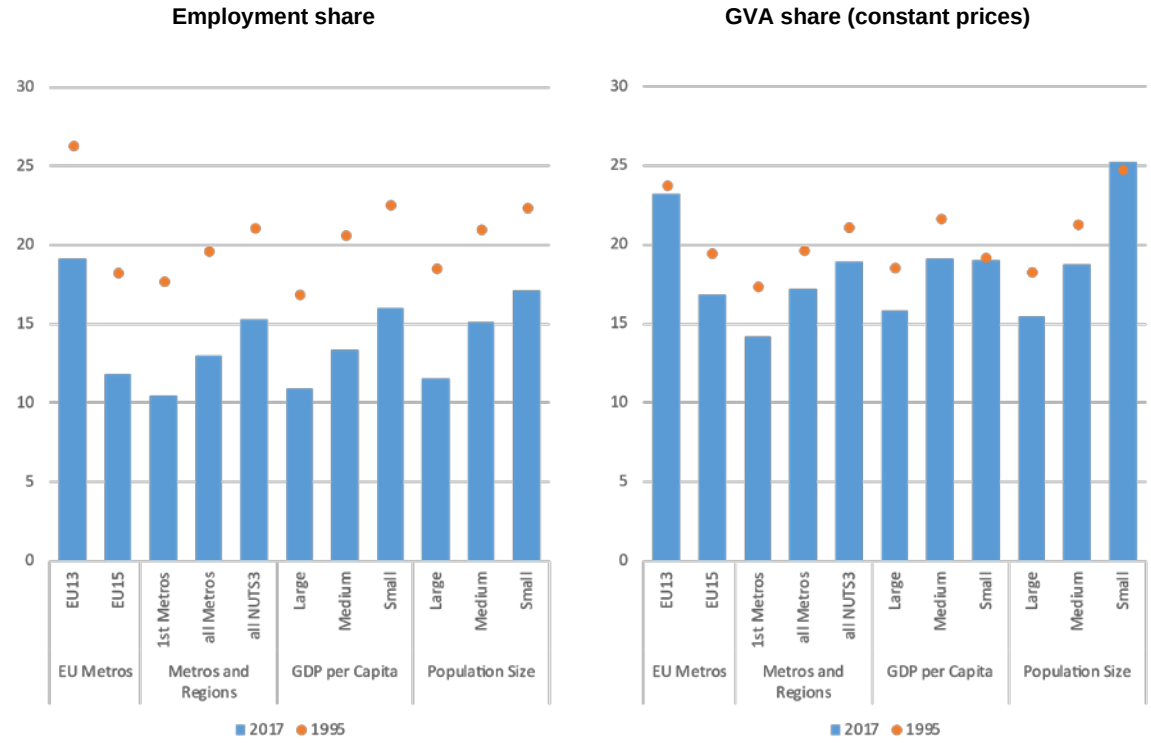
Table 5-2: Industry in European major metro regions: Industry share by type

	Industry Employment Share		Industry GVA Share	
	In %	1995=100	In %	1995=100
Major Metros	10.4	58.9	14.2	81.5
All Metro Regions	13.0	66.1	17.2	87.6
All EU Regions	15.3	72.3	19.0	89.7
Capital Metros	8.0	56.4	10.5	78.0
2nd Tier Metro Regions	14.8	65.5	19.5	88.2
Lower Tier Metros	15.4	72.6	21.9	96.0
Large Metro Regions	11.6	62.2	15.5	84.7
Medium-sized Metros	15.1	71.8	18.8	88.0
Small Metro Regions	17.1	76.4	25.2	102.1
High-Income Metros	10.9	64.3	15.8	85.3
Medium-Income Metros	13.4	64.7	19.1	88.2
Low-Income Metros	16.0	70.8	19.0	98.9
Service-based Metros	7.6	56.8	11.3	78.0
Mixed-based Metros	13.5	64.1	19.8	86.8
Industry-based Metros	22.9	79.6	30.6	105.9
EU15 Metro Regions	11.9	64.8	16.8	86.6
EU13 Metro Regions	19.1	72.7	23.2	97.7

Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

[33] The typology according to the position of a metropolitan region in the city hierarchy (capital city – 2nd tier metro – lower tier metro) was taken from *Dijkstra – Poelman* (2011). The typologies according to city size, income level and sectoral orientation differentiate the (289) metro regions reflect the terciles of population size, BRP per capita and industry share respectively.

Figure 5.2: Share of industry by type of metro region
1995 and 2017, in %



Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

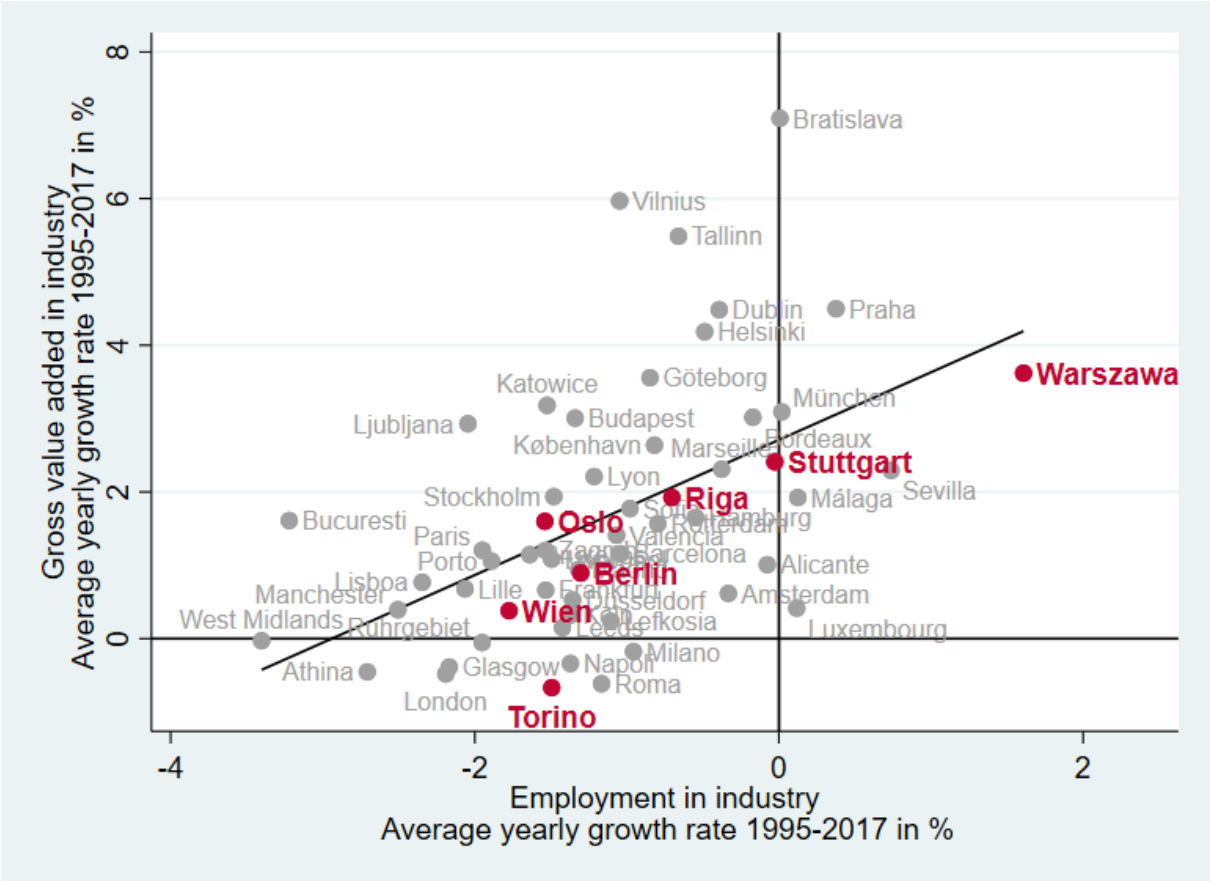
Overall, this points to considerable and systematic differences in industry evolutions according to metro characteristics (see also Figure 5.2). In particular de-industrialisation is not an equally evident trend in all metro regions, but a heterogeneous phenomenon according to the metro "type" considered. In addition, while over the entire period 1995 to 2017 a decrease of the industry share was a common feature of the bulk of the metro regions, this decline was consistently more pronounced in employment than in (real) output. This suggests both productivity levels and higher productivity gains in industry than in the economy in total.

5.1.2 Industry development in major metro regions

These findings are also confirmed when focusing on the major metros, which are the reference group for our case study regions. The vast majority among these combine shrinking employment with a rising output in industry in the period 1995 to 2017 – a stylised fact that again reflects significant productivity gains in the sector. In addition, correlating the employment growth of these metropolitan regions with their output growth (see Figure 5.3) suggests that – as would be expected – metropolitan regions with higher value-added growth in the period 1995 to 2017 also experienced higher employment growth, respectively, lower employment declines. This correlation is, however, not very strong with substantial variation across individual metros. In particular, even some of the metro regions with the highest GVA growth in this period (e.g., Bratislava, Vilnius or Tallinn) experienced declines or a stagnation of employment. Furthermore, also most metros combine a positive GVA growth with declining employment and considering the regression line in Figure 5.3, which represents the "average" employment

intensity of industry output growth in the sample, suggests that the “average” metropolitan region in our sample needed an average annual GVA growth rate of above 2% per year to experience growth in industrial employment. This means that in the period observed "jobless growth" indeed was highly relevant in industry in most metro regions.

Figure 5.3: Employment and GVA growth in industry in European major metro regions
major metro regions and case study metro regions, 1995-2017

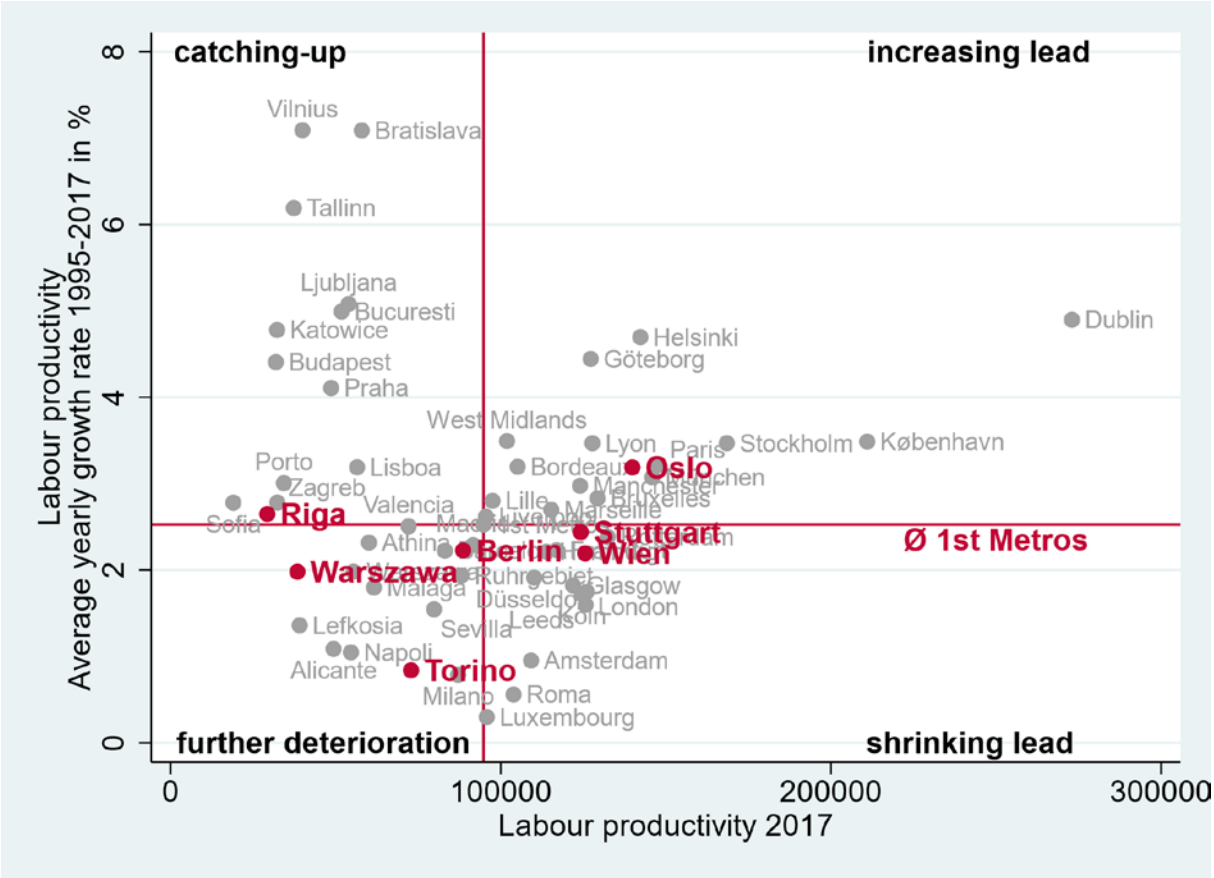


Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

Interestingly, this “jobless growth” phenomenon seems to have been more pronounced in most of the case study metro regions of the MISTA project, as all of these regions with the exception of Oslo are located below the regression line between employment and GVA growth presented in Figure 5.3. In Stuttgart, Warszawa, Berlin, Wien and Torino, compared to the (weighted) average of all major metro regions, a relatively low industrial output growth was necessary to realise sectoral employment gains in the period 1995 to 2017. This high employment intensity may in part be due to increasing part-time work in these metros[34], but by definition also implies lower per capita productivity gains.

[34] At the NUTS-3 level ARDECO provides data on employed persons (and not by hours worked). Therefore, rising employment figures may mask a stable or even shrinking labour volume in the case of increasing part-time work.

Figure 5.4: Labour productivity in major metro regions industry: Current status and mid-term development
GVA per employed person (constant prices)



Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

As a consequence of this rather varied picture with respect to employment and GVA, growth differences in productivity are quite substantial even within the group of major metro regions. The productivity of the highest productivity metropolitan region in this group (Dublin) exceeds that of the lowest ranging region by a factor of more than 10. In particular metro regions in northern (and north-western) Europe tend to be favoured over those in the east and south of Europe in productivity levels as well as productivity growth. This can probably be explained by higher labour costs and a resulting greater pressure to rationalise in the former. Over time, several northern metro regions have been able to further improve their efficiency lead[35], whereas the majority of the highly productive metro regions show up in the group with a shrinking lead (see Figure 5.4). In contrast, for the southern and eastern European major metro regions we find rather heterogeneous productivity developments, with some of them (mainly the eastern ones) catching up and others (more often in the south) falling further behind. Our case study metros fit into these heterogeneous development paths in quite different ways: while Riga and Stuttgart achieved efficiency gains in the sector in line with the (weighted) average of

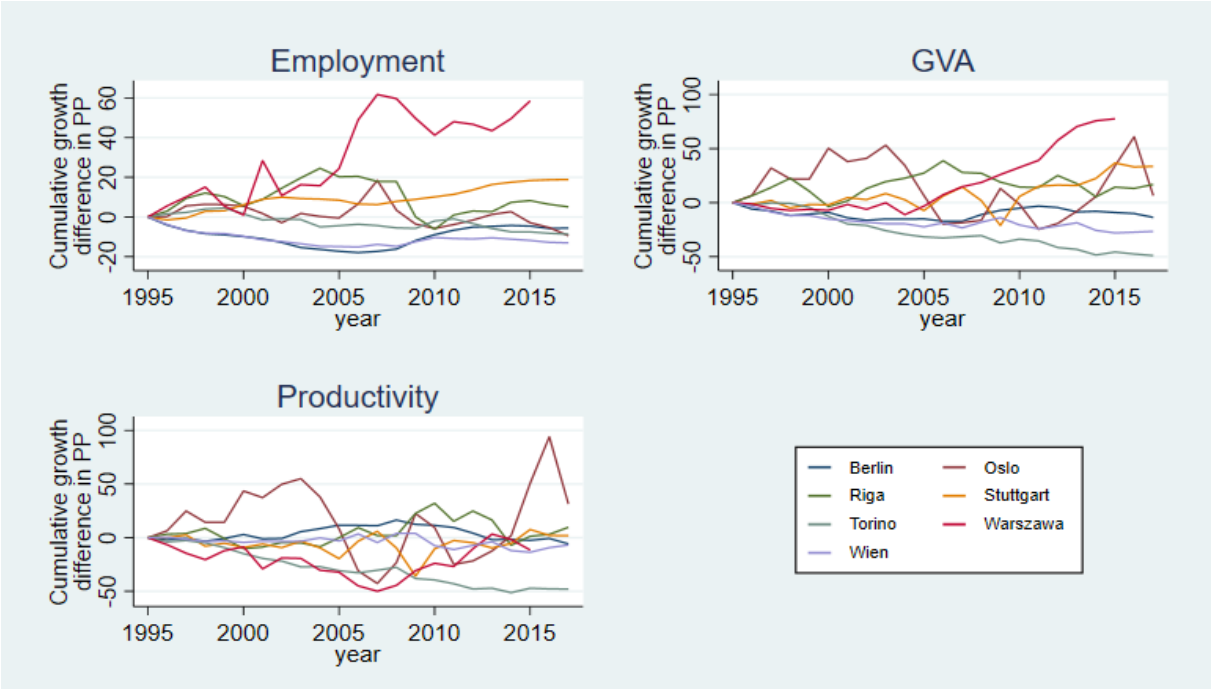
[35] This refers in particular to metro regions that are considered "innovation leaders" according to relevant rankings, e.g., the EU Regional Innovation Scoreboard (*European Commission*, 2019).

the major metro regions (indicated by the red horizontal line), the position of Berlin, Wien and Warszawa deteriorated noticeably. Oslo, however, was able to extend its productivity lead in industry significantly, while Torino lost further ground.

These average productivity differences in the sector over the entire period 1995-2017 may be based on different time paths within this period and may also have different origins in the interaction between employment and output evolutions in industry in the individual metropolitan regions. To better understand these differences, Figure 5.5 plots the cumulative growth differential of industry in the 7-case study metro to the average of all (289) metropolitan regions. This reveals the relative employment and output developments in industry in these metros, as well as the respective (relative) productivity developments as a result of both. Thereby the zero-line represents the growth of the respective indicator in (the average of) all metropolitan regions and the deviation from this line indicates the (cumulative) growth differential in the respective case study metro in percentage points.

According to the results the comparatively favourable productivity trend of Oslo's industry over the entire period is based on a rather volatile development in time, which in turn is triggered by substantial fluctuations in industrial output (at a more stable, albeit slightly negative, employment trend). In contrast, the medium-term decline in the productivity position of Torino's industry is due to a largely constant erosion in (relative) efficiency, which in turn is caused by an increasing output growth gap, accompanied by an equally significant (relative) decline in employment. Of the case study metros with more inconspicuous industry productivity trends over the entire period, Warszawa and, to a lesser extent, Riga deserve special mention, as the development in these metros is based on considerable and temporarily co-incident growth leaps in employment and output, which may indicate the impact of major settlements of new companies (such as through FDI) in these regions. Among the remaining case study metros, only Stuttgart shows a comparable (positive) development in both indicators. By contrast, a similarly unspectacular development of industry efficiency in Berlin and Wien was mainly due to both metros lagging behind the average of the metropolitan regions in terms of both employment and gross value added for almost the entire period considered.

Figure 5.5: Differences in industry development by case study metro regions
Cumulative growth differential to the Ø of metro regions in percentage points; 1995-2017



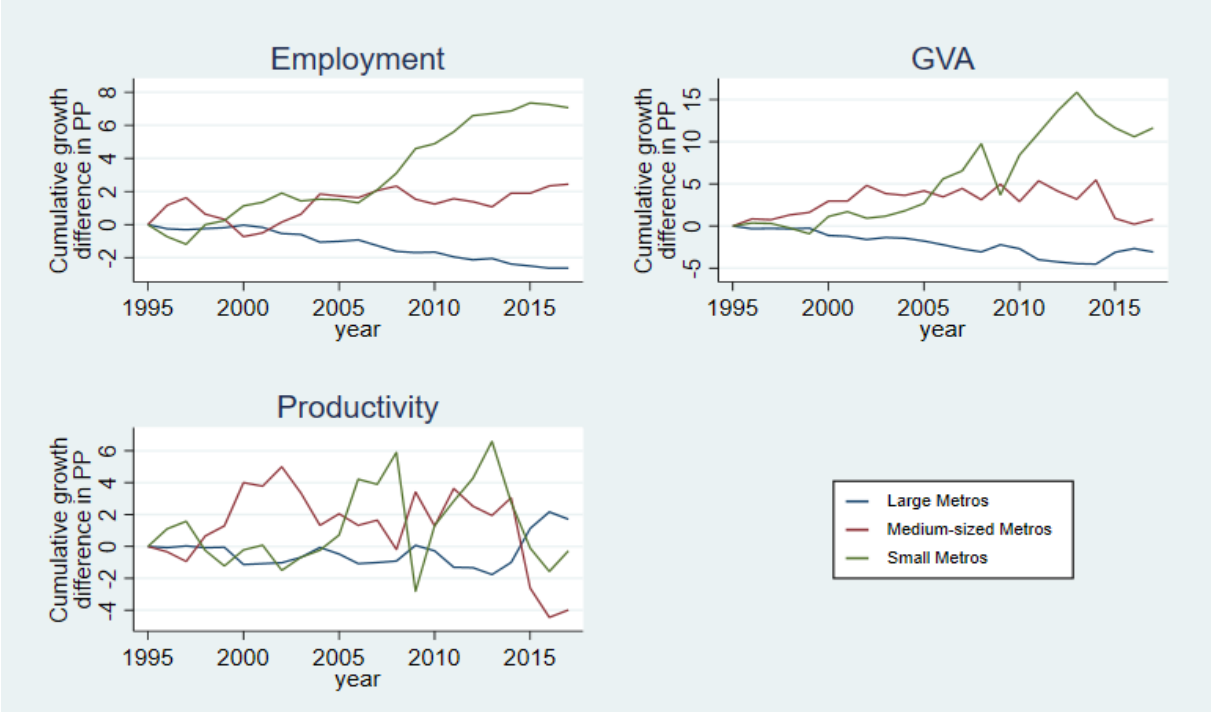
Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

5.1.3 Industry development by type of metropolitan region

While these developments in the various case study metros may have been due to specific influencing factors (e.g., different national or regional policies), a broader analysis of all metropolitan regions shows systematic effects of metro size and economic development level on productivity as well as on employment and output during the period under review. For example, with respect metro size (Figure 5.6) we see a less dynamic development of industry employment and output in large metro regions compared to medium-sized and (above all) smaller ones. This is probably due to disadvantages of the larger metropolitan regions in production costs and/or the handling of bulk goods. In contrast, the pattern of productivity growth is more differentiated and shows no clear relationship across metros of different sizes, which could be an indication of agglomeration economies in efficiency. In fact, despite weaker employment and output development, the productivity evolution of the large conurbations remained barely below that of (the average of) all metro regions over long stretches of the observation period. In the buoyant economy of the last half decade the large metros were even able to significantly increase their (relative) industry productivity. This resulted in a cumulative efficiency growth edge of around 2 pp over the average of the metro regions total (zero-line). In contrast, a mid-term cumulative lead of medium-sized metro regions in productivity growth, which had mainly emerged in the late 1990s, was lost in recent years, as the dynamics of industry employment remained high, while value added developments could not keep up with this. Finally, in the small metro regions a still rather inconspicuous development until the mid-2000s was replaced by an increasing growth lead in industry output and employment thereafter. In productivity terms, this upward trend was accompanied above all by an increase in volatility,

driven by an increased exposure of industry output to the "Great Recession" and an only weak development of this in recent boom years.

Figure 5.6: Differences in industry development by metro region size
Cumulative growth differential to the Ø of metro regions in percentage points; 1995-2017



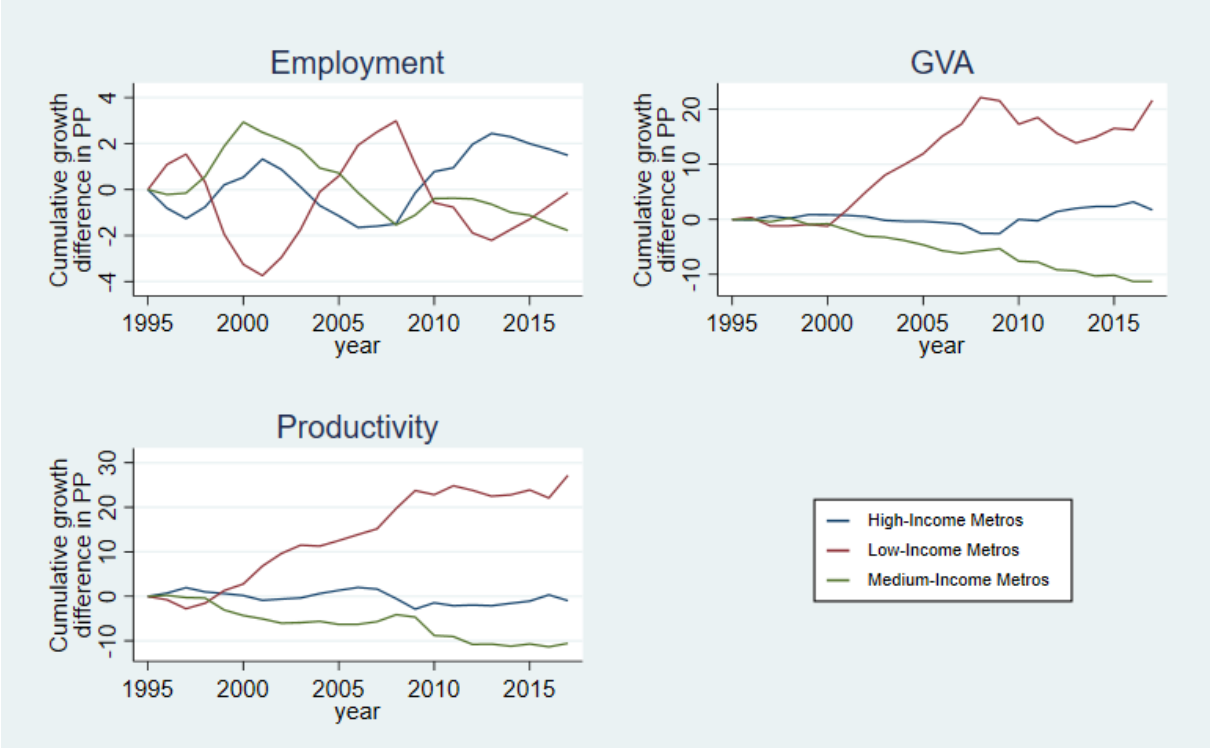
Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

A comparable analysis by metro regions in different income groups (Figure 5.7) indicates a considerable catching-up process of the weakest metro regions in industry productivity. At the same time, as recently also recognized in the latest EU cohesion report (*European Union*, 2017), disadvantages of metro regions with a medium economic development level become apparent[36]. While in high-income metros productivity developments and the underlying output and employment trends were in line with all metro regions in Europe, for the medium-income metro regions we find a continuous (relative) erosion of their industry productivity position. This was driven by comparatively high employment dynamics in the first half of the observation period, and a relative deterioration of industry output in the "Great Recession" and beyond. While this may indicate rising problems of the Southern European metros in the macroeconomic imbalances since the turn of the millennium, the remarkable improvement of industry in the low-income metros is probably due to the largely successful transformation process of the new member states and their urban centres from the mid-1990s on. Indeed, we find a rising growth advantage of the low-income metros in industry productivity that peaked at more than +20 pp before the "Great Recession" and remained rather stable in the years thereafter. This lead was built up by labour shedding until the early 2000s, but later by higher output growth. After the

[36] In literature this is discussed under the catch word of a "middle income trap" (see *Gill – Kharas,* 2015 and *Glawe – Wagner,* 2016) for recent surveys.

crisis, growth advantages in industry output in this metro region type declined noticeably, as did the employment growth advantage. Nevertheless, the cumulative growth advantage of the low-income metro regions was maintained until the end of the period.

Figure 5.7: Differences in industry development by metros income (GDP per capita)
Cumulative growth differential to the Ø of metro regions in percentage points; 1995-2017



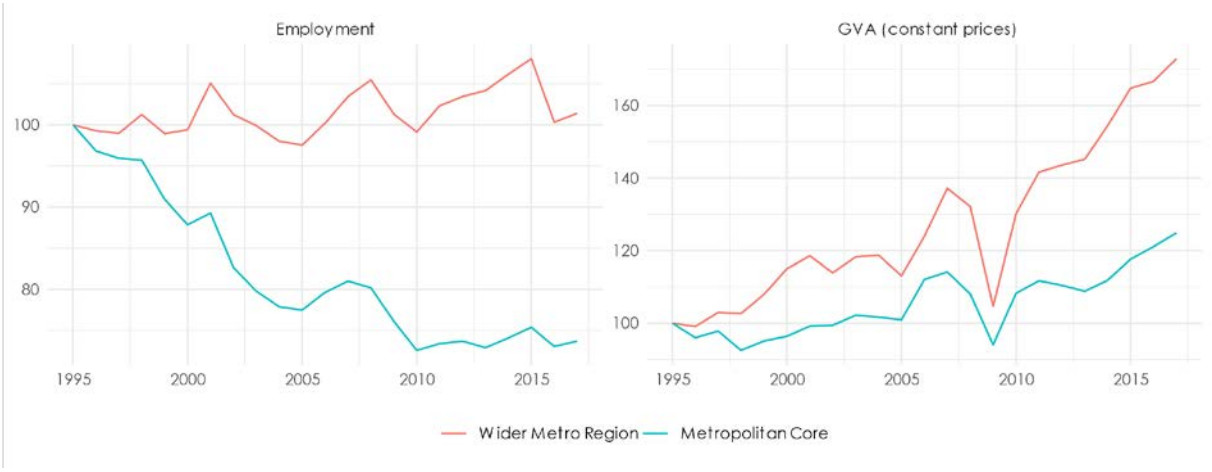
Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

5.1.4 Disparities between core metros and surrounding regions?

Next to these differences between metro regions of different sizes and income levels, previous literature also suggests a substantial differentiation of industry developments in core metro regions and their environs. According to this industrial growth should primarily occur in the metro environs. With respect to this question our data can provide information on intra-metropolitan long-term trends for those European metropolitan regions that consist of at least three NUTS-3 regions[37]. This reduces our sample to 52 (larger) European metro regions, including 4 of the 7 case study metros of the present ESPON-project.

[37] This is necessary to allow for a clear distinction between the core and the wider metro region.

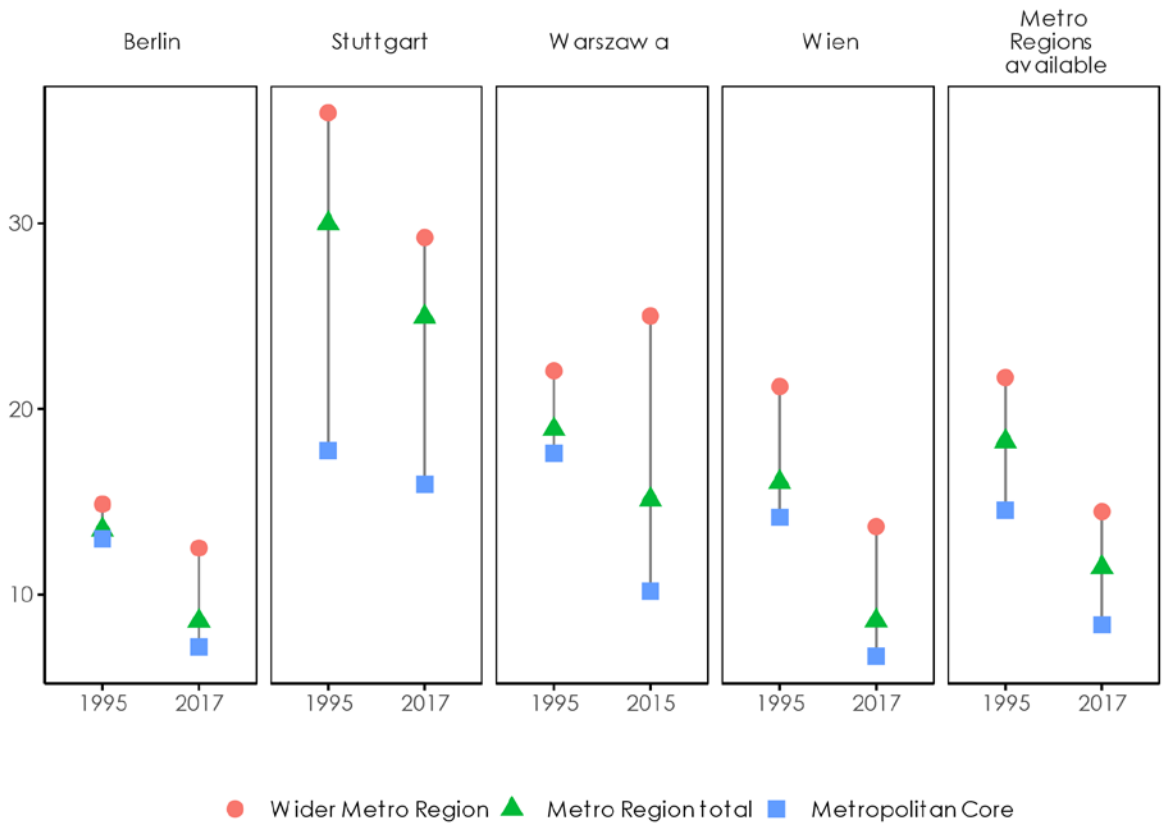
Figure 5.8: Development of industry in core and wider metro region
(52) European metro regions with at least 3 NUTS-3-Regions; 1995=100



Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

Figure 5.8 shows the results of an analysis of the intra-metropolitan trends in all (52) metro regions analysable in terms of employment and gross value added. It illustrates the clearly more favourable development of industry in the wider metro regions compared to the metropolitan. This reflects the better location conditions for (large-scale) productive activities in the former. In detail these results show that industry employment (left panel) in the metro cores declined significantly over the first decade of the observation period, with a considerable cumulative loss of industrial jobs of about -22.5% from 1995 to the mid-2000s. However, this downward trend then gives way to a rather stable employment trend (apart from the effects of the "Great Recession" of 2009/10) even in the metro cores – a situation as seen in the wider metropolitan region over the entire period (1995 to 2017, +1.4%). For industry value added (right panel), the trend for both the core-metros as well as their environs is substantially more favourable. However, a slight increase in output in the core regions is accompanied by a significantly higher growth in the wider metro regions, with this growth advantage increasing even further, especially after the "Great Recession".

Figure 5.9: Intra-metropolitan differences in the importance of industry: Employment share 52 European metro regions with at least 3 NUTS-3 regions, 1995 and 2017

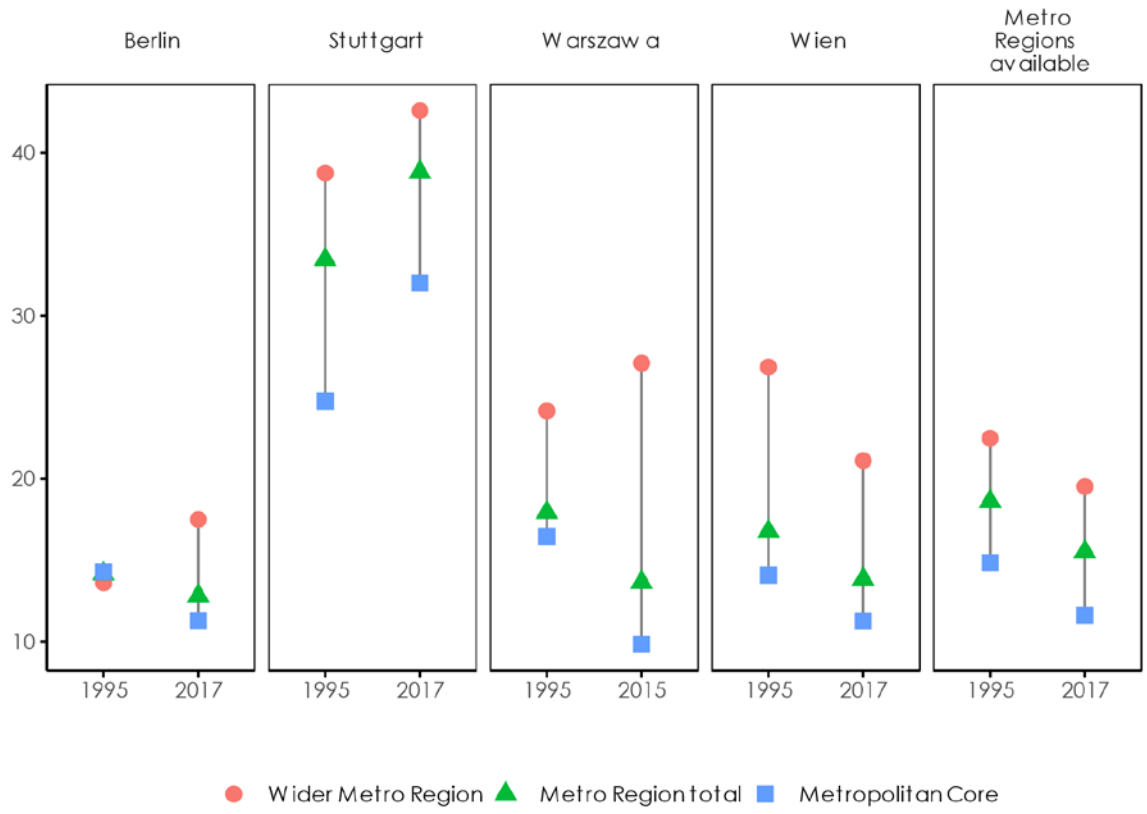


Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

While, according to these results, industry development in the wider metro regions was apparently more favourable than in the metro cores, industry also lagged the rest of the economy in employment as well as output in both sub-regions. Therefore, the industry shares in metro cores and their environments fell equally according to both indicators. This can be seen in Figure 5.9 (for employment) and Figure 5.10 (for output), which show the industry shares in the metropolitan cores and their surroundings for all metro regions as well as the 4 case study metros for which data are available.

According to Figure 5.9, the industry shares of employment in the (52) metro regions that can be evaluated fell considerably between 1995 and 2017, from 18.3% to 11.5% respectively. Thereby, as expected, the industry shares in the cores (squares) are significantly lower than in the wider metro regions (circles), while the two sub-regions hardly differ in the decline in this share in the period observed (core regions from 14.5% to 8.4%, wider metro regions from 21.7% to 14.5%). So, it is by no means only the densely populated core areas of the metro regions that experienced de-industrialisation in employment during the period under review, but also their wider environs.

Figure 5.10: Intra-metropolitan differences in the importance of industry: GVA at constant prices Industry share in 52 European metro regions with at least 3 NUTS-3 regions, 1995 and 2017



Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

This observation also applies to the observable case study metros, although their spatial development patterns within metro regions differed substantially. While the spread in the employment share between core and wider metro region was largely stable in Wien and even decreased in Stuttgart due to a better industry development in the metro core between 1995 and 2017, Berlin and especially Warszawa experienced a rising differentiation in industry orientation between the two sub-regions, with the Polish capital the only case study metro with an increasing employment share of industry in the wider metro region.

Measured in gross value added (Figure 5.10), an increasing industry share in the wider metro region is a more common result in our case study metros and can be seen in Berlin, Warszawa and Stuttgart. However, only in the latter this share also increased in the core, so that (only) in Stuttgart an already high specialisation in industry has continued to increase from 1995 to 2017. In fact, intra-regional developments in the case study metros were quite heterogenous, also measured in terms of output in the period observed, with a rising spread between metro core and wider metro region in Berlin and Warszawa and a shrinking differential in Wien (due to a particularly unfavourable development in the surroundings) as well as in Stuttgart (due to a particularly favourable development in the core).

In all metro regions available (right panel), the share of industry decreased slightly also in terms of output on average, with both cores and their surrounding areas responsible for this. Finally,

when comparing Figure 5.9 and 5.10, we see that the industry share is consistently higher in GVA than in employment in all the sub-regions distinguished, and that this also applies to the change in these shares. This again speaks for higher productivity levels as well as productivity growth in industry compared to other sectors.

Table 5-3: Intra-metropolitan development in industry
52 European Metro Regions with at least 3 NUTS-3 regions; 1995-2017, in % p.a.

	Employment			GVA at constant prices (2015)		
	1995-2000	2000-2008	2008-2017	1995-2000	2000-2008	2008-2017
Berlin	–3.0	–2.2	+0.5	+0.6	+1.1	+0.8
Metropolitan Core	–4.1	–3.0	+0.3	–1.5	+0.9	+0.0
Wider Metro Region	–0.6	–0.8	+0.8	+8.0	+1.8	+2.8
Stuttgart	+0.4	–0.8	+0.4	+1.9	+1.7	+3.3
Metropolitan Core	+1.8	–1.7	+1.1	+2.1	+1.8	+3.7
Wider Metro Region	+0.0	–0.5	+0.3	+1.8	+1.7	+3.2
Warszawa	–0.7	+5.4	–1.0	+1.0	+3.9	+5.2
Metropolitan Core	–2.2	+3.2	–2.9	–0.6	+3.5	+2.8
Wider Metro Region	+2.0	+8.4	+0.9	+5.0	+4.8	+9.2
Wien	–3.0	–2.0	–0.9	–0.6	+1.1	+0.3
Metropolitan Core	–3.5	–2.7	–1.5	–2.6	+1.0	+0.4
Wider Metro Region	–2.2	–0.9	+0.0	+2.9	+1.3	+0.1
Metro Regions available (52)	–1.8	–1.4	–0.6	+1.0	+0.7	+1.6
Metropolitan Core	–2.4	–1.5	–0.9	–0,1	+1,1	+1.2
Wider Metro Region	–1.4	–1.4	–0.4	+1.8	+0.5	+1.9

Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

Considerable productivity gains in industry, largely independent of the (sub-)areas of the metropolitan regions analysable, are ultimately also evident from Table 5.3. It shows the development of industry in employment and value-added *levels* (instead of shares) in the two sub-spaces of the metro regions and case study metros observable for different sub-periods. Several stylised facts become apparent: First, the development of industry output was (except from Warszawa in 2000 to 2008) almost consistently more favourable than that of industry employment (indicating substantial productivity gains), irrespective of the (sub-)region and the time period under consideration. Second, industry development was consistently more favourable in the wider metro regions than in their cores (except from Stuttgart), irrespective of the indicator used and the time period observed. Finally, industrial development improved over time, and this largely independent of the indicator used and the (sub-)region considered as well.

5.2 Main take-aways

1. **Industrial employment and production development in metro regions improved substantially in the recent decade**. Over the period 1995 to 2017 both employment and GVA share of industry declined in all European major metropolitan regions. This was most dramatic in terms of employment and resulted in only 10.4% of all employed

still work in industry in metro regions in 2017. Since the turn of the century and even more clearly since the “Great Recession”, however, this decline gave way to a more stable development.

2. **During the de-industrialisation phase in the 1990s industry employment levels in metro regions reduced substantially. Output, by contrast, continued to increase**. Although there has been a clear downward trend in industry (i.e., NACE sectors B to E) employment in most European urban areas developments in terms of GVA were less uniform and were strongly influenced by metro characteristics, with some metros actually expanding the industrial output share.
3. **The data impressively confirm the role of industry as a "productivity machine" especially for metropolitan regions.** While cumulative productivity gains in industry over the period 1995 to 2017 (measured in constant prices and per employed person) amounted to +70.1% in the major metro regions, +64.4% in the other metro regions and +59.7% in all NUTS-3 regions of the EU and Norway, the corresponding figures for the respective economies as a whole (including services) were much lower at +24.3%, +27.1% and +28.7%. Thereby the productivity lead of industry over the economy total is particularly large in the major metro regions (+€ 22.711 or +31.5%)
4. **Production is favouring urban fringes.** Within metropolitan regions, industry developed more favourably in the wider metro environs than in the metropolitan core metros, reflecting better location conditions for (large-scale) productive activities in the former. Over time, intra-metropolitan specialisation apparently increases alongside the advantages of the metro centres for knowledge-intensive services and of the wider environs for industry production proper. Despite this, metro regions remain to be central locations for modern industry as they integrate service and manufacturing functions in an environment where industry is using increasingly "hybrid" and servo-industrial production methods.
5. **There is substantial heterogeneity in the development of industry among metro regions.** The different industry developments in different metropolitan areas identified in this section are reflection of different respective locational (dis-)advantages of these regions. According to our results, larger metro regions and those in the EU15 were more exposed to a downward trend in employment.

6 The causes of employment changes in metro regions: De-industrialisation or "up-grading"

6.1 A methodology to decompose industrial employment change

These facts lead directly to the question to which degree the productivity dynamics of industry in urban regions have influenced or even caused the overall rather unfavourable industry employment trends. This Chapter addresses this question using an analysis, which decomposes the overall employment changes in industry into four components that are related to (1) sector specific output developments; (2) productivity gains; (3) the aggregate performance of the respective region; and (4) overall national developments. It therefore contributes to the ongoing discussion on the determinants of de-industrialisation, by distinguishing different "types" of industry development at the level of metropolitan regions depending on the importance of these determinants.

The starting point of our approach is a two-way decomposition of industry employment change, proposed by *Tregenna* (2009) and used for an analysis of de-industrialisation at the country level. Its basic idea is that the employment level (*L*) in a sector *i* (here: industry) of region *j* at time *t* is, by definition, given as the product of the labour intensity (as the inverse of productivity) in this sector (φ_{ijt}) and its value-added level (Q_{ijt}):

(1) $$L_{ijt} = \varphi_{ijt} Q_{ijt}; \text{ whereby } \varphi_{ijt} = \frac{L_{ijt}}{Q_{ijt}}.$$

This implies that changes in industry employment can be attributed to effects from changes in sectoral labour intensity (as the inverse of productivity; Equation 2, first term on the right) and from changes in industry output (as an indicator for the performance of the sector; Equation 2, second term on the right):

(2)

$$\Delta L_{ij} = \varphi_{ijt} Q_{ijt} - \varphi_{ijt-h} Q_{ijt-h} = \underbrace{(\varphi_{ijt} - \varphi_{ijt-h})\left(\frac{Q_{ijt-h}+Q_{ijt}}{2}\right)}_{Productivity\ growth\ effect} + \underbrace{(Q_{ijt} - Q_{ijt-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)}_{GVA\ growth\ effect}.$$

This approach requires improvement in two aspects if it is to be applied to data to metropolitan regions. Firstly, in a growing economy, an increasing industry output is not a good indicator of industrial success. Rather, an increasing output *share* of industry would be an indication of industrial prosperity, while an unfavourable development of industry would be reflected in a decrease in this share. Secondly, the performance of industry at the level of individual metropolitan regions is additionally influenced by the growth of the metro economy and the

respective country in total[38]. We take these points into account by expanding the two way to a 4-way decomposition and defining:

(3) $$L_{ijt} = \varphi_{ijt}\delta_{ijt}\varepsilon_{jt}Q_t \text{ ; whereby } \varphi_{ijt} = \frac{L_{ijt}}{Q_{ijt}};\ \delta_{ijt} = \frac{Q_{ijt}}{Q_{jt}};\ \varepsilon_{jt} = \frac{Q_{jt}}{Q_t}.$$

Here, the employment level in industry in each of the individual metro regions is equal to the product of 4 components:

- The labour intensity (i.e., the inverse of labour productivity) in industry (φ_{ijt});
- The share of industry in metropolitan value added (δ_{ijt}) as an indicator of the performance of industry in the respective metro region;
- The value-added share of the metro region in the economy of the respective country (ε_{jt}) as an expression of the strength of the metro region in a national context; and
- The output (Q_t) of the country as a proxy for the strength of the national economy.

Hence, in the decomposition of industrial employment *change*, 4 influencing factors, which in a normalised form add up to the respective percentage change in industry employment, can be considered[39]:

1. A *"*labour intensity effect", which, as before, indicates the change in industry employment that is associated with a change in labour intensity in the sector (and thus in industry productivity growth). In a normalised form, this component shows the *contribution of efficiency increases (and thus "industrial up-grading") to the industry employment change* of the metro region considered in percentage points.
2. A "sector share effect", which maps industry employment evolutions based on changes in the output share of industry in a metro region, such as indicating a weak or strong performance of the industry sector in the metro under review. In a normalised form, this component thus shows the *contribution of "real" de-industrialisation to industry employment change* in the metro region considered in percentage points.
3. A "metro share effect", which measures the change in industry employment that is related to shifts in the share of the metro region in national value added. In a normalised form, this component reflects the *contribution of the performance of the metro region to the change in its industry employment* in percentage points.
4. An "economic growth effect", which results from the value-added growth of the national economy in which the metro region under review is embedded. In a normalised form, this component reflects the *contribution of the respective country growth to industry employment change* in the metro region considered in percentage points.

[38] The (net) effects from the development of the metropolitan as well as the national economy on the employment dynamics in a metro region's industry can only be determined empirically due to potentially opposing influences: From a demand-side perspective, a positive correlation between these developments and industry employment is likely as an upward trend of the (local and/or national) economy total leads to increased demand for industrial products from consumers and firms. However, the sign of supply-side effects is less clear: On the one hand, a good economic development can lead to a deeper and broader supply of inputs and complementary services that metropolitan industry needs to produce and prosper. On the other hand, a booming metropolitan and/or national economy may result in higher wages, which in turn may reduce incentives to create jobs in industry. Our decomposition approach can reveal which of these influences is dominant.

[39] See the annex to chapter 6 for a derivation of these components of industry employment change.

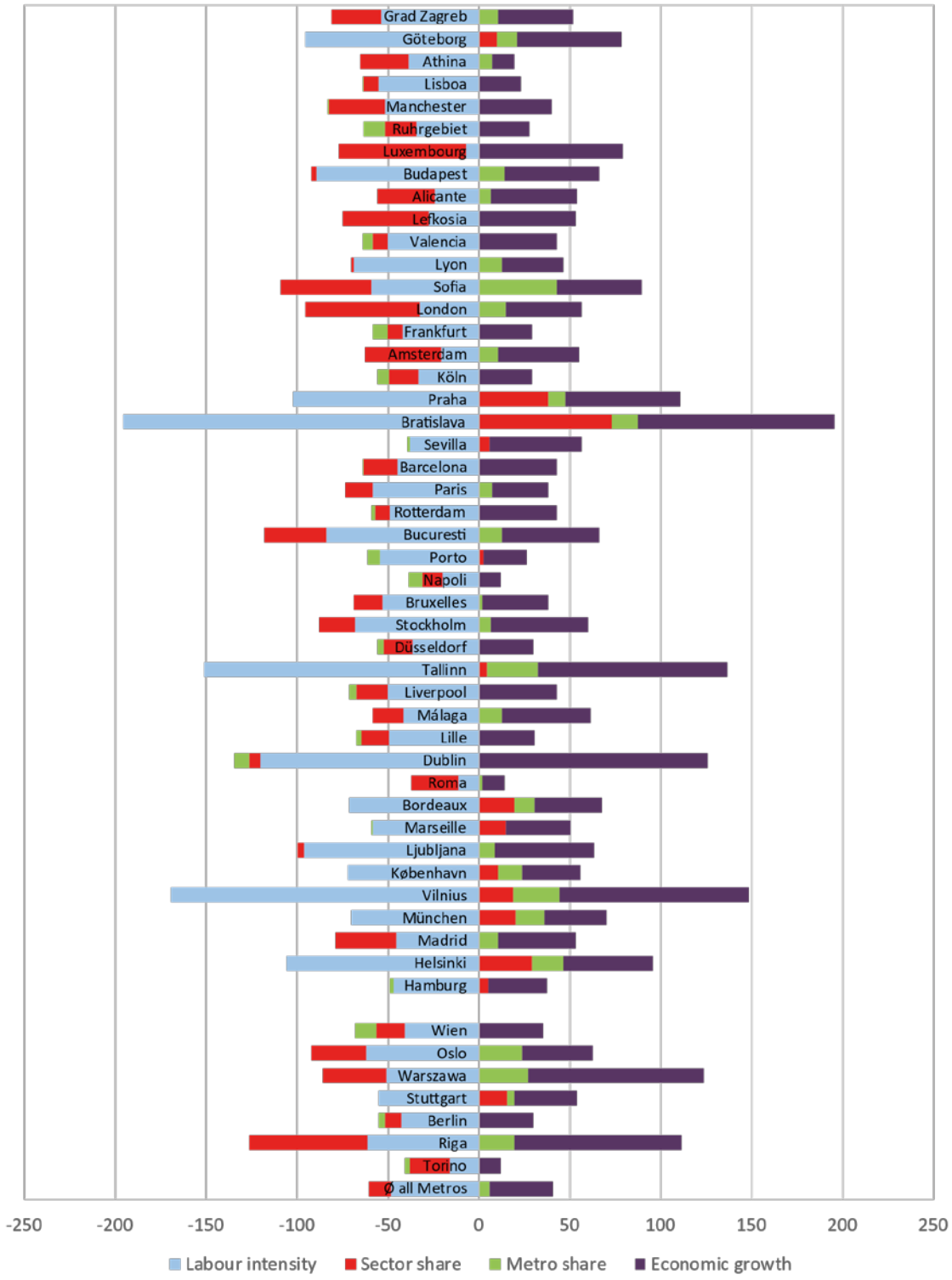
6.2 The factors influencing employment growth in Industry

The results of this analysis (in Figure 6.1) for the years 1995 to 2017 suggest that there are considerable differences in the determinants of employment change between the individual metro regions, but also remarkable regularities. In particular:

- A positive "economic growth effect" (dark purple) can be identified for all major metro regions. This is not surprising because the economies of the EU countries have grown on average over the last quarter century without exception. The magnitude of this effect is in many cases quite considerable. This highlights the importance of the national economic environment for regional industry development.
- More importantly also that the "labour intensity effect" (light blue) is negative throughout and large in most metro regions. This indicates that productivity evolutions play a decisive role in the development of industry jobs in urban agglomerations. Here, too, the differences by metro regions are considerable, with a particularly large (negative) contribution to industry employment change in the agglomerations of the central and eastern European countries, where economic restructuring during the first years of transition to market economies involved significant labour shedding.
- Neither the "sector share effect" (red) nor the "metro share effect" (green) follow a single trend. In some metro regions, a favourable development of the industry sector in terms of its output contributes to employment in the production of tangible goods (positive sector share effect), while in other metros (the majority) industry employment losses (also) result from this "real" de-industrialisation. Similarly, the dynamism of the metro environment supports the development of industry employment in some metro regions, while it clearly curbs it in others.

Aside from this, the overall picture is very heterogeneous, however. Industry development is thus not as uniform even in the major metro regions (as a rather homogeneous "region type") as it may first. This obviously also applies to the case study metros of our project, whose results regarding the components of industry employment change are shown in the lower panel of the figure and are presented in detail in Table 6.1.

Figure 6.1: Components of employment change in metropolitan industry: individual major metro regions 4-way-decomposition, 1995-2017; contributions of the different components in percentage points



Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

These results show that the major metro regions as a group lost on average a quarter (–25.3%) of their industry jobs since 1995. With a contribution of –49 pp, this was mainly due to productivity gains (from labour-saving innovations) and only to a lesser extent to "real" de-industrialisation (from a shrinking industry sector in terms of output; –18.5 pp). The erosion of

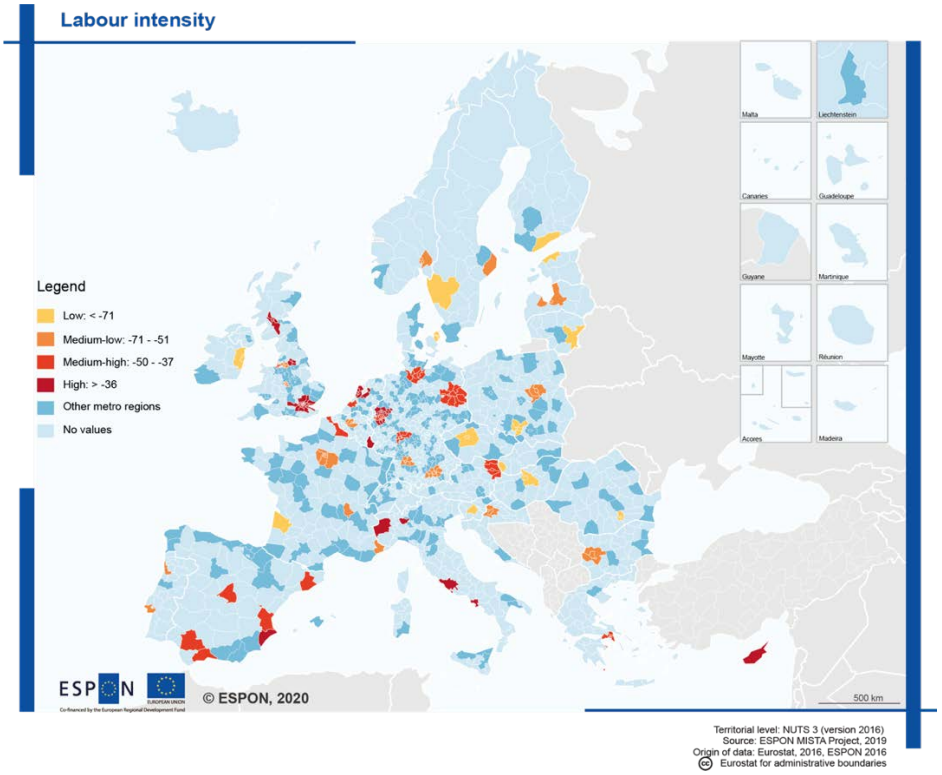
industry employment was dampened mainly by positive stimuli from a growing national economy (+34.2 pp), but also by specific impacts from the performance of the respective metro region, contributing +8.2 pp to industry employment change on average.

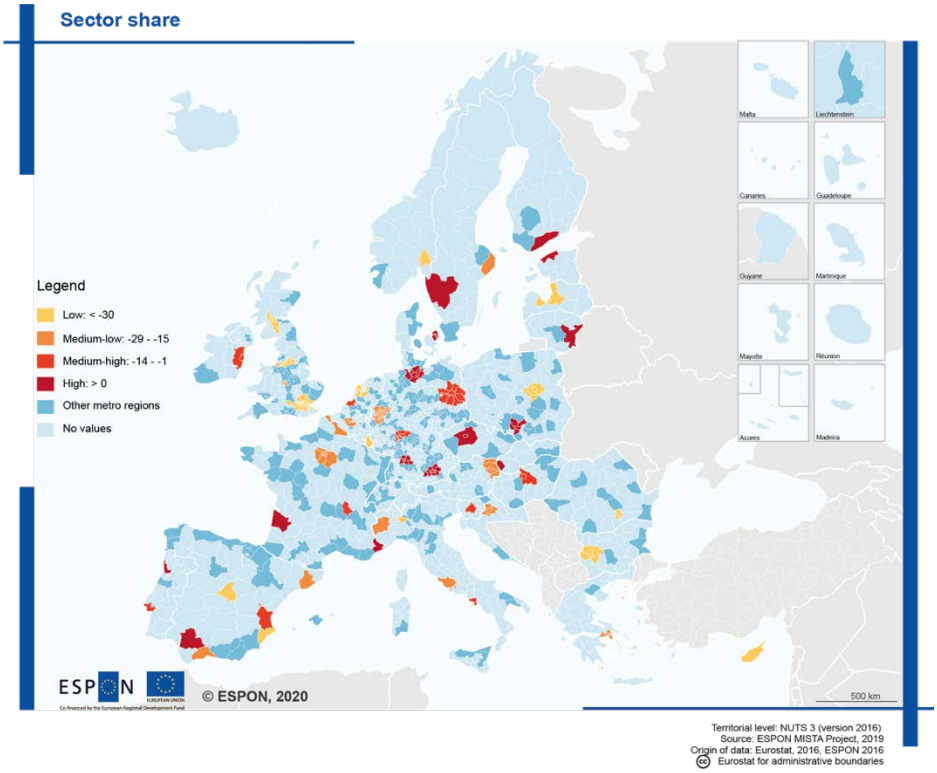
Table 6-1: Components of employment change in metropolitan industry: 7 case study metro regions
4-way-decomposition, 1995-2017; cumulative change in %, contributions of the different components in percentage points

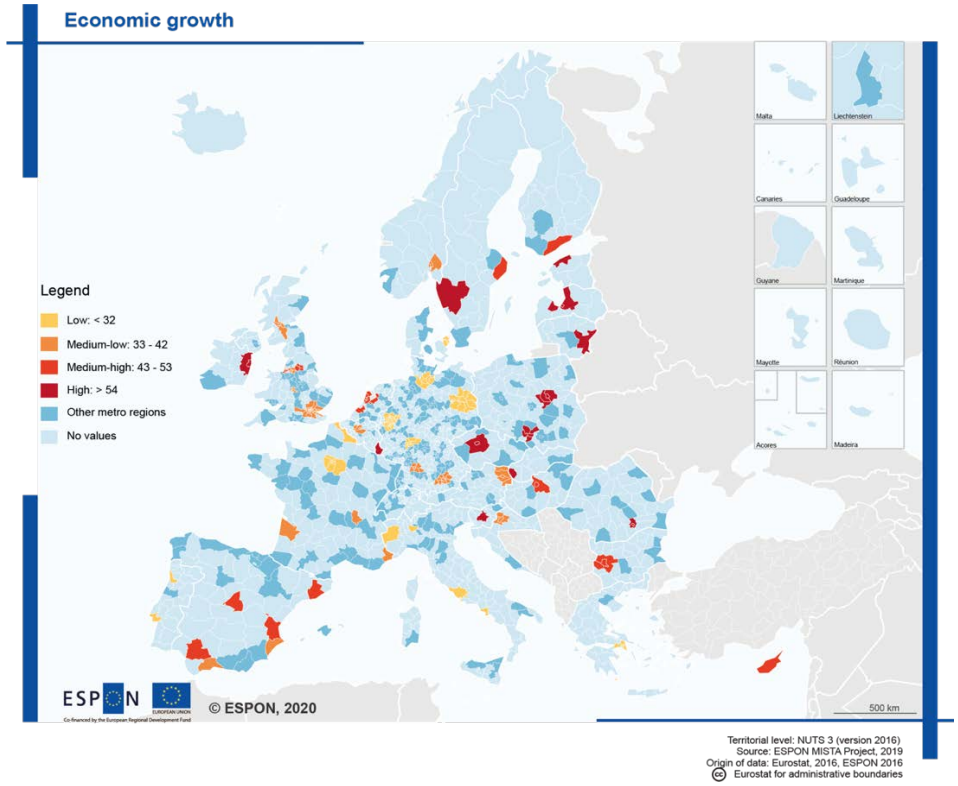
	Employment Change (%)	Contribution to Employment Change of …. (percentage points)			
		Productivity growth	"Real" de-industrialisation	Performance of Metro Region	Country growth
Major Metros	–25.3	–49.2	–18.5	+8.2	+34.3
Berlin	–25.1	–42.9	–9.0	–3.2	+30.0
Oslo	–28.9	–62.0	–29.8	+24.0	+38.8
Riga	–14.4	–60.9	–65.3	+19.6	+92.3
Stuttgart	–0.6	–54.7	+15.4	+4.5	+34.1
Torino	–28.2	–15.7	–22.1	–2.4	+12.1
Warszawa	+37.6	–50.7	–35.3	+27.0	+96.6
Wien	–32.6	–40.3	–16.3	–11.4	+35.5

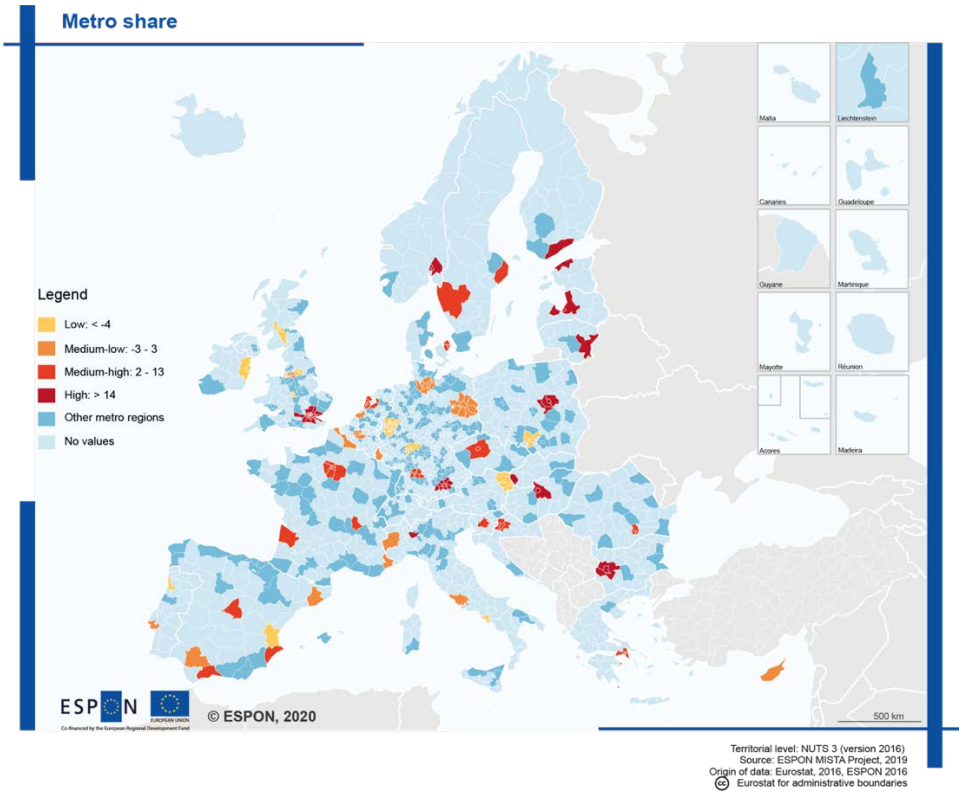
Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

Map 6-1/6-4: Components of employment change in metropolitan industry: 7 case study metro regions 4-way-decomposition, 1995-2017; cumulative change in %, contributions of the different components in percentage points







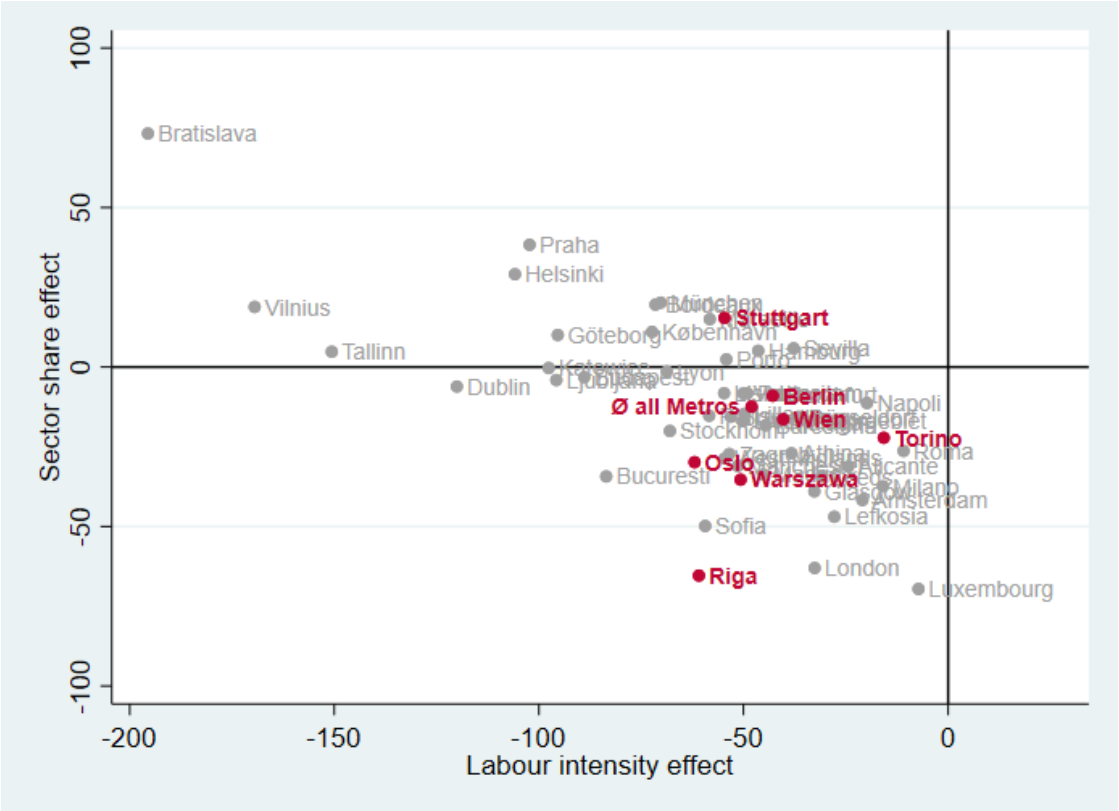


Source: ESPON MISTA (2020).

The development in the individual case study metros was similar to this benchmark only in so far as the largest contributions to the change in industry employment typically result from productivity gains (negative) and national economic growth (positive). In detail, however,

industry employment trends and their determinants were by no means uniform between the project's case study metros: While Warszawa had suffered substantially under the crisis triggered by the polish shock therapy during transition from planned to a market economy and was thus was able to significantly expand its industry employment in the subsequent two decades, Stuttgart lost hardly any industry jobs since 1995, By contrast, the reductions in Torino, Oslo and Wien were larger than in the average of the major metro regions. Thereby the outstanding employment trend in Warszawa and also the only mild job losses in Riga were mainly due to a higher national growth and its concentration in metro regions in the new EU member states (in part caused by the rebound from the transition crisis). These effects (over-)compensated for above-average efficiency gains, but also for a comparatively strong decline in the industry output share in these metros, driven by a catch-up of hitherto underrepresented service sectors.

Figure 6.2: Contribution of labour intensity- and sector share effect to industry employment change
4-way-decomposition; major metro regions, in percentage points



Source: ARDECO database (JRC/EC); ESPON MISTA (2020).

Among the EU15 case study metros, the healthy development of Stuttgart's industry employment, despite high productivity gains and inconspicuous contributions from national and regional growth, can be attributed to Stuttgart being the only case study metro that managed to further expand a high industry orientation in its economic base in 1995 to 2017. In Berlin, too, "real" de-industrialisation played a minor role in determining the moderate industry employment trend. Productivity gains were more important, accompanied by a comparatively weak

development of the urban economy total, which thus had a slightly negative impact on the industry employment change in the region. This was also true for Torino and Wien, whereby in the latter a weak performance of the metro economy was particularly responsible for an above-average labour shedding in industry since the mid-1990s. On the other hand, a similar development in Torino was led by a flat growth path of the Italian economy, a problem that was compounded by the fact that only in this case study metro employment losses were caused more by "real" de-industrialisation than by productivity gains. In contrast, Oslo as the only extra-EU case study metro combined striking productivity gains and significant de-industrialisation phenomena. These resulted in a clear downward trend in industry employment, which was, however, limited by a high performance of the metro economy total and an above-average growth of the Norwegian economy.

Further findings can be obtained by a graphical analysis of the components of industry employment change in the individual major metro regions. To this end, Figure 6.2 plots these metro regions in a coordinate system with the "labour intensity effect" (as the impact of productivity growth on industry employment change) on the horizontal and the "sector share effect" (as the impact of "real" de-industrialisation on this change) on the vertical axes. This shows that there is not a single major metro region in Europe that combines a growing industry sector and an increasing labour intensity, such as productivity losses (northeast quadrant). There is also a lack of metro regions characterised by a particularly unfavourable combination of "real" de-industrialisation (i.e., a negative sector share effect) on the one hand, and a declining efficiency (i.e., a positive labour intensity effect – south-eastern quadrant). Rather, all metro regions show a negative labour intensity effect, which once again indicates that productivity gains contribute massively to the development of industrial employment.

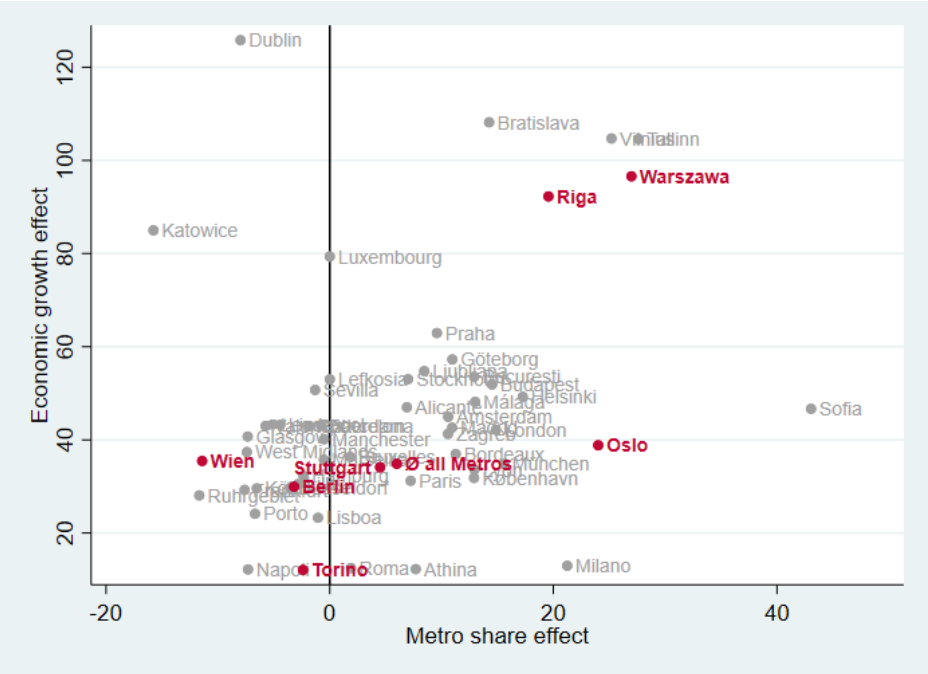
The contribution of the sector share effect, such as (de-)industrialisation to industrial employment change, obviously varies greatly between the metro regions considered, however. On the one hand, we find a group of metro regions in which the output share of industry continues to rise (north-western quadrant). In these cases, a negative industry employment trend does not mean "de-industrialisation" in the literal sense of the word, as job losses in a favourable industry development (measured in terms of output) are caused solely by efficiency gains. This in particular applies to some metro regions in the EU13 countries, but also to a handful of metro regions in the EU15, namely successful centres in northern Europe and Germany, including Stuttgart as the only case among the project's case study metros.

By contrast, most of the major metro regions (as well as their weighted average) are to be found in the south-western quadrant of our figure. This means that they combine industry employment losses from productivity gains with an industry sector that is also shrinking in terms of output

(i.e., "real" de-industrialisation). Apart from Munich, this applies not least to all really "big" metro regions in Europe as well as to most of the project's case study metro regions[40].

Figure 6.3 shows an analogous mapping for the remaining (2) components of our 4-way-decomposition. Here the "economic growth effect", representing the contribution of national growth to industry employment change, is quantitatively significant for the overall results, but requires little interpretation because it essentially depicts differences in the economic development of the countries in which the metro regions are located[41]. More interesting is the metro share effect, which (with less significance for the overall result; note the scaling of the axes) varies greatly between the major metro regions and the project's case study metros.

Figure 6.3: Contribution of metro share- and economic growth effect to industry employment change
4-way-decomposition; major metro regions, in percentage points



Source: ARDECO database (JRC/EC); ESPON MISTA (2020) calculations.

Here a favourable economic trend of the metro's total economy has made a positive contribution to industry employment change in the narrow majority of the metro regions considered, especially in those of the EU13 countries (including Warszawa and Riga). However, there are also metros from north-western Europe (including Oslo) and even "large" and "rich" metros such as London, Brussels, Paris or Milan in the north-eastern quadrant – metro regions that have developed into "growth engines" of their national economies during the period under

[40] The particularly negative sector share effects in Warsaw and Riga were probably due less to a shrinking industry competitiveness than to a particularly good performance of the regional service sector (see above).

[41] Both southern quadrants of Figure 6.2 are empty. This means that all EU countries' economies grew in 1995-2017 and therefore contributed positively to the major metro regions industry employment change.

review. On the other hand, we also find a substantial number of metro regions where industry employment change was hampered by a weak urban economy (north-west quadrant). This applies not the least to some industry towns with structural problems (e.g., British metros, the Ruhr area etc.), but also to large (case study) metro regions like Wien, Berlin and Torino. These results show that the development paths of industry employment in the major metro regions in general and the case study metros of the current project in particular are almost consistently determined more by efficiency gains (and thus by "industrial upgrading") than by a widespread erosion of the industry base (and thus "real" de-industrialisation) – a finding that can certainly be seen as positive with regard to the perspectives of these metros industry in locational competition.

6.3 Differences between metro types

Extending our analysis to the broader sample of all (289) European metropolitan regions yields similar findings. In addition, this allows some key insights into the mechanisms behind metropolitan industry evolutions by metro region types (Table 6.2). According to this extension all (289) metro regions on a weighted average lost 19.5% of industry employment in 1995 to 2017. This is slightly less than in the (typically larger and "richer") sub-group of the major metro regions analysed above. This can primarily be attributed to a greater (negative) contribution of "real" de-industrialisation in the latter, which is not entirely offset by slightly larger positive effects stemming from overall metro growth. However, also in the full sample of the (289) metropolitan regions the (negative) contribution of productivity increases the overall result, while a relevant effect from the respective country's growth impacts positively to industrial employment change since the mid-1990s.

Concerning the different metro region groups, there are some regularities, but also differences: first, a positive contribution from the respective country's growth (the "economic growth effect") is ubiquitous across all metro groups tested. This, however, only indicates that (all) EU countries have grown over the last quarter-century, albeit with a considerable growth bonus for the EU13. More importantly for the contribution of productivity growth ("labour intensity effect") is large and negative for all metro region groups. This again indicates that efficiency gains played a key role in the downward employment trend of industry in the European metro regions from the mid-1990s, largely irrespective of metro characteristics. At the same time, also "real" de-industrialisation (as a shrinking industry share in value added; "sector share effect") contributed negatively to employment evolutions in most of the metro region groups. However, its impact is much smaller than that of efficiency gains in all groups distinguished, indicating that it was industrial upgrading (such as improvements in technology or production processes) rather than "real" de-industrialisation that drove the erosion of metropolitan employment in industry in 1995 to 2017. Finally, the contribution of the performance of the metro region ("metro share effect") was mostly positive and seems to increase with the size of the respective metro region group, which is suggestive of the relevance of agglomeration economies for productive activities in (large) metro regions.

Table 6-2: Components of employment change in metropolitan industry: by metro region groups 4-way-decomposition; 289 European metro regions, 1995-2017; cumulative change in %, contributions of the different components in percentage points

	Employment Change (%)	Contribution to Employment Change of …. (percentage points)			
		Productivity growth	"Real" de-industrialisation	Performance of Metro Region	Country growth
All Metros	–19.5	–48.0	–12.3	+6.0	+34.9
Major Metros	–25.3	–49.2	–18.5	+8.2	+34.3
Capital Metros	–26.5	–53.3	–22.6	+12.8	+36.6
2nd Metros	–22.3	–50.1	–11.6	+2.4	+36.9
Lower tier Metros	–14.1	–44.4	–3.9	–0.9	+35.1
Large Metros	–22.1	–48.2	–15.3	+7.7	+33.7
Medium-sized Metros	–17.1	–46.5	–12.1	+4.0	+37.5
Small Metros	–12.4	–49.8	+2.0	+0.2	+35.1
High-Income Metros	–18.0	–48.0	–15.0	+9.5	+35.6
Medium-income Metros	–21.3	–41.3	–11.5	–1.6	+33.1
Low-income Metros	–19.6	–62.5	–1.0	+6.3	+37.6
Service-based Metros	–27.6	–47.8	–22.2	+6.2	+36.1
Mixed-based Metros	–22.4	–45.5	–12.9	+1.6	+34.4
Industry-based Metros	–10.0	–56.9	+5.7	+7.5	+33.7
EU15 Metros	–19.8	–44.7	–13.4	+4.4	+33.9
EU13 Metros	–19.1	–97.3	–2.5	+1.0	+79.6

Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

Other metro group differentials mostly correspond to theoretical expectations but are in parts also surprising: As expected, industry employment losses were larger in capital metros, large metro regions and (consequently) the major metro regions compared to the respective reference groups. This was due to a significantly larger (negative) contribution from "real" de-industrialisation (the "sector share effect"), that was not compensated fully by a highly positive contribution of the performance of the respective metro region's economy (the "metro share effect") in these groups. By contrast, the decrease in industry employment was surprisingly similar in high- and low-income metro regions as well as in metros of the EU15 and the EU13 respectively. This, even though low-income and (above all) EU13 metros have received a greater boost from national economic growth ("economic growth effect") and, in addition, were barely confronted with any "real" de-industrialisation phenomena ("sector share effect"). The reason for this is a much larger negative contribution of productivity gains ("labour intensity effect") in these metro groups – a fact that indicates substantial catching-up processes of these initially less competitive metro types over the last decades. Finally, it is striking that despite higher productivity gains, industry-based metros were much less affected by industry employment losses than those with a mixed or service-oriented economy. This is because these metros, unlike all other metro region groups (apart from small metros), have been able

to even expand their industry in terms of output (positive "sector share effect") and in addition received a relevant impetus from a growing local economy (positive "metro share effect").

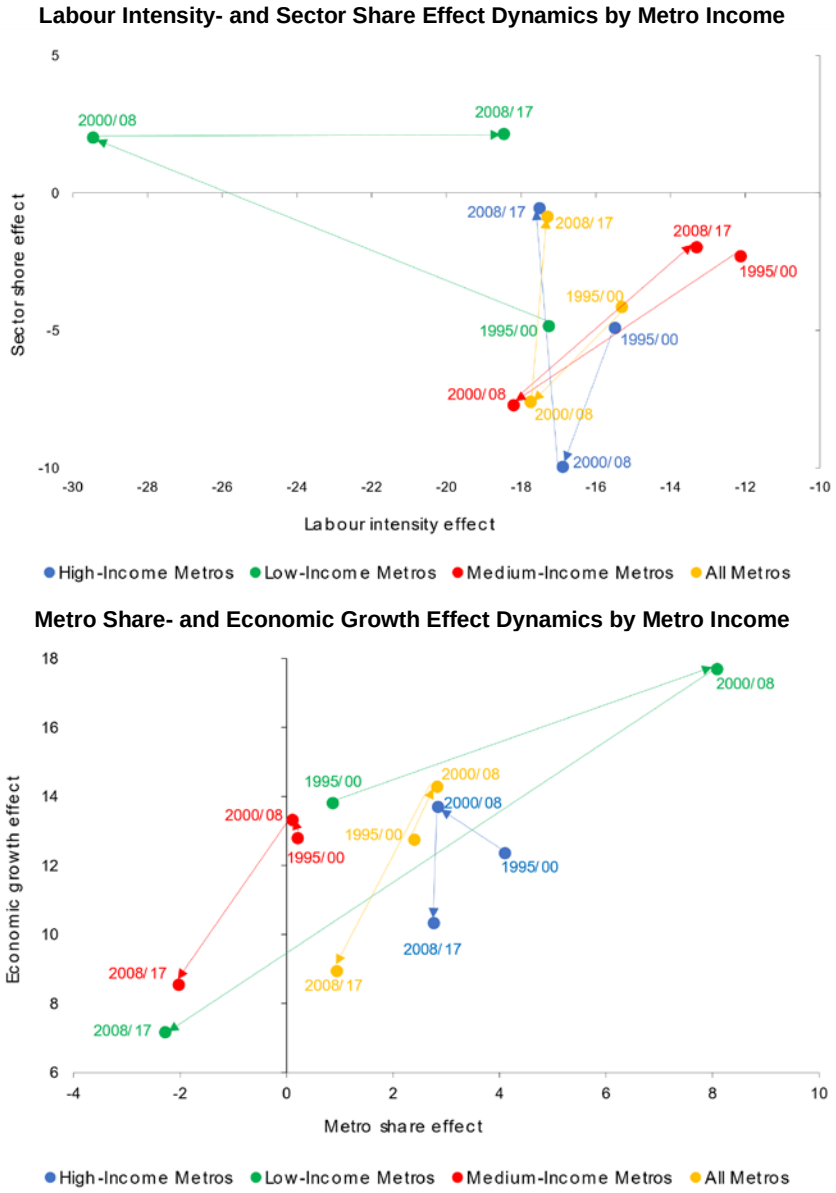
6.4 Differences across time periods

According to additional analyses, this seems not least due to a significant decrease in the contribution of this "real" de-industrialisation since the mid-2000. This is suggested by Figure 6.4, which shows the respective components of industry employment change for all metropolitan regions and by metro region income groups for separate sub-periods (1995 to 2000, 2000 to 2008 and 2008 to 2017). In this figure, the lower panel shows that in all (289) metropolitan regions (yellow), both impacts from a strong metro economy (“metro share effect”) as well as from national growth (economic growth effect) contributed positively to industry employment change already in 1995 to 2000, with both effects subsequently becoming even stronger in the following period (2000 to 2008).

However, the "Great Recession" brought about a noticeable turnaround: In the period 2008 to 2017, impacts from regional and national growth continued to be positive but were much smaller than in the previous periods. In a breakdown by metro income, this pattern was to a large degree driven by the low-income metro regions (green): in this metro type, a highly positive contribution to industry employment change from national growth in 1995 to 2000 was further strengthened in the 2000s, supplemented by massive impulses from a favourable performance of the metro economies total. However, these (positive) evolutions ended abruptly with the 2008/09 crisis. In 2008 to 2017 the average contribution of national growth was less than half of that in the early 2000s in the low-income metro group, and the metro regions' performance impacted even negatively on industry employment for the first time. In the middle-income metro regions (red), the development was quite similar recently, with the difference being that industrial employment in these metros had hardly benefited from impacts of their urban economies and the contribution of national growth already in the previous periods.

Finally, in the high-income metros (blue) the industrial employment contributions of the national as well as local economies remained comparatively stable across the periods observed. While the influence of the metro economy total declined slightly in the 2000s compared to the period before, this was offset by a higher national growth in this period. Following the "Great Recession", also in these metros industry employment was affected by a lacking national prosperity, but their status as engines of growth for their respective economies remained largely unchanged.

Figure 6.4: Change in the contributions to industry employment change over time 4-way-decompositions for 1995-2000, 2000-2008 and 2008-2017; by metro region groups, in percentage points



Source: ARDECO database (JRC/EC); ESPON MISTA 2020.

The dynamics of the labour intensity and sector share effect across the sub-periods considered are more decisive for our research questions. Thus Figure 6.4, in its upper panel shows that on average for all metropolitan regions (yellow) a clearly negative employment contribution from productivity growth (labour intensity effect) as well as "real" de-industrialisation (sector share effect) was evident in the late 1990s, whereby the former was about four times as large as the latter. In the following period (2000 to 2008) these impacts still increased in both dimensions, dampening industry employment change in 2000 to 2008 by –17.9 pp (productivity growth) and –7.4 pp (de-industrialisation) respectively. After the "Great Recession", influences from efficiency gains at –16.7 pp remained of a similar magnitude, while the negative impact of "real" de-industrialisation lost much of its significance and (with –1.5 pp) made hardly any negative contribution to industry employment change in the metro regions after 2008.

6.5 Types of metro regions

Given these heterogeneous developments, it seems warranted to define different "types" of metropolitan industry development that represent different mechanisms of action and may thus also suggest different economic policy approaches, based on the signs of the calculated components of employment change. An application of this scheme on the 1st metro regions as well as the project's case study metro regions is shown in Table 6.3. Here, based on our evidence, a sub-group of the major metro regions can be defined in which industry (despite a falling employment) is still growing in terms of output share (positive sector share effect). This is more of an "industrial up-grading" than a de-industrialisation process, because sectoral job losses result solely from productivity gains (and thus a decline in labour intensity). Within this sub-group, a distinction can be made between metro regions that are developing more favourably overall than their national economy (type 1) and those where this is not the case (type 2). On the other hand, in most of the major metro regions, a negative industry employment change is in part due to an erosion of industry in terms of output (negative sector share effect) – a situation that can thus be considered "real" de-industrialisation. Here again, a distinction can be made between metro regions with a dynamic (type 3) and weak (type 4) metro region total economy, which may well be decisive for the importance of industry evolutions in overall metro developments.

According to our results in Table 6.3, a quarter of Europe's major metro regions were characterised by a combination of productivity gains and an increasing industry share, and thus "industrial up-grading" in 1995-2017. This is quite surprising in that almost all major metros are capitals, large and "rich"– characteristics which tend to promote de-industrialisation phenomena due to our previous findings (see Table 6.4). In as many as 10 of these industrially favoured metro regions, the metropolitan environment was also favourable (type 1), including Stuttgart as the only case study metro region characterised by industrial upgrading. In the remaining (40) major metro regions, de-industrialisation phenomena formed a relevant (though usually small) component of industry employment change in 1995-2017. However, half of these regions, including Riga, Oslo and Warszawa, benefited from a strong metropolitan environment that curbed industry employment losses. The rest, among them Wien, Berlin and Torino, combined de-industrialisation with a weak metro environment. This group mainly includes metro regions in the EU15 with medium and higher income levels and (often) a mixed or service based economic structure.

However, it also seems clear from our results that the industry development path of a metropolitan region is not determined solely by its metro characteristics. Rather, in all industry development groups we distinguish, we find large and small metro regions, rich and poor metro regions, capitals and lower metro regions, as well as industry metros and service centres. Given the characteristics of a given metro region, there is obviously a considerable degree of freedom with regard to possible industry evolutions.

Table 6-3: Types of industry development in European major metro regions I
Results from 4-way-decompositions of employment change in the individual major metro regions, 1995 to 2017

Metro	Country Type	Capital	Metro Income	Economic Base	Labour Intensity	Sector Share	Metro Share	National Growth
Type 1: Industrial Up-grading / Strong Metro Environment								
Praha	EU13	yes	low	Manufacturing	-	+	+	+
München	EU15	no	high	Mixed	-	+	+	+
Stuttgart	EU15	no	high	Manufacturing	-	+	+	+
København	EU15	yes	high	Services	-	+	+	+
Tallinn	EU13	yes	low	Manufacturing	-	+	+	+
Helsinki	EU15	yes	high	Services	-	+	+	+
Bordeaux	EU15	no	medium	Services	-	+	+	+
Vilnius	EU13	yes	low	Mixed	-	+	+	+
Göteborg	EU15	no	high	Mixed	-	+	+	+
Bratislava	EU13	yes	high	Mixed	-	+	+	+
Type 2: Industrial Up-grading / Weak Metro Environment								
Hamburg	EU15	no	high	Mixed	-	+	-	+
Sevilla	EU15	no	low	Services	-	+	-	+
Marseille	EU15	no	medium	Services	-	+	-	+
Porto	EU15	no	low	Manufacturing	-	+	-	+
Type 3: De-industrialisation / Strong Metro Environment								
Bruxelles	EU15	yes	high	Services	-	-	+	+
Sofia	EU13	yes	low	Mixed	-	-	+	+
Athina	EU15	yes	low	Services	-	-	+	+
Madrid	EU15	yes	medium	Services	-	-	+	+
Málaga	EU15	no	low	Services	-	-	+	+
Alicante	EU15	no	low	Mixed	-	-	+	+
Paris	EU15	yes	high	Services	-	-	+	+
Lyon	EU15	no	high	Services	-	-	+	+
Grad Zagreb	EU13	yes	low	Manufacturing	-	-	+	+
Budapest	EU13	yes	low	Mixed	-	-	+	+
Roma	EU15	yes	high	Services	-	-	+	+
Milano	EU15	no	high	Mixed	-	-	+	+
Riga	EU13	yes	low	Mixed	-	-	+	+
Amsterdam	EU15	yes	high	Services	-	-	+	+
Olso		yes	high	Services	-	-	+	+
Warszawa	EU13	yes	low	Mixed	-	-	+	+
Bucuresti	EU13	yes	low	Services	-	-	+	+
Stockholm	EU15	yes	high	Services	-	-	+	+
Ljubljana	EU13	yes	medium	Mixed	-	-	+	+
London	EU15	yes	high	Services	-	-	+	+

Source: ARDECO database (JRC/EC); ESPON MISTA (2020). Case study metro regions in italics.

Table 6-4: Types of industry development in European major metro regions II
Results from 4-way-decompositions of employment change in the individual major metro regions, 1995-2017

Metro	Country Type	Capital	Metro Income	Economic Base	Labour Intensity	Sector Share	Metro Share	National Growth
Type 4: De-industrialisation / Weak Metro Environment								
Wien	EU15	yes	high	Services	-	-	-	+

Berlin	EU15	yes	medium	Services	-	-	-	+
Köln	EU15	no	high	Mixed	-	-	-	+
Frankfurt	EU15	no	high	Mixed	-	-	-	+
Düsseldorf	EU15	no	high	Mixed	-	-	-	+
Ruhrgebiet	EU15	no	medium	Mixed	-	-	-	+
Barcelona	EU15	no	medium	Mixed	-	-	-	+
Valencia	EU15	no	low	Mixed	-	-	-	+
Lille	EU15	no	medium	Services	-	-	-	+
Dublin	EU15	yes	high	Services	-	-	-	+
Napoli	EU15	no	low	Mixed	-	-	-	+
Torino	EU15	no	medium	Manufacturing	-	-	-	+
Rotterdam	EU15	no	high	Services	-	-	-	+
Katowice	EU13	no	low	Manufacturing	-	-	-	+
Lisboa	EU15	yes	low	Services	-	-	-	+
West Midlands	EU15	no	medium	Mixed	-	-	-	+
Leeds	EU15	no	high	Services	-	-	-	+
Glasgow	EU15	no	medium	Services	-	-	-	+
Liverpool	EU15	no	medium	Services	-	-	-	+
Manchester	EU15	no	high	Services	-	-	-	+

Source: ARDECO database (JRC/EC); ESPON MISTA (2020). Case study metro regions in italics.

6.6 Main take-aways

1. **Industrial upgrading dominates employment trends in explaining employment declines in the industry of metro regions.** Higher efficiency was a central factor behind the employment trends of metropolitan industry according to our findings. In fact, productivity gains – and thus industrial upgrading – contributed much more to employment developments in the European metro regions in 1995 to 2017 than "real" de-industrialisation, such as a shrinking industrial sector also in terms of output.
2. **“Real” de-industrialisation is more relevant for capital metros, large metro regions and (consequently) the major metro regions**. In these larger regions, the decline in industry employment was due to a significantly larger (negative) contribution from "real" de-industrialisation, which was not compensated fully by a highly positive contribution of the performance of the respective metro region's economy (the "metro share effect").
3. **The "Great Recession" brought about a noticeable turnaround in the development of industry employment in metro regions.** In the period 2008 to 2017, impacts from regional and national growth continued to be positive but were much smaller than in the previous periods. By contrast, the negative impact of "real" de-industrialisation lost much of its significance and made hardly any negative contribution to industry employment change in the metro regions in the post 2008 period.
4. **With respect to the factors impacting on industry employment there is great heterogeneity even among metro regions of the same type.** A typology based on the contribution of different impacts to overall employment growth shows that industry development of metro regions was not determined solely by metro characteristics. Rather, in all the types of industry development, we find large and small metro regions, rich and poor metro regions, capitals and lower metro regions, as well as industry metros and service centres. This thus once more highlights that industrial development in metro regions is highly region specific depending on local specifics. Consequently, adequate industrial development is likely to require region specific approaches.

7 The industrial specialisation of European Agglomeration Areas

The sectors analysed in aggregate in the last two Chapters cover a heterogenous group of production activities in terms of the products produced, geographic extent of markets, size of enterprises and technologies used. They may include the activities of large multinational enterprises (for instance in the engineering or electronics sectors) that employ a few thousand workers as well as of local producers (such as the local bakery or repair shops) that are operated as single person companies. Equally, they cover the activities of high-tech research facilities (like pharmaceutics), whose only tangible outputs may consist only of prototypes and/or patents for new products and processes, headquarters, which specialize on management activities with hardly any production taking place anymore, but also traditional production enterprises (such as for instance in the crafts or the construction sector) or repair services. They may encompass the production of globally traded goods, produced in highly segmented transnational production networks (such as in the automotive sector) or goods produced for the local market only (e.g., in the areas of waste management and recycling).

Cities are unlikely to present equally favourable conditions for the production of all of these parts of industry. In consequence, it is likely that the aggregate trends discussed in the previous Chapter do not apply to all parts of the productive sector alike.

The current Chapter therefore extends the previous analysis to the trends in different sub-sectors of production in European city regions. It addresses the following research questions:

a) On which productive activities are European metro regions (relative to others) specialised in terms of employment?
b) In which productive activities has employment grown above average in European metro regions?
c) To what degree is there heterogeneity with respect to specialisation on productive activities amongst European metro regions (i.e., do different types of metro regions differ amongst each other with respect to specialisation and growth patterns)?

In addition, we analyse the developments of the structure of employment within the productive sector in metro regions by using data from the European Labour Force Survey (ELFS). Here we ask how the structure of employment in industry (in terms of education and occupation) in European metro regions differs from that in other regions and what have been the central trends in employment in industries in European metro regions in the last decade.

7.1 Data

To address these issues, as discussed in Chapter 4, we must shift the data source of our analysis to data that provides greater sectoral detail. Since such data are only available at a regionally more aggregated (NUTS-2) level and for a shorter period of time, we shift the regional level of analysis to the European Agglomeration Areas (AAs) defined in Chapter 2 and focus on the more recent developments from 2010 to 2016 by using Eurostat's Structural Business Statistics data and WIFO's Regional Structure Database. Furthermore, we augment this information with data from the micro-use data set of the European Labour Force Survey (ELFS),

since this is the only comparable data source that allows for an analysis of the occupational and educational structure of productive activities in the European AAs.

7.1.1 SBS and WIFO's regional structure database

The Structural Business Statistics (SBS) are a standard data set provided by Eurostat (see https://ec.europa.eu/eurostat/cache/metadata/en/sbs_esms.html for a description). At the regional (NUTS-2) level they provide information on the employment and number of establishments for the period from 2008 to 2016 at a sectoral breakdown of NACE 2-digits. They cover industry (NACE Sections B to E), construction (NACE Section F) and non-financial services (NACE Sections G to J and L to N and division 95), which are commonly referred to as the non-financial business economy. The data thus exclude the NACE divisions K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations). This is, however, of lesser relevance for the current study, as these sectors are not part of the analysis of the MISTA project.

WIFO's Regional Structure Database which was estimated by the Austrian Institute of Economic Research (WIFO) in earlier projects (see *Unterlass et al*., 2015), provide a more detailed sectoral breakdown of the industrial structure of NUTS-2 regions. This is consistent with existing official data and also amenable to using various sectoral typologies operating at the NACE 3 level. These data can be used to analyse the employment structure of cities in a more detailed level than possible from SBS data and also allow to calculate regional location and industrial specialisation indicators at the NACE 3-digit/NUTS-2 level based on employment data. Since these data are not based on official statistics but have been estimated[42], we use them only to augment findings of the NACE 2-digit/NUTS-2 analysis conducted on official SBS data. The rationale for this is that this combines the advantages of a more reliable 2-digit level analysis as the main part of our analysis, with the value added that can be gained from a more detailed, albeit slightly less reliable, analysis at the NACE 3-digit level.

7.1.2 The European Labour Force Survey (ELFS)

The ELFS is a representative survey conducted in all EU and EFTA countries, which amongst other asks respondents (in paid employment for at least one hour in the week preceding the

[42] The data contain a NACE 3-digit NUTS-2-digit industry structure matrix. To estimate this in a first step the information on the location of each of the over 21 million firms reported in Amadeus data (address, postal code or city and NACE 3-digit industry affiliation) was used to construct a raw NACE 3-digit NUTS-2-digit industry structure matrix. In the second step this raw industry structure matrix was adjusted to the official SBS data at the NUTS-2/NACE 2-digit level using standard data reconciliation methods (RAS) which build on the fact that the sum employment of all NACE 3-digit industries in a NUTS-2 region must be equal to the official employment level provided in SBS data. Despite all the caution taken, inconsistencies between official data and the estimates may occur, whenever a firm is assigned to a different NACE 3-digits industry in Amadeus, is classified differently according to official statistics or if the address reported in Amadeus differs from that provided in official data. Cross-checks with Austrian data suggest that this occurs only in a small share of cells. Nonetheless, this imputation may result in minor misrepresentations of the official data.

interview) for their place of residence as well as their place of work and a number of demographic and workplace characteristics (e.g., branch of employment at NACE 1-digit, age, gender, occupation and highest completed education). Consequently, the data are informative on the extent and structure of employment in the production sectors. Unfortunately, however, the Greek and Portuguese questionnaires do not pose the question on the place of work. Furthermore, Belgium, Bulgaria, Denmark, Ireland, Greece Spain, Hungary, the Netherlands, Portugal, Sweden and the UK as well as the EFTA countries do not provide data or only insufficient data on the place of work on a NUTS-2 level. These countries therefore have to be excluded from this part of the analysis. As a result, the analysis based on this data covers only 31 of the 58 agglomeration areas considered in the remainder of the study. Also, the ELFS, while representative, is based on a sample of the households in the analysed countries and is therefore subject to sampling variance. To avoid misinterpretation, we therefore follow the reporting rules of Eurostat by putting all numbers with high standard errors (which are measured with a large variance) in brackets and suppressing numbers where employment levels are below the lower confidence bounds for a meaningful interpretation suggested by Eurostat[43].

7.1.3 Sector, educational and occupation typologies

A third ingredient to the current Chapter is a variety of typologies of sectors, branches and occupations that are used to condense the information in the different sources. In particular three sector typologies are of central interest. In the first of these sectors are grouped into[44]:

- (Core) Manufacturing and repair, these are the NACE 1-digit divisions of manufacturing (NACE C) and the NACE 2-digit group of general workshops, repair services (NACE 95).
- Construction, which includes the NACE division of NACE F.
- Logistics, which is composed of the NACE categories of transport (NACE H) and the NACE 2-digit division of wholesale and storage (NACE 46 + 45).
- Utilities, which contains the NACE 1-digit division of electricity, gas, steam and air-conditioning supply (NACE D) and water supply, sewerage, waste management and remediation (NACE E); and
- Others, which includes all other NACE divisions not explicitly mentioned above that are not analysed in detail in the MISTA project.

In the second typology we further divide the core manufacturing sector into technology classes (high-tech, medium-high-tech, medium low-tech and low-tech) according to the typology provided

by Eurostat (see https://ec.europa.eu/eurostat/statistics-explained /index.php/Glossary:High-tech_classification_of_manufacturing_industries), which is also the source for the European Commission's high tech report.

[43] The respective relevant upper and lower reliability limits can be found under: https://ec.europa.eu/eurostat/web/microdata/labour-force-survey

[44] A full list of the classifications used can be found in Annex Table-A 6: Correspondence table for mapping NACE 3-digit groups to sector typesTable-A 6 to this report.

A third sector classification used is Eurostat's definition of the ICT sector (see *OECD*, 2011 for details). This typology allows us to assess the importance of ICT related manufacturing for European AAs.

With respect to occupations, by contrast we focus on the international standard classification of occupation (ISCO) [45] 1-digit level provided in ELFS data and group occupations into high-skilled white collar (and thus service and or managerial occupations), medium-skilled service occupations and into less skilled mostly blue-collar occupations. Here we group the ISCO 1-digit groups: 1 (managers), 2 (professionals) and 3 (technicians and associate professionals) into the first category, while the ISCO group's 4 (clerical support workers) and 5 (services and sales workers) are grouped as medium-skilled service occupations. The medium-skilled production occupations are defined as the ISCO groups 6 (skilled agricultural, forestry and fishery workers), 7 (crafts and related trades workers) and 8 (plant and machine operators and assemblers), while the less skilled jobs are defined as ISCO group 9 (elementary occupations).

For the classification of educational attainment levels, by contrast, we use the international standard classification of education (ISCED) to group workers according to their highest completed education, with the groups being tertiary (ISCED 5 or higher), an upper secondary (ISCED 3 and 4), or a lower secondary education (ISCED 2 or lower) according to the ISCED 2011 classification.

Finally, we also classify the AA areas into large and small areas (where in contrast to the previous Chapter, large AAs are those with over a million inhabitants) as well as capital regions and other AAs located in EU13 and EU15 countries (plus Norway, where the typologies continue to follow the definitions used in the previous Chapters).

7.2 Importance of different productive activities for the European Agglomeration Areas

7.2.1 The share of production in urban employment

A first glance at the SBS data suggests that – in accordance with the results of the last Chapter - cities as a rule have below average employment shares in the production sector. According to SBS data only 45.2% of all employed working in the European AAs work in production sectors. In EU average (including Norway) this share is 50% (see Table 7.1).

[45] ISCO (International Standard Classification of Occupations) is an International Labour Organization (ILO) classification for jobs. Its current version (ISCO-08) published in 2008, divides jobs into 10 major groups: Managers, Professionals, Technicians and associate professionals, Clerical support workers, Service and sales workers, Skilled agricultural, forestry and fishery workers, Craft and related trades workers, Plant and machine operators, and assemblers, Elementary occupations, Armed forces occupations. The basic criteria used to define the system are the skill level and specialization required to competently perform the tasks and duties of the occupations. In the current analysis military personnel are not not included in the current analysis.

Table 7-1: Share of employed in European Agglomeration Areas by branch of production and type of agglomeration area (in %, 2016)

	Overall		By city type					
			Function		Region		Size	
	AAs	EU + NO	Capital	Other	EU15+ NO	EU13	Large	Small
Manufacturing & Repair	16.8	21.2	13.0	20.7	16.0	21.6	16.6	21.6
- of this								
High technology	*1.1*	*1.1*	*1.1*	*1.1*	*1.1*	*1.0*	*1.1*	*0.7*
Medium-high-technology	*5.1*	*6.2*	*3.2*	*7.1*	*5.2*	*4.6*	*5.1*	*4.3*
Medium-low-technology	*4.7*	*6.3*	*3.5*	*6.0*	*4.5*	*6.4*	*4.7*	*6.2*
Low technology	*5.6*	*7.4*	*4.8*	*6.3*	*5.0*	*9.3*	*5.4*	*10.1*
Repair	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	*0.4*	*0.3*	*0.3*
Material services & Construction	8.1	8.9	8.3	7.9	7.9	9.0	8.0	10.7
Utilities	1.6	1.6	2.0	1.1	1.4	2.7	1.6	2.3
Logistics	8.3	7.8	9.4	7.2	8.2	9.2	8.3	9.6
Wholesale & Storage	10.4	10.3	10.1	10.7	10.1	12.0	10.4	11.2
Others	54.8	50.0	57.2	52.3	56.3	45.6	55.2	44.6

Source: Eurostat -SBS. Note: Others=sectors not included in the MISTA project. Data do not the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

This low share of production is, however, solely due to the low share of manufacturing and here in particular to manufacturing in branches that are not high-tech industries. Overall, 16.8% of the employed in European AAs work in manufacturing, in the average region of the EU and Norway this is 21.2%. This 5.4 pp difference therefore accounts for more than the total difference in the employment share of production activities between European AAs and the aggregate. The employment shares of utilities, logistics as well as wholesale and storage are larger or equally large in the European AAs than in the average of the EU and Norway and the only other sector where the employment share is moderately lower in the European AAs is construction.

Similarly, the differences in the employment share of the production sector pertain mainly to capitals and large cities as well as cities located in EU15 countries or Norway. Cities that are not capitals, are located in the EU13 or are small cities, have an employment share of manufacturing that is comparable to or even exceed the average (see A first glance at the SBS data suggests that – in accordance with the results of the last Chapter - cities as a rule have below average employment shares in the production sector. According to SBS data only 45.2% of all employed working in the European AAs work in production sectors. In EU average (including Norway) this share is 50% (see Table 7.1).

Table 7-1). Similar observations apply to smaller cities, in which the employment share of manufacturing is of a similar magnitude as their overall employment share 2.1%, while the employment share of all other main sectors considered in this study exceed this level.

Table 7-2: Share of European Agglomeration Areas in EU wide employment by branch of production and type of agglomeration area (in %, 2016)

	Overall	By city type					
		Function		Region		Size	
	AAs	Capital	Others	EU15+NO	EU13	Large	Small
Manufacturing	40.2	15.6	24.6	32.9	7.3	38.0	2.1
- of this							
High technology	50.0	26.2	23.8	43.3	6.7	48.7	1.3
Medium-high-technology	41.9	13.1	28.8	36.6	5.3	40.5	1.4
Medium-low-technology	38.3	14.1	24.2	31.0	7.3	36.2	2.1
Low technology	38.3	16.8	21.6	29.3	9.0	35.5	2.9
Repair	51.0	27.6	23.4	42.7	8.3	49.0	2.0
Material services	45.8	23.6	22.2	38.6	7.2	43.3	2.5
Utilities	49.1	31.6	17.6	37.1	12.0	46.2	2.9
Logistics	54.1	30.8	23.2	45.6	8.4	51.5	2.6
Wholesale & Storage	51.0	24.8	26.2	42.7	8.3	48.7	2.3
Other	55.5	29.2	26.3	48.9	6.6	53.6	1.9
Total	50.7	25.5	25.2	43.5	7.2	48.6	2.1

Source: Eurostat -SBS. Note: Others=sectors not included in the MISTA project. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

Despite this lower share of production and in accordance with previous results, the European AAs account for a sizeable part of the overall Europe-wide employment in the production sector. This also applies to all sub-sectors of industry (see Table 7-2). Even in manufacturing 40.7% the Europe-wide employment is located in the European AAs. For material services and construction this share is 46.8% of the employment and in utilities 42,4% of the employment is accounted for by the European Agglomeration Areas. In addition, these areas also account for over half of the employment in logistics (54.1%) and wholesale and storage (51,0%). Furthermore, breaking down manufacturing employment by branches according to technology level, European cities are of a particularly high importance for high technology manufacturing, where they hold a share of 53.0% of EU-wide employment. Their importance in low-tech manufacturing is somewhat lower than average with 46,2% of European employment.

These patterns too, differ substantially between cities of different sizes, with different functions and also in different locations. Relative to their overall employment share, AAs located in EU13 countries are much more strongly specialized in manufacturing than AAs located in EU15 countries and Norway. Overall, AAs of the EU13 countries account for 7.1% of EU-wide employment, their share of EU-wide manufacturing employment is 7.4% and thus higher than the average employment share. In the EU15 AAs this ratio is 49.4 to 33.2%. Large cities, by contrast, differ from smaller ones mainly through a (relative to their share of overall employment) smaller manufacturing sector, while here too the other sectors considered (i.e.,

material services, utilities, logistics, wholesale and storage) are larger in relation to their average weight in European employment.

Finally, the capital cities, next to being marked by a stronger specialisation on material services, utilities and logistics as well as wholesale and storage, also have a stronger specialisation in the high-tech parts of manufacturing and repair services than other cities. Although capital cities contribute only 15.6% to EU wide manufacturing employment, in high tech manufacturing their share of EU wide employment is 26.2%. In repair services this share is 27,6% (relative to a 25.5% total employment share). In other cities these shares are 23.8% and 23,4% relative to a very similar total employment share of 25.5%.

7.3 Localisation by NACE divisions and groups

Figure 7.1 extends this analysis by plotting the share of employment in the 40 NACE 2-digit divisions of the productive in the European AAs against their employment share in the European average[46]. Thus, divisions located above the 45-degree line have a higher share of employment in the European AAs than in the EU average and are thus regarded as "localized" in the European AAs. This applies to 10 divisions[47] among the 40 considered. Among these only three belong to the manufacturing sector[48], while the remainder are related to either transport and logistics[49], public utilities and waste management[50], and general workshops and repair services (S95) as well as wholesale trade (G46).

[46] NACE (**N**omenclature générale des **A**ctivités économiques dans les **C**ommunautés **E**uropéennes) is an acronym for the statistical classification of economic activities in the EU.

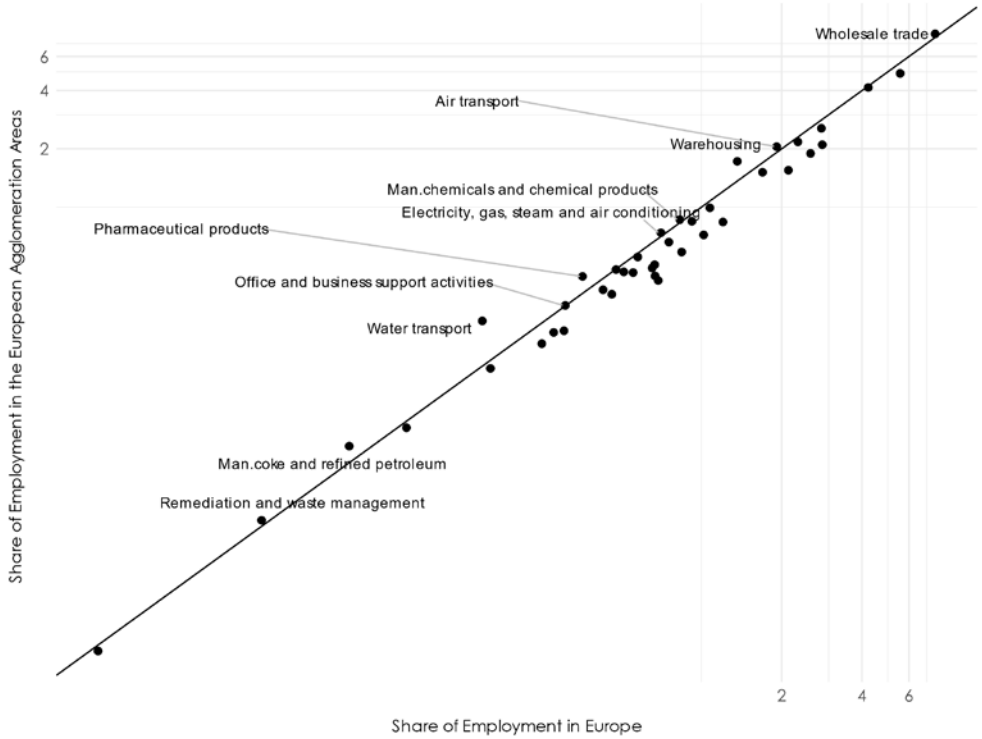
[47] These are manufacturing of coke and refined petroleum products (NACE C19), manufacturing of chemicals and chemical products (C20), manufacturing of pharmaceutical products and pharmaceutical preparations (C21), electricity, gas, steam and air conditioning supply (D35), remediation and waste management services (E39), wholesale trade (G46), water transport (H51), air transport (H52), warehousing and support for transportation (H53), office support and other business support activities (S95).

[48] These are manufacturing of coke and refined petroleum products (NACE C19), manufacturing of chemicals and chemical products (C20), manufacturing of pharmaceutical products and pharmaceutical preparations (C21).

[49] These are water transport (H51), air transport (H52), warehousing and support for transportation (H53).

[50] These include electricity, gas, steam and air conditioning supply (D35), remediation and waste management services (E39).

Figure 7.1: Localisation of productive activities in the European Agglomeration areas



Source: Eurostat, Structural Business Statistics. Share in Europe is measured as the share of the respective sector in total employment of the EU28 and Norway according to SBS data. Horizontal axes – share of the sector in European employment (in %). Vertical axes Share of employment in European AAs (in %). Dots represent the NACE 2-digit industries. Labelled sectors are those with above average localisation in AAs. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

These specialisation patterns clearly illustrate the function of urban AAs as central transportation hubs and central locations for international trade and business support activities. They also reflect the high importance of public utilities serving the demands of the large populations and the high relevance of environmental concerns in these densely populated areas, as quite a large number of these sectors are related to public utilities, many of which are also related to waste management and recycling activities. Further some sectors such (such as logistics, but also utilities), profit from forward and backward linkages as well as knowledge spill-overs from the production sector.

In addition, European AAs are also usually specialized in productive sectors that have an overall small employment share. Among the sectors localized in European AAs only three (air transport, warehousing and wholesale trade) hold an employment share of more than 1% in total European employment. Among these, in particular wholesale trade, with a share of 7.5% in total Europe wide employment sticks out. The 7 others account for a combined 3% of total EU wide employment. This inter alia highlights the fact that many urban agglomerations are also important locations for enterprise start-ups in newly emerging sectors and for sectors with a high share of SMEs.

7.3.1 Heterogeneity between different Agglomeration Areas

This analysis, however, hides the substantial differences between AAs and the NACE 2-digit industries considered. For this reason, Figure-A 6, Figure-A 7 and Figure-A 8 in the Annex repeat Figure 7.1 for individual types of AAs. In this analysis once more the differences between AAs located in the EU13 and the EU15 and Norway, capitals and other cities as well as between large and small cities stick out:

- The AAs located in EU13 countries are marked by a much larger number of localised branches than AAs located in the EU15 countries or Norway. In the AAs in EU13 countries also some less technology intensive divisions of manufacturing (e.g., furniture production, wearing apparel and wood products) are localized. In part this is owed to the much later beginning of de-industrialisation in the EU13 countries, which had been marked by central planning regimes, that strongly believed in the importance of production and economies of scale, until the late 1980s and early 1990s. Upon economic liberalisation these countries were marked by large industrial sectors and even more startling average enterprise sizes (see *Brülhart – Koenig*, 2006 for discussion of cities and industry in EU13 countries).
- The number of localised sectors in industry is strongly related to city size, as smaller cities have a substantially larger number of localised branches within the production sector than larger ones. As a consequence, within the production sector smaller cities also tend to have a broader range (more diverse set of branches) in which they are specialised. By contrast, larger cities, although more diverse when considering all economic activities, are much more strongly focused on just a few production branches (and even more so when focusing on manufacturing alone). The higher overall diversity of capital cities is thus mainly owed to the higher diversity in the service sector.
- In capitals – due to the different function of these cities in the urban system – there is a clearer specialisation on NACE 2-digit divisions in utilities (such as electricity, gas and water provision, remediation of waste materials) and logistics (including wholesale trade, warehousing, water transport, air transport). Among the sectors of core manufacturing only chemicals and chemical products, pharmaceutical products and coke as well as refined petroleum are localised in capitals. By contrast, in cities that are not capitals there is also a localisation of the machinery and equipment industries as well as of car production and basic metals, textiles and leather products. This implies that a city's function within the urban system has a strong impact not only on the development of industry in general, but also on its specialisation within production activities.[51] This, due to the path dependence of industrial activities, is likely to do so also for the future development of cities.

[51] This is not driven by the higher share of public services located in capital cities, as these are not included in the SBS data used for this analysis.

7.3.2 Localisation of NACE 3-digit groups

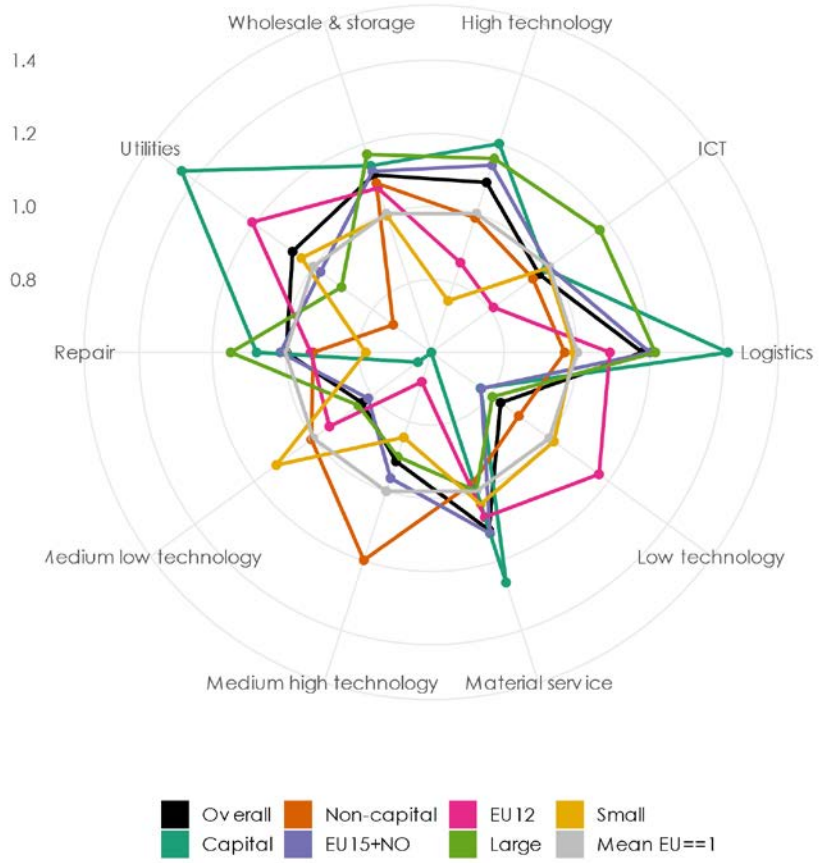
With respect to the heterogeneity within 2-digit divisions, a more detailed analysis at the level of NACE 3-digit industries (using the WIFO Structural Analysis Database) reveals a slightly larger set of industries with above average localisation in the European AAs. In this analysis 33 out of 139 NACE 3-digit groups have an above average localisation in the European AAs[52]. Once more, the employment share of these industry groups is small, as they combine for 12.7% of total EU wide employment and 14.2% of the employment in the AAs considered[53].

The consideration of industry groups at the NACE 3-digit level also allows for an analysis of productive activities by the functions of interest for the current project (i.e. manufacturing, transport and logistics, wholesale and storage, material services, general workshops and repair services as well as public utilities (i.e. energy and water supply and waste management) and for a further differentiation of manufacturing by the type of technologies used (into high, high-medium, medium-low and low technology). This grouping (displayed in Figure 7.2) therefore allows **for a slightly better approximation of the hybrid servo-industrial production in cities than aggregations at lower industrial levels.**

[52] The ten most heavily localized groups at this level of disaggregation are manufacture of magnetic and optical media (C286), freight air and space transport (H512), passenger air transport (H511), postal activities (H53), manufacture of air and spacecraft machinery (C303), Wholesale of communication and communication equipment (G465), manufacture of pharmaceutical products (C211), manufacture of cleansing materials (C204), transportation in pipelines (C495), manufacture of refined petroleum products (C192). These also illustrate the function of many cities as a headquarter location for many larger scale enterprises, as a number of these groups (e.g., pharmaceutics, petrol) are characterized by very large international enterprises.

[53] This analysis also allows for a more detailed consideration of sectoral diversity and structural change, which reconfirms that in general AAs have a more diverse structure of productive activities and also suggests that they have also experienced substantially more structural change in the last decade than other European regions. This is confirmed when considering aggregate diversity measures for the overall economy and industry alone. When focusing on the Herfindahl index (i.e., the sum of squared sector shares) as a measure of concentration that takes on a value of 1 when a city is specialised entirely on one NACE 2-digit division (lowest possible diversity) and $1/n^2$ if all sectors have the same employment share (i.e. the highest possible diversity), larger cities are consistently more diverse when considering the overall economy, but less diverse within the production sector (lowest possible diversity) than smaller AAs.

Figure 7.2: Localisation of types of productive activities the agglomeration area



Source: Eurostat, Structural Business Statistics and WIFO regional structure data base. Note: The Figure shows the localisation coefficient of the respective sector groupings among the European AAs. If this is larger than unity the respective group has a higher employment share than the European average in that group (i.e., is localized). If it is smaller than unity the opposite applies (see Table-A 6 in the Annex for a definition of the industry types).

On the one hand this analysis clearly shows that within the manufacturing sector the agglomeration areas on average are **more strongly specialized in high-tech sectors** than the European industry and less so in low-tech sectors (see Figure 7.2). On the other hand, the figure also underscores the **substantial heterogeneity of the specialisation across different types** of AAs, which applies in particular to low-tech manufacturing. Thus, AAs in the EU13 countries have an above average localisation in many industries closely related to consumer demand[54] as well as in some divisions of mechanical engineering and chemicals industry[55]. The former also show stronger localisation in consumer goods industries and medium-high

[54] These are manufacture of food products (C10), manufacture of beverages (C11), manufacture of tobacco products (C12), manufacture of wearing apparel (C14), manufacture of leather and related products (C15), manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (C16), printing and reproduction of recorded media (C18), manufacture of furniture (C31).

[55] Manufacture of rubber and plastic products (C22), manufacture of other non-metallic mineral products (C23), manufacture of electrical equipment (C27), manufacture of motor vehicles, trailers and semi-trailers (C29).

technology. The same applies to the AAs that are not national capital city regions. These non-capital AAs mainly stick out through an above average localisation of the metal, machinery and vehicle production. In sum, thus, a large part of the aggregate picture related to the small industrial base of AAs, is mainly related to AAs containing capital cities and in the EU15 countries.

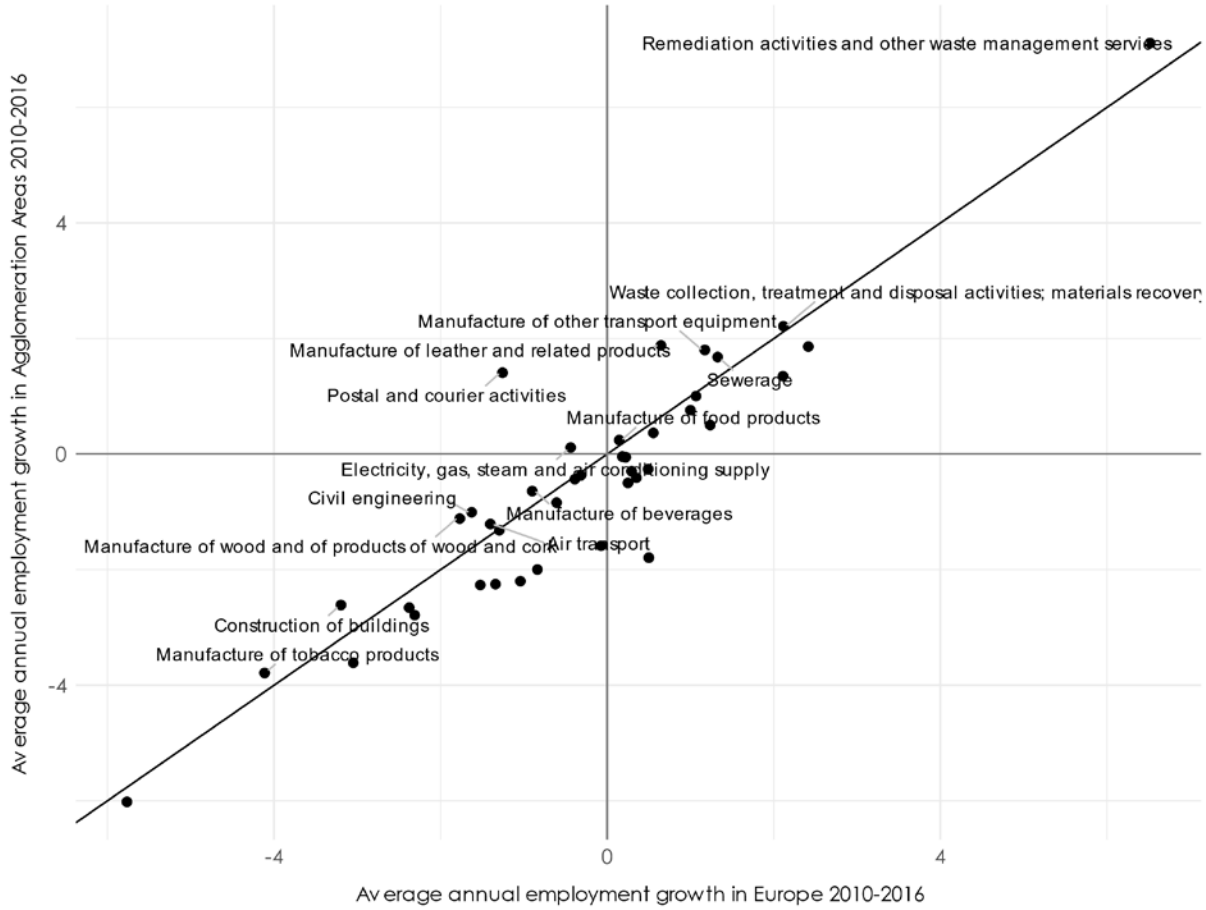
7.4 Growth

The sectoral growth performance of the European AAs in the years 2010 to 2016 is equally diverse (see Figure 7.3). Overall, over a third (14) of the 40 NACE 2-digit divisions in the productive activities analysed in this project increased employment more rapidly in the AAs than in the European average[56]. This applies in particular to the following sectors (see also Figure 7.3)

- Waste management and utilities which have grown with an average rate of 1.7% annually in the European AAs in the period 2010 to 2016 (relative to 1.6% in other EU regions) and where almost all NACE 2-digit divisions (Remediation activities and waste management services, waste collection, treatment and disposal activities, Sewerage, Electricity, gas and air conditioning supply) have shown above average growth in the European AAs.
- Logistics, which have shown an average employment growth rate of 1.1% per year in the European AAs (relative to 0.7% in other regions) and in which among the NACE 2-digit divisions in particular postal and courier services as well as air transport, have grown with an above average rate in the period 2010 to 2016.
- Material services and in particular construction where employment has expanded by 0.8% annually in European AAs (relative to 0,1% in other regions) and where among the NACE 2-digit divisions the construction of buildings has shown an above average employment growth.

[56] These are manufacture of food products, manufacture of beverages, manufacture of tobacco products, manufacture of leather and related products, manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, manufacture of other transport equipment, electricity, gas, steam and air conditioning supply, sewerage, waste collection, treatment and disposal activities; materials recovery, remediation activities and other waste management services, construction of buildings, civil engineering, air transport, postal and courier activities.

Figure 7.3: Relative growth performance of European agglomeration areas.



Source: Eurostat, Structural Business Statistics and WIFO regional structure data base. Notes: the figure shows average annual employment growth rates in the period 2010 and 2016. The horizontal axis measures the EU wide growth rate. The vertical axis the average growth rate in the European AAs. Thus, divisions located above the 45-degree line.

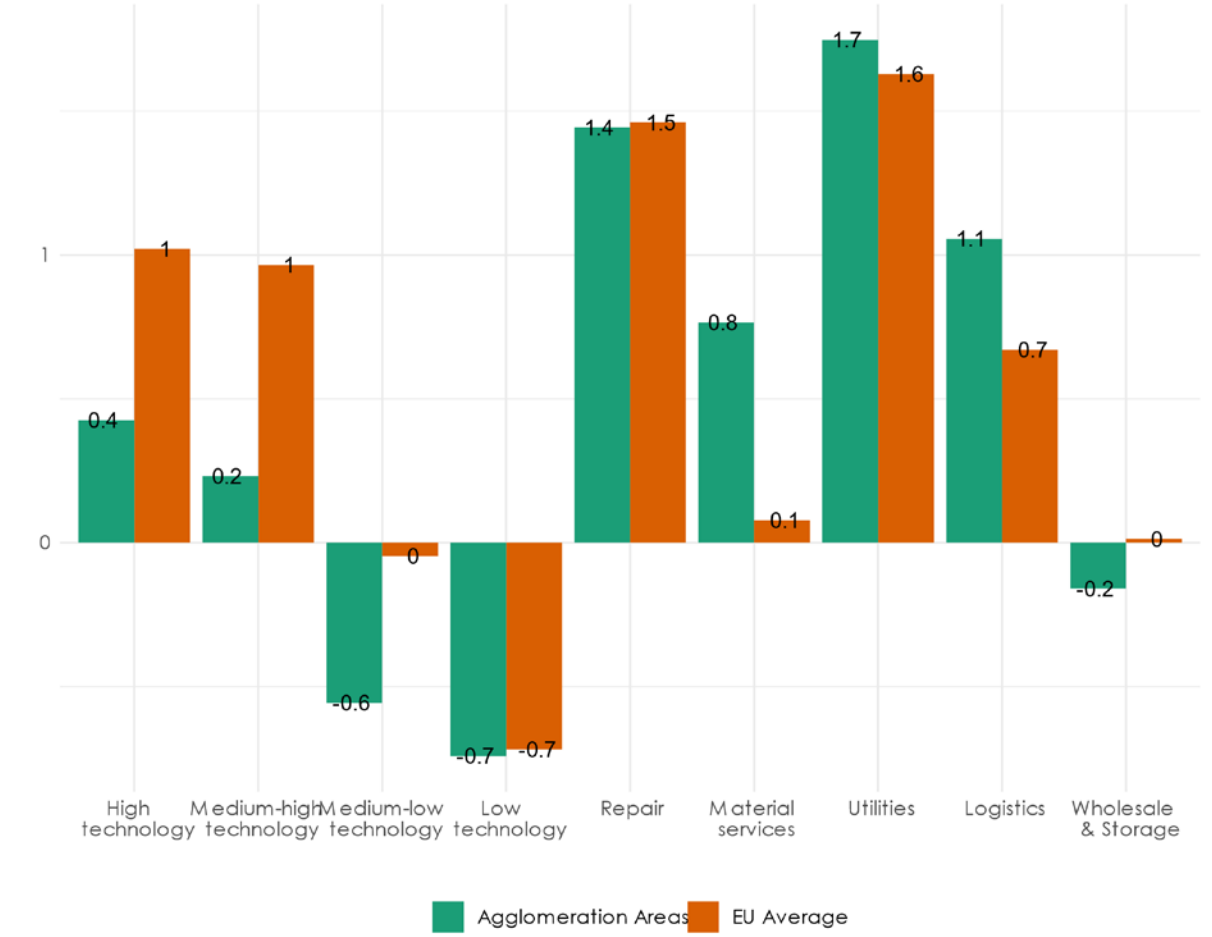
On the one hand employment growth in these sectors is closely related to the continued population growth in European AAs and the ever-increasing demand for public and transportation services as well as housing space resulting from this population growth. On the other hand it also reflects major societal and technological developments (such as increasing environmental concerns in particular in densely populated areas, increased mobility, increased demands on housing resulting from a change lifestyles, declining household sizes the fragmentation of the value chain and the growth of internet trade services) that have led to an increased demand for logistics services and housing as well as more elaborate systems of waste management in the last decades.

By contrast, in the core manufacturing sectors as well as in wholesale trade and storage the European AAs have experienced below average employment growth in the years from 2010 to 2016. In wholesale trade and storage this applies to all NACE 2-digit branches of this division and is caused by a catching up of smaller centres relative to the large urban agglomerations. Somewhat more surprisingly, employment growth in core manufacturing has been below average irrespective of the technology intensity of the branch considered. Therefore, the

analysis based on NACE 3-digit level industry groupings indicates that employment in manufacturing in the European AAs has grown at a substantially slower pace than in the European average even in high tech and high-medium tech sectors and that – in parallel with the European average – it has declined in medium and low-tech sectors.

Nonetheless, even in the core manufacturing sectors, there are some NACE 2-digit branches that have shown above average growth in the European AAs. In particular here – next to some industries where growth has been driven mainly by the presence of the headquarter functions of large multinational enterprises and activities with a large consulting content (e.g., Manufacture of transport equipment, manufacture of tobacco products, civil engineering) – a variety of consumption goods producing, industries, profiting from high local demand in European AAs have experienced above average employment growth recently. This applies to industries such as manufacture of leather and related products, food products, beverages and of wood products all of which include a substantial share of small-scale producers from the crafts that have inter alia profited from the increased preferences for locally produced consumption goods in recent years. Unfortunately, however, these sectors still have a low employment share in most cities. Their combined share in employment is 10.0% in the AAs and 10.9% in the European total. Nonetheless, the above average growth of these small branches may be indication that – as also suggested in the literature survey – **some of the manufacturing sectors are increasingly returning to urban spaces in Europe**.

Figure 7.4: Average annual growth 2010-2016 of types of productive activities the AAs



Source: Eurostat, Structural Business Statistics and WIFO regional structure data base.

In sum, next to **material services, utilities, and logistics** also some parts of manufacturing have shown above average employment growth in European AAs recently. This applies in particular to consumption goods producers as well as production activities with a high service content and to sectors where European AAs are typically the location of larger multinational companies. This suggests that these activities may be returning to cities**.**

7.4.1 Differences between city types

Once more there is, however, substantial heterogeneity in growth performance among European AAs (see Figure-A 9, Figure-A 10 and Figure-A 11 in the Annex on this issue). In particular smaller city AAs show a larger number of productive activities growing above the European average as well as a higher share of employees in these sectors, while in larger cities, employment growth hinges much more strongly on the service sectors not considered in this study. In the large European AAs only 12 NACE 2-digit divisions had an above average employment growth in the period 2010 to 2016[57]. By contrast, in smaller European AAs a much

[57] These were remediation of waste management, waste collection, manufacture of other transport equipment, electricity, gas, steam and air conditioning, sewerage, beverages, food products, water

larger number of NACE 2-digit divisions experienced above average growth. In particular these branches also included a fair number of core manufacturing branches, such as the manufacture of chemicals and chemical products, textiles, coke and refined petroleum, motor vehicles and many others.

Similar observations apply to the differentiation between capital city AAs and other AAs. Here too AAs that are not capital cities show a larger number of productive activities growing above the European average as well as a higher share of employees in these sectors. In capital city AAs, above average employment growth is observed in just a few sectors. Thus, in the large European AAs only 11 NACE 2-digit divisions had an above average employment growth in the period 2010 to 2016, with the list of branches experiencing such above average growth being very similar to that in the large cities[58].

AAs located in the EU13 countries and EU15 countries have a similar number of NACE 2-digit industries with above average employment growth, but these branches differ somewhat in nature and, due to the higher industrialisation of the AAs in EU13 countries, also account for a higher share of employment in the EU13 countries. While in the AAs of the EU15 countries the NACE 2-digit branches growing above average are very similar to those showing above average growth in the European AAs overall, and thus are mostly working in material services, logistics, utilities or in consumption goods industries, in the EU13 AAs also producer goods industries have experienced above average growth.

In sum, just as for the specialisation of AAs on different branches, also the overall growth experiences of European AAs are dominated by the large, capital cities located in the EU15 countries. For these cities growth in employment in productive activities is strongly related to growth in material services, logistics and utilities and of a potential return of some mainly producer goods industries to these AAs applies even more strongly. By contrast, for the smaller AAs and AAs that are not capital cities, which as shown in the last Chapter were also not as strongly de-industrialized in the last decades, this finding is less applicable. In these cities also a fair number of core manufacturing branches still show above average growth. Furthermore, cities in the EU13 seem to differ from cities in the EU15 as they also host a number of strongly growing industries in the producer goods sector.

7.5 Employment structure by educational attainment and occupation

Next to changes in the composition of the production sector in terms of branches and sub-sectors recent decades have also seen important changes in the structure of employment within industry. In particular through improved communication and transport infrastructure, enterprises

transport, civil engineering, wood and wood products, construction of buildings and manufacture of tobacco products.

[58] These branches were: remediation of waste management, manufacture of transport equipment, warehousing, specialised construction, electricity, gas, steam and air conditioning, sewerage, civil engineering, wood and wood products, construction of buildings, non-metallic mineral products and manufacture of tobacco products.

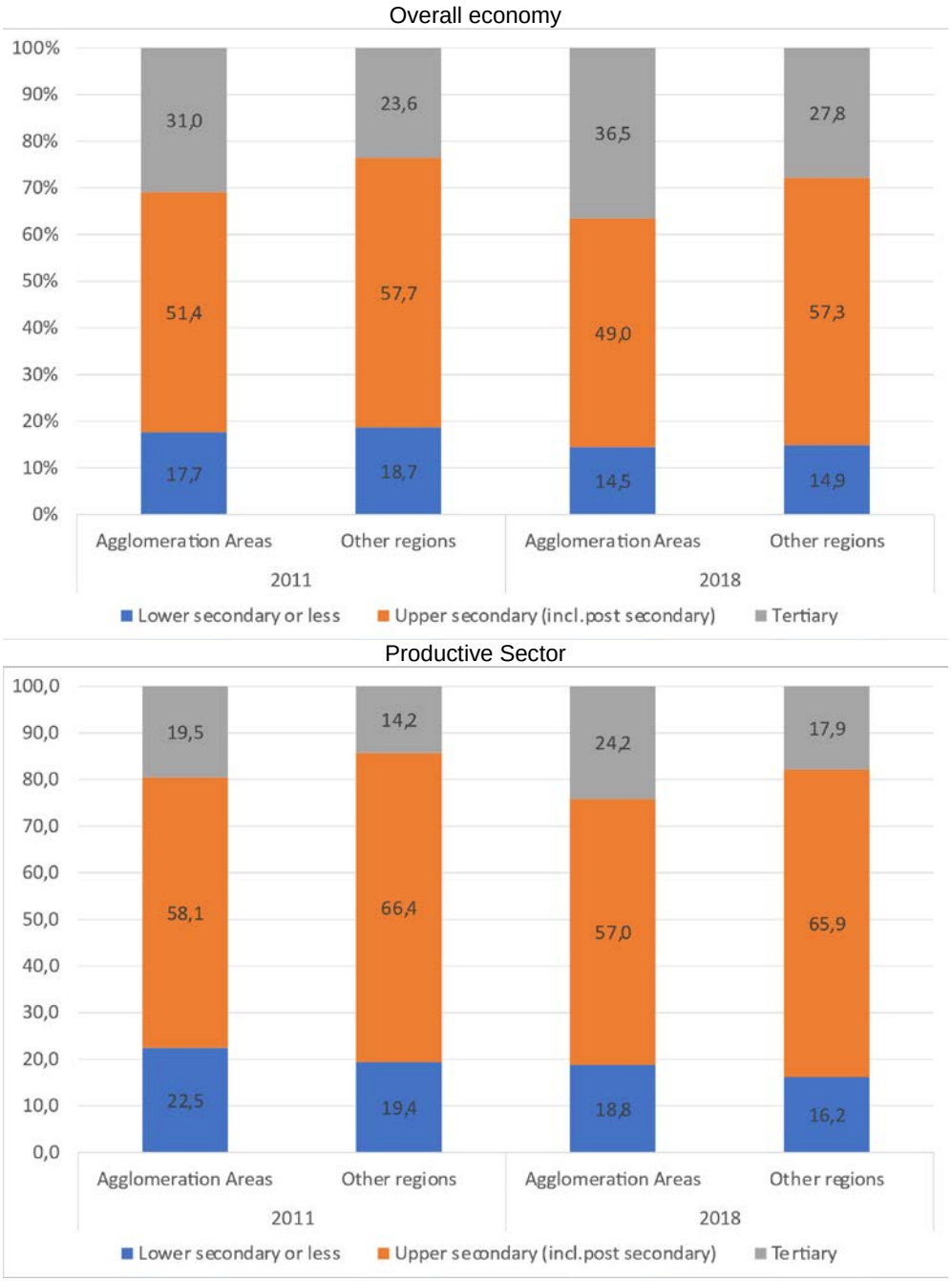
have become increasingly capable to outsource certain functions of their enterprises (e.g., mass production and assembly) to other locations, while at the same time retaining other functions (such as e.g., headquarters, R&D centres or product design) in cities (see the literature survey in Chapter 3 for references). This increased functional specialisation has led to a marked shift of the employment structure in production enterprises in cities. On the one hand, the increased specialisation on dispositive (i.e., headquarter, R&D etc.) functions shifted employment within production enterprises in the direction of service occupations, because these functions usually require mainly service tasks. On the other hand, the employment structure of urban manufacturing also shifted to high-skilled employment on account of a combination of technological developments, functional specialisation well as the outsourcing of many low-skilled service activities (such as e.g., cleaning and security services) to specialised service sector firms.

7.5.1 Employment by highest completed education

As a consequence, as can be seen from, the share of high-skilled workers (with a completed tertiary education) employed in the European AAs is nowadays substantially higher than in other EU regions (see Figure 7.5). This applies to the overall economy, where – according to the top panel of Figure 7.5 – 31% of the employed in European AAs had a tertiary education, while outside the AAs the respective share is 23.6%. It, however, also applies to the productive sector where respective shares are 19.5% and relative to 14.2%.

In addition, the share of tertiary educated workers has also increased more rapidly in the European AAs than in the European average. In the European average the share of high-skilled employed in all employed increased by 4.2 pp between 2011 and 2018 in the overall economy and by 3.7 pp in industry. In the European AAs the respective increases were 5.5 pp (in the total economy) and 4.7 pp (in industry). This confirms that European AAs have been more strongly affected by the shift to more highly qualified employment that characterized economic development in the past decades than other EU regions. In addition, they are also more reliant on a highly qualified workforce for their industrial development, as they employ a larger share of these workers.

Figure 7.5: Employment structure of the Overall economy and in the production sector the EU and in European AAs by qualification 2011 and 2018



Source: ELFS micro data. Figure excludes the following countries (as well as AAs located in these countries): Belgium, Bulgaria, Denmark, Ireland, Greece Spain, Hungary, the Netherlands, Portugal, Sweden, UK and Norway. High-skilled = ISCED 5 or more, Medium-skilled = ISCED 3 and 4, Low-skilled = ISCED 2 or less.

By contrast, the share of persons with medium level (i.e., vocational or an upper secondary) education is substantially lower both in the overall economy as well as in industry in the European AA's than in the European average. In 2018 57.3% of all employed and 65.3% of the employed in industry in the regions of the EU outside the AAs had a completed medium education. In the European AAs this applied to only 49.0% of all employed and 57,0% of the employed in industry. Also, in contrast to the remainder of the economy, where these

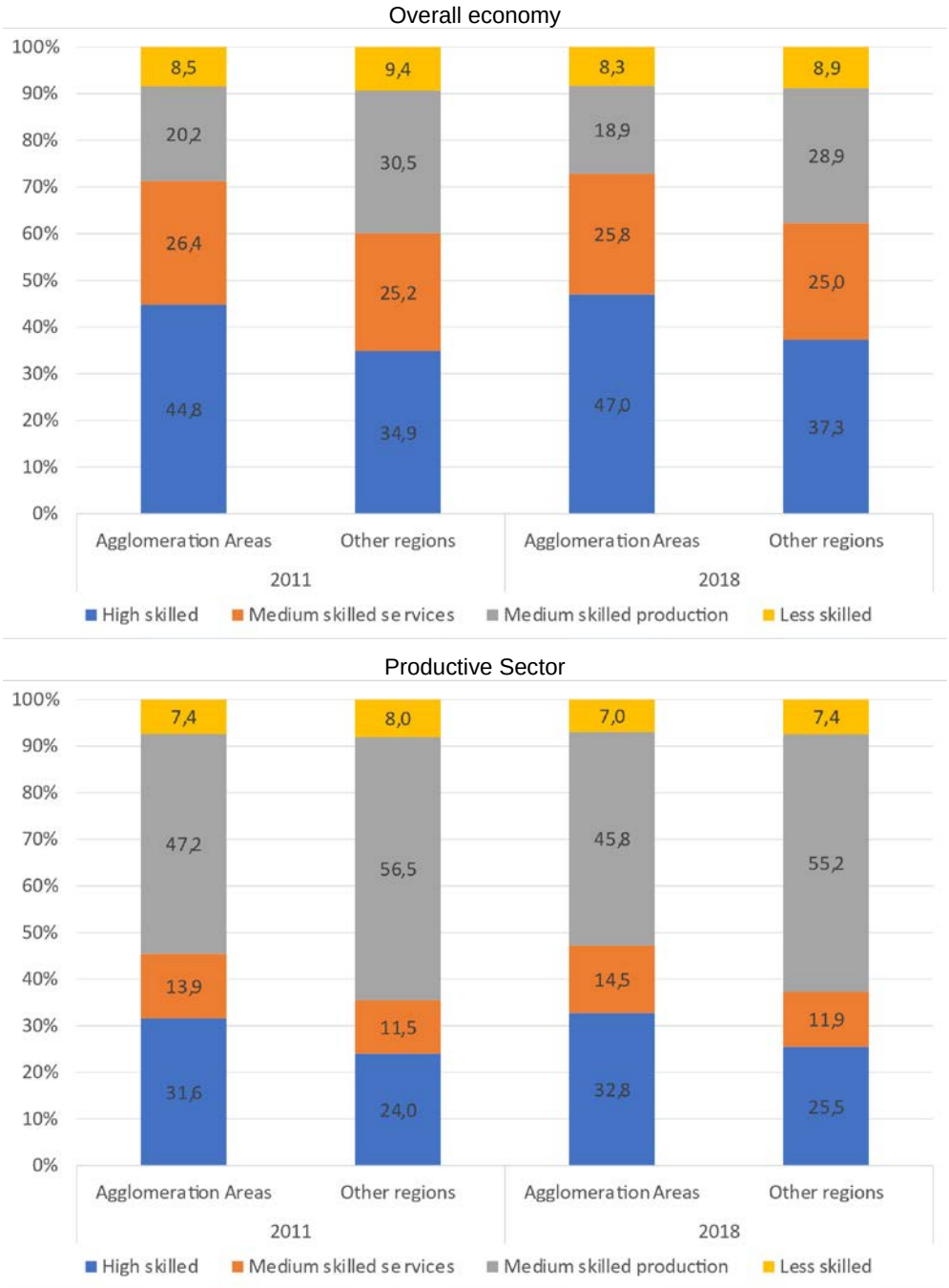
employment shares almost stagnated, these employment shares have declined (by 2.4 respectively 1.1 pp) in European AAs between 2011 and 2018. In consequence, while industry (relative to other sectors) employs a disproportionately high share of persons with medium qualification levels in both European AAs and other regions, this specificity of industry is less pronounced in the European AAs and – in contrast to the development in other regions - the employment in this qualification segment declined in European AAs in recent years.

The share of low-skilled employed (with a compulsory education or less), finally, is higher in the production sector than in the overall economy and, somewhat more surprisingly, it is also higher in the production sector of the European AAs than in the production sector of other regions. In 2018 14,5% of all employed in AAs, but 14.9% in other regions had completed only a compulsory education or less. In industry the respective shares were 18.8% in the European AAs but 16.2% in other European regions. The decline in these shares has been rather similar in both the European AAs and other regions, though. It amounted to –3.2 pp respectively –3.7 pp in the overall economy and –3.7 pp respectively –3.2 pp in industry. Thus, while the share of low-skilled in the workforce has been shrinking in all sectors and regions to a fairly similar amount, industry provides employment to a disproportionately large share of low-skilled (both relative to other sectors and relative to other regions) in the European AAs.

7.5.2 Employment by occupations

Figure 7.6 repeats the above figure by showing the occupation structure in the overall economy and the production sector by occupation. The most eye-catching stylised fact arising from this analysis is the substantially higher share of workers in high-skilled and medium-skilled service occupations in the European AAs. When considering the total economy in 2018 according to ELFS data 47.0% of all employed working in the European AAs were working in high-skilled occupations and a further 25.8% in medium-skilled service occupations. Thus, in the European AAs almost three quarters of the employed, worked in service occupations, while in other regions this applies only to two-thirds of the employed.

Figure 7.6: Employment structure of the overall economy and in the production sector the EU and in European AAs by occupation 2011 and 2018



Source: ELFS micro data. Figure excludes the following countries (as well as AAs located in these countries): Belgium, Bulgaria, Denmark, Ireland, Greece Spain, Hungary the Netherlands, Portugal, Sweden, UK and Norway. High-skilled = ISCO 1-3, Medium-skilled Services = ISCO 4 & 5, Medium-skilled production = ISCO 6-8, low-skilled = ISCO 9.

This disproportionately high share of persons employed in service occupations also applies to industry in the European AAs. Although for obvious reasons, industry employs a higher share of workers working in production occupations than the overall economy, in European AAs around a third (32.8%) of the employed in industry worked in high-skilled white-collar occupations and another 14.5% in medium-skilled service occupations. In other European region these percentages were 25.5% and 11.9% respectively. In addition, the tertiarisation of

the employment structure of industry in the European AAs proceeded at a rate that is comparable to the growth in other regions in the 2010s. Between 2011 and 2018 the share of employed in industry working in highly skilled white collar jobs has increased by 1.2 pp in the European AAs and thus almost by the same share as in other regions (1.5 pp), while the share of employed in medium-skilled service occupations increased by 0.6 pp in industry in the European AAs but 0.4 pp in other regions.

Industrial employment in the European AAs is therefore much more strongly focused on service occupations than in other regions and it is to be expected that a substantial share of the jobs in industry in European AAs are actually office jobs that are associated with demands for office spaces. Furthermore, recent trends suggest that this tendency to an increased tertiarisation of the employment structure still continues to this day.

7.5.3 Differences between sectors and city types

As with most of the other trends analysed in this study also this one, however, differs substantially across sectors and city types. This can be illustrated by considering the employment shares by occupation and education in different sectors and city types (see Table 7.3Table 7.4 to Table 7.6)[59]. With respect to differences between sectors this consideration indicates that while the general trends stated above apply to all sectors alike, industry and logistics have been most strongly affected both the changes in employment structure in industry in European AAs. This means in particular:

- The relatively higher shares of high and low-skilled employed working in industry in the AAs and the substantially lower share of medium-skilled applies to all of the large sectors considered, but is slightly less pronounced in utilities, where over a third of the labour force has a tertiary education in AAs (Table 7.3).
- The decline in the employment share of the less educated and the rising employment share of highly educated affected all sectors and all regions. In the European AAs the reduction in low-skilled employment was, however, most pronounced in the construction sector and in manufacturing. In these sectors these shares declined by between –4.8 and –3.9 pp between 2011 and 2018 in the European AAs. The strongest increases in the share of high-skilled, by contrast, occurred in manufacturing (6.6 pp) and in utilities (5.2 pp). Overall, the manufacturing sector, which is also most strongly exposed to international competitions as well as outsourcing, has experienced the strongest shift in its employment structure (see Table 7.3).

Table 7-3: Employment structure in the production sector of European AAs by highest completed education and sector 2011 and 2018

	2011		2018	
	AAs	Other regions	AAs	Other regions
	Manufacturing			
Lower secondary or less	21.1	18.4	17.2	14.9
Upper secondary (incl. post-secondary)	57.4	66.1	56.0	65.6
Tertiary	21.6	15.4	26.8	19.4

[59] The ELFS only provides information on the NACE 1-digit level

	Utilities			
Lower secondary or less	15.3	14.4	14.9	14.1
Upper secondary (incl. post-secondary)	56.6	62.9	50.3	59.2
Tertiary	28.2	22.7	34.8	26.7
	Construction			
Lower secondary or less	28.0	23.6	23.2	20.3
Upper secondary (incl. post-secondary)	56.5	64.6	57.1	65.5
Tertiary	15.5	11.8	19.8	14.2
	Logistics			
Lower secondary or less	21.6	18.2	19.1	16.3
Upper secondary (incl. post-secondary)	62.4	71.6	61.5	69.8
Tertiary	16.0	10.3	19.4	13.9

Source: ELFS micro data. Figure excludes the following countries (as well as AAs located in these countries): Belgium, Bulgaria, Denmark, Ireland, Greece Spain, Hungary, the Netherlands, Portugal, Sweden, UK and Norway. High-skilled = ISCED 5 or more, Medium-skilled = ISCED 3 and 4, Low-skilled = ISCED 2 or less.

The general stylised fact of a higher employment share in high-skilled and medium-skilled service occupations at the expense of low-skilled and medium-skilled service occupations in the European AAs applies to almost all sectors. They are, however, most pronounced in manufacturing. Here the employment share in high-skilled occupations is by more than 9 pp higher in the European AAs than in other regions and the employment share of medium-skilled service occupations by over 2 pp. In addition, in logistics the employment share in medium-skilled service occupations is by over 4 pp higher in the European AAs than in other regions. By contrast the utilities sector is the only sector, where the employment share in medium-skilled service occupations is lower in the European AAs than in the other regions (see Table 7.4).

Table 7-4: Employment structure in the production sector of European AAs by occupation and sector 2011 and 2018

	2011		2018	
	AAs	Other regions	AAs	Other regions
	Manufacturing			
High-skilled	35.6	25.9	37.4	28.1
Med.-skilled services	12.3	10.4	12.7	10.5
Med.-skilled production	45.6	56.2	43.8	54.3
Low-skilled	6.6	7.6	6.2	7.1
	Utilities			
High-skilled	48.1	41.9	48.2	40.0
Med.-skilled services	15.0	12.5	13.4	14.1
Med.-skilled production	24.9	33.1	24.9	30.0
Low-skilled	12.0	12.5	13.5	15.9
	Construction			
High-skilled	25.4	20.1	28.0	21.7
Med.-skilled services	6.2	5.6	7.0	6.0
Med.-skilled production	60.0	65.0	59.2	65.5
Low-skilled	8.4	9.3	5.8	6.9
	Logistics			

High-skilled	44.9	43.8	47.2	44.8
Med.-skilled services	26.9	21.0	26.1	22.0
Med.-skilled production	19.7	26.3	18.4	24.8
Low-skilled	8.5	9.0	8.3	8.4

Source: ELFS micro data. Figure excludes the following countries (as well as AAs located in these countries): Belgium, Bulgaria, Denmark, Ireland, Greece Spain, Hungary, the Netherlands, Portugal, Sweden, UK and Norway High-skilled = ISCO 1-3, Medium-skilled Services = ISCO 4 & 5, Medium-skilled production = ISCO 6-8, Low-skilled = ISCO 9.

The shift towards a higher share of high-skilled occupations in European AAs applies to all sectors. It is, however, most pronounced in construction (+ 2.6 pp) and logistics (+2.3 pp). By contrast the employment share of medium-skilled service occupation has declined in the utilities and logistics. The strongest decline in the share of medium-skilled productions occupations was in manufacturing (with –1.8 pp), while the share of low-skilled occupations decreased most in the construction sector (–1.6 pp). By contrast, the share of medium-skilled production occupations stagnated and that of low-skilled occupations even increased in among those employed in utilities in the European AAs in the period from 2011 to 2018.

With respect to the heterogeneity between AAs a more varied picture emerges. This suggests that the focus on high-skilled employment in the industrial sector is particularly pronounced in capital city regions. In these 26,7% of the employed in industry, compared to 22.6% in other AAs, have a completed tertiary education. Higher than average shares of low-skilled employment, by contrast, are found primarily in non-capital city regions. In these cities 21.6% of the employed in industry had only a lower secondary or lower education level (relative to 14.2% in capital cities).

Table 7-5: Employment structure in the production sector of European AAs by highest completed education and city type 2011 and 2018

	2011		2018	
	By function			
	Capital City	Other	Capital City	Other
Lower secondary or less	17.2	25.6	14.2	21.6
Upper secondary (incl. post-secondary)	60.7	56.5	59.1	55.8
Tertiary	22.1	17.9	26.7	22.6
	By location			
	EU15+NO	EU13	EU15+NO	EU13
Lower secondary or less	26.3	9.4	22.0	8.1
Upper secondary (incl. post-secondary)	54.2	71.1	53.7	67.9
Tertiary	19.5	19.5	24.2	23.9
	By size			
	large	small	Large	small
Lower secondary or less	23.2	14.2	19.4	12.7
Upper secondary (incl. post-secondary)	57.5	65.1	56.6	61.8
Tertiary	19.4	20.7	24.0	25.4

Source: ELFS micro data. Figure excludes the following countries (as well as AAs located in these countries): Belgium, Bulgaria, Denmark, Ireland, Greece Spain, Hungary, the Netherlands, Portugal, Sweden, UK and Norway. High-skilled = ISCED 5 or more, Medium-skilled = ISCED 3 and 4, Low-skilled = ISCED 2 or less.

The differences between large and small cities as well as between cities located in the EU15 countries or Norway and EU13 countries, lies mainly in the importance of medium education levels. In the AAs located in EU13 countries and also in small AAs the share of medium-skilled is substantially higher (with 67.9% and 61.8%), and the share of less educated is substantially lower (with 8.1% and 12.7%), than in AAs located in EU13 countries and in larger AAs. The share of highly educated workers in industry is rather similar in the larger and smaller AAs and located in the EU15 and Norway as well as the AAs located in the EU13 and ranges between 23.9% (in AAs located in EU13 countries) and 25.4% (in smaller AAs). Further, the share of highly educated workers in industry increased by more than 4 pp in all AAs, but the reduction in the employment share of the less educated was highest in capital city AAs (–3.0 pp), AAs located in EU16 countries or Norway (–4.5 pp) and larger AAs (–3.8 pp). In smaller AAs (–3.2 pp) and in AAs located in the EU13 countries the decline in the share of medium educated employees was larger than the decline in less educated.

Table 7-6: Employment structure in the production sector of European AAs by occupation and city type 2011 and 2018

	2011		2018	
	By function			
	Capital City	Other	Capital City	Other
High-skilled	32.4	31.1	32.8	32.7
Med.-skilled services	12.1	15.0	12.4	15.8
Med.-skilled production	47.9	46.7	47.6	44.6
Low-skilled	7.6	7.2	7.2	6.9
	By location			
	EU15+NO	EU13	EU15+NO	EU13
High-skilled	32.9	27.1	33.7	29.7
Med.-skilled services	15.1	9.8	15.8	10.2
Med.-skilled production	44.8	55.2	43.6	53.1
Low-skilled	7.2	7.9	7.0	7.0
	By size			
	large	small	large	small
High-skilled	31.9	27.3	33.1	28.8
Med.-skilled services	14.3	9.6	15.0	9.7
Med.-skilled production	46.5	55.3	44.9	54.7
Low-skilled	7.3	7.9	7.0	6.9

Source: ELFS micro data. Figure excludes the following countries (as well as AAs located in these countries): Belgium, Bulgaria, Denmark, Ireland, Greece Spain, Hungary, the Netherlands, Portugal, Sweden, UK and Norway. High-skilled = ISCO 1-3, Medium-skilled Services = ISCO 4 & 5, Medium-skilled production = ISCO 6-8, Low-skilled = ISCO 9.

In terms of occupational structure, the AAs located in EU13 countries stick out as regions in which the share of workers working in medium-skilled production occupations is still rather high (with 53.1% in 2018), while the shares of workers in high-skilled and medium-skilled service occupations (29.7% and 10.2%) are rather low. The same applies to the smaller AAs, where the share of workers employed in medium-skilled occupations was still at 54.7% and that of high-skilled and medium-skilled service occupations at 28.8% respectively 9.7%. However, AAs

located in EU13 countries are also the ones that have seen the strongest decline in the shares of employed in medium-skilled production occupations (of –2.1 pp).

In sum, the trend towards a higher educational structure of workforce in industry has led to rather similar employment shares of the highly educated (and also similar increase in this share over the years 2011 to 2017) in all AAs, but less educated workers are a much more important but also more rapidly shrinking part of the workforce in large AAs, capital city AAs and in AAs located in the EU15 countries and Norway, while in the AAs that are not capital cities as well as the small AAs and AAs located in EU13 countries medium-skilled workers are of higher importance in the employment structure of industry.

7.6 Main take-aways

1. **There is a return of certain forms of production to city regions.** Recent growth trends suggest that some sectors of production activities have been growing more rapidly in urban regions than in the European average. Although this tendency starts from a rather low level (as more rapidly growing sectors account only for 14% of total employment), this may indicate a return of certain production to urban regions.
2. **Cities are demanding greater levels of customisation.** This phenomenon is not restricted to logistics, utilities and some high-tech industries, but also applies to some divisions in consumer goods production and other less technology intensive sectors. In conjunction with the results of the literature survey these sectors should be mainly affiliated with the hand-crafted, design-oriented, high-quality production for local high-income demand.
3. **Smaller city regions are more diverse.** This said, there is also substantial heterogeneity across regions. There is a notable difference in production between capital city regions located in EU15-countries on the one hand, and smaller cities in general. Small AAs represented a higher level of diversity than the capital.
4. **In European AAs the employment structure of industry is marked by both a higher share of highly and less educated, but a substantially lower share of employed with medium education**. This suggests that next to being an important employer of high-skilled workers, industry is of a disproportionately higher relevance for employment of less skilled workers in the European AAs, even if the share of these workers has declined substantially in recent decades both in AAs and other regions.
5. **European AAs have been more strongly affected by the shift to more highly qualified employment than other EU regions.** The share of tertiary educated workers has increased more rapidly in the European AAs than in the European average in the last years. In the European average the share of high-skilled employed in all employed increased by 4.2 pp between 2011 and 2018 in the overall economy and by 3.7 pp in industry. In the European AAs the respective increases were 5.5 pp (in the total economy) and 4.7 pp (in industry). This thus confirms that. In addition, they are also more reliant on a highly qualified workforce for their industrial development, as they employ a larger share of these workers.
6. **The specifics of the employment structure in industry are more pronounced in large AAs as well as in AAs located in the EU15 and Norway as well as in capital city AAs.** Throughout these AAs show a more polarized employment structure by education (on highly and less educated) and a stronger tertiatisation of the occupations structure in industry.

8 Summary

This report is the first background report of ESPON's MISTA project (Metropolitan Industrial Spatial Strategies and Economic Sprawl). It among other things, aimed to provide an empirical overview of the development of industry in European urban agglomerations over the last 30 years.

This analysis is motivated by an important recent shift in the focus of the literature on industrial development. Up until the "Great Recession" of 2008/09 de-industrialisation and tertiarisation were mostly seen as an unavoidable side effect of economic development and a large manufacturing sector was considered as more or less obsolete in a fundamental change towards a post-industrial, service-oriented economy. More recently, however, the role of manufacturing in highly developed countries and regions has been reassessed. Particularly since the Great Recession, a dynamic manufacturing sector has been increasingly considered as a prerequisite for innovation and growth in countries and regions, but also cities (e.g., *Van Winden et al*., 2011; *Baily – Bosworth*, 2014).

The report addresses the following central research questions:

- How has industry in urban agglomerations developed in aggregate over the last 30 years?
- To what degree has the general trend to de-industrialisation differed across different types of cities and time periods?
- To what degree have different sectors of industry different development trends in the major European agglomerations?
- To what degree is the more recent trend to a reindustrialisation of cities reflected in empirical data and which of the industrial sectors are most strongly affected by changing trends in the location of productive activities in Europe.

In addition, we analyse the development of the structure of employment in city regions within the productive sector to ask how the education and workforce structure in industry in European city regions differs from that in other regions and what have been the central trends in employment in industries in European city regions in the last decade in aggregate as well as in different sectors and type of urban regions.

8.1 Aggregate developments

We document a number of stylised facts that highlight the importance of industry for the economic development of urban agglomerations. In particular we show that industry serves as a nucleus for research and innovation in the local economic systems, is a main driver of productivity and also wage growth and has important input-output linkages to the service sector. Thus in 2018, manufacturing alone accounted for over 60% of total business R&D in the EU and Norway. Similarly, labour productivity levels were by far higher in industrial activities than in the European economy total in 2017, in all EU regions and the compensation of employees in industry was some 31% higher than in the economy total.

The data also impressively confirms the role of industry as a "productivity machine" for metropolitan regions. While cumulative productivity gains in industry over the period 1995 to

2017 (measured in constant prices and per employed person) amounted to +70.1% in the major metro regions, +64.4% in the other metro regions and +59.7% in all NUTS-3 regions of the EU and Norway, the corresponding figures for the respective economies as a whole (including services) were much lower at +24.3%, +27.1% and +28.7%. The resulting advantage of the (larger) metro regions in their current industry productivity level is impressive. A GVA per employed person of (2017) € 94.776 at constant prices in the major metro regions industry and of € 79.321 in other metro regions industry is contrasted by € 72.935 in the industry of all NUTS-3 regions.

Further, the production sector of metropolitan regions remains to be of central importance to the European production system as a whole. More than half (54%) of the workforce in European industry (or 19.8 million people) is employed in metropolitan regions and almost two thirds (64%) of the industrial output of the whole European Union is generated in these regions.

The project results also corroborate previous results indicating a substantial decline in the employment and GVA share in cities since the 1970's and a much more stable development since the "Great Recession" in 2008/09. It, however, also extends these findings by demonstrating that:

a) Despite a clear downward trend in industry employment in most European urban areas since the 1990s, developments in terms of GVA were much more favourable although far from uniform and strongly influenced by metro characteristics.
b) As shown by a novel decomposition analysis of employment growth of industry in European metro regions, the bulk of the decline in industrial employment in industry has been due to a substantial increase in labour productivity and thus industrial upgrading rather than "true" de-industrialisation. Indeed, productivity increases can explain the total employment loss in this sector, while the effects of "true" de-industrialisation (i.e., a decline of production in cities), although mostly negative, are often balanced out by additional effects stemming from the growth of metropolitan areas or countries in general.
c) Trends in both the employment and GVA share in industry have been markedly more stable since the Great Recession, than before. In particular, the period 2008 to 2017 contrasts the negative impact of "real" de-industrialisation loss lost much of its significance and made hardly any negative contribution to industry employment change in the metro regions in the post 2008 period.
d) There is some evidence of a return of certain forms of production to city regions. Recent growth trends suggest that some sectors of production activities have been growing more rapidly in urban regions than in the European average. Although this tendency starts from a rather low level (as more rapidly growing sectors account only for 14% of total employment), this may indicate a return of certain production to urban regions.
e) This return of production to cities is not restricted to logistics, utilities and some high-tech industries, but also applies to some divisions in consumer goods production and other less technology intensive sectors. In conjunction with the results of the literature survey, these sectors should be mainly affiliated with the hand-crafted, design-oriented, high-quality production for local high-income demand.
f) Next to the shift from industrial sectors to more service-oriented sectors, urban regions in Europe have been affected by a shift of the employment structure within industry to more highly qualified and service-oriented employment. This shift is still ongoing and

affects urban regions more strongly than others. In consequence, an increasing share of the jobs in urban production are service or white-collar jobs such that in 2016 just below half (47.2%) of the employed in industry in urban regions of the EU were working in such jobs.

8.2 Differentiation of developments

A further central contribution of the current report is that it provides a more detailed and in-depth analysis of the heterogeneity in the development of productive activities than has hitherto been available. In particular, the report highlights a number of differences that apply to heterogeneity within and across metropolitan regions as well as to differences within and across individual sectors of productive activities.

8.2.1 Differences within and between metro regions

For example, with respect to differences within metropolitan regions we find that in the last 30 years production has in general favoured the urban fringes as industry developed more favourably in the wider metro environs than in the metropolitan core. Over time, intra-metropolitan specialisation apparently increases alongside the advantages of the metro centres for knowledge-intensive services and of the wider environs for industry production proper. This to a large degree reflects better location conditions (such as lower land prices and fewer congestion effects) for (large-scale) productive activities in the wider metro areas.

Despite this, core metro regions remain central locations for a modern industry. On the one hand, this is because of the increasingly integrated nature of service and manufacturing functions in industrial value chains, that increasingly use "hybrid" and servo-industrial production methods. This leads to a situation where although industry (and within industry in particular manufacturing) is increasingly located in the wider metro regions, it increasingly needs the complementary industry-related services located in the metro cores for market success.

On the other hand, this is also due to changing tastes and lifestyles (such as increased environmental concerns in urban cores and increased tastes for customisation and individualisation through consumption) and the still growing population in urban cores. This leads to a larger demand for activities related to the implementation of the circular economy and supply of public goods in urban cores as well as to an increasing demand for largely small-scale customized productions in city centres, that also has to be satisfied by nearby producers.

With respect to differences between metro regions**,** the current study indicates that – next to substantial variation between individual cities, that highlight the economic importance of institutions, history and policy – the aggregate picture of the development of productive activities in cities is strongly influenced by large metropolitan regions, capital city regions and by metropolitan regions located in the EU15 countries and Norway. By contrast, the patterns of industrial development differ markedly in smaller metro regions, as well as in regions that are not capitals or are located in EU13 countries. These different industry developments in different metropolitan areas are reflection of different locational (dis-)advantages and suggest that:

- Small and medium sized metropolitan areas did not experience declining employment in production as radically as large metro areas and thus also provide a much broader industrial base (in terms of localised branches) than large cities. In addition, these cities were also less strongly affected by the shift of the employment structure to high-skilled employees and to white collar and service occupations than larger cities.
- Metro regions that are not capital cities have also been less strongly affected from employment losses and also differ markedly in terms of industrial specialisation from capital cities. Capitals are much more strongly specialised on utilities (such as electricity, gas and water provision, remediation of waste materials) and logistics (like wholesale trade, warehousing, water transport, air transport). By contrast, in metropolitan areas that are not capitals there is also a disproportionately strong localisation of the machinery and equipment industries as well as of car production and basic metals, textiles and leather products. This is due to larger population sizes in capital cities, that lead to more pressing concerns with respect to environmental issues, as well as the different functions of these cities in the European city system, as capital cities are often gateways to national markets and thus host a large number of enterprises with high logistics needs. In addition, due to the path dependence of industrial activities, this is likely to also impact on the future development of different cities.
- Cities located in EU13 countries – in part for historic reasons and in part due to generally lower income levels in EU13 countries as well as substantial inflows of foreign investments in the last three decades – are much more "production affine" than cities located in EU15 countries and Norway. This is documented by a larger share of production (and manufacturing) in value added and employment, a larger number of localised branches in particular in manufacturing, and an occupational structure of the employed in industry that is much more strongly focused on medium qualification levels and above all on medium-skilled production occupations. This last fact also suggests that functional specialisation (on service functions) of production within metro regions has progressed much less in metro regions of EU13 countries than in metro regions located in EU15 countries and Norway.

This vast heterogeneity between city types, paired with the equally huge differences between individual metro regions, warns about an overgeneralisation of aggregate results based on the averages of all metro regions. It also highlights the importance of city specific, idiosyncratic factors that may be rooted in specific policies, institutional differences or history (such as the presence of the headquarter of a large industrial enterprise) affecting industrial development, that have to be considered when designing industrial policy for a specific city.

8.3 Differences within and between industry groups

Next to these differences within and between metro regions also the heterogeneity of the production sector in metropolitan regions has to be considered. This is also because of the vast heterogeneity of this sector in terms of the products produced, geographic extent of markets, size of enterprises and technologies used. From a theoretical perspective this leads to an expectation that cities in general are unlikely to present equally favourable conditions for the production of all of these parts of industry and may provide a range of locational advantages for certain activities within production. It also leads to the expectation that may be substantial heterogeneous among cities with respect to their locational advantages.

These expectations are largely confirmed by the results of this study. These conclusions apply to both the specialisation of metro regions on specific production branches as well as to the functional specialisation within branches. Thus, with respect to individual sub-sectors, the evidence of this study suggests that many of the negative developments observed in the production sector in aggregate (such as a low localisation of production, long-term declining employment and a long-term loss in production shares) are closely linked to the development of manufacturing activities (typically represented by businesses in NACE sector C).

The production sector as understood by the MISTA project, however, covers a much larger set of activities (including logistics, construction, utilities and wholesale trade). In these activities metro regions have experienced a much better development than in the manufacturing sector, which drives the aggregate picture of production. For instance, on average a larger share of the employed work in logistics, utilities and wholesale trade and storage in European metro areas than in other regions. Consequently, these sectors are more strongly localised in urban regions than elsewhere. Similarly, employment growth in recent years (2012 to 2018) has been higher or at par with growth in other regions in all of these sectors except for manufacturing.

In addition, even for manufacturing, our results do not support a complete loss of locational advantages for metro regions per se. Rather growth trends, suggest that some sectors of manufacturing activities have been growing more rapidly in urban regions than in the European average. Interestingly these sectors correlate less strongly with high technology and highly qualified staff and more strongly with consumption close production. Indeed, the current study finds next to some high-skilled product activities in particular consumption close branches of manufacturing (such as furniture, food and beverages or the manufacture of leather products) have grown more strongly in urban areas than elsewhere even in terms of employment. While these branches are still small in urban employment shares, this suggests that some parts of production may indeed be returning to metropolitan regions. This form or production differs vastly in nature from the large-scale (and often environmentally problematic) mass production, what has been classically associated with the term “industry”, as it is usually related to small-scale production of highly customized goods with low or even favourable environmental impact.

Irrespective of whether this trend will hold out in the future or not, our results suggest that the different occupational and educational structure of employment in production in metro-areas, are also closely linked to the manufacturing sector, but the marked differences in this structure are also mirrored in other sectors. Thus, manufacturing employment in metro areas have been more strongly affected by the general trend towards an increasing share of high-skilled employment in recent years and similar trends have been observed in all other sectors (i.e., construction). Furthermore, one of the outstanding features of the employment structure of urban manufacturing is a lower share of employed with a medium (upper secondary or vocational) education, such that in urban regions both the share of highly and less educated workers exceeds that of manufacturing in other regions. Thus, in urban regions manufacturing

is a more important employer for both high-skilled and low-skilled workers than in other EU regions.

In parallel the occupational structure of manufacturing in metro regions is also much more tertiarised than in other regions. As a result of increasing functional specialisation, industrial employment in the European AAs is therefore much more strongly focused on service occupations than in other regions and it is to be expected that a substantial share of the jobs in manufacturing in European AAs are actually office jobs that are associated with demands for office spaces. Furthermore, recent trends suggest that this tendency towards an increased tertiarisation of the employment structure still continues to this day.

8.4 Policy

From an economic policy perspective, these empirical results therefore allow a cautiously optimistic view on the further development of industry in European city regions and also highlight the need to adopt new lenses when trying to grasp the nature of contemporary manufacturing. They also suggest that there may be a fertile ground for industrial policies aiming to strengthen the metropolitan industrial base. Our results indicate that the decreases in industrial employment in city regions were primarily triggered by the particularly high productivity gains in metropolitan industry. At the same time, however, it is precisely these productivity advantages that will determine the competitiveness of city regions despite high incomes, especially in technology- and knowledge-intensive productive activities. Maintaining high productivity levels will therefore be of central importance in order to keep production in cities, even if this implies slower employment growth in this sector.

Policy makers should be warned against "one-size-fits-all" solutions which are unlikely to yield success here given the large heterogeneity in industry evolutions in both regional and sectoral terms. From a structural policy perspective, this will mean building on existing sectoral strengths of the respective city region and expanding these towards cognitively "related" but new activities (such as by encouraging spin-offs) that are particularly accessible to knowledge spill-overs. To promote productive activities in cities in the long run, it is essential to understand the nature of the manufacturing that has remained in a specific city and why it has done so. Also promoting an economically healthy environment for the total local economy that fosters innovation and entrepreneurial activities is conducive to productive activities in the long run. This requires:

- *City-specific solutions based on intensive dialogue between policy makers, businesses, economists and urban planners, and a change in perspective from factories, capital equipment and technology towards a people-based view of cities as productive platforms.* Developing and maintaining such platforms, that require intensive personal contact, is therefore one important element in designing successful industrial policies in metro regions.
- *Tools for supporting productive activities.* While some cities are conscious of the value of their industrial land and manufacturing businesses, few actively support these activities. In the past, manufacturing and industrial land operated with relative independence of public planning regimes and were driven by standard market dynamics, only requiring support for the development of new infrastructure. Since

productive activities have become the ‘” weaker” activity (compared with housing, recreation, offices and commercial activities), public authorities have been poorly equipped to prioritise manufacturing activities over other activities. Therefore, there is relatively little contemporary experience with how to manage or support productive activities. Some cities have released development strategies to encourage densification. Other cities have supported financing for education or through financial incentives for businesses to address certain urban issues (such as the circular economy and resource management).

- *Resources for monitoring policy success (or failure) including the development of data sources that allow for an improved evidence base for policy making.* In the context of the current project the most pressing needs would be to provide comparable regionally and granular sectoral data on employment, GVA and the number of enterprises in all EU countries. In addition, there are also a need for an increased harmonisation of basic statistical definitions.

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Annexes

Additional Information for Chapter 3

Table-A 1: Possible delineations of the functional urban area for the city regions participating in our study

LAU-based typology: Functional Urban Areas – FUA (Eurostat)			NUTS-3-based typology: Metropolitan Regions (Eurostat)				NUTS-2-based typology: Agglomeration Areas			
Code	*Name*	*Inhabitants (in 000's)*	*Code*	*Name*	*Inhabitants (in 000's)*		*Code*	*Name*	*Inhabitants (in 000's)*	
				in % of City/FUA				***in % of Metropolitan region***		
BERLIN										
City			**Core (NUTS-3)**							
DE001C1	Berlin	3520.0	DE300	Berlin	3547.4	**101%**				
+ Commuting zone			+ DE404, DE40C, DE405, DE406, DE40E, DE408, DE409, DE40H, DE40A		1628.2					
Functional Urban Area			**Metropolitan region (MR)**				**Agglomeration Area**			
DE001L1	Berlin	5143.0	DE001MC	Berlin	5175.6	**101%**	DE30, DE40		6037.1	**117%**
OSLO										
City			**Core (NUTS-3)**							
NO001C1	Oslo	624.0	NO011	Oslo	663.1	**106%**				
+ Commuting zone			+ NO012		599.1					
Functional Urban Area			**Metropolitan region (MR)**				**Agglomeration Area**			
NO001L1	Oslo	1278.9	NO001MC	Oslo	1262.2	**99%**	NO01	Oslo og Akershus	1262.2	**100%**
RIGA										
City			**Core (NUTS-3)**							
LV001C1	Riga	639.3	LV006	Riga	640.5	**100%**				
+ Commuting zone			+ LV007		365.6					
Functional Urban Area			**Metropolitan region (MR)**				**Agglomeration Area**			
LV001L1	Riga	937.6	LV001MC	Riga	1006.1	**107%**	LV00	Latvija	1959.3	**195%**

Table-A 2: Table-A 1 continued

STUTTGART										
City			**Core (NUTS-3)**							
DE007C1	City of Stuttgart	623.7	DE111	Stuttgart, Stadtkreis	625.9	**100%**				
+ Commuting zone			+ DE112, DE113, DE114, DE115, DE116		2120.9					
Functional Urban Area			**Metropolitan region (MR)**				**Agglomeration Area**			
DE007L1	FUA of Stuttgart	2735.4	DE007M	Stuttgart	2746.8	**100%**	DE11	Stuttgart	4083.9	**149%**
TORINO										
City			**Core (NUTS-3)**							
IT004C1	Torino	890.5	*Metropolitan region consists of only one NUTS-3 region (ITC11)*							
+ Commuting zone										
Functional Urban Area			**Metropolitan region (MR)**				**Agglomeration Area**			
IT004L2	Torino	1769.5	IT004M	Torino	2280.1	**129%**	ITC1	Piemonte	4398.4	**193%**
WIEN										
City			**Core (NUTS-3)**							
AT001C1	Wien	1766.7	AT130	Wien	1853.1	**105%**				
+ Commuting zone			+ AT112, AT125, AT126, AT127		940.1					
Functional Urban Area			**Metropolitan region (MR)**				**Agglomeration Area**			
AT001L3	Wien	2405.6	AT001MC	Wien	2793.2	**116%**	AT11, AT12, AT13		3805.9	**136%**
WARSAW										
City			**Core (NUTS-3)**							
PL001C1	Warszawa	1735.4	PL911	Miasto Warszawa	1748.9	**101%**				
+ Commuting zone			+ PL912, PL913		1249.5					
Functional Urban Area			**Metropolitan region (MR)**				**Agglomeration Area**			
PL001L2	Warszawa	3100.8	PL001MC	Warszawa	2998.4	**97%**	PL91	Warszawski stołeczny	2998.4	**100%**

Source: ESPON MISTA (2020) calculations. The number of inhabitants is measured in 2016, for the city/FUA of Wien and Warsaw in 2014, for the city/FUA Oslo in 2013 due to data availability.

***Table-A 3*: Correspondence table for Agglomeration Areas**

Metropolitan Region		approximated by NUTS-2 Region(s) …	
		Burgenland (AT)	AT11
Wien	AT001MC	Niederösterreich	AT12
		Wien	AT13
		Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	BE10
Bruxelles / Brussel	BE001MC	Prov. Vlaams-Brabant	BE24
		Prov. Brabant wallon	BE31
Sofia	BG001MC	Yugozapaden	BG41
Lefkosia	CY001MC	Kypros	CY00
Praha	CZ001MC	Praha	CZ01
		Strední Cechy	CZ02
Berlin	DE001MC	Berlin	DE30
		Brandenburg	DE40
Hamburg	DE002M	Hamburg	DE60
		Schleswig-Holstein	DEF0
München	DE003M	Oberbayern	DE21
Köln	DE004M	Köln	DEA2
Frankfurt am Main	DE005M	Darmstadt	DE71
Stuttgart	DE007M	Stuttgart	DE11
Düsseldorf	DE011M	Düsseldorf	DEA1
		Düsseldorf	DEA1
Ruhrgebiet	DE038M	Münster	DEA3
		Arnsberg	DEA5
København	DK001MC	Hovedstaden	DK01
		Sjælland	DK02
Tallinn	EE001MC	Eesti	EE00
Athina	EL001MC	Attiki	EL30
Madrid	ES001MC	Comunidad de Madrid	ES30
Barcelona	ES002M	Cataluña	ES51
Valencia	ES003M	Comunidad Valenciana	ES52
Sevilla	ES004M	Andalucía	ES61
Málaga - Marbella	ES006M	Andalucía	ES61
Alicante/Alacant - Elche/Elx	ES021M	Comunidad Valenciana	ES52
Helsinki	FI001MC	Helsinki-Uusimaa	FI1B
Paris	FR001MC	Île de France	FR10
Lyon	FR003M	Rhône-Alpes	FRK2
Bordeaux	FR007M	Aquitaine	FRI1
Lille - Dunkerque - Valenciennes	FR009M	Nord-Pas-de-Calais	FRE1
Marseille	FR203M	Provence-Alpes-Côte d'Azur	FRL0
Zagreb	HR001MC	Kontinentalna Hrvatska	HR04
Budapest	HU001MC	Budapest	HU11
Budapest	HU001MC	Pest	HU12
Dublin	IE001MC	Eastern and Midland	IE06
Roma	IT001MC	Lazio	ITI4
Milano	IT002M	Lombardia	ITC4
Napoli	IT003M	Campania	ITF3
Torino	IT004M	Piemonte	ITC1
Luxembourg	LU001MC	Luxembourg	LU00
Riga	LV001MC	Latvija	LV00
Valletta	MT001MC	Malta	MT00
Amsterdam	NL002MC	Flevoland	NL23
		Noord-Holland	NL32
Rotterdam	NL003M	Zuid-Holland	NL33
Oslo	NO001MC	Oslo og Akershus	NO01
Warszawa	PL001MC	Warszawski stoleczny	PL91
Katowice	PL010M	Slaskie	PL22
Lisboa	PT001MC	Área Metropolitana de Lisboa	PT17
Porto	PT002M	Norte	PT11
Bucuresti	RO001MC	Bucuresti - Ilfov	RO32
Stockholm	SE001MC	Stockholm	SE11

Göteborg	SE002M	Västsverige	SE23
Ljubljana	SI001MC	Zahodna Slovenija	SI04
Bratislava	SK001MC	Bratislavský kraj	SK01
		Bedfordshire and Hertfordshire	UKH2
		Essex	UKH3
		Inner London - West	UKI3
		Inner London - East	UKI4
London	UK001MC	Outer London - East and North East	UKI5
		Outer London - South	UKI6
		Outer London - West and North West	UKI7
		Berkshire, Buckinghamshire and Oxfordshire	UKJ1
		Surrey, East and West Sussex	UKJ2
		Kent	UKJ4
West Midlands urban area	UK002M	West Midlands	UKG3
Leeds	UK003M	West Yorkshire	UKE4
Glasgow	UK004M	West Central Scotland	UKM8
		Southern Scotland	UKM9
Liverpool	UK006M	Lancashire	UKD4
		Merseyside	UKD7
		Greater Manchester	UKD3
Manchester	UK008M	Cheshire	UKD6
		Derbyshire and Nottinghamshire	UKF1

Source: ESPON MISTA (2020) illustration.

Additional Information for Chapter 5

***Table-A 4*: European Metropolitan Regions (MR): Assignment to the Typologies used**

MR-Code	Name	Size	Income level	Function in city hierarchy	Sectoral orientation	location	major Metros
AT001MC	Wien	Large	High-income	Capital	Service-based	EU15	Yes
DE001MC	Berlin	Large	Medium income	Capital	Service-based	EU15	Yes
DE007M	Stuttgart	Large	High-income	Second	Industry-based	EU15	Yes
IT004M	Torino	Large	Medium income	Second tier	Industry-based	EU15	Yes
LV001MC	Riga	Large	Low-income	Capital	Mixed-based	EU13	Yes
NO001MC	Oslo	Large	High-income	Capital	Service-based	-	Yes
PL001MC	Warszawa	Large	Low-income	Capital	Mixed-based	EU13	Yes
AT002M	Graz	Medium	High-income	Other	Mixed-based	EU15	No
AT003M	Linz	Medium	High-income	Second tier	Industry-based	EU15	No
AT004M	Salzburg	Small	High-income	Other	Mixed-based	EU15	No
AT005M	Innsbruck	Small	High-income	Other	Mixed-based	EU15	No
BE001MC	Bruxelles	Large	High-income	Capital	Service-based	EU15	Yes
BE002M	Antwerpen	Large	High-income	Second tier	Service-based	EU15	No
BE003M	Gent	Medium	High-income	Other	Mixed-based	EU15	No
BE004M	Charleroi	Small	Low-income	Other	Mixed-based	EU15	No
BE005M	Liège	Medium	Medium-income	Second tier	Service-based	EU15	No
BG001MC	Sofia	Large	Low-income	Capital	Mixed-based	EU13	Yes
BG002M	Plovdiv	Medium	Low-income	Second tier	Industry-based	EU13	No
BG003M	Burgas	Small	Low-income	Second tier	Mixed-based	EU13	No
BG004M	Varna	Small	Low-income	Other	Mixed-based	EU13	No
CH001M	Zürich	-	-	Second tier	-	-	No
CH002M	Genève	-	-	Other	-	-	No
CH003M	Basel	-	-	Second tier	Industry-based	-	No
CH004MC	Bern	-	-	Capital	-	-	Yes
CH005M	Lausanne	-	-	Other	-	-	No
CY001MC	Lefkosia	Medium	Low-income	Capital	Service-based	EU13	Yes
CZ001MC	Praha	Large	Low-income	Capital	Industry-based	EU13	Yes
CZ002M	Brno	Large	Low-income	Second tier	Industry-based	EU13	No
CZ003M	Ostrava	Large	Low-income	Second tier	Industry-based	EU13	No
CZ004M	Plzen	Medium	Low-income	Other	Industry-based	EU13	No
DE002M	Hamburg	Large	High-income	Second tier	Mixed-based	EU15	Yes
DE003M	München	Large	High-income	Second tier	Mixed-based	EU15	Yes
DE004M	Köln	Large	High-income	Other	Mixed-based	EU15	Yes
DE005M	Frankfurt	Large	High-income	Second tier	Mixed-based	EU15	Yes
DE008M	Leipzig	Large	Medium-income	Other	Mixed-based	EU15	No
DE009M	Dresden	Large	Medium-income	Other	Industry-based	EU15	No
DE011M	Düsseldorf	Large	High-income	Other	Mixed-based	EU15	Yes
DE012M	Bremen	Large	High-income	Other	Mixed-based	EU15	No
DE013M	Hannover	Large	High-income	Other	Mixed-based	EU15	No
DE014M	Nürnberg	Large	High-income	Other	Industry-based	EU15	No
DE017M	Bielefeld	Small	High-income	Other	Mixed-based	EU15	No
DE018M	Halle	Small	Medium-income	Other	Mixed-based	EU15	No
DE019M	Magdeburg	Small	Medium-income	Other	Mixed-based	EU15	No
DE020M	Wiesbaden	Small	High-income	Other	Mixed-based	EU15	No
DE021M	Göttingen	Small	Medium-income	Other	Industry-based	EU15	No
DE025M	Darmstadt	Small	High-income	Other	Industry-based	EU15	No
DE027M	Freiburg	Medium	Medium-income	Other	Industry-based	EU15	No
DE028M	Regensburg	Small	High-income	Other	Industry-based	EU15	No
DE031M	Schwerin	Small	Low-income	Other	Mixed-based	EU15	No
DE032M	Erfurt	Small	Medium-income	Other	Industry-based	EU15	No
DE033M	Augsburg	Medium	High-income	Other	Industry-based	EU15	No
DE034M	Bonn	Medium	High-income	Other	Service-based	EU15	No
DE035M	Karlsruhe	Medium	High-income	Other	Industry-based	EU15	No
DE036M	Mönchengladbach	Small	Medium-income	Other	Mixed-based	EU15	No
DE037M	Mainz	Small	High-income	Other	Mixed-based	EU15	No
DE038M	Ruhrgebiet	Large	Medium-income	Second tier	Mixed-based	EU15	Yes
DE039M	Kiel	Medium	Medium-income	Other	Service-based	EU15	No
DE040M	Saarbrücken	Medium	High-income	Other	Industry-based	EU15	No
DE042M	Koblenz	Small	High-income	Other	Mixed-based	EU15	No
DE043M	Rostock	Small	Medium-income	Other	Service-based	EU15	No
DE044M	Kaiserslautern	Small	Medium-income	Other	Mixed-based	EU15	No
DE045M	Iserlohn	Small	Medium-income	Other	Industry-based	EU15	No
DE052M	Flensburg	Small	Medium-income	Other	Service-based	EU15	No
DE054M	Konstanz	Small	Medium-income	Other	Industry-based	EU15	No
DE057M	Gießen	Small	Medium-income	Other	Mixed-based	EU15	No
DE059M	Bayreuth	Small	Medium-income	Other	Industry-based	EU15	No
DE061M	Aschaffenburg	Small	High-income	Other	Industry-based	EU15	No
DE064M	Neubrandenburg	Small	Low-income	Other	Mixed-based	EU15	No
DE069M	Rosenheim	Small	Medium-income	Other	Industry-based	EU15	No
DE073M	Offenburg	Small	High-income	Other	Industry-based	EU15	No

DE074M	Görlitz	Small	Low-income	Other	Industry-based	EU15	No
DE077M	Schweinfurt	Small	High-income	Other	Industry-based	EU15	No
DE079M	Wetzlar	Small	Medium-income	Other	Industry-based	EU15	No
DE083M	Braunschweig	Large	High-income	Other	Industry-based	EU15	No
DE084M	Mannheim	Large	High-income	Other	Industry-based	EU15	No
DE504M	Münster	Small	High-income	Other	Service-based	EU15	No
DE507M	Aachen	Medium	Medium-income	Other	Mixed-based	EU15	No
DE510M	Lübeck	Small	Medium-income	Other	Mixed-based	EU15	No
DE513M	Kassel	Small	High-income	Other	Industry-based	EU15	No
DE517M	Osnabrück	Small	Medium-income	Other	Industry-based	EU15	No
DE520M	Oldenburg	Small	Medium-income	Other	Mixed-based	EU15	No
DE522M	Heidelberg	Medium	High-income	Other	Mixed-based	EU15	No
DE523M	Paderborn	Small	Medium-income	Other	Industry-based	EU15	No
DE524M	Würzburg	Small	High-income	Other	Industry-based	EU15	No
DE527M	Bremerhaven	Small	Low-income	Other	Mixed-based	EU15	No
DE529M	Heilbronn	Small	High-income	Other	Industry-based	EU15	No
DE532M	Ulm	Small	High-income	Other	Industry-based	EU15	No
DE533M	Pforzheim	Small	Medium-income	Other	Industry-based	EU15	No
DE534M	Ingolstadt	Small	High-income	Other	Industry-based	EU15	No
DE537M	Reutlingen	Small	High-income	Other	Industry-based	EU15	No
DE540M	Siegen	Small	Medium-income	Other	Industry-based	EU15	No
DE542M	Hildesheim	Small	Low-income	Other	Industry-based	EU15	No
DE544M	Zwickau	Small	Medium-income	Other	Industry-based	EU15	No
DE546M	Wuppertal	Small	High-income	Other	Industry-based	EU15	No
DE548M	Düren	Small	Medium-income	Other	Industry-based	EU15	No
DE549M	Bocholt	Small	Medium-income	Other	Industry-based	EU15	No
DK001MC	København	Large	High-income	Capital	Service-based	EU15	Yes
DK002M	Århus	Medium	High-income	Second tier	Mixed-based	EU15	No
DK003M	Odense	Small	High-income	Second tier	Service-based	EU15	No
DK004M	Aalborg	Medium	High-income	Second tier	Mixed-based	EU15	No
EE001MC	Tallinn	Medium	Low-income	Capital	Industry-based	EU13	Yes
EL001MC	Athina	Large	Low-income	Capital	Service-based	EU15	Yes
EL002M	Thessaloniki	Large	Low-income	Second tier	Service-based	EU15	No
ES001MC	Madrid	Large	Medium-income	Capital	Service-based	EU15	Yes
ES002M	Barcelona	Large	Medium-income	Second tier	Mixed-based	EU15	Yes
ES003M	Valencia	Large	Low-income	Second tier	Mixed-based	EU15	Yes
ES004M	Sevilla	Large	Low-income	Second tier	Service-based	EU15	Yes
ES005M	Zaragoza	Large	Low-income	Other	Industry-based	EU15	No
ES006M	Málaga	Large	Low-income	Other	Service-based	EU15	Yes
ES007M	Murcia/Cartagena	Large	Low-income	Other	Mixed-based	EU15	No
ES008M	Las Palmas	Medium	Low-income	Other	Service-based	EU15	No
ES009M	Valladolid	Small	Low-income	Other	Mixed-based	EU15	No
ES010M	Palma de Mallorca	Medium	Medium-income	Other	Service-based	EU15	No
ES012M	Vitoria/Gasteiz	Small	Medium-income	Other	Industry-based	EU15	No
ES013M	Oviedo/Gijón	Large	Low-income	Other	Mixed-based	EU15	No
ES014M	Pamplona/Iruña	Medium	Medium-income	Other	Industry-based	EU15	No
ES015M	Santander	Medium	Low-income	Other	Mixed-based	EU15	No
ES019M	Bilbao	Large	Medium-income	Other	Mixed-based	EU15	No
ES020M	Córdoba	Medium	Low-income	Other	Mixed-based	EU15	No
ES021M	Alicante	Large	Low-income	Other	Mixed-based	EU15	Yes
ES022M	Vigo	Medium	Low-income	Other	Industry-based	EU15	No
ES025M	Santa Cruz Tenerife	Medium	Low-income	Other	Service-based	EU15	No
ES026M	A Coruña	Large	Low-income	Other	Mixed-based	EU15	No
ES501M	Granada	Medium	Low-income	Other	Service-based	EU15	No
ES510M	Guipúzcoa	Medium	Medium-income	Other	Industry-based	EU15	No
ES522M	Cádiz	Large	Low-income	Other	Service-based	EU15	No
FI001MC	Helsinki	Large	High-income	Capital	Service-based	EU15	Yes
FI002M	Tampere	Small	High-income	Second tier	Industry-based	EU15	No
FI003M	Turku	Small	High-income	Second tier	Mixed-based	EU15	No
FR001MC	Paris	Large	High-income	Capital	Service-based	EU15	Yes
FR003M	Lyon	Large	High-income	Second tier	Service-based	EU15	Yes
FR004M	Toulouse	Large	High-income	Second tier	Service-based	EU15	No
FR006M	Strasbourg	Large	Medium-income	Other	Mixed-based	EU15	No
FR007M	Bordeaux	Large	Medium-income	Second tier	Service-based	EU15	Yes
FR008M	Nantes	Large	Medium-income	Other	Service-based	EU15	No
FR009M	Lille/Dunkerque	Large	Medium-income	Second tier	Service-based	EU15	Yes
FR010M	Montpellier	Large	Medium-income	Other	Service-based	EU15	No
FR011M	Saint-Etienne	Medium	Low-income	Other	Mixed-based	EU15	No
FR013M	Rennes	Large	Medium-income	Other	Service-based	EU15	No
FR014M	Amiens	Medium	Low-income	Other	Mixed-based	EU15	No
FR015M	Rouen/Le Havre	Large	Medium-income	Other	Mixed-based	EU15	No
FR016M	Nancy	Medium	Low-income	Other	Service-based	EU15	No
FR018M	Reims	Medium	Medium-income	Other	Service-based	EU15	No
FR019M	Orléans	Medium	Medium-income	Other	Mixed-based	EU15	No
FR020M	Dijon	Small	Medium-income	Other	Service-based	EU15	No
FR021M	Poitiers	Small	Medium-income	Other	Service-based	EU15	No
FR022M	Clermont-Ferrand	Medium	Medium-income	Other	Mixed-based	EU15	No

FR023M	Caen	Medium	Medium-income	Other	Service-based	EU15	No
FR024M	Limoges	Small	Medium-income	Other	Service-based	EU15	No
FR025M	Besanþon	Small	Medium-income	Other	Industry-based	EU15	No
FR026M	Grenoble	Large	Medium-income	Other	Mixed-based	EU15	No
FR030M	Fort-de-France	Small	Low-income	Other	Service-based	EU15	No
FR035M	Tours	Medium	Medium-income	Other	Service-based	EU15	No
FR036M	Angers	Medium	Low-income	Other	Mixed-based	EU15	No
FR037M	Brest	Medium	Low-income	Other	Mixed-based	EU15	No
FR038M	Le Mans	Medium	Medium-income	Other	Mixed-based	EU15	No
FR040M	Mulhouse	Medium	Medium-income	Other	Mixed-based	EU15	No
FR043M	Perpignan	Small	Low-income	Other	Service-based	EU15	No
FR044M	Nimes	Medium	Low-income	Other	Service-based	EU15	No
FR045M	Pau	Medium	Medium-income	Other	Service-based	EU15	No
FR048M	Annecy/Genève	Medium	Medium-income	Other	Mixed-based	EU15	No
FR203M	Marseille	Large	Medium-income	Second tier	Service-based	EU15	Yes
FR205M	Nice	Large	Medium-income	Other	Service-based	EU15	No
HR001MC	Grad Zagreb	Large	Low-income	Capital	Industry-based	EU13	Yes
HR005M	Split	Small	Low-income	Second tier	Industry-based	EU13	No
HU001MC	Budapest	Large	Low-income	Capital	Mixed-based	EU13	Yes
HU002M	Miskolc	Medium	Low-income	Second tier	Industry-based	EU13	No
HU004M	Pécs	Small	Low-income	Other	Mixed-based	EU13	No
HU005M	Debrecen	Small	Low-income	Other	Mixed-based	EU13	No
HU009M	Székesfehérvár	Small	Low-income	Other	Industry-based	EU13	No
IE001MC	Dublin	Large	High-income	Capital	Service-based	EU15	Yes
IE002M	Cork	Medium	High-income	Second tier	Mixed-based	EU15	No
IT001MC	Roma	Large	High-income	Capital	Service-based	EU15	Yes
IT002M	Milano	Large	High-income	Second tier	Mixed-based	EU15	Yes
IT003M	Napoli	Large	Low-income	Second tier	Mixed-based	EU15	Yes
IT005M	Palermo	Large	Low-income	Other	Service-based	EU15	No
IT006M	Genova	Medium	Medium-income	Other	Service-based	EU15	No
IT007M	Firenze	Large	High-income	Other	Industry-based	EU15	No
IT008M	Bari	Large	Low-income	Other	Mixed-based	EU15	No
IT009M	Bologna	Large	High-income	Other	Industry-based	EU15	No
IT010M	Catania	Large	Low-income	Other	Service-based	EU15	No
IT011M	Venezia	Medium	Medium-income	Other	Mixed-based	EU15	No
IT012M	Verona	Medium	Medium-income	Other	Industry-based	EU15	No
IT022M	Taranto	Medium	Low-income	Other	Mixed-based	EU15	No
IT027M	Cagliari	Medium	Low-income	Other	Service-based	EU15	No
IT028M	Padova	Medium	Medium-income	Other	Industry-based	EU15	No
IT029M	Brescia	Large	Medium-income	Other	Industry-based	EU15	No
IT501M	Messina	Medium	Low-income	Other	Service-based	EU15	No
IT502M	Prato	Small	Medium-income	Other	Industry-based	EU15	No
IT503M	Parma	Small	Medium-income	Other	Industry-based	EU15	No
IT505M	Reggio nell'Emilia	Small	Medium-income	Other	Industry-based	EU15	No
IT511M	Bergamo	Large	Medium-income	Other	Industry-based	EU15	No
LT001MC	Vilnius	Medium	Low-income	Capital	Mixed-based	EU13	Yes
LT002M	Kaunas	Medium	Low-income	Second tier	Industry-based	EU13	No
LU001MC	Luxembourg	Medium	High-income	Capital	Service-based	EU15	Yes
MT001MC	Valletta	Small	Low-income	Capital	Mixed-based	EU13	Yes
NL001M	s' Gravenhage	Large	High-income	Second tier	Service-based	EU15	No
NL002MC	Amsterdam	Large	High-income	Capital	Service-based	EU15	Yes
NL003M	Rotterdam	Large	High-income	Second tier	Service-based	EU15	Yes
NL004M	Utrecht	Large	High-income	Second tier	Service-based	EU15	No
NL005M	Eindhoven	Medium	High-income	Other	Mixed-based	EU15	No
NL006M	Tilburg	Small	Medium-income	Other	Service-based	EU15	No
NL007M	Groningen	Small	High-income	Other	Service-based	EU15	No
NL008M	Enschede	Medium	Medium-income	Other	Mixed-based	EU15	No
NL009M	Arnhem/Nijmegen	Medium	Medium-income	Other	Service-based	EU15	No
NL012M	Breda	Medium	High-income	Other	Mixed-based	EU15	No
NL015M	Leeuwarden	Small	Medium-income	Other	Service-based	EU15	No
NL507M	Leiden	Small	Medium-income	Other	Service-based	EU15	No
NL511M	Zwolle	Small	High-income	Other	Service-based	EU15	No
NO002M	Bergen	Large	High-income	Second tier	Industry-based	-	No
PL002M	Lódz	Large	Low-income	Second tier	Industry-based	EU13	No
PL003M	Kraków	Large	Low-income	Second tier	Industry-based	EU13	No
PL004M	Wroclaw	Medium	Low-income	Second tier	Mixed-based	EU13	No
PL005M	Poznan	Large	Low-income	Second tier	Industry-based	EU13	No
PL006M	Gdansk	Large	Low-income	Second tier	Industry-based	EU13	No
PL007M	Szczecin	Small	Low-income	Other	Mixed-based	EU13	No
PL008M	Bydgoszcz/Torún	Medium	Low-income	Other	Industry-based	EU13	No
PL009M	Lublin	Medium	Low-income	Other	Industry-based	EU13	No
PL010M	Katowice	Large	Low-income	Second tier	Industry-based	EU13	Yes
PL011M	Bialystok	Small	Low-income	Other	Industry-based	EU13	No
PL012M	Kielce	Medium	Low-income	Other	Industry-based	EU13	No
PL014M	Olsztyn	Medium	Low-income	Other	Industry-based	EU13	No
PL015M	Rzeszów	Medium	Low-income	Other	Industry-based	EU13	No
PL016M	Opole	Medium	Low-income	Other	Industry-based	EU13	No

PL024M	Czestochowa	Small	Low-income	Other	Industry-based	EU13	No
PL025M	Radom	Medium	Low-income	Other	Industry-based	EU13	No
PL506M	Bielsko/Biala	Medium	Low-income	Other	Industry-based	EU13	No
PL514M	Tarnów	Small	Low-income	Other	Industry-based	EU13	No
PT001MC	Lisboa	Large	Low-income	Capital	Service-based	EU15	Yes
PT002M	Porto	Large	Low-income	Second tier	Industry-based	EU15	Yes
PT005M	Coimbra	Small	Low-income	Other	Mixed-based	EU15	No
RO001MC	Bucuresti	Large	Low-income	Capital	Service-based	EU13	Yes
RO002M	Cluj-Napoca	Medium	Low-income	Second tier	Industry-based	EU13	No
RO003M	Timisoara	Medium	Low-income	Second tier	Industry-based	EU13	No
RO004M	Craiova	Medium	Low-income	Second tier	Mixed-based	EU13	No
RO501M	Constanta	Medium	Low-income	Other	Industry-based	EU13	No
RO502M	Iasi	Medium	Low-income	Second tier	Mixed-based	EU13	No
RO503M	Galati	Small	Low-income	Other	Industry-based	EU13	No
RO504M	Brasov	Medium	Low-income	Other	Industry-based	EU13	No
RO505M	Ploieşti	Medium	Low-income	Other	Industry-based	EU13	No
SE001MC	Stockholm	Large	High-income	Capital	Service-based	EU15	Yes
SE002M	Göteborg	Large	High-income	Second tier	Mixed-based	EU15	Yes
SE003M	Malmö	Large	High-income	Second tier	Service-based	EU15	No
SE006M	Uppsala	Small	High-income	Other	Service-based	EU15	No
SI001MC	Ljubljana	Small	Medium-income	Capital	Mixed-based	EU13	Yes
SI002M	Maribor	Small	Low-income	Second tier	Industry-based	EU13	No
SK001MC	Bratislava	Medium	High-income	Capital	Mixed-based	EU13	Yes
SK002M	Košice	Medium	Low-income	Second tier	Industry-based	EU13	No
UK001MC	London	Large	High-income	Capital	Service-based	EU15	Yes
UK002M	West Midlands	Large	Medium-income	Second tier	Mixed-based	EU15	Yes
UK003M	Leeds	Large	High-income	Second tier	Service-based	EU15	Yes
UK004M	Glasgow	Large	Medium-income	Second tier	Service-based	EU15	Yes
UK005M	Bradford	Small	Low-income	Other	Mixed-based	EU15	No
UK006M	Liverpool	Large	Medium-income	Second tier	Service-based	EU15	Yes
UK007M	Edinburgh	Medium	High-income	Other	Service-based	EU15	No
UK008M	Manchester	Large	High-income	Second tier	Service-based	EU15	Yes
UK009M	Cardiff	Large	Medium-income	Other	Mixed-based	EU15	No
UK010M	Sheffield	Medium	Medium-income	Other	Service-based	EU15	No
UK011M	Bristol	Large	High-income	Other	Service-based	EU15	No
UK012M	Belfast	Medium	High-income	Other	Service-based	EU15	No
UK013M	Newcastle	Large	Medium-income	Second tier	Service-based	EU15	No
UK014M	Leicester	Large	Medium-income	Other	Mixed-based	EU15	No
UK016M	Aberdeen	Small	High-income	Other	Industry-based	EU15	No
UK017M	Cambridge	Medium	High-income	Other	Service-based	EU15	No
UK018M	Exeter	Medium	Medium-income	Other	Service-based	EU15	No
UK023M	Portsmouth	Medium	Medium-income	Other	Service-based	EU15	No
UK025M	Coventry	Medium	High-income	Other	Mixed-based	EU15	No
UK026M	Kingston	Medium	Medium-income	Other	Mixed-based	EU15	No
UK027M	Stoke-on-Trent	Large	Medium-income	Other	Mixed-based	EU15	No
UK029M	Nottingham	Small	High-income	Other	Service-based	EU15	No
UK501M	Kirklees	Medium	Medium-income	Other	Mixed-based	EU15	No
UK506M	Doncaster	Medium	Low-income	Other	Mixed-based	EU15	No
UK510M	Sunderland	Small	High-income	Other	Industry-based	EU15	No
UK513M	Medway	Small	Medium-income	Other	Service-based	EU15	No
UK515M	Brighton and Hove	Small	High-income	Other	Service-based	EU15	No
UK516M	Plymouth	Small	Medium-income	Other	Mixed-based	EU15	No
UK517M	Swansea	Small	Medium-income	Other	Mixed-based	EU15	No
UK518M	Derby	Small	High-income	Other	Mixed-based	EU15	No
UK520M	Southampton	Medium	High-income	Other	Service-based	EU15	No
UK528M	Northampton	Small	High-income	Other	Service-based	EU15	No
UK539M	Bournemouth	Small	High-income	Other	Service-based	EU15	No
UK546M	Colchester	Small	Medium-income	Other	Service-based	EU15	No
UK550M	Dundee	Small	Medium-income	Other	Service-based	EU15	No
UK553M	Blackburn/Blackpool	Medium	High-income	Other	Mixed-based	EU15	No
UK559M	Middlesbrough	Medium	Medium-income	Other	Service-based	EU15	No
UK560M	Oxford	Medium	High-income	Other	Service-based	EU15	No
UK566M	Norwich	Small	High-income	Other	Service-based	EU15	No
UK568M	Cheshire/Chester	Medium	High-income	Other	Mixed-based	EU15	No
UK569M	Ipswich	Medium	Medium-income	Other	Service-based	EU15	No

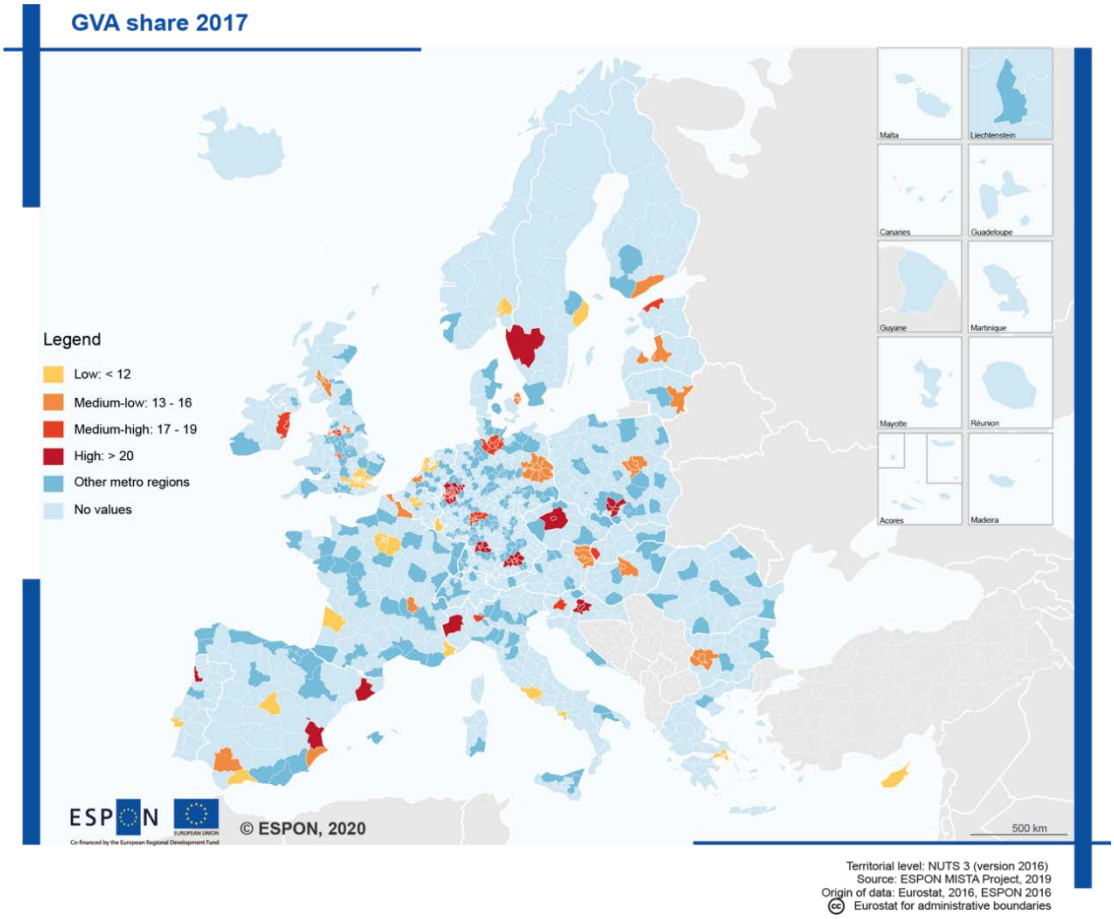
Source: ESPON MISTA (2020) illustration.

***Table-A 5*: Industry in European First-tier Metro Regions: Output**
Industry GVA share; 56 major tier metro regions; 2017

	Industry GVA Share						
	In %	**1995=100**	**Growth Rank**		**In %**	**1995=100**	**Growth Rank**
Stuttgart	*38.8*	*116.0*	*8*	Vilnius	15.7	117.0	6
Katowice	34.6	99.7	15	Liverpool	15.5	82.7	32
Porto	24.3	102.9	14	Rotterdam	15.2	91.8	20
Göteborg	22.5	110.3	10	København	15.1	111.9	9
Praha	22.4	139.0	2	Glasgow	15.1	62.2	51
Torino	*22.3*	*77.2*	*37*	**major Metros**	**14.2**	**81.5**	
Barcelona	22.0	82.2	34	Sofia	13.9	60.4	52
Ruhrgebiet	21.5	81.5	35	*Wien*	13.8	82.6	33
Valencia	21.0	91.5	21	Alicante	13.8	73.8	41
München	20.6	121.0	4	*Warszawa*	*13.7*	*76.3*	*38*
Köln	19.9	82.8	31	*Riga*	*13.4*	*53.9*	*54*
Grad Zagreb	19.7	73.8	40	*Berlin*	*12.8*	*90.4*	*24*
Düsseldorf	19.3	83.8	28	Marseille	12.4	116.2	7
Dublin	19.2	95.0	19	Bordeaux	12.3	120.6	5
Manchester	18.6	68.2	45	Napoli	12.3	87.8	25
West Midlands	18.5	68.0	46	Madrid	10.8	69.1	44
Ljubljana	18.0	95.7	18	Athina	10.7	70.3	43
Frankfurt	17.9	90.5	22	Lisboa	10.5	90.5	23
Hamburg	17.5	105.4	11	Stockholm	9.9	80.6	36
Tallinn	17.5	104.1	13	Paris	9.3	83.7	30
Bratislava	17.5	172.1	1	Bruxelles	8.9	83.8	29
Milano	16.9	66.6	48	Amsterdam	8.6	65.9	49
Bucuresti	16.4	65.8	50	Roma	8.5	74.3	39
Helsinki	16.4	131.0	3	Lefkosia	8.2	60.4	53
Leeds	16.3	67.9	47	Luxembourg	7.0	53.0	55
Sevilla	16.2	105.4	12	Málaga	6.9	85.1	26
Budapest	16.1	96.8	17	*Oslo*	*5.5*	*72.1*	*42*
Lyon	16.1	98.5	16	London	5.4	47.2	56
Lille	16.1	83.9	27				
All Metro Regions	17.2	87.8					
All EU Regions	19.0	89.7					

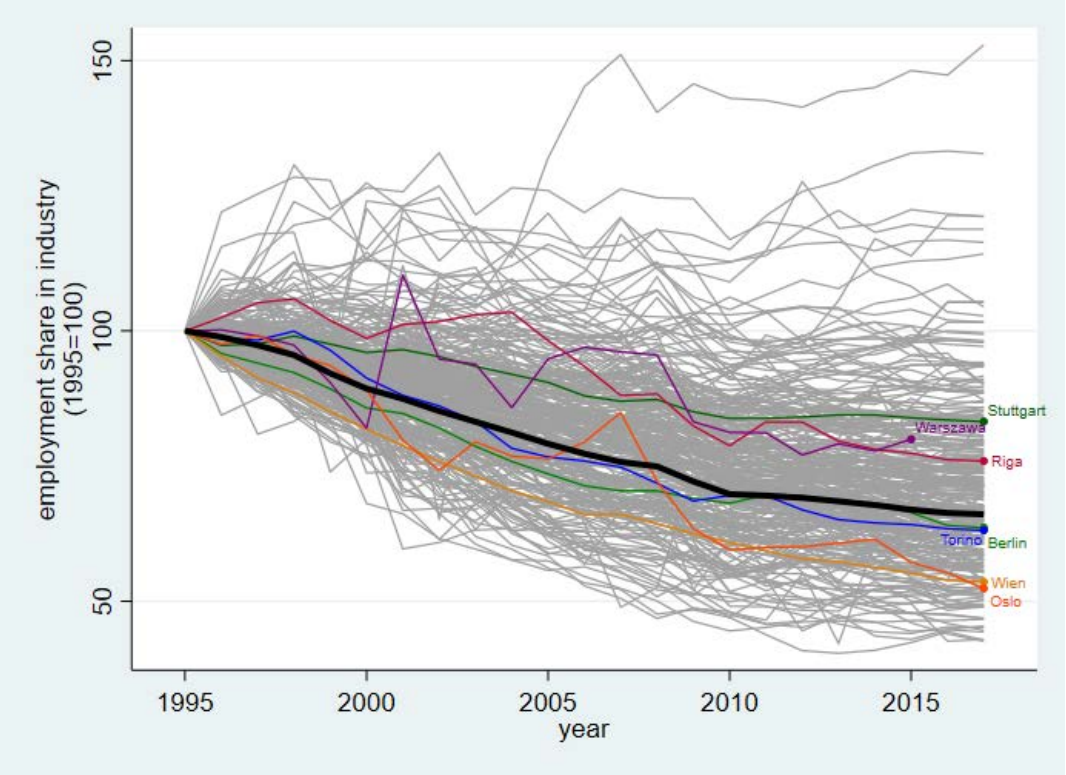
Source: ARDECO database (JRC/EC); ESPON MISTA (2020) calculations. No data for Zurich and Valetta.

Map A-1: Industry in European First-tier Metro Regions: Output Industry GVA share; 56 major tier metro regions; 2017



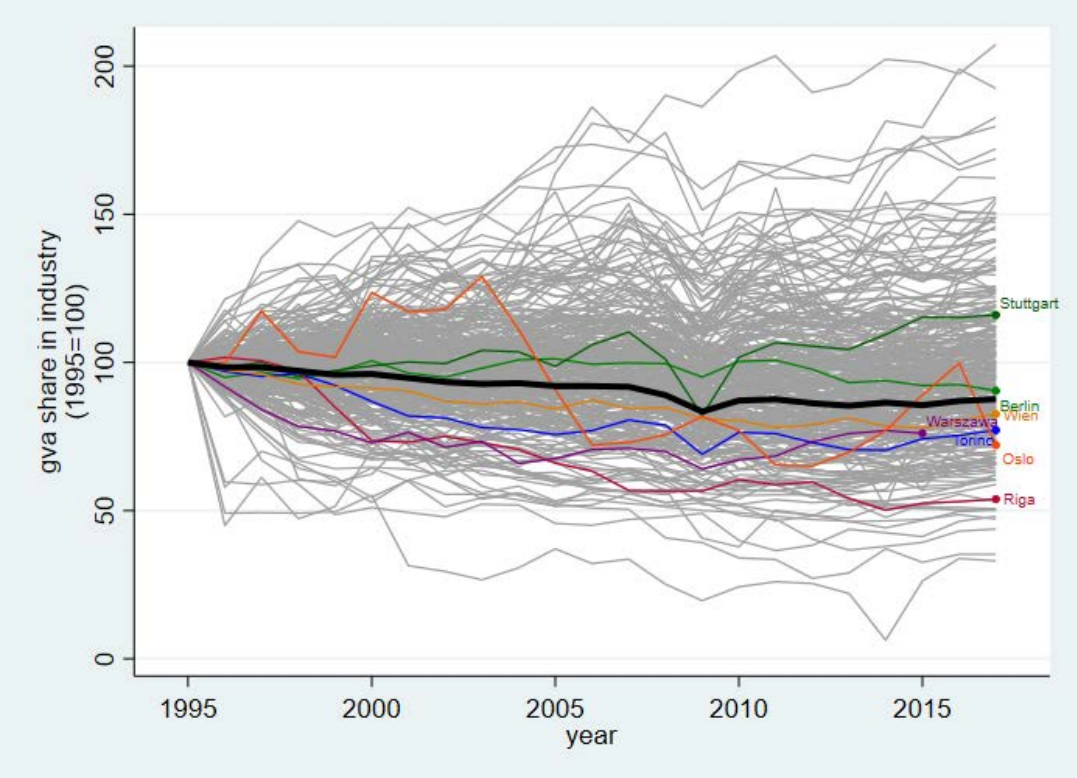
Source: ESPON MISTA (2020).

***Figure-A 1*: Change in Employment Share of Industry by individual Metro Regions**
289 metropolitan regions, 1995=100



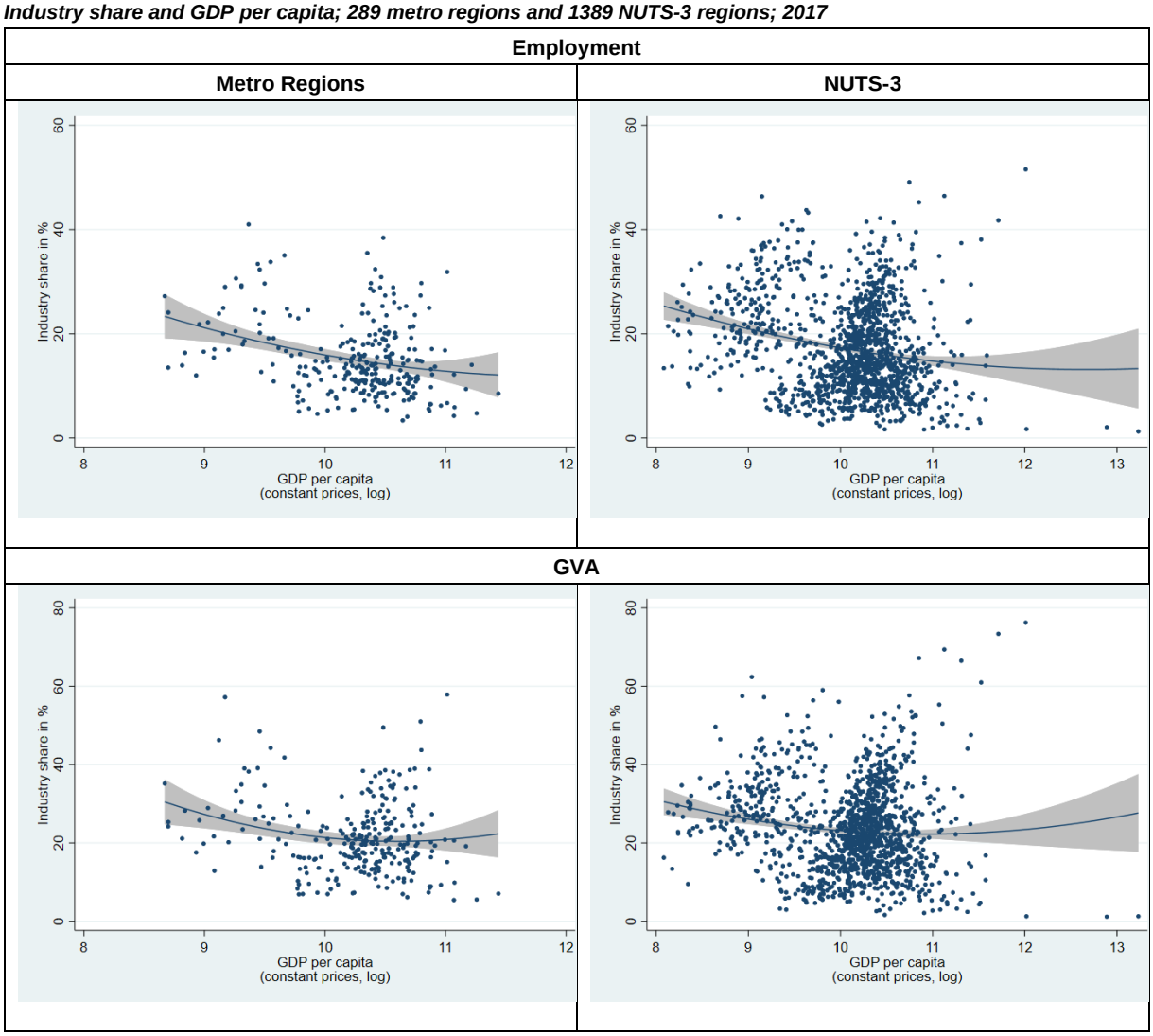
Source: ARDECO database (JRC/EC); ESPON MISTA (2020) calculations.

***Figure-A 2*: Change in GVA Share of Industry by individual Metro Regions**
289 metropolitan regions, 1995=100



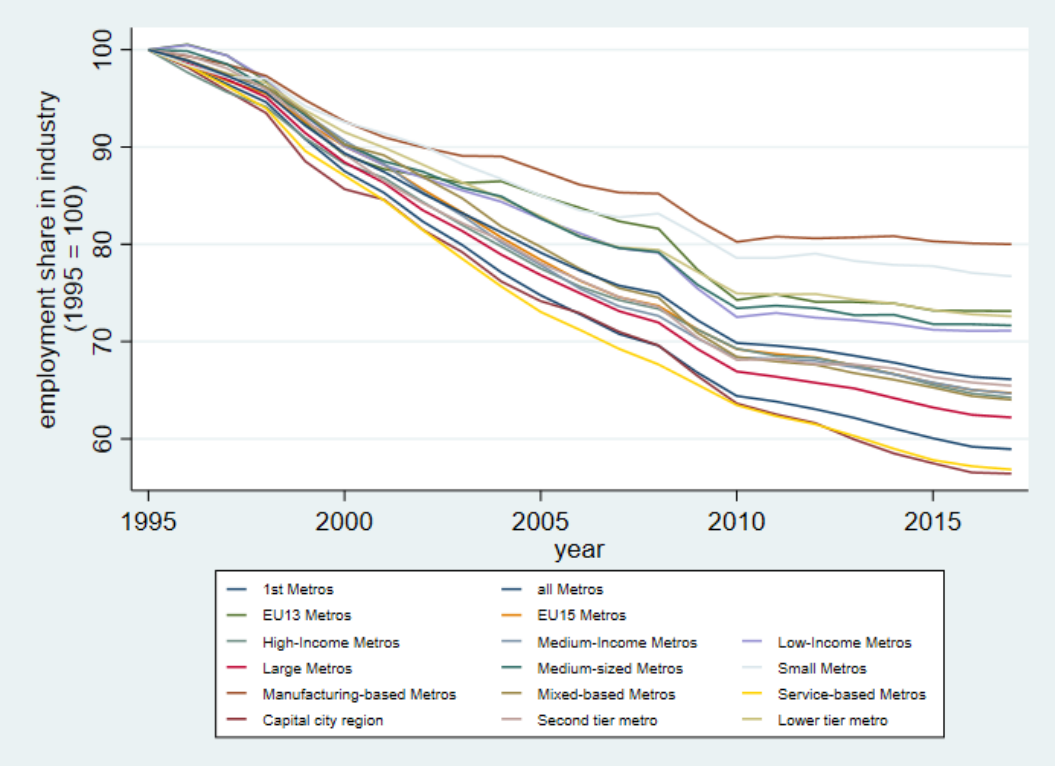
Source: ARDECO database (JRC/EC); ESPON MISTA (2020) calculations.

Figure-A 3: Importance of Industry and Economic Development Level
Industry share and GDP per capita; 289 metro regions and 1389 NUTS-3 regions; 2017



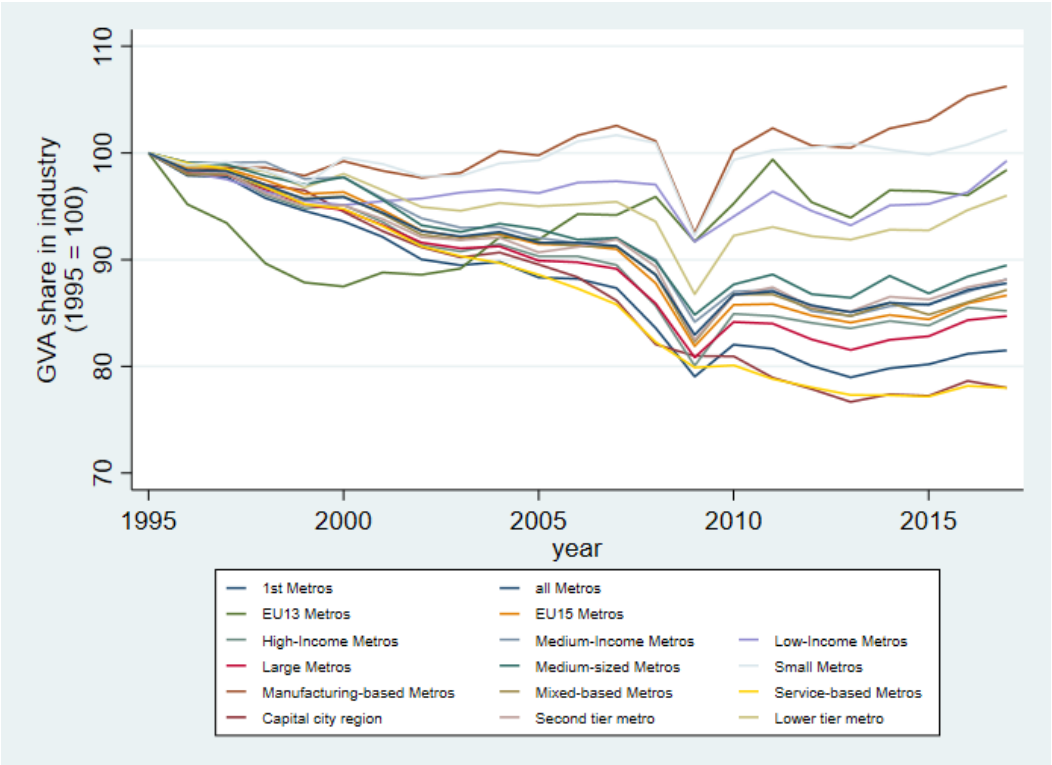
Source: ARDECO database (JRC/EC); ESPON MISTA (2020) calculations. Areas in grey indicate confidence bands (5%-level).

Figure-A 4: Change in Industry Employment Share by Metro Region Groups
289 European metropolitan regions; 1995=100.



Source: ARDECO database (JRC/EC), ESPON MISTA (2020) calculations.

Figure-A 5: Change in Industry GVA Share by Metro Region Groups
289 European metropolitan regions; 1995=100.



Source: ARDECO database (JRC/EC), ESPON MISTA (2020) calculations.

Additional Information for Chapter 6

Technical Supplement: derivation of the components of industry employment change in a new 4-way decomposition

Based on the identity for the industry employment level in our 4-way decomposition shown in Equation 3 in the main text

(3) $$L_{ijt} = \varphi_{ijt}\delta_{ijt}\varepsilon_{jt}Q_t \text{ ; whereby } \varphi_{ijt} = \frac{L_{ijt}}{Q_{ijt}};\ \delta_{ijt} = \frac{Q_{ijt}}{Q_{jt}};\ \varepsilon_{jt} = \frac{Q_{jt}}{Q_t}.$$

it is possible to derive the following relationships for the *change* in industry employment in the metro region under review:

$$\Delta L_{ij} = \varphi_{ijt}\delta_{ijt}\varepsilon_{jt}Q_t - \varphi_{ijt-1}\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h} =$$

$$= \left(\varphi_{ijt} - \varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\delta_{ijt}\varepsilon_{jt}Q_t}{2}\right) + \left(\delta_{ijt} - \delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t}{2}\right) + \left(\varepsilon_{jt} - \varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right) + (Q_t - Q_{t-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right) =$$

$$= \left(\varphi_{ijt} - \varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t}{2}\right) + \left(\delta_{ijt} - \delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\varphi_{ijt}\varepsilon_{jt}Q_t}{2}\right) + \left(\varepsilon_{jt} - \varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right) + (Q_t - Q_{t-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right) =$$

$$= \left(\varphi_{ijt} - \varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right) + \left(\delta_{ijt} - \delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right) + \left(\varepsilon_{jt} - \varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}Q_{t-h}+\varphi_{ijt}\delta_{ijt}Q_t}{2}\right) + (Q_t - Q_{t-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right) =$$

$$= \left(\varphi_{ijt} - \varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right) + \left(\delta_{ijt} - \delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right) + \left(\varepsilon_{jt} - \varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right) + (Q_t - Q_{t-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h}+\varphi_{ijt}\delta_{ijt}\varepsilon_{jt}}{2}\right),$$

Note that in each of these four breakdowns the components add up to the change in industry employment, but they differ a little bit in detail. Therefore, the decomposition finally used is calculated by averaging the respective components. From this final decomposition, which also

fulfils the additionality conditions, the 4 following effects can be derived, which in a normalised form sum up to the respective change in industry employment in percentage points[60]:

(1) The "**labour intensity effect**" has the form

$$\frac{1}{4}\left\{\left(\varphi_{ijt}-\varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\delta_{ijt}\varepsilon_{jt}Q_t}{2}\right)+\left(\varphi_{ijt}-\varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t}{2}\right)+\left(\varphi_{ijt}-\varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)+\left(\varphi_{ijt}-\varphi_{ijt-h}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\right\}=$$

$$\frac{1}{8}\left(\varphi_{ijt}-\varphi_{ijt-h}\right)\left\{\left(\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\delta_{ijt}\varepsilon_{jt}Q_t\right)+\frac{(\delta_{ijt-h}+\delta_{ijt})(\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t)}{2}+\frac{(\delta_{ijt-h}+\delta_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})(Q_{t-h}+Q_t)}{2}\right\}.$$

In its normalised version it is

$$\frac{1}{8}\left(\varphi_{ijt}-\varphi_{ijt-h}\right)\left\{\left(\delta_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\delta_{ijt}\varepsilon_{jt}Q_t\right)+\frac{\left(\delta_{ijt-h}+\delta_{ijt}\right)\left(\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t\right)}{2}+\frac{\left(\delta_{ijt-h}+\delta_{ijt}\right)\left(\varepsilon_{jt-h}+\varepsilon_{jt}\right)\left(Q_{t-h}+Q_t\right)}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

and represents the **contribution of productivity increases (i.e., "industrial up-grading")** to the industry employment change in the metro region considered in percentage points.

(2) The "**sector share effect**" has the form

$$\frac{1}{4}\left\{\left(\delta_{ijt}-\delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\varphi_{ijt}\varepsilon_{jt}Q_t}{2}\right)+\left(\delta_{ijt}-\delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t}{2}\right)+\left(\delta_{ijt}-\delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)+\left(\delta_{ijt}-\delta_{ijt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\right\}=$$

$$\frac{1}{8}\left(\delta_{ijt}-\delta_{ijt-h}\right)\left\{\left(\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\varphi_{ijt}\varepsilon_{jt}Q_t\right)+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t)}{2}+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})(Q_{t-h}+Q_t)}{2}\right\}.$$

In its normalised version it is

$$\frac{1}{8}\left(\delta_{ijt}-\delta_{ijt-h}\right)\left\{\left(\varphi_{ijt-h}\varepsilon_{jt-h}Q_{t-h}+\varphi_{ijt}\varepsilon_{jt}Q_t\right)+\frac{\left(\varphi_{ijt-h}+\varphi_{ijt}\right)\left(\varepsilon_{jt-h}Q_{t-h}+\varepsilon_{jt}Q_t\right)}{2}+\frac{\left(\varphi_{ijt-h}+\varphi_{ijt}\right)\left(\varepsilon_{jt-h}+\varepsilon_{jt}\right)\left(Q_{t-h}+Q_t\right)}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

and represents the **contribution of a falling industry output share and thus "real" de-industrialisation** to industry employment change in the metro region considered in percentage points.

(3) The "**metro share effect**" hast the form

$$\frac{1}{4}\left\{\left(\varepsilon_{jt}-\varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}Q_{t-h}+\varphi_{ijt}\delta_{ijt}Q_t}{2}\right)+\left(\varepsilon_{jt}-\varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)+\left(\varepsilon_{jt}-\varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)+\left(\varepsilon_{jt}-\varepsilon_{jt-h}\right)\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{Q_{t-h}+Q_t}{2}\right)\right\}=$$

[60] For an explanation of the meaning of these effects see the main text.

$$\frac{1}{8}\left(\varepsilon_{jt}-\varepsilon_{jt-h}\right)\left\{\left(\varphi_{ijt-h}\delta_{ijt-h}Q_{t-h}+\varphi_{ijt}\delta_{ijt}Q_t\right)+\frac{(\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt})(Q_{t-h}+Q_t)}{2}+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\delta_{ijt-h}+\delta_{ijt})(Q_{t-h}+Q_t)}{2}\right\}.$$

In its normalised version it is

$$\frac{1}{8}\left(\varepsilon_{jt}-\varepsilon_{jt-h}\right)\left\{\left(\varphi_{ijt-h}\delta_{ijt-h}Q_{t-h}+\varphi_{ijt}\delta_{ijt}Q_t\right)+\frac{\left(\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}\right)(Q_{t-h}+Q_t)}{2}+\frac{\left(\varphi_{ijt-h}+\varphi_{ijt}\right)\left(\delta_{ijt-h}+\delta_{ijt}\right)(Q_{t-h}+Q_t)}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

and represents the **contribution of the (relative) performance of the metro region** to industry employment change in the metro region considered in percentage points.

(4) The "**economic growth effect**" has the form

$$\frac{1}{4}\left\{(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h}+\varphi_{ijt}\delta_{ijt}\varepsilon_{jt}}{2}\right)+(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)+(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon_{jt-h}+\varepsilon_{jt}}{2}\right)+(Q_t-Q_{t-h})\left(\frac{\varphi_{ijt-h}+\varphi_{ijt}}{2}\right)\left(\frac{\delta_{ijt-h}+\delta_{ijt}}{2}\right)\left(\frac{\varepsilon j_{t-h}+\varepsilon_{jt}}{2}\right)\right\}=$$

$$\frac{1}{8}(Q_t-Q_{t-h})\left\{\left(\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h}+\varphi_{ijt}\delta_{ijt}\varepsilon_{jt}\right)+\frac{(\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})}{2}+\frac{(\varphi_{ijt-h}+\varphi_{ijt})(\delta_{ijt-h}+\delta_{ijt})(\varepsilon_{jt-h}+\varepsilon_{jt})}{2}\right\}.$$

In its normalised version it is

$$\frac{1}{8}(Q_t-Q_{t-h})\left\{\left(\varphi_{ijt-h}\delta_{ijt-h}\varepsilon_{jt-h}+\varphi_{ijt}\delta_{ijt}\varepsilon_{jt}\right)+\frac{\left(\varphi_{ijt-h}\delta_{ijt-h}+\varphi_{ijt}\delta_{ijt}\right)\left(\varepsilon_{jt-h}+\varepsilon_{jt}\right)}{2}+\frac{\left(\varphi_{ijt-h}+\varphi_{ijt}\right)\left(\delta_{ijt-h}+\delta_{ijt}\right)\left(\varepsilon_{jt-h}+\varepsilon_{jt}\right)}{2}\right\}\left(\frac{100}{L_{ijt-h}}\right)$$

and represents the **contribution of the performance of the respective country** to industry employment change in the metro region considered in percentage points.

Additional Information for Chaper 7

***Table-A 6*: Correspondence table for mapping NACE 3-digit groups to sector types**

Sector Type	Nace code	Name
other	B051	Mining of hard coal
other	B052	Mining of lignite
other	B061	Extraction of crude petroleum
other	B062	Extraction of natural gas
other	B071	Mining of iron ores
other	B072	Mining of non
other	B081	Quarrying of stone, sand and clay
other	B089	Mining and quarrying n.e.c.
other	B091	Support activities for petroleum and natural gas extraction
other	B099	Support activities for other mining and quarrying
Low-technology:	C101	Processing and preserving of meat and production of meat products
Low-technology:	C102	Processing and preserving of fish, crustaceans and molluscs
Low-technology:	C103	Processing and preserving of fruit and vegetables
Low-technology:	C104	Manufacture of vegetable and animal oils and fats
Low-technology:	C105	Manufacture of dairy products
Low-technology:	C106	Manufacture of grain mill products, starches and starch products
Low-technology:	C107	Manufacture of bakery and farinaceous products
Low-technology:	C108	Manufacture of other food products
Low-technology:	C109	Manufacture of prepared animal feeds
Low-technology:	C110	Manufacture of beverages
Low-technology:	C120	Manufacture of tobacco products
Low-technology:	C131	Preparation and spinning of textile fibres
Low-technology:	C132	Weaving of textiles
Low-technology:	C133	Finishing of textiles
Low-technology:	C139	Manufacture of other textiles
Low-technology:	C141	Manufacture of wearing apparel, except fur apparel
Low-technology:	C142	Manufacture of articles of fur
Low-technology:	C143	Manufacture of knitted and crocheted apparel
Low-technology:	C151	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness; dressing and dyeing of fur
Low-technology:	C152	Manufacture of footwear
Low-technology:	C161	Sawmilling and planing of wood
Low-technology:	C162	Manufacture of products of wood, cork, straw and plaiting materials
Low-technology:	C171	Manufacture of pulp, paper and paperboard
Low-technology:	C172	Manufacture of articles of paper and paperboard
Medium-low-technology:	C181	Printing and service activities related to printing
Low-technology:	C182	Reproduction of recorded media
Medium-low-technology:	C191	Manufacture of coke oven products
Medium-low-technology:	C192	Manufacture of refined petroleum products
Medium-high-technology:	C201	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
Medium-high-technology:	C202	Manufacture of pesticides and other agrochemical products
Medium-high-technology:	C203	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
Medium-high-technology:	C204	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
Medium-high-technology:	C205	Manufacture of other chemical products
Medium-high-technology:	C206	Manufacture of man
High technology	C211	Manufacture of basic pharmaceutical products
High technology	C212	Manufacture of pharmaceutical preparations
Medium-low-technology:	C221	Manufacture of rubber products
Medium-low-technology:	C222	Manufacture of plastics products
Medium-low-technology:	C231	Manufacture of glass and glass products
Medium-low-technology:	C232	Manufacture of refractory products
Medium-low-technology:	C233	Manufacture of clay building materials
Medium-low-technology:	C234	Manufacture of other porcelain and ceramic products
Medium-low-technology:	C235	Manufacture of cement, lime and plaster
Medium-low-technology:	C236	Manufacture of articles of concrete, cement and plaster
Medium-low-technology:	C237	Cutting, shaping and finishing of stone
Medium-low-technology:	C239	Manufacture of abrasive products and non
Medium-low-technology:	C241	Manufacture of basic iron and steel and of ferro
Medium-low-technology:	C242	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
Medium-low-technology:	C243	Manufacture of other products of first processing of steel
Medium-low-technology:	C244	Manufacture of basic precious and other non
Medium-low-technology:	C245	Casting of metals
Medium-low-technology:	C251	Manufacture of structural metal products
Medium-low-technology:	C252	Manufacture of tanks, reservoirs and containers of metal
Medium-low-technology:	C253	Manufacture of steam generators, except central heating hot water boilers
Medium-high-technology:	C254	Manufacture of weapons and ammunition
Medium-low-technology:	C255	Forging, pressing, stamping and roll
Medium-low-technology:	C256	Treatment and coating of metals; machining
Medium-low-technology:	C257	Manufacture of cutlery, tools and general hardware
Medium-low-technology:	C259	Manufacture of other fabricated metal products
High technology	C261	Manufacture of electronic components and boards
High technology	C262	Manufacture of computers and peripheral equipment
High technology	C263	Manufacture of communication equipment
High technology	C264	Manufacture of consumer electronics

High technology	C265	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
High technology	C266	Manufacture of irradiation, electromedical and electrotherapeutic equipment
High technology	C267	Manufacture of optical instruments and photographic equipment
High technology	C268	Manufacture of magnetic and optical media
Medium-high-technology:	C271	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
Medium-high-technology:	C272	Manufacture of batteries and accumulators
Medium-high-technology:	C273	Manufacture of wiring and wiring devices
Medium-high-technology:	C274	Manufacture of electric lighting equipment
Medium-high-technology:	C275	Manufacture of domestic appliances
Medium-high-technology:	C279	Manufacture of other electrical equipment
Medium-high-technology:	C281	Manufacture of general
Medium-high-technology:	C282	Manufacture of other general
Medium-high-technology:	C283	Manufacture of agricultural and forestry machinery
Medium-high-technology:	C284	Manufacture of metal forming machinery and machine tools
Medium-high-technology:	C289	Manufacture of other special
Medium-high-technology:	C291	Manufacture of motor vehicles
Medium-high-technology:	C292	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi
Medium-high-technology:	C293	Manufacture of parts and accessories for motor vehicles
Medium-low-technology:	C301	Building of ships and boats
Medium-high-technology:	C302	Manufacture of railway locomotives and rolling stock
High technology	C303	Manufacture of air and spacecraft and related machinery
Medium-high-technology:	C304	Manufacture of military fighting vehicles
Medium-high-technology:	C309	Manufacture of transport equipment n.e.c.
Low-technology:	C310	Manufacture of furniture
Low-technology:	C321	Manufacture of jewellery, bijouterie and related articles
Low-technology:	C322	Manufacture of musical instruments
Low-technology:	C323	Manufacture of sports goods
Low-technology:	C324	Manufacture of games and toys
Medium-high-technology:	C325	Manufacture of medical and dental instruments and supplies
Low-technology:	C329	Manufacturing n.e.c.
Medium-low-technology:	C331	Repair of fabricated metal products, machinery and equipment
Medium-low-technology:	C332	Installation of industrial machinery and equipment
Utilities	D351	Electric power generation, transmission and distribution
Utilities	D352	Manufacture of gas; distribution of gaseous fuels through mains
Utilities	D353	Steam and air conditioning supply
Utilities	E360	Water collection, treatment and supply
Utilities	E370	Sewerage
Utilities	E381	Waste collection
Utilities	E382	Waste treatment and disposal
Utilities	E383	Materials recovery
Utilities	E390	Remediation activities and other waste management services
Material service	F411	Development of building projects
Material service	F412	Construction of residential and non
Material service	F421	Construction of roads and railways
Material service	F422	Construction of utility projects
Material service	F429	Construction of other civil engineering projects
Material service	F431	Demolition and site preparation
Material service	F432	Electrical, plumbing and other construction installation activities
Material service	F433	Building completion and finishing
Material service	F439	Other specialised construction activities
Material service	G45.1	Sale of motor vehicles
Material service	G45.2	Maintenance and repair of motor vehicles
Material service	G45.3	Sale of motor vehicle parts and accessories
wholesale and storage	G45.4	Sale, maintenance and repair of motorcycles and related parts and accessories
wholesale and storage	G46.1	Wholesale on a fee or contract basis
wholesale and storage	G46.2	Wholesale of agricultural raw materials and live animals
wholesale and storage	G46.3	Wholesale of food, beverages and tobacco
wholesale and storage	G46.4	Wholesale of household goods
wholesale and storage	G46.5	Wholesale of information and communication equipment
wholesale and storage	G46.6	Wholesale of other machinery, equipment and supplies
wholesale and storage	G46.7	Other specialised wholesale
wholesale and storage	G46.9	Non
other	G47.1	Retail sale in non
other	G47.2	Retail sale of food, beverages and tobacco in specialised stores
other	G47.3	Retail sale of automotive fuel in specialised stores
other	G47.4	Retail sale of information and communication equipment in specialised stores
other	G47.5	Retail sale of other household equipment in specialised stores
other	G47.6	Retail sale of cultural and recreation goods in specialised stores
other	G47.7	Retail sale of other goods in specialised stores
other	G47.8	Retail sale via stalls and markets
other	G47.9	Retail trade not in stores, stalls or markets
other	H49.1	Passenger rail transport, interurban
logistics	H49.2	Freight rail transport
logistics	H49.3	Other passenger land transport
logistics	H49.4	Freight transport by road and removal services
logistics	H49.5	Transport via pipeline
logistics	H50.1	Sea and coastal passenger water transport
logistics	H50.2	Sea and coastal freight water transport
logistics	H50.3	Inland passenger water transport
logistics	H50.4	Inland freight water transport

logistics	H51.1	Passenger air transport
logistics	H51.2	Freight air transport and space transport
logistics	H52.1	Warehousing and storage
logistics	H52.2	Support activities for transportation
logistics	H53.1	Postal activities under universal service obligation
logistics	H53.2	Other postal and courier activities
other	I55.1	Hotels and similar accommodation
other	I55.2	Holiday and other short
other	I55.3	Camping grounds, recreational vehicle parks and trailer parks
other	I55.9	Other accommodation
other	I56.1	Restaurants and mobile food service activities
other	I56.2	Event catering and other food service activities
other	I56.3	Beverage serving activities
other	J58.1	Publishing of books, periodicals and other publishing activities
other	J58.2	Software publishing
other	J59.1	Motion picture, video and television programme activities
other	J59.2	Sound recording and music publishing activities
other	J60.1	Radio broadcasting
other	J60.2	Television programming and broadcasting activities
other	J61.1	Wired telecommunications activities
other	J61.2	Wireless telecommunications activities
other	J61.3	Satellite telecommunications activities
other	J61.9	Other telecommunications activities
other	J62.0	Computer programming, consultancy and related activities
other	J63.1	Data processing, hosting and related activities; web portals
other	J63.9	Other information service activities
other	K64.1	Monetary intermediation
other	L68.1	Buying and selling of own real estate
other	L68.2	Renting and operating of own or leased real estate
other	L68.3	Real estate activities on a fee or contract basis
other	M69.1	Legal activities
other	M69.2	Accounting, bookkeeping and auditing activities; tax consultancy
other	M70.1	Activities of head offices
other	M70.2	Management consultancy activities
other	M71.1	Architectural and engineering activities and related technical consultancy
other	M71.2	Technical testing and analysis
other	M72.1	Research and experimental development on natural sciences and engineering
other	M72.2	Research and experimental development on social sciences and humanities
other	M73.1	Advertising
other	M73.2	Market research and public opinion polling
other	M74.1	Specialised design activities
other	M74.2	Photographic activities
other	M74.3	Translation and interpretation activities
other	M74.9	Other professional, scientific and technical activities n.e.c.
other	M75.0	Veterinary activities
other	N77.1	Renting and leasing of motor vehicles
other	N77.2	Renting and leasing of personal and household goods
other	N77.3	Renting and leasing of other machinery, equipment and tangible goods
other	N77.4	Leasing of intellectual property and similar products, except copyrighted works
other	N78.1	Activities of employment placement agencies
other	N78.2	Temporary employment agency activities
other	N78.3	Other human resources provision
other	N79.1	Travel agency and tour operator activities
other	N79.9	Other reservation service and related activities
other	N80.1	Private security activities
other	N80.3	Investigation activities
other	N80.2	Security systems service activities
other	N81.2	Cleaning activities
other	N82.1	Office administrative and support activities
other	N82.9	Business support service activities n.e.c.
Repair	S95.1	Repair of computers and communication equipment
Repair	S95.2	Repair of personal and household goods

Source: ESPON MISTA (2020) illustration.

Figure-A 6: Localisation of productive activities in the European Agglomeration areas by groups of Agglomeration Areas (Location)

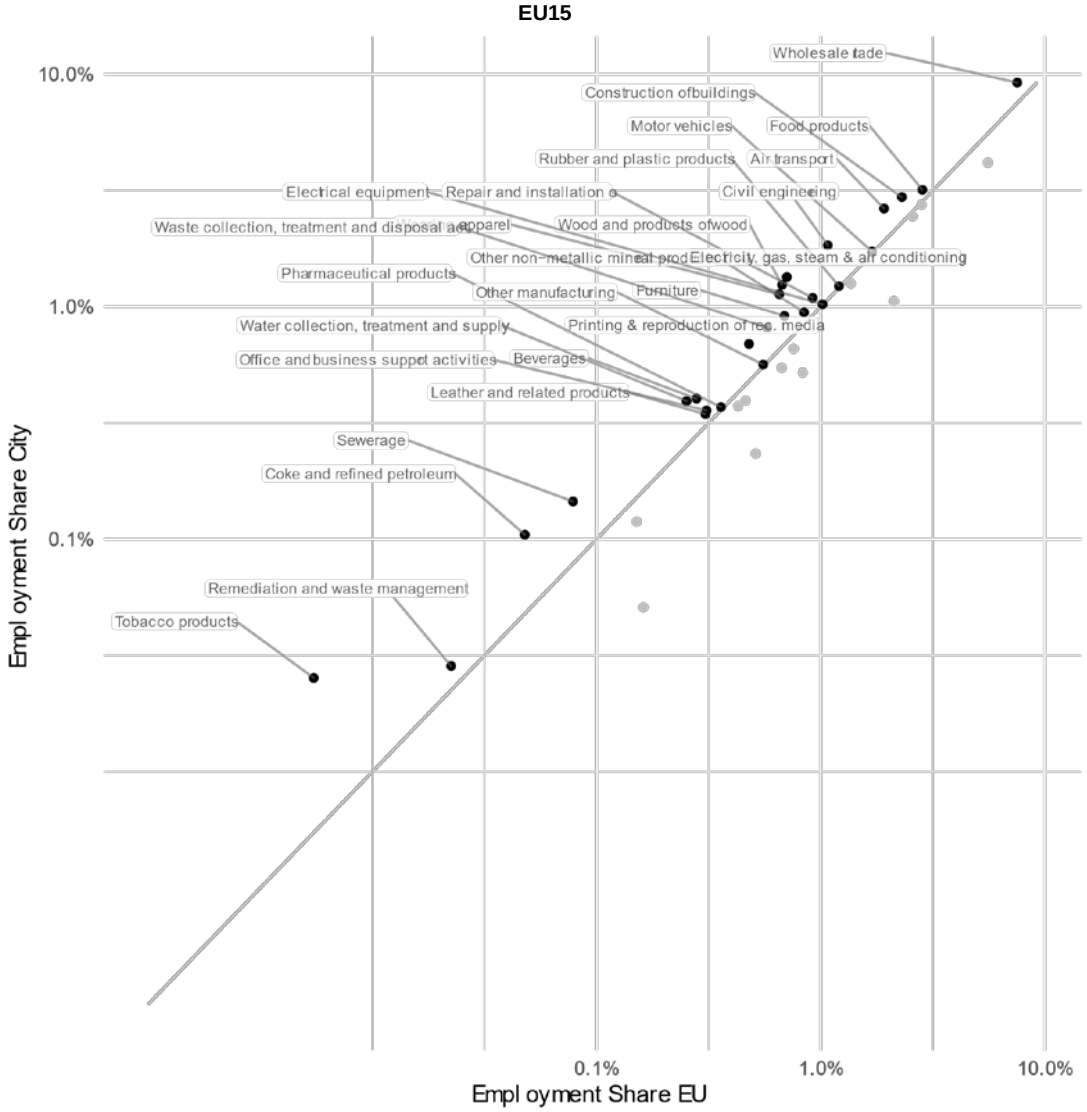
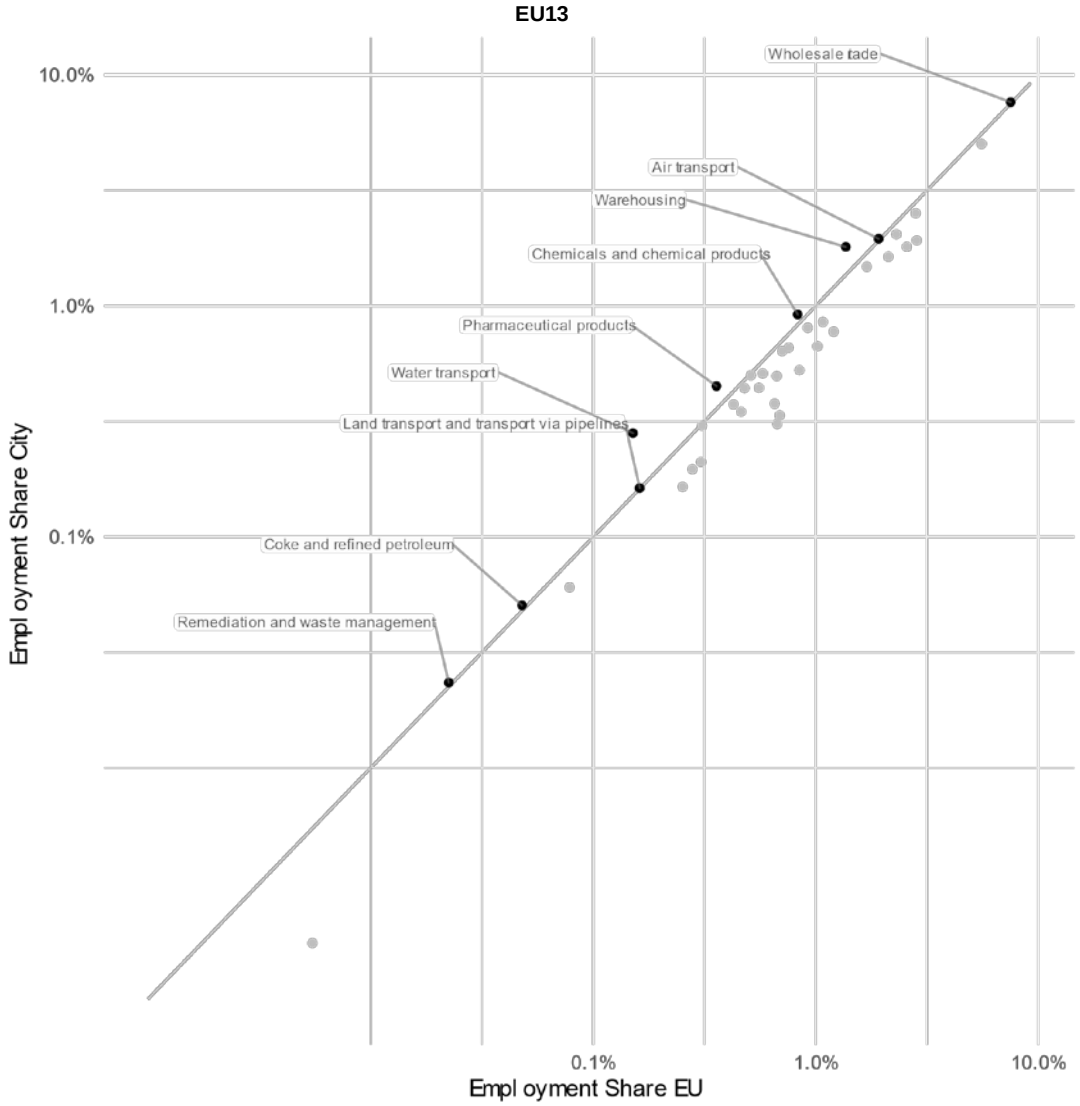


Figure-A 6a: Figure-A 6 continuing



Source: Eurostat, Structural Business Statistics. Share in Europe is measured as the share of the respective sector in total employment of the EU28 and Norway according to SBS data. Horizontal axes – share of the sector in European employment (in %). Vertical axes Share of employment in European AAs (in %). Dots represent the NACE 2-digit industries. Labelled sectors are those with above average localisation in Aas. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

Figure-A 7: Localisation of productive activities in the European Agglomeration areas by groups of Agglomeration Areas (Function)

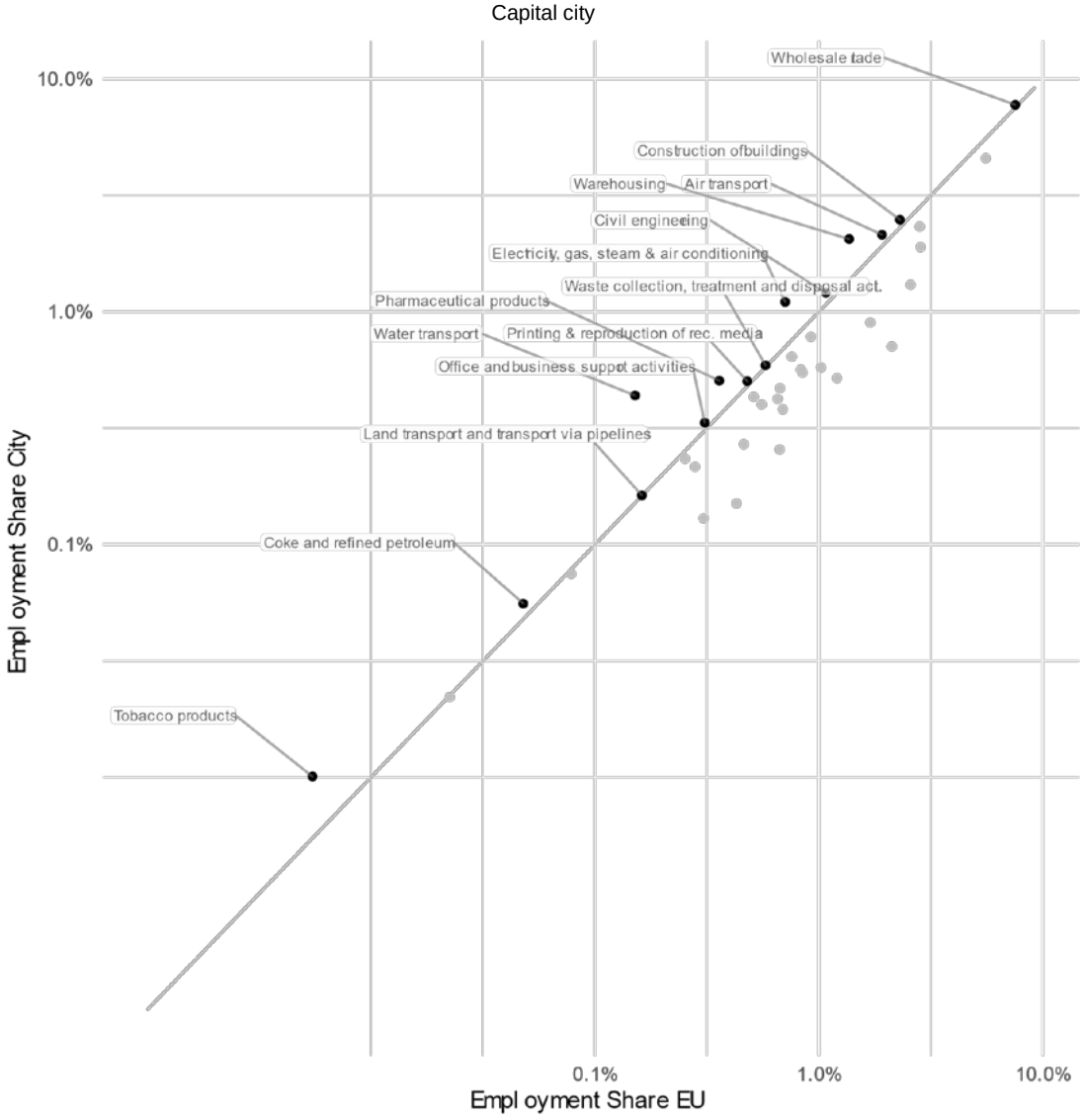
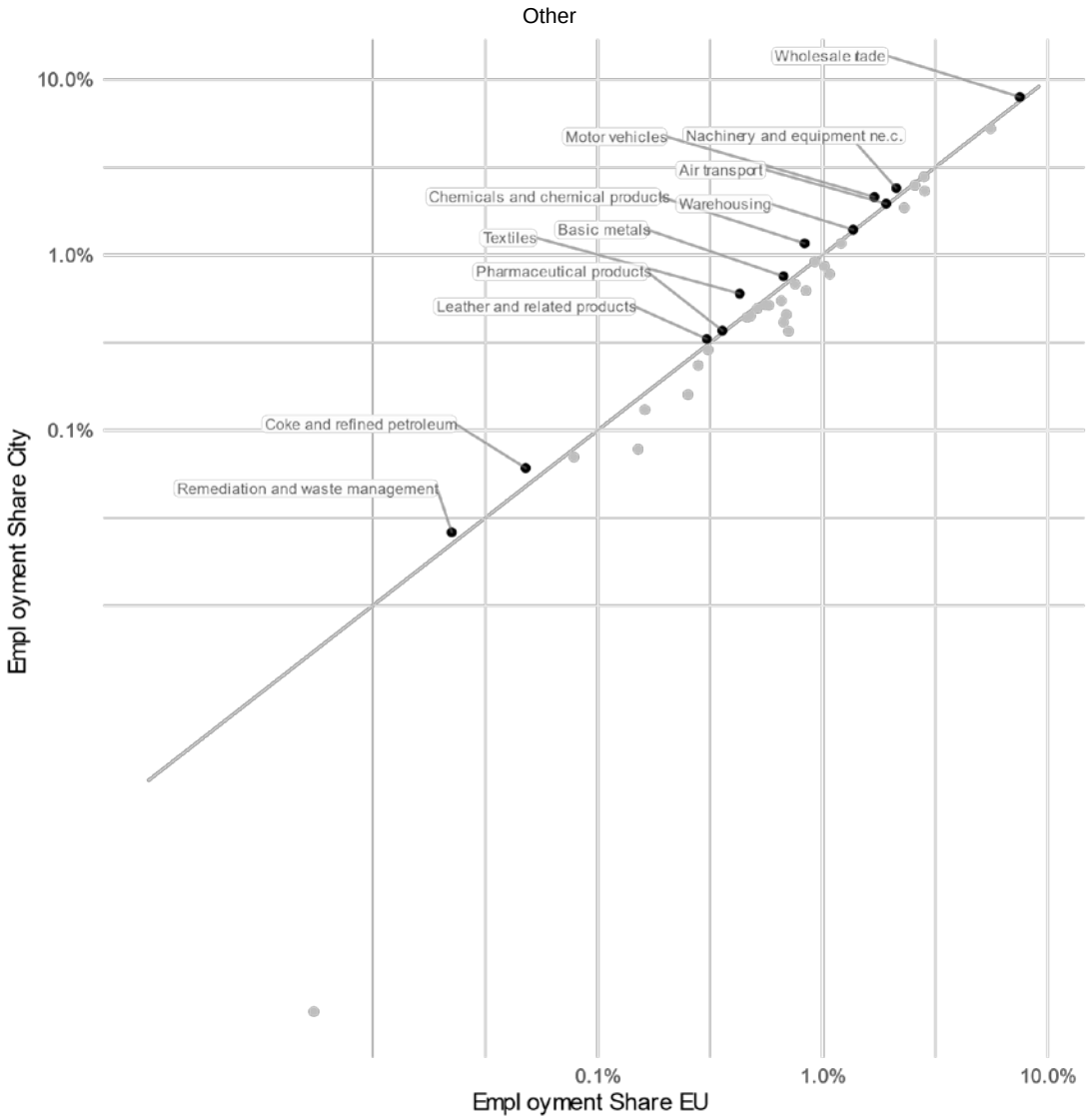


Figure-A 7a: Figure-A 7continuing



Source: Eurostat, Structural Business Statistics. Share in Europe is measured as the share of the respective sector in total employment of the EU28 and Norway according to SBS data. Horizontal axes – share of the sector in European employment (in %). Vertical axes Share of employment in European AAs (in %). Dots represent the NACE 2-digit industries. Labelled sectors are those with above average localisation in Aas. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

Figure-A 8: Localisation of productive activities in the European Agglomeration areas by groups of Agglomeration Areas (Size)

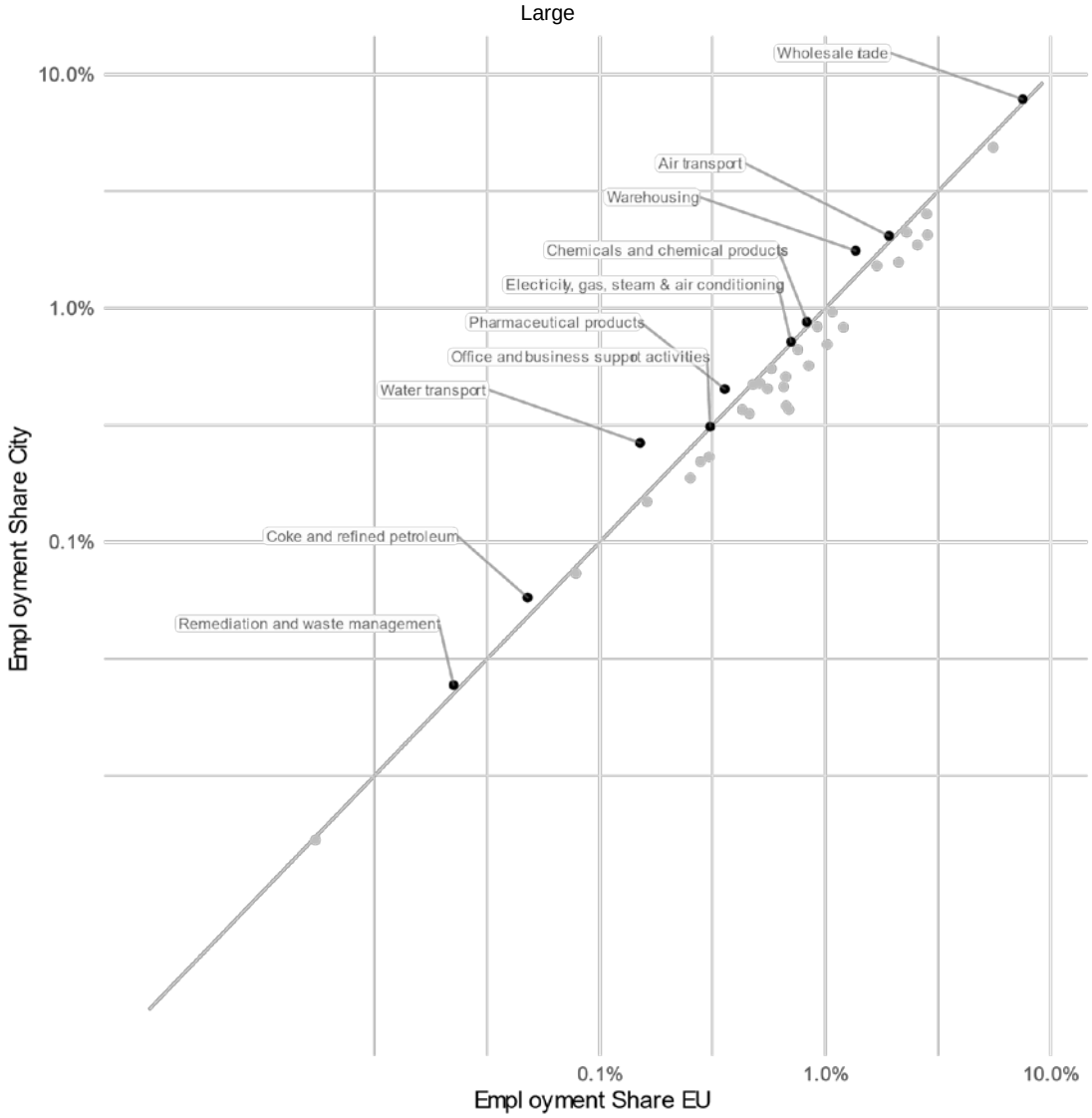
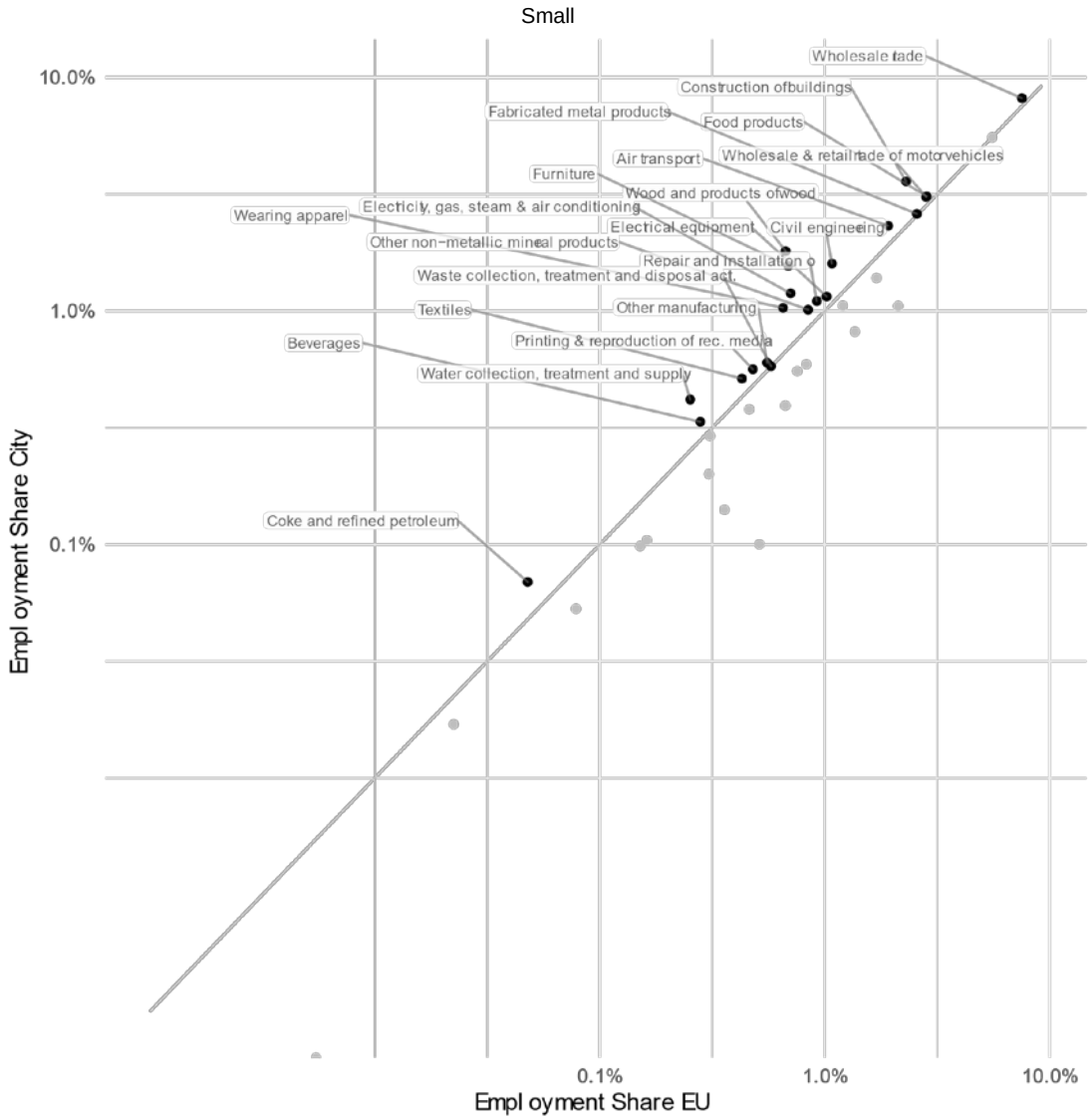
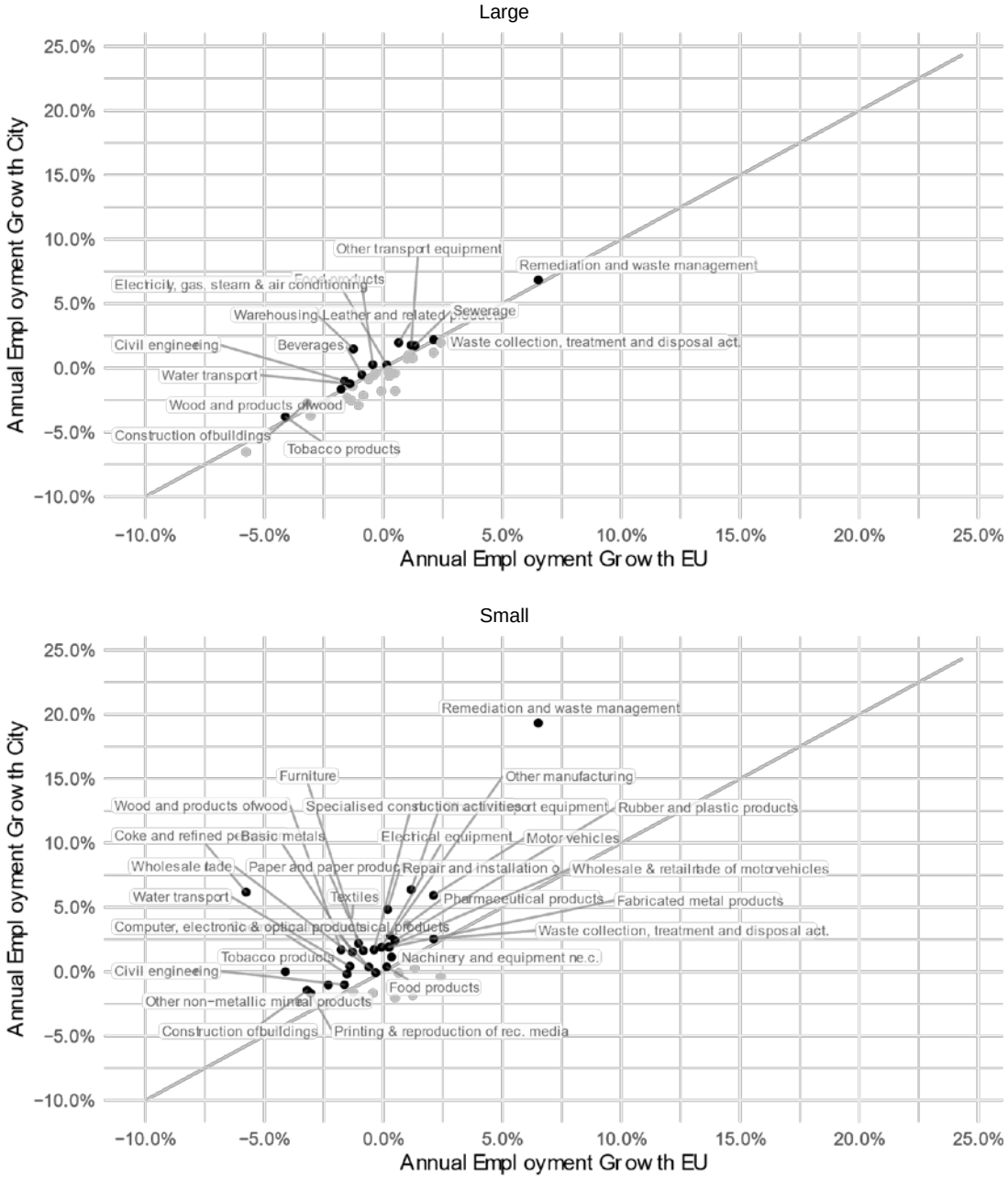


Figure-A 8a: Figure-A 8 continuing



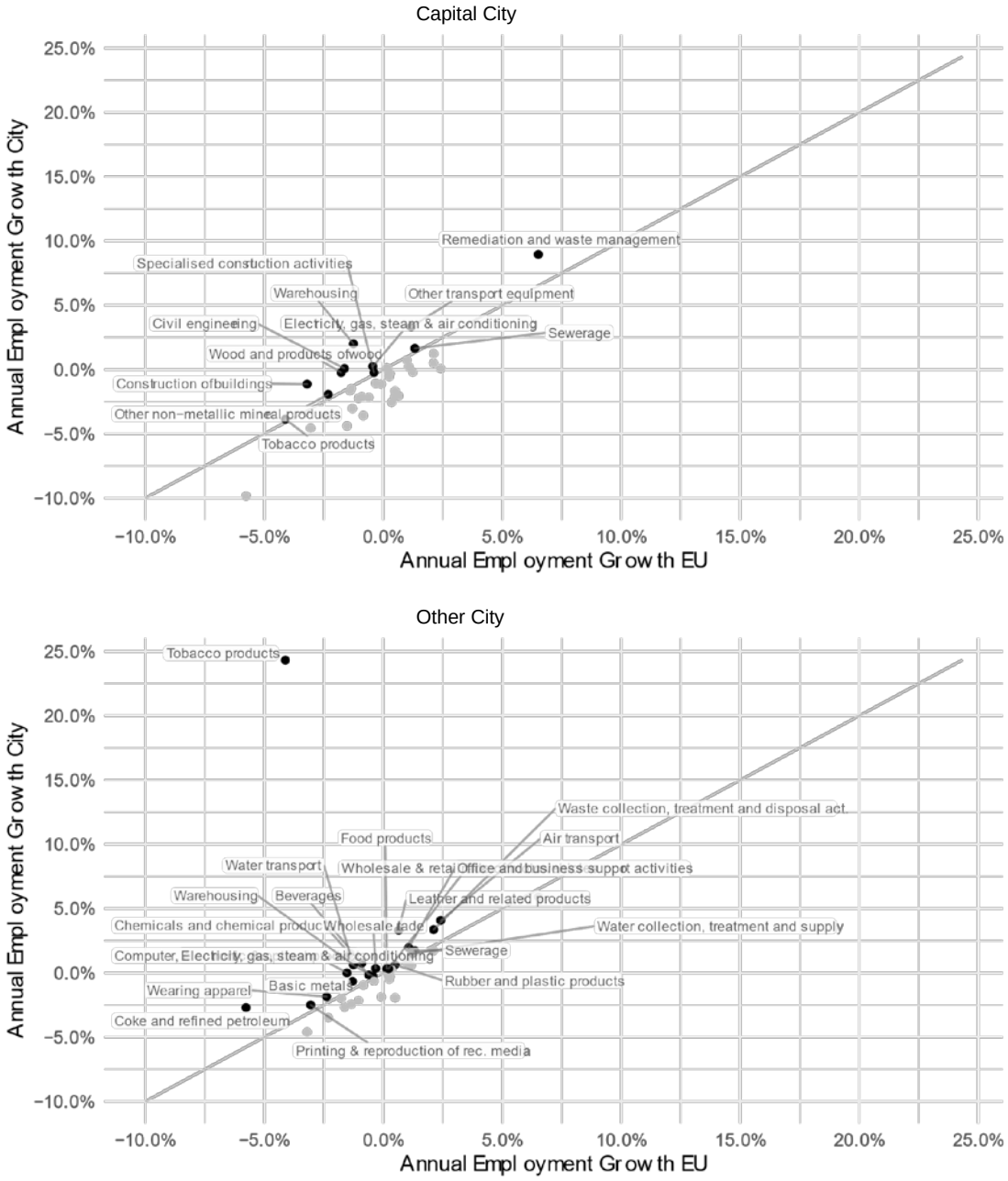
Source: Eurostat, Structural Business Statistics. Share in Europe is measured as the share of the respective sector in total employment of the EU28 and Norway according to SBS data. Horizontal axes – share of the sector in European employment (in %). Vertical axes Share of employment in European AAs (in %). Dots represent the NACE 2-digit industries. Labelled sectors are those with above average localisation in Aas. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

Figure-A 9: Employment growth of productive activities in the European Agglomeration areas by groups of Agglomeration Areas



Source: Eurostat, Structural Business Statistics. Share in Europe is measured as the share of the respective sector in total employment of the EU28 and Norway according to SBS data. Horizontal axes – share of the sector in European employment (in %). Vertical axes Share of employment in European AAs (in %). Dots represent the NACE 2-digit industries. Labelled sectors are those with above average localisation in Aas. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

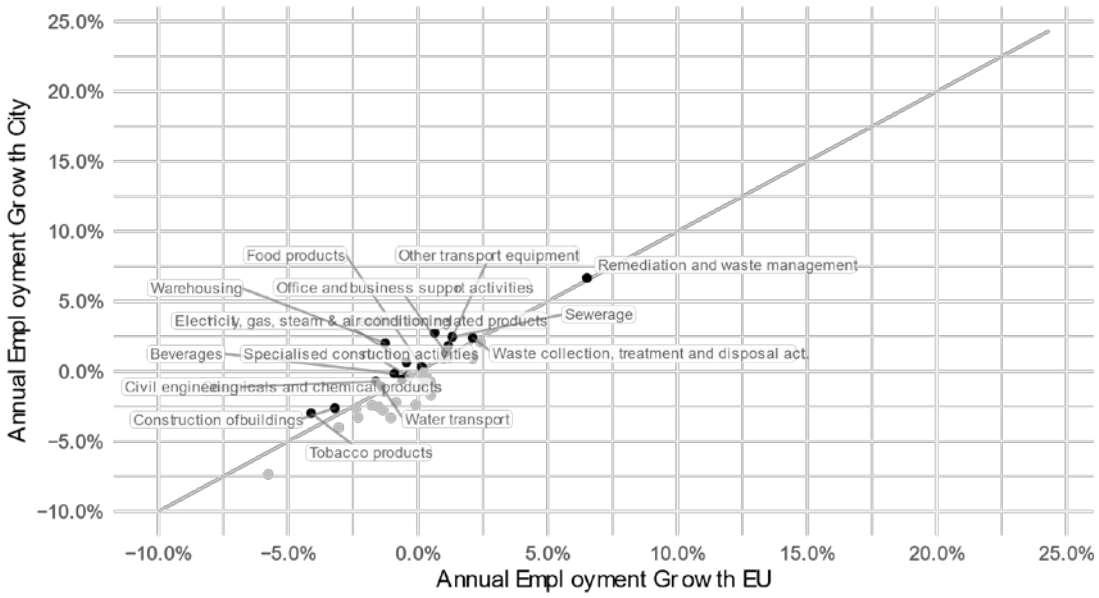
Figure-A 10: Employment growth of productive activities in the European Agglomeration areas by groups of Agglomeration Areas



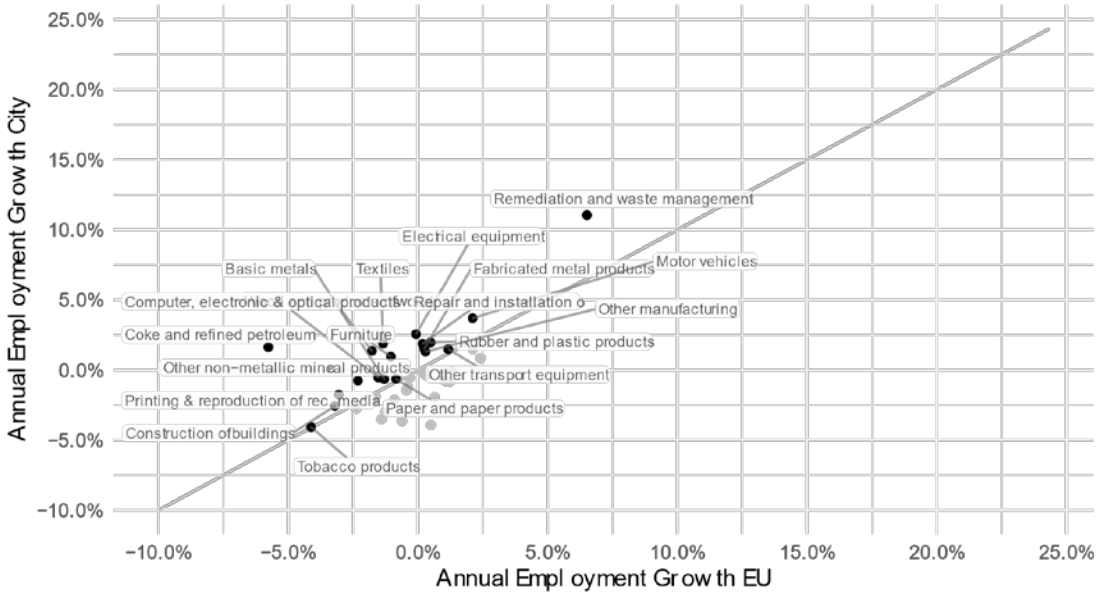
Source: Eurostat, Structural Business Statistics. Share in Europe is measured as the share of the respective sector in total employment of the EU28 and Norway according to SBS data. Horizontal axes – share of the sector in European employment (in %). Vertical axes Share of employment in European AAs (in %). Dots represent the NACE 2-digit industries. Labelled sectors are those with above average localisation in Aas. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

Figure-A 11: Employment growth of productive activities in the European Agglomeration areas by groups of Agglomeration Areas

EU15



EU13



Source: Eurostat, Structural Business Statistics. Share in Europe is measured as the share of the respective sector in total employment of the EU28 and Norway according to SBS data. Horizontal axes – share of the sector in European employment (in %). Vertical axes Share of employment in European AAs (in %). Dots represent the NACE 2-digit industries. Labelled sectors are those with above average localisation in Aas. Data do not include the NACE categories K (financial and insurance activities), and O to U (public administration and defence, education, human health and social work activities, arts, entertainment and recreation, other service activities, activities of households as well as activities of extraterritorial organisations).

ESPON 2020 – More information

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