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Going local: a regional
perspective on how trade
affects labour markets
and inequality

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By Elena Rusticelli, David Haugh, Axelle Arquie and Lilas Demmou

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ABSTRACT/RÉSUMÉ**Going local: A regional perspective on how trade affects labour markets and inequality**

The increase of emerging market economies in international trade and rapid rise in global trade intensity over the past three decades has been accompanied by growing, regionally concentrated, discontent with trade in advanced OECD countries. One of the main concerns is the negative effects of growing import competition on employment. This paper focuses on manufacturing sector employment because of its high trade exposure and potential for wider spillovers. It finds that while trade appears to have only a minor association with manufacturing employment shares at the national level compared with technology, trade has an important role in regional labour market developments due to the geographical concentration of industrial activities. The "sticky" nature of manufacturing employment and sometimes inefficient inter-regional migration mean that trade shocks to local manufacturing can affect entire regional labour markets, leading to widening regional inequalities. Policies should, in particular, focus on boosting regional resilience to industry related shocks, whether they come from trade or technology by building local capacity, both in terms of people – more educated labour is more mobile across jobs – and innovation.

JEL classification codes: F16; J61; O19

Keywords: trade, technology, regions, labour market, manufacturing, employment, wages, inequality

Approche locale : analyser l'influence des échanges sur les marchés du travail et les inégalités sous un angle régional

La montée en puissance des économies de marché émergentes dans le commerce international et la progression rapide de l'intensité du commerce mondial au cours des trente dernières années ont provoqué, dans les économies avancées de l'OCDE, un mécontentement croissant et concentré sur le plan régional à l'égard des échanges. L'une des principales préoccupations concerne la manière dont l'accroissement de la concurrence en matière d'importations pénalise l'emploi. Ce rapport met l'accent sur l'emploi dans le secteur manufacturier, caractérisé par une forte exposition commerciale et des retombées potentielles de grande portée. Il montre que, si les liens entre les échanges et la part de l'emploi manufacturier semblent ténus au niveau national par comparaison avec les technologies, les échanges influent considérablement sur l'évolution des marchés du travail à l'échelon régional en raison de la concentration géographique des activités industrielles. Du fait de la nature « rigide » de l'emploi manufacturier et de migrations inter-régionales parfois inefficaces, les chocs commerciaux sur le secteur manufacturier local peuvent avoir des répercussions sur des marchés du travail régionaux entiers, contribuant ainsi à creuser les inégalités entre les régions. Les pouvoirs publics devraient plus particulièrement s'attacher à renforcer la résilience régionale face aux chocs sectoriels, qu'ils soient provoqués par les échanges ou les technologies, en renforçant les capacités locales, tant sur le plan des ressources humaines – une main-d'œuvre plus instruite est plus mobile d'un emploi à l'autre – que de l'innovation.

Codes de classification JEL : F16 ; J61 ; O19

Mots-clés : échanges, technologie, régions, marché du travail, secteur manufacturier, emploi, salaires, inégalités

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Going local: A regional perspective on how trade affects labour markets and inequality

By Elena Rusticelli, David Haugh, Axelle Arquie, and Lilas Demmou¹

Introduction

Following a historically rapid expansion of world trade and a sharp drop in the share of global industrial activity of the G7 economies in the two decades prior to the 2008-09 global financial crisis, discontent in advanced OECD countries with trade has grown. Although there were both large national and regional gains from faster trade growth in all countries, adjustment costs were highly concentrated within a few regions (OECD, 2016, Caliendo et al., 2017, Autor et al., 2016a). This appears in some cases to have generated sizable spillovers to the non-trade-intensive sectors of the region, disrupting whole regional economies and labour markets.

The role of trade in job losses remains disputed partly because rapid technological change has also been taking place at the same time, with investments in new technology increasing the premium on skills and automation reducing demand for low-skill labour (IMF, 2017). Moreover, financial globalisation is frequently indicated as one of the main causes of the rapid pace of income inequality characterising regional and sectoral dimensions in advanced and emerging economies over the last two decades (IMF, 2007).

This paper aims to shed further light on the relationship between trade and labour market and inequality trends by focussing on the sub-national level because the negative consequences of trade shocks appear to be particularly harmful at the local level, and dissatisfaction with trade is often correspondingly locally concentrated. Ironically, regional dissatisfaction with the EU, expressed in terms of support for Brexit, has also even been positively correlated with the strength of trade of the region with the EU. This further highlights the need to better document the effects of trade on regions (Springford et al., 2016, McCann, 2018)

The paper first gives an overview of trade, technology trends and their role in the labour market through the lens of employment in the manufacturing sector. The focus on the manufacturing sector is motivated by its high trade intensity and hence its greater propensity to be subject to trade shocks as well as spillovers to the wider economy. The analysis then turns to the effects of trade shocks on the labour market at the sub-national level. This is followed by an examination of why, in the absence of policy intervention, these shocks are likely to have durable consequences for regional disparities. Despite the many dimensions of inequality, this paper concentrates on the jobs perspective associated with the rise in regional disparities as employment status is an important driver of income,

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health and wellbeing. The paper concludes with a brief discussion of policies to build regional resilience to these types of shocks. The main findings of the paper are:

- Compared to technology, trade has only a minor association with national manufacturing employment shares.
- Imports of intermediate goods and integration in global value chains is positively associated with national and manufacturing employment and wages, while increased import penetration in final consumption goods tends to be associated with lower manufacturing employment and wages.
- Trade has a stronger influence on regional than national labour markets because of the spatially concentrated nature of industrial activities, "sticky" nature of wages in the manufacturing sector and sometimes inefficient inter-regional migration.
- Regions that suffer a greater decline in the manufacturing employment rate than the national average also tend to suffer a greater fall in their total employment rate than the national average indicating that inter-industry regional reallocation is difficult in many countries.
- Insufficient migration from weaker to better performing regions implies that migration is not helping to disperse localised shocks to labour markets in some countries.
- The failure of regional economies to adjust to regional shocks to manufacturing is evidenced by a positive correlation across regions between manufacturing employment rates and market income per worker.
- Low reallocation of labour to growing sectors and migration to income growing regions leads to widening regional inequality following shocks to manufacturing employment.
- Boosting regional resilience to industry related shocks, whether they come from trade or technology, requires building local capacity, both in terms of innovation and people – more educated labour is more mobile across jobs. It also requires a coordinated and locally tailored support to promote business and job growth. A greater diversification in industrial activities helps regions to adjust to macroeconomic shocks that propagate from the manufacturing sector to the whole regional economy

The pattern of trade and manufacturing has shifted significantly

One of the key concerns associated with globalisation and increasing trade intensity (ratio of exports and imports to GDP) relates to the falling share of activity and job destruction affecting the OECD manufacturing sector. The declining share of manufacturing in GDP is of concern because it is highly tradable and therefore has a particularly strong role in encouraging absolute income convergence due to high rates of innovation and spillovers to other sectors (Rodrik, 2013; OECD, 2016). On the labour market side apprehension is high because manufacturing, which provides high-productivity and high-paying jobs to the low-and medium-skilled individuals, has been on a strong long-term downward trend and the national labour market is relatively sticky (OECD, 2009), with low job turnover making shocks to the sector, including from trade, long-lasting. From 1990 to 2015, the share of the manufacturing sector in total employment fell in all advanced economies and the share of jobs in services increased (Figure 1).

Figure 1. Evolution of jobs in manufacturing and services in OECD countries

Source: OECD National accounts.

All OECD countries shown in Figure 1 have seen a decline in the share of manufacturing employment in total employment, both in the pre- and post-crisis periods. The decline in the manufacturing employment share was, however, negligible in some Eastern European countries -- Slovak Republic, Czech Republic and Estonia -- especially prior to the crisis. The countries that experienced the most rapid decline include Canada, the United Kingdom, Ireland and Slovenia (in the pre-crisis period) and Slovenia and Sweden (in the post-crisis period). By contrast, the share of the manufacturing sector in emerging market economies has been fairly stable in emerging economies and even rose in China and Vietnam (World Bank, 2018). Identifying the reasons for this decline in advanced economies, and whether trade has a role in it, and, if so, how large it is, is difficult because of the simultaneous nature of a number of relevant trends.

Figure 2. Global Value Chains have expanded markedly since 1990

Note: The structural GVC indicator is computed as the ratio of intermediate goods imports to final domestic demand corrected for commodity price and cyclical effects. See Haugh et al. (2016) for further details. “Americas” includes: Argentina, Brazil, Canada, Chile, Columbia, Costa Rica, Mexico and the United States. “Asia-Pacific” includes: Australia, China, Dynamic Asia, Japan, India, Indonesia, Korea and New Zealand. “Europe” includes: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Latvia, Lithuania, Luxemburg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Source: OECD STAN Bilateral Trade Database by industry and end-use category; OECD Economic Outlook 101 database; and authors’ calculations.

First, the fast entry of emerging market economies into world trade has increased competition, potentially putting low productivity firms out of business in the OECD countries. Second, technological change in the form of the IT revolution has sharply decreased the cost of transmitting information across borders, in turn allowing the splitting of production stages across borders in global value chains and making participation in global value chains more vital to trade and especially manufacturing success (Baldwin, 2016, Figure 2). Third, technology has allowed the substitution of capital for labour in manufacturing processes, contributing to productivity gains. Fourth, at the aggregate level, as consumers get richer, they tend to devote a higher proportion of their income to services compared to manufacturing (Ngai et al., 2007; Herrendorf et al., 2013). This implies a lower share of manufacturing employment and a higher services one.

To try to untangle some of these trends, a cross-country regression of manufacturing employment share was estimated over the period 1990-2017 (Table 1). However, given the simultaneity and the complexity of several ongoing structural changes, this analysis aims at exploring the existing association between different factors underlying globalisation and recent developments in national labour markets without claiming exhaustive coverage of causality linkages. The regression contains a number of explanatory variables that aim to capture trade, technology and preference influences, including: import penetration (ratio of imports to final domestic demand plus exports) divided into consumption goods to try to capture competition effects from trade; intermediate imports to capture integration into global value chains; R&D expenditure and machinery investment to proxy substitution of labour with technology and machinery; as well as the share of consumption expenditures devoted to manufactures (Annex A). In addition, the regression equation contains time dummy variables to account for secular trends.

The results show that at a national level, total trade appears to play a minor role in manufacturing employment share changes. This is in line with other research, which suggests that trade has a minor influence on jobs and inequality relative to technology, and that the strength of its influence depends on the skill level of the jobs offshored (WTO, 2008; OECD, 2011a, Lopez Gonzalez et al., 2015, OECD, 2017). The most important contribution to the declining manufacturing employment share is a common trend across countries, which has contributed between $\frac{1}{4}$ and $\frac{1}{2}$ a percentage point per annum to the decline since the 1990s. The universal and long-run nature of this downward trend, which pre-dates the large increase in the ratio of trade-to-GDP growth from the mid-1980s onwards, suggests that it is most likely driven by technology and consumer preference that has not been captured fully by the technology and consumption terms in the regression.

Table 1. Explaining the decline in the manufacturing employment share for selected OECD countries

Dependent variable: change in the share of manufacturing in total employment

	(1)	(2)	(3)	(4)	(5)
Imports for final consumption	-0.48 **	-0.47 **	-0.29	-0.56 ***	-0.51 ***
Intermediate imports	0.19 ***	0.17 ***	0.18 ***	0.20 ***	0.17 ***
Investment in machinery	-0.06 *	-0.05 *	-0.09 ***	-0.06 **	-0.05 *
ICT investment	-0.09	-0.08	-0.05	-0.08	-0.08
Export performance (log)		0.01			0.01
Imports for final consumption from China			-0.95		
Intermediate imports from China			-0.18		
Consumption share				0.24 *	0.20 *
Constant	-0.02 ***	-0.02 ***	-0.02 ***	-0.02 ***	-0.02 ***
Time dummy: 1990-96	0.00	0.00	0.00		
:1996-2002	0.00	0.00	0.00		
:2002-08	-0.01 ***	-0.01 *	0.00		
Countries	17	17	17	17	17
Periods (maximum)	4	4	4	4	4
Number of obs	47	47	45	47	47
Adjusted R-squared	0.28	0.28	0.30	0.30	0.31

Note: All variable are expressed in change form. For the purposes of the regression the change in the data is constructed over sub-periods 1990-6, 1996-2002, 2002-08 and 2008-14. “***”, “**” and “*” denote statistical significance at the 1%, 5% and 10% level, respectively.

The dependant variable is the change in the ratio of manufacturing to total employment. The variable intermediate imports is the change in the import penetration of intermediate goods of all sectors as a share of total domestic expenditure. The variable imports for final consumption is the change in the import penetration of consumptions goods calculated as the ratio of imports of consumption goods of all sectors to total domestic expenditure. The variable ICT investment is calculated as the ratio of investment in ICT equipment in the manufacturing sector to the GDP of the manufacture sector. The variable investment in machinery is the change in the investment in machinery calculated as the ratio of the investment in machinery other than transport and ICT in the manufacturing sector to the GDP of the manufacturing sector. Consumption share is constructed as a weighted sum of the share of the value of consumption of durable and semi durable goods in total consumption across 37 countries. Period dummies are included for the first three sub-periods.

Source: Data comes from various OECD databases: employment data is taken from STAN or GOV database; import data from STAN database; investment data from OECD national accounts; and total domestic expenditure and exchange rate from the Economic Outlook database; and authors’ calculations.

Various other variables capturing a long-term structural trend were tried, including global trade intensity (exports plus imports divided by GDP), but they were not significant jointly. The most significant of these, consumer preferences (measured as the share of durable and semi-durables consumption in total consumption) was included and found to be significant alone, which reduced the size of the unexplained residuals (Figure 3).

Increased import penetration of intermediate goods, which is correlated with greater involvement in global value chains, has been associated with higher manufacturing employment (or rather the employment share falling less steeply), with substantial positive contributions to manufacturing employment share of at least $\frac{1}{4}$ percentage point per annum in the Czech Republic, Slovakia and Estonia. The contribution to employment has been smaller in most countries in the post-crisis period compared to the pre-crisis period, reflecting the plateauing of global GVC activity.

Conversely, increased import penetration in final consumption goods tends to be associated with lower manufacturing employment, although the effects are not statistically robust and for most countries tend to be relatively small. Moreover, for those countries for which the negative effects are estimated to be larger, they are typically out-weighted by the positive effect of intermediate imports. No significant distinct effect was found for the effect of increased import penetration from China, either in terms of intermediate or finished goods. Finally, there is some weak evidence that countries that experience more rapid investment in ICT or in machinery and equipment experience greater losses in manufacturing employment. However, the effect is not robust and generally small.

Besides an impact on employment, trade can also affect manufacturing workers' welfare through its impact on wages. Such an effect has been documented by Ebenstein et al. (2010), and Liu and Trefler (2008), which find that wages grow more slowly in occupations more exposed to import penetration. However, the direction of the effect may also depend on the type of imports. A regression analysis finds that import penetration, both of intermediate goods and of consumption goods, are significant determinants of the average wages in the manufacturing sector relative to the national average across different specifications, but they have opposite signs (Annex B). A positive growth of import penetration of consumption goods is associated with a negative growth of relative average manufacturing wages, while growth of import penetration of intermediate goods is positively associated with relative manufacturing wages. This latter relationship may be a result of the diffusion of innovation embodied in intermediate goods increasing the productivity of workers and therefore making it possible to increase their wages.

Figure 3. Explaining the decline in the manufacturing employment share for selected OECD countries

Annual average percentage point change in the share of manufacturing in total employment

Note: Decomposition based on equation (4) in Table 1. The start of the pre-crisis sample period varies across countries depending on data availability. The “common trend” effect is calculated as the effect of the constant and the time dummies. Countries are ranked according to the decline in the manufacturing employment share in the pre-crisis period.

Source: Authors’ calculations.

A brief overview of the literature on effects of trade at the regional level

While the association between trade and manufacturing employment shares at a national level appears to be relatively minor, especially by comparison with technology, recent experience suggests that pressure from trade shocks becomes more evident at the sub-national level. This is due to the geographical concentration of industry and therefore vulnerability to industry-related shocks. Variation in regional attitudes towards globalisation also suggests differing effects across regions (Arnorsson and Zoega, 2016; Colantone and Stanig, 2016). Indeed, an Institut français d'opinion publique (IFOP) poll in the region surrounding Paris showed that opposition to globalisation increases with distance from the centre of Paris and is correlated with the difficulty of reaching the centre of the metropolis (see *The Economist*, 2017).

A key challenge is identifying the effect of trade at the regional level vis-à-vis other factors. This is because the effects of trade are bi-directional. It can be a source of a negative shock to manufacturing employment (e.g. growing import competition for the domestic market). It can also be a positive shock, increasing regional exports, productivity and jobs, and, as discussed above, imports may be complementary and not competing with domestic firms if they are intermediates used as part of a global value chain. Indeed, recent OECD work finds that regions with a greater share of tradeable services and manufacturing converge faster to the productivity frontier (OECD, 2016; OECD, 2018). At the same time there are many other shocks (e.g. technology, product preference and regulation) that influence regional manufacturing output and employment. Because of these multiple and possibly countervailing forces, determining the role of increasing trade in regional labour markets can at best be done approximately.

There is a growing literature of the consequences of trade on regional labour markets (e.g. Autor et al., 2013 and 2016b; Dauth et al., 2014; Donoso et al., 2015; Balsvik et al., 2015; Malgouyres, 2014). This literature is largely based on the experiences of industrialised countries facing a long-run structural shift in employment away from manufacturing sectors towards services industries. It suggests that the effect of increasing exposure to imports from low-income countries workers across regions depends on the regional industrial structure, the type of imports and labour market institutions.

Imports seem to have a heterogeneous impact across industrial sectors depending on whether they are complements or substitutes with respect to domestic products. Complements, such as imports of intermediate inputs, appear to contribute positively to firms' productivity, and therefore lead to employment growth via higher-quality and more differentiated foreign inputs, and knowledge transfers (Amiti and Konings, 2007; Grossman and Rossi-Hansberg, 2008). By contrast, imports of final goods consumed directly by customers, or intermediate goods competing with inputs produced domestically, may take market share from local manufacturing production and lead to output cuts and job losses. Variation in the nature of imported goods explains different consequences of increased exposure to Chinese imports on labour markets. Indeed, while some manufacturing sectors may benefit from the recent rise in Chinese exports of intermediate goods thanks to their deeper integration into the same value chain; local labour markets have been negatively affected by the increased competition in final goods markets (Taniguchi, 2016).

Although the literature finds significantly negative effects of imports on employment at the regional level, these tend to be relatively small compared with national labour market turnover, underlining the sub-national character of the negative side of greater trade integration. However, even at the sub-national level, the size of the effect varies markedly across countries suggesting that national policy plays a big role in cushioning the downside. Autor, et al. (2013, 2016b) estimate that about a quarter of the decline in US manufacturing employment between 2000 and 2007 was due to Chinese import penetration. These estimates imply Chinese import competition resulted in a net reduction in US manufacturing employment of 948 000 from 2000 to 2007. However, while this had significant and serious consequences at the personal and regional levels, this effect is relatively minor in a national macroeconomic context where there were 1,854,000 involuntary separations (Bureau of Labour Statistics) per month on average over this period.

A similar result but of greater magnitude is reported by Donoso et al. (2015) in the case of Spain over the period 1999-2007. The authors find that a one thousand US dollar increase in Chinese import penetration per worker at the provincial level is associated with a decline in manufacturing employment of approximately 2 percentage points of the working-age population versus 0.4 percentage points in Autor's calculations adjustment. Empirical work shows that regional labour markets with rigid wages, such as in Italy, tend to adjust to shocks via employment rather than wages (Ciani et al., 2017). Thus, the larger negative impact of heightened import competition in Spain than in the United States is likely due to the more rigid Spanish labour market, where adjustment to demand shocks occurs via variations of quantities, and especially the firing of temporary labour, rather than reducing wages. Highlighting that there are many influences on local labour markets beyond trade, the large expansion of the construction sector and construction-related services during the pre-financial crisis period partially offset manufacturing job losses, with local non-manufacturing sectors experiencing a rise in employment.

In Norway, regional exposure to competition from China is also estimated to have a negative effect on the manufacturing employment share in local labour markets from 1996 to 2007 (Balsvik et al., 2015). Nonetheless, Norwegian labour markets experienced only half of the reduction in the manufacturing employment share estimated by Autor et al. (2013), around 0.13 percentage points. This may be due to a different industrial structure, openness to trade, and labour market institutions characterising Norwegian regional economies. By contrast to the United States, German local labour markets faced only minor manufacturing job displacement effects due to increasing Chinese import penetration, while the rise of trade with Eastern Europe had a much stronger effect in the pre-crisis period 1988-2008 (Dauth et al., 2014 and 2017). In fact, the overall impact from an increased trade exposure to East and Far East Asia was positive. Export-oriented regions experienced total manufacturing employment gains and positive spillovers to non-manufacturing sectors that more than offset manufacturing job losses in import-competing regions.

A model of regional employment: the role of trade and technology

The model of manufacturing employment at a national level (Table 1) has been adapted to analyse the impact of globalisation at the regional level. This was partially based on an exploratory data analysis of the relationship between trade and technology trends associated with globalisation and developments in manufacturing and other sectoral employment regional shares (Annex C).

Regressions were estimated to explain the fall in regional manufacturing employment, expressed as a share of total regional employment, as well as the rise in market and business services employment shares. The estimation period covers 2000-2010, which is the longest possible common time span over which several indicators are available at a regional level, given that harmonised regional input-output data only go up to 2010. To control for possible demand shocks related to the business cycle, two different sub-periods have been identified: the pre-crisis period, 2000-2008; and the crisis, 2009-2010.

Regional data are available from the OECD Regional database and a new dataset used and described in Los et al. (2017) and Los and Chen (2016) that is based on regional input-output tables and provides information on regional GVC integration. In addition, some trade exposure indicators have been constructed following Autor et al. (2013) by applying regional shares of national sectoral employment as weights to national sectoral imports of different goods (Annex D) from the OECD Structural Analysis database. Moreover, regional indices of sectoral specialisation and geographical concentration have also been computed (Annex D) and included in the regression.

Regional trade indicators used include: i) vertical specialisation, computed as regional domestic value added as a share of regional gross exports; ii) GVC competitiveness, calculated as the share of regional GVC value added of five manufacturing activities in world GVC value added; iii) backward participation in GVCs, calculated as the regional share of intermediate imports by all sectors in final domestic demand; iv) intermediate goods import exposure of the manufacturing sector, computed following Autor's methodology (2013) and described in Annex D; v) capital goods import exposure of the manufacturing sector described in Annex D; and vi) household consumption goods import exposure of the manufacturing sector described in Annex 4.

Regional innovation indicator data used encompass: i) patenting intensity calculated as the number of Patent Cooperation Treaty (PCT) patents applications per million inhabitants; ii) the share of R&D expenditures performed by the business sector as a percentage of GDP; iii) the share of R&D expenditures performed by the government sector as a percentage of GDP; iv) the share of R&D expenditures performed by the higher-education sector as a percentage of GDP.

Regional higher education indicators that were used consist of: i) the share of labour force with tertiary education; ii) the enrolment rate of students in tertiary education expressed as a percentage of the population. A growing share of the labour force with college education proxies the ability of a region to adapt to rapid technological changes and the digitalisation of the economy generated across all sectors by increased levels of global innovation. Regional indices of sectoral specialisation and geographic concentration include: i) the specialisation index of the manufacturing sector as described in Annex D; ii) the adjusted geographic concentration index of the manufacturing sector as described in Annex D.

Time series and cross-country data have been pooled in a panel regression, with two periods, pre-crisis 2000-2008 and post-crisis 2009-2010, and 308 regions from 33 countries. Different sets of explanatory variables have been tested first separately and then combined together in the same equation (Table 2). As expected and in line with the national level results, the region's integration in global value chains, measured by its import exposure of intermediate and capital goods, together with an increasing level of GVC competitiveness, is associated with a larger ratio of manufacturing employment to total employment (Table 2, column 1). Conversely, the manufacturing sector's imports of final goods for household consumption, not a component of the manufacturing production, do not necessarily show a positive impact on the sector's employment. In general, a rise in R&D expenditures as well as a higher share of labour force with tertiary education (Table 2, columns 2 and 3) appear to be negatively associated with the manufacturing employment share and positively associated with services sector employment (Tables 3 and 4), consistent with a transition away from manufacturing towards high value-added services.

A similar regression estimated with manufacturing labour productivity as a dependent variable confirms that there is a positive and significant effect of R&D investments and increases in the higher educated workforce, indicating the crucial role of innovation and higher education in supporting manufacturing output growth. Regions showing a higher degree of specialisation in manufacturing activities are also characterised by a larger change in the shares of manufacturing jobs in total employment thanks to the presence of infrastructure and professional networks favouring the sector's expansion (Table 2, column 4). The preferred specification, including all significant explanatory variables, implies that an increase in imports of intermediate and capital goods by 1 percentage point of regional GDP is associated with a rise in the share of regional manufacturing employment of 0.1 and 0.8 percentage points respectively (Table 2, column 5).

Table 2. Regional manufacturing sector employment

Dependent variable: change in the share of regional manufacturing in total employment over 2000-2010

	(1)	(2)	(3)	(4)	(5)
Trade					
Vertical specialisation	-0.01				
GVC competitiveness (manufacturing sector)	15.80	**			
Backward participation in GVCs (all sectors)	-0.02				
Intermediate g. import exposure (manufacturing sector)	0.15	***			0.11 ***
Capital g. import exposure (manufacturing sector)	0.28	*			0.81 ***
Household cons. import exposure (manufacturing sector)	-0.55	***			-0.88 ***
Innovation					
Patenting intensity (per million inhabitants)		0.00			
Business R&D (% of GDP)		0.08			
Government R&D (% of GDP)		-0.20			
Higher education R&D (% of GDP)		-1.34 ***			-0.53 **
Higher Education					
Tertiary edu. attainment (% of LF)			-0.13 ***		
Students in tertiary edu. (% of pop)			0.13		
Sectoral specialisation and concentration					
Specialisation index in manufacturing				16.05 ***	11.71 ***
Geog. concentration index of manufacturing				-5.88	
Constant	-1.53 ***	-2.33 ***	-1.98 ***	-2.37 ***	-2.32 ***
Time dummy: 2009-2010	1.09 ***	2.17 ***	1.82 ***	1.99 ***	1.86 ***
Countries	20	20	24	18	20
Periods (maximum)	2	2	2	2	2
Number of obs	318	307	382	190	354
Adjusted R-squared	0.31	0.42	0.45	0.53	0.69

Note: All variables are expressed as change over 2 periods: pre-crisis 2000-2008 and post-crisis 2009-2010. OLS panel regression with robust standard errors. The inclusion of cross-section fixed effects, tested through the Hausman test, is rejected for the majority of the specifications. Robust clustered standard errors at the regional level have been applied. Asterisks ***, **, * indicate that the estimated coefficient is significant at the 1%, 5% and 10% levels, respectively.

Source: OECD Regional database; OECD Structural Analysis database; World Input-Output Database including regional economic accounts, regional supply and use tables, regional input-output tables and transportation data (Bart Los and Wen Chen, 2016); and authors' calculations.

In order to evaluate the robustness of the specification chosen to measure the impact of globalisation on regional employment developments, two similar sets of regional panel regressions have been estimated on non-manufacturing employment, i.e. market services (Table 3) and business services (Table 4). The role played by the region's integration into global value chains is less clear in the case of services, also because it is more challenging to construct an indicator of import exposure for the sector due to the lack of regional data on trade flows in services. However, given the deep interconnection between manufacturing activities and distribution, marketing and transport activities, a higher level of regional GVC competitiveness of the manufacturing sector is positively and significantly associated with a larger share of employment in market services (Table 3, column 5).

Table 3. Regional market services sector employment

Dependent variable: change in the share of regional market services in total employment over 2000-2010

	(1)	(2)	(3)	(4)	(5)
Trade					
Vertical specialisation	-0.06	**			-0.75 ***
GVC competitiveness (manufacturing sector)	17.22	***			16.06 ***
Backward participation in GVCs (all sectors)	-0.06	***			-0.05 ***
Innovation					
Patenting intensity (per million inhabitants)		0.01	***		
Business R&D (% of GDP)		-0.09			
Government R&D (% of GDP)		0.13			4.37 ***
Higher education R&D (% of GDP)		0.87	**		
Higher Education					
Tertiary edu. attainment (% of LF)			0.05		
Students in tertiary edu. (% of pop)			-0.25 *		0.27 *
Sectoral specialisation and concentration					
Specialisation index in services				19.01 ***	23.14 ***
Geog. concentration index of services				-5.14	
Constant	1.10	***	0.18	0.12	1.00 ***
Time dummy: 2009-2010	-0.81	***	-0.30 *	-0.32	-1.01 ***
Countries	20	20	24	17	15
Periods (maximum)	2	2	2	2	2
Number of obs	311	307	367	169	145
Adjusted R-squared	0.13	0.06	0.04	0.52	0.76

Note: All variables are expressed as change over 2 periods: pre-crisis 2000-2008 and post-crisis 2009-2010. OLS panel regression with robust standard errors. The inclusion of cross-section fixed effects, tested through the Hausman test, is rejected for the majority of the specifications. Robust clustered standard errors at the regional level have been applied. Asterisks ***, **, * indicate that the estimated coefficient is significant at the 1%, 5% and 10% levels, respectively

Source: OECD Regional database; OECD Structural Analysis database; World Input-Output Database including regional economic accounts, regional supply and use tables, regional input-output tables and transportation data (Bart Los and Wen Chen, 2016); and authors' calculations.

Public expenditures in R&D help job creation in market services, possibly due to the rapid development of high-tech knowledge-intensive services (e.g. telecommunications, computer programming, information service activities, research and development services, etc.) across OECD economies. A larger share of the population with tertiary education seems to be complementary to market services employment. More precisely, an increase of 1 percentage point in the regional population with a higher educational qualification is associated with a rise in the share of local market services employment of about 0.3 percentage points (Table 3, column 5).

As expected, given the high propensity of the business sector (including architectural and engineering activities, scientific and technical activities, advertising and marketing activities) to innovate, higher patenting intensity is positively associated with the sector's employment growth (Table 4, column 2). Similarly, an increase in R&D intensity boosts business sector employment via jobs creation and new products and services commercialisation (Bogliacino and Vivarelli, 2012). The significant negative effect of higher education on business sector employment is in line with other empirical findings (Malgouyres, 2016) and is a result of a reduced labour supply of highly skilled workers oriented to the business sector when the contemporaneous change in the share of college graduates is included in the regression.

Table 4. Regional business sector employment

Dependent variable: change in the share of regional business in total employment over 2000-2010										
	(1)	(2)	(3)	(4)	(5)					
Trade										
Vertical specialisation	-0.04				-0.06	***				
GVC competitiveness (manufacturing sector)	1.90									
Backward participation in GVCs (all sectors)	-0.03				-0.03	***				
Innovation										
Patenting intensity (per million inhabitants)		0.01	***		0.01	**				
Business R&D (% of GDP)		0.20	**							
Government R&D (% of GDP)		0.31	*							
Higher education R&D (% of GDP)		0.59	*							
Higher Education										
Tertiary edu. attainment (% of LF)			0.06	**						
Students in tertiary edu. (% of pop)			-0.33	***						
Sectoral specialisation and concentration										
Specialisation index in business					4.90	***	4.86	***		
Geog. concentration index of business					2.09	***	2.17	***		
Constant	1.69	***	1.31	***	1.50	***	1.33	***	1.21	***
Time dummy: 2009-2010	-1.47	***	-1.22	***	-1.27	***	-1.14	***	-1.05	***
Countries	20	20	23		17		13			
Periods (maximum)	2	2	2		2		2			
Number of obs	311	307	365		168		141			
Adjusted R-squared	0.45	0.46	0.48		0.72		0.81			

Note: All variables are expressed as change over 2 periods: pre-crisis 2000-2008 and post-crisis 2009-2010. OLS panel regression with robust standard errors. The inclusion of cross-section fixed effects, tested through the Hausman test, is rejected for the majority of the specifications. Robust clustered standard errors at the regional level have been applied. Asterisks ***, **, * indicate that the estimated coefficient is significant at the 1%, 5% and 10% levels, respectively.

Source: OECD Regional database; OECD Structural Analysis database; World Input-Output Database including regional economic accounts, regional supply and use tables, regional input-output tables and transportation data (Bart Los and Wen Chen, 2016); and authors' calculations.

Shocks from trade are likely to have long-lasting consequences for regional inequality

Across most OECD countries, the regional concentration of employment in the manufacturing sector is typically much higher than in non-tradeable service sectors (Figure 4). More disaggregated country-specific evidence confirms that manufacturing industries -- in particular the manufacture of motor vehicles, ships and boats, and aircraft as well as pharmaceuticals and chemicals -- tend to display high levels of geographical employment concentration, whereas industries that have an advantage from being close to the population they serve -- such as the provision of retail services, restaurants, education and social work activities -- are more geographically dispersed (Campos, 2012). Along with significant scale economies, the high trade intensity of manufacturing is an important reason for this concentration. Indeed, evidence for the United States suggests that manufacturing industries that are intensively involved in international trade are significantly more geographically concentrated than manufacturing industries with less involvement in trade (Shelburne and Bednarzik, 1993). The regional concentration of manufacturing employment means that sector-specific shocks to manufacturing, whether originating from trade or technology, may have a substantial regional impact even if their overall macroeconomic effect on the national economy is modest.

Figure 4. Employment in manufacturing is more regionally concentrated than services

Note: The Adjusted Geographic Concentration Index measures the extent to which an activity is concentrated in particular regions, varying between 0 (no concentration) and 1 (maximum concentration). See the Annex D for details of the calculation. “Distributive trades” includes distributive trade, repairs, transportation and storage, accommodation and food service activities. “Public administration” includes public administration, compulsory social security, education, human health and social work activities.

Source: OECD Regional Database; and authors’ calculations.

Inter-industry reallocation of labour and/or migration of labour across regions, can equilibrate the initially concentrated gains and losses from trade. However, an exploratory data analysis suggests that these channels only operate partially, if at all. Positive correlations of regional manufacturing and total employment rates indicate that inter-industry reallocation is difficult in many countries (Figure 5), although the size and strength of this positive correlation does vary markedly across countries (Table 5).

Figure 5. Correlation between the change in regional manufacturing and total employment rates since 2000

Note: Sample restricted to countries with data for 15 or more regions. If you do not need a note, please delete this line.

Source: OECD Regional Database; and authors' calculations.

Table 5. Employment, Migration and Incomes

<i>Correlation of</i>				
	Number of regions	Manufacturing employment rate vs. total employment rate	Total employment rate vs. net inter-regional migration rate	Market income vs. manufacturing employment rate
AUS	9	0.10	-0.15	0.62*
AUT	35	0.54***	0.52	0.90***
BEL	3	0.59		0.61
CAN	13	0.23	0.42	0.69**
CZE	14	0.53**	0.67*	-0.67*
DEU	16	0.48**	0.46*	0.92***
DNK	11	0.19	-0.66	0.47*
ESP	59	0.28**	-0.01	-0.02
EST	5	0.39		
FIN	19	0.59***	0.94***	0.13
GBR	173	0.40***		0.21**
GRC	13	0.16		-0.64***
HUN	20	0.87***	0.41	0.83**
IRL	8	0.96***		0.88***
ITA	110	0.43***	-0.32	0.21
KOR	17	0.71***	0.75**	0.42*
LVA	6	-0.64		
MEX	32	0.24		0.01
NLD	12	-0.22	0.12	-0.56**
NOR	19	0.32	-0.22	
POL	16	0.80***	0.33	0.42*
PRT	25	0.64***	0.25	0.14
SVK	8	0.76**	-0.98**	0.06
SVN	12	0.48		0.06
SWE	21	0.76***	0.58*	0.69**
TUR	26	0.51***	0.09	
USA	51	0.42***	0.51***	0.56***

Note: Correlation coefficients are computed over periods from 2000 (or later but not shorter than a 5 year period) to the latest available data. A different level of regional data (i.e. large regions - L2 level or small regions - L3 level) is chosen across countries to assure the largest possible sample size. The number of regions or sub-regions included is as reported in the first column except for the correlation with inter-regional migration flows which are computed only on a L2 level. (*), (**) and (***) denote statistical significance at the 10%, 5% and 1% levels respectively.

Source: OECD Regional Database, Structural Analysis Database; and authors' calculations.

Corroborating this, regions that suffer a greater decline in the manufacturing employment rate than the national average also tend to suffer a greater fall in their total employment rate than the national average (Table 5). For example, in the United States, labour market adjustment to negative shocks to manufacturing since 2000 was relatively poor. Fifteen states representing 37% of national employment suffered from a greater fall than the national average in both the manufacturing and total employment rates (Figure 6). Among the fifteen are some of the so-called "rust belt" states including Indiana, Ohio, Michigan, and Wisconsin. It also includes the southern states of Alabama, Arkansas, Georgia, South Carolina and Tennessee.

Figure 6. Regional total and manufacturing employment rates versus the national average

Note: States in the bottom left of the chart, where both total and manufacturing employment decline more than the national average, include Alabama, Arkansas, Connecticut, Delaware, Georgia, Indiana, Maine, Michigan, Minnesota, New Hampshire, North Carolina, Ohio, South Carolina, Tennessee and Wisconsin.

Source: OECD Regional Database; and authors' calculations.

The greater regional spillovers from a shock to the manufacturing sector stem in part from a "sticky" labour market. The turnover of jobs is lower than in other sectors so that if there is a negative trade shock, the consequences are longer lasting. Among sectors accounting for a similar proportion of total employment (including distribution, accommodation and food, professional services, public administration, health and education), changes in manufacturing employment are the most correlated with total regional employment in more than half of the countries considered in the analysis. This suggests either that the re-employment prospects of displaced manufacturing workers are less than displaced workers from other sectors and/or the knock-on multiplier effects are greater. Indeed, OECD (2009) finds that job churn (i.e. total worker movements within the sector in excess of job creation and destruction) is among the lowest in the manufacturing sector, especially compared to services sectors, such as hotels and restaurants. In other words, in the manufacturing sector, the labour market is a lot less fluid for workers.

A greater diversification in industrial activities helps regions to adjust to macroeconomic shocks that propagate from the manufacturing sector to the whole regional economy (Figure 7). Countries with a highly concentrated industrial system and therefore with low regional industrial diversification are more exposed to risks generated by rising globalisation mainly affecting manufacturing activities. Laid-off manufacturing workers will struggle to be reintegrated in local labour markets due to scarcity of alternative jobs and negative long-lasting spillovers will transmit to the total employment reducing the resilience of the region to trade shocks.

Figure 7. Industrial diversification helps resilience to trade shocks

Note: The Regional Resilience Index is computed as inverse of the correlation between the change in regional manufacturing employment and the change in regional total employment between 2000 and last year available. The lower the correlation between regional manufacturing employment and total employment, the higher is the resilience of the region and the more laid-off manufacturing workers are reintegrated somewhere else within the regional labour market. The Regional Diversification Index is computed as standard deviation across the regional adjusted geographical concentration indices of 9 industrial sectors (see Annex D). Both indices are normalized to have a more intuitive scale, i.e. the larger the unit the higher the resilience and the diversification. Sample restricted to countries with data for 15 or more regions.

Source: OECD Regional Database; and authors' calculations.

There is evidence of migration of workers from regions with shrinking industries to those with growing ones in Korea, the United States and Germany (Figure 8). However, in other countries, such as Italy, insufficient migration from weaker to better performing regions implies that migration is not helping to disperse localised shocks to labour markets (Ciani et al., 2017). This is also the case Denmark and Spain, for instance, where the correlation between employment growth and interregional mobility is negative. Indeed, attracted by low housing costs, inward migration of the low-skilled and jobless to the region suffering a negative shock may even exacerbate the situation.

Figure 8. Correlation between the change in regional total employment rates and in net inter-regional migration rates since 2000

Note: Sample restricted to countries with 15 regions or more. For Spain and Turkey the correlation coefficient is not statistically significant; for all other countries, the statistical significance of the correlation coefficient is 1% (see Table 5).

Source: OECD Regional Database; and authors' calculations.

The apparent failure of these two important adjustment mechanisms to help regional economies adjust to regional shocks to manufacturing is also evidenced by a positive correlation across regions between manufacturing employment rates and market income per worker (before taxes and transfers) since 2000 measured in constant US dollars measured at PPP exchange rates. Across regions, a faster decline/rise in manufacturing employment rates tends to be associated with a greater decrease/increase in average income per worker in the region (Figures 9 and 10, Table 5). The correlation of manufacturing employment rates and disposable income tends to be a little lower, consistent with the tax and welfare system helping to disperse shocks.

Figure 9. Correlation between the change in regional average market and disposable income per worker and change in regional manufacturing employment rate since 2000

Note: Sample restricted to countries with at least 15 regions. For Spain the correlation coefficient is significant at the 5% level for disposable income but not market income. This chart shows the correlation between the change in regional manufacturing employment rates and average market and disposable income per worker where disposable income = Market income – taxes + transfers and market income includes both labour and capital income. Correlation significance is shown for disposable income. Statistical significance of the correlation coefficient at the 10%, 5% and 1% significance level are denoted *, ** and *** respectively.

Source: OECD Regional Databases; and authors' calculations.

Figure 10. Regional average market income per worker and manufacturing employment rates versus the national average

United States, change since 2000

Note: This chart shows the correlation between the change in regional manufacturing employment rates and average market income per worker where market income includes both labour and capital income. Each data point represents a state or district of the United States. States in the bottom left of the chart, where both average market income per worker and manufacturing employment decline more than the national average, include Alabama, Delaware, Georgia, Illinois, Indiana, Maine, Michigan, Mississippi, New Hampshire, New Jersey, North Carolina, Ohio, South Carolina, Tennessee and Wisconsin.

Source: OECD Regional Databases; and authors' calculations.

Lower total employment and average wages associated with weaker manufacturing employment then appears to translate into greater regional income inequality as measured by the increase in the P90/P50 ratio (Figure 11). Despite the substantial decline in manufacturing jobs, the relatively lower increase in income inequality in some countries, such as Sweden or Finland, points to the importance of country-specific institutions and policies to deal with the displacement of workers in manufacturing.

Figure 11. A decline in manufacturing employment rates is associated with an increase in income inequality across regions, since 2000

Note: Sample restricted to countries with at least 5 regions. The P90/P50 ratio is computed between the upper bound value of the ninth decile to the median primary income.

Source: OECD Regional Databases; and authors' calculations.

Policy intervention is required to build regional resilience and convergence

This paper finds that, while trade appears to only have a minor association with manufacturing employment shares at the national level compared with technology, trade has an important role in regional labour market developments due to the geographical concentration of industrial activities, "sticky" nature of manufacturing employment and inefficient inter-regional migration. In common with the literature, this paper finds that integration in global value chains and importing intermediates are associated with better regional labour market performance. By contrast, the import of final consumption goods tends to have a negative effect on regional manufacturing employment. Nevertheless, the regression results show that this is a minor influence compared with the long-term downward trend in manufacturing employment that pre-dates the large increase in global trade from the mid-1980s onwards, and that this trend is most likely technology-driven substitution away from labour towards capital and greater technology-use.

Although localised problems from these trends could in theory be reduced through reallocation of labour to growing sectors and migration to growing regions, there is evidence that these market mechanisms are not always working, leading to widening regional inequality. Policy could better facilitate market adjustment mechanisms, by reducing the regulation of services product markets that is associated with stronger employment growth in the sector (Kongsrud and Wanner, 2005), facilitating an efficient rental housing market with adequate supply so workers can more easily migrate (Andrews et al., 2011) and encouraging new capital flows to regions. However, previous work suggests that achieving those objectives will be challenging and can have unintended consequences. For example, although some papers find investment subsidies to generate new jobs have boosted employment, particularly when applied to smaller firms (Wren and Waterson, 1991; Criscuolo et al., 2012), others have found they have led to labour-to-capital substitution, and fewer jobs (Harris, 1991; Driehuis and van den Noord,

1998). Providing transport infrastructure, another major regional policy instrument, may lead to even further and unintended divergence between regions. Lowering transportation costs also makes it less costly for firms located in rich regions to supply poor regions at a distance, and therefore may further increase agglomeration of activities in the rich regions and also as well as harming the development of the poor region (Puga, 1999). To ensure infrastructure investments contribute to reducing regional divergences it is important to take a coordinated policy approach, for example integrating land use and housing planning and transport development across local boundaries (OECD, 2017a).

To tackle the cost side of greater trade, some countries have introduced trade adjustment assistance policies. This assistance is targeted at workers and firms that are deemed to have lost their jobs or sales due to changing trade policies and/or flows. These programmes provide inter alia income support, assistance for job search and moving and training (OECD, 2018). Experience in the United States suggests that, while these programmes provide higher levels of benefits than those available to the unemployed generally, applications are low and they are complex to administer (OECD, 2016a). Resources used in certifying the unemployment is related to trade would be better used in combined programmes for all displaced workers, whether due to trade, technology or other structural forces.

Boosting regional resilience to industry-related shocks, whether they come from trade or technology, can help prevent rising regional inequalities. This requires building local capacity, both in terms of people – more educated labour is more mobile across jobs – and innovation (Konugrad and Wanner, 2005). However, policies aimed at expanding innovation capacity should be tailored to the specificities of each region type (dominance of SMEs or of large firms locked into old technologies), clustering (low or too high), and skill mix. At the same time, sound policies should not only focus on R&D and the technological aspects of innovation but also on the organisational, financial, educational and commercial dimension of innovation. This can be fostered through policies such as funding for cross-firm research projects and specialised research institutes to promote clustering in networks of firms, both manufacturing and marketing, as well research institutions, unions and the local authorities (Cooke et al. 2000; OECD, 2016b).

To promote regional convergence in a globalised world requires embracing, not turning away from, trade, especially because a larger tradables sector is associated with stronger income convergence. Indeed, a distinguishing feature of low growth regions in Europe is difficulty in shifting towards tradeable services (OECD, 2018). However, assisting a sectoral shift of jobs and activity from manufacturing to tradeable services is challenging because even low to medium-skilled workers can achieve high productivity and pay in manufacturing, while high productivity (and paying) jobs in tradeable services are normally knowledge intensive (OECD, 2018). Training and education is part of the solution but this needs to be complemented with policies to boost enterprise and job growth across regions. This requires coordination across levels of government and agencies to tailor policies to local circumstances, while ensuring regulatory consistency across the economy. One of the tools to achieve is to create business support programmes co-funded by different levels of government giving them all a stake in programme success. This needs to be complemented with introducing common standards and certification to reduce barriers to growing across local borders (OECD, 2016b). Similarly, in a more fiscally decentralised setting, catching-up regions, farther away from the productivity frontier, appear to adopt policy innovations more rapidly and more effectively through improved taxing power and own-source revenues management (Blöchliger et al., 2017).

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Annex A. : DATA DESCRIPTION

Table A A.1.

Variable	Description	Units	Source
National consumption share	Weighted sum of the share of the value of consumption of durable and semi durable goods in total consumption across 37 countries	percent	OECD National Accounts
National export performance	Ratio of a countries export volume growth to that of its export market	ratio	OECD Economic Outlook Database
Regional geographic concentration index	Share of regional employment of industry in country's employment in that industry relative to the working age population of region as share of the country working age population	ratio normalized to vary between 0 and 1	OECD Regional Database
National ICT investment	Ratio of investment in ICT equipment in the manufacturing sector to the GDP of the manufacturing sector	percent	OECD National Accounts
National imports for final consumption	Import penetration of consumption goods calculated as the ratio of imports of consumption goods of all sectors to total domestic expenditure	percent	OECD STAN database
National intermediate imports	Import penetration of intermediate goods of all sectors as a share of total domestic expenditure	percent	OECD STAN database
National investment in machinery in manufacturing	Ratio of investment in machinery other than transport and ICT in the manufacturing sector to the GDP of the manufacturing sector	percent	OECD National Accounts
Regional manufacturing employment share	Ratio of manufacturing to total employment	percent	OECD Regional Database
Regional business sector employment share	Ratio of employment in legal and accounting, management and consultancy, architecture, scientific research and development, advertising and marketing activities and other scientific and technical activities to total employment	percent	OECD Regional Database
Regional industrial diversification	Computed as standard deviation across the regional geographical concentration indices of 9 industrial sectors	standard deviation of a ratio normalized to vary between 0 and 1	OECD Regional Database
Regional industrial specialisation index	Ratio of the share of a sector's employment in a region and the weight of the same sector's employment in the country	ratio	OECD Regional Database

Variable	Description	Units	Source
Regional labour productivity	Regional total gross value added per employee	millions of national currency at current prices	OECD Regional Database
Regional manufacturing GVC indicator	Share of regional GVC value added in World GVC value added.	percent	World Input-Output Database, regional economic accounts and regional input-output tables
Regional market services employment share	Ratio of employment in wholesale and retail trade, transportation and storage, accommodation and food service activities to total employment	percent	OECD Regional Database
Regional resilience index	Inverse of the correlation between the change in regional manufacturing employment and the change in regional total employment between 2000 and last year available	ratio	OECD Regional Database
Regional trade vulnerability (import exposure)	National imports of sector a multiplied by the share of a region's employment or gross value added in national totals.	ratio	OECD STAN database and OECD Regional Database
Regional P90/P50 ratio	Ratio of upper bound value of the ninth decile to the median income	ratio	OECD Regional Database
National intermediate imports	Import penetration of intermediate goods of all sectors as a share of total domestic expenditure	percent	OECD STAN database
National investment in machinery in manufacturing	Ratio of investment in machinery other than transport and ICT in the manufacturing sector to the GDP of the manufacturing sector	percent	OECD National Accounts
Regional manufacturing employment share	Ratio of manufacturing to total employment	percent	OECD Regional Database
Regional business sector employment share	Ratio of employment in legal and accounting, management and consultancy, architecture, scientific research and development, advertising and marketing activities and other scientific and technical activities to total employment	percent	OECD Regional Database
Regional industrial diversification	Computed as standard deviation across the regional geographical concentration indices of 9 industrial sectors	standard deviation of a ratio normalized to vary between 0 and 1	OECD Regional Database
Regional industrial specialisation index	Ratio of the share of a sector's employment in a region and the weight of the same sector's employment in the country	ratio	OECD Regional Database
Regional labour productivity	Regional total gross value added per employee	millions of national currency at current prices	OECD Regional Database
Regional manufacturing GVC indicator	Share of regional GVC value added in World GVC value added.	percent	World Input-Output Database, regional economic accounts and regional input-output tables

Variable	Description	Units	Source
Regional market services employment share	Ratio of employment in wholesale and retail trade, transportation and storage, accommodation and food service activities to total employment	percent	OECD Regional Database
Regional resilience index	Inverse of the correlation between the change in regional manufacturing employment and the change in regional total employment between 2000 and last year available	ratio	OECD Regional Database
Regional trade vulnerability (import exposure)	National imports of sector a multiplied by the share of a region's employment or gross value added in national totals.	ratio	OECD STAN database and OECD Regional Database

Annex B. : Explaining relative manufacturing wages for selected OECD countries

The impact of import competition on manufacturing wages is analysed at the country level by estimating a cross-country regression of the yearly changes in the manufacturing average wages as a share in national average wage as a function a number of explanatory variables, all expressed in yearly changes, including: import penetration of intermediate goods; import penetration of consumption goods along with a number of controls, such as machinery investment, ICT investment, consumption share, output gaps. The average wage in the manufacturing sector is assessed in relative terms, i.e. by comparing it to the average wage in the whole economy: a positive growth of the ratio of average wage in the manufacturing sector to the average national wage for all sectors corresponds to a relative gain in average wage for manufacturing workers, while a negative growth points to a relative deterioration. By focusing only on relative average wages, due to data availability, possible distributional effects are not explored, even though those effects would matter for welfare. The regression is estimated using annual changes contrary to the employment regression that was run on longer periods, because wages are expected to adjust faster than employment making it more appropriate to examine changes at a higher frequency.

Table A B.1.

Dependent variable: change in the share of manufacturing in total wage				
	(1)		(2)	
Imports for final consumption	-0.695	***	-0.697	***
Intermediate imports	0.234	***	0.257	***
Investment in machinery	-0.020		-0.023	
ICT investment	0.110		0.116	
Consumption share			-0.005	
Constant	0.003	***	0.004	***
Output gap	-0.001	***	-0.001	**
Countries	12		12	
Number of obs	219		219	
Adjusted R-squared	0.2		0.2	

Source: Data comes from various OECD databases: employment data is taken from STAN or GOV database, import data from STAN database, investment data from OECD national accounts, and total domestic expenditure and exchange rate from the Economic Outlook database.

Annex C. REGIONS, TRADE AND INNOVATION: AN EXPLORATORY DATA ANALYSIS

Regional GVCs participation and employment and productivity developments

The emergence of global value chains has had notable consequences for regions because they allow a region to enter international trade in a niche without having to build an entire value chain (Baldwin, 2016). A significant share of the economy of many catching-up regions is in manufactured goods, mining or services that can be traded internationally (OECD, 2016b) and linkages with the global economy appear important for regions to catch up. Indeed, greater integration of regional economies into global value chains (GVCs) appears to be positively correlated with regional employment growth. In particular, analysis using data for 170 European regions over the period from 2000 to 2010 reveals that stronger involvement in GVCs, as measured by the region's share of global value added, is significantly associated with an expansion of the regional manufacturing employment rate, but also service employment (Figure A3.1).

Figure A C.1. The evolution of regional employment in Europe is associated with greater integration in global value chains - change over 2000-2010

Figure A C.1. The evolution of regional employment in Europe is associated with greater integration in global value chains - change over 2000-2010 (Cont.)

B. Market services employment rate

Note: The regional manufacturing GVC indicator is measured as the share of the regional GVC Value Added in World GVC Value Added (in %). The five manufacturing activities are included in the GVC indicator: mining products, textiles, fuel products, machinery and for other manufacturing products. The market services sector in panel B includes wholesale and retail trade, transportation and storage, accommodation and food service activities.

Source: World Input-Output Database; regional economic accounts; regional supply and use tables; regional input-output tables and transportation data (Bart Los and Wen Chen, 2016); OECD Regional Database; and authors' calculations.

This positive association may be in part due to the fact that participation in global value chains enables local firms to increase their productivity through upgrading their technological and human capital, and broader exposure to information and learning opportunities. For European countries regional labour productivity gains appear to be generally positively correlated with higher integration in regional manufacturing supply chains (Figure A3.2).

Figure A C.2. Correlation between the annual change in the regional manufacturing GVC indicator and regional labour productivity growth

Note: Correlation coefficients are computed over periods from 2000-2010. Only coefficients which are statistically significant are reported, with Ireland, Slovak Republic and Finland significant at 10%, Germany and France significant at 5% and all others significant at 1%. Regional labour productivity is measured as regional total gross value added per employee. The regional manufacturing GVC indicator is measured as the share of the regional GVC Value Added in World GVC Value Added (in %).

Source: World Input-Output Database; regional economic accounts; regional supply and use tables; regional input-output tables and transportation data (Bart Los and Wen Chen, 2016); OECD Regional Database; and authors' calculations.

Innovation and employment at the regional level

Although many knowledge-intensive services are frequently related to the manufacturing sector, innovation-related assets are mainly concentrated in a few leading regions that have higher GDP per capita and high shares of students in higher education and employees in high-technology industries (OECD, 2007). Regions scoring highly in the number of new patents annually issued do not always coincide with large industrial production zones. Indeed, an increase in the number of patents per capita is negatively associated with employment levels in the manufacturing sector (Figure A2.3, Panel A). Conversely, regional business sector employment seems to be correlated with innovation activity represented by increased patenting intensity (Figure A3.3, Panel B).

Figure A C.3. Regional patenting and sectoral employment – change since 2000 or later

Note: The business sector in panel B includes legal and accounting activities, management and consultancy activities, architectural and engineering activities, scientific research and development, and advertising and marketing activities, other scientific and technical activities.

Source: Eurostat database on employment in technology and knowledge-intensive sectors by NUTS 2 regions; OECD Regional Database on Innovation; and authors' calculations.

Higher education and regional employment

Higher education's relation with regional employment is quite varied across industrial sectors. Several indicators are commonly chosen to measure human capital, and advancement in innovation investment and outcomes on a regional level. The percentage of the population having completed a tertiary education qualification is used as a proxy for highly educated workforce, while R&D expenditures and patents applications are used to proxy increases in innovation systems and applied research. More recently, employment statistics on high-tech industry and knowledge-intensive services on a regional level complement the set of available data to analyse innovation progress made across local sectors.

A rise in the regional share of labour force with tertiary educational attainment does not seem to be correlated with manufacturing employment growth (Figure A3.4, Panel A), probably due to a trend shift towards services employing more tertiary educated workers. Similarly, a larger share of students in tertiary education does not seem to be associated with an increase regional manufacturing employment (Figure A3.4, Panel B). However, again this is likely not causation as the location of higher education institutions is mainly in larger cities and capital towns far from local areas where manufacturing employment is mostly concentrated.

Conversely, a highly-educated regional labour force seems to be associated with the expansion of employment in non-manufacturing sectors. A positive correlation between an increase in regional tertiary education attainment and regional employment is observed for business, ICT and market services (Figure A3.5).

Figure A C.4. Regional higher education and manufacturing employment – change since 2000 or later

Note: Tertiary education corresponds to levels 5-8 in the International Standard Classification of Education (ISCED 2011) classification.

Source: OECD Regional Database; and authors' calculations.

Figure A C.5. Regional higher education and other sectors employment – change since 2000 or later

A. Business sector

B. Information and communication sector

Note: The business sector in panel A includes legal and accounting activities, management and consultancy activities, architectural and engineering activities, scientific research and development, and advertising and marketing activities, other scientific and technical activities. The information and communication sector in panel B includes publishing activities, programming and broadcasting activities, telecommunications, computer programming, consultancy and related activities, information service activities. The market services sector in panel C includes wholesale and retail trade, transportation and storage, accommodation and food service activities.

Source: OECD Regional Database; and authors' calculations.

Regional sectoral specialisation and innovation

Despite the increased offshoring of activities away from higher cost locations, firms still concentrate together in industrial districts and specialised sectoral agglomerations to benefit from the clustering benefits created by the geographical proximity. The degree of specialisation in high-tech activities within a specific industrial sector is measured by the Balassa-Hoover specialisation index – location quotient - (OECD, 2013), as the ratio between the weight of the high-tech manufacturing employment in a region and the weight of the same sector's employment in the country. A region is considered to be specialised in a specific industrial sector if that industry has higher share of total regional employment than the national average. Using the same approach, a sector is defined to be highly concentrated in one or few regions when a very large share of its total employment is located in these regions.

Innovation-oriented firms and research hubs are frequently clustered in metropolitan areas and capital cities (Eurostat, 2016), thereby attracting new start-ups and highly qualified personnel far from large manufacturing areas. As a consequence, highly skilled manufacturing employment (e.g. manufacture of pharmaceutical and chemical products, electronics and optical products, air and spacecraft machinery, etc.), specialised in high-tech processes, is not always located in regions where the geographical concentration of the manufacturing sector is the highest (Figure A3.6, Panel A). Conversely, high-tech knowledge-intensive services (e.g. R&D, information service activities, telecommunications, programming and broadcasting activities, etc.) are mainly situated in regions where information and telecommunication activities are clustered (Figure A3.6, Panel B).

Figure A C.6. Correlation between regional specialisation in high-tech and knowledge - Intensive industrial sectors and their geographical concentration

Figure A C.7. Regional specialisation by technology level of the information and communication sector

Regional specialisation in ICT

Note: The specialisation index is measured according to the Balassa-Hoover index (OECD, 2013). The specialisation index is measured by the ratio of the industry's share of employment in a region to the industry's share in the country. The information and communication sector includes publishing activities, programming and broadcasting activities, telecommunications, computer programming, consultancy and related activities, information service activities.

Source: Eurostat database on employment in technology and knowledge-intensive sectors by NUTS 2 regions; OECD Regional Database; and authors' calculations.

Annex D. SPECIALISATION, CONCENTRATION AND TRADE VULNERABILITY INDICES

Specialisation index

The specialisation index is computed according to the Balassa-Hoover Index (BHI), which compares the share of employment in a given industry of a given region to that industry's share in the country's overall employment structure. The index is defined as:

$$BHI_{jr} = \frac{E_{jr}/E_r}{E_{jc}/E_c}$$

where E_{jr}/E_r denotes the share of employment in industry j of region r in total employment of region r across all industries, and E_{jc}/E_c represents the same employment share of industry j on a country level.

A value of BHI above 1 indicates a region's specialisation in industry j above the national average, while a value below 1 shows a level of specialisation below the national average.

Adjusted Geographic Concentration index

The index of Adjusted Geographic Concentration (AGC) is calculated to enable international comparability of the Geographic Concentration index (GC) proposed by Spezia (2002). The original version of the index is defined as:

$$GC_{jc} = \sum_r \left| \frac{E_{jr}}{E_{jc}} - a_r \right|$$

where E_{jr}/E_{jc} denotes the share of regional employment of industry j in country's employment of the same industry, while a_r is the area of region r as share of the country area. More precisely, $a_r = WApop_r/WApop_c$ takes into account the size of different regions expressed in terms of working-age population.

If the employment share in industry j of each region equals its relative population, then there is no concentration and GC equals 0. Conversely, the larger the value of GC, the higher is the geographic concentration of industry j . The index is normalized, to vary between 0 and 1, by dividing it by its maximum reached when the whole industry's employment is concentrated in the smallest region, i.e.:

$$GC^{max} = \sum_{r \neq min} a_r + 1 - a_{min} = 1 + 1 - 2a_{min} = 2(1 - a_{min})$$

where $a_{\min}$ is the relative area of the smallest region. Hence, the Adjusted Geographic Concentration index equals

The AGC index lies between 0 (no concentration) and 1 (maximum concentration). The index can be also computed on a regional level by summing across sub-regional territories.

Trade vulnerability indicator

A trade vulnerability indicator has been computed to measure the import exposure of the manufacturing sector at a regional level. Because of very scarce availability of information on regional import flows, using the approach of Autor et al. (2013), regional trade dynamics are quantified using import data of the manufacturing sector at a national level weighted by the share of regional manufacturing employment in the national manufacturing employment as:

$$IV_{\{CRS\}} = \frac{M_{\{CRS\}}}{GDP_{\{CR\}}}$$

where for country c , region r and sector, s . Total imports, M , observed at a national level, by sector, are weighted by the share of regional manufacturing employment in the national manufacturing employment as follows:

$$M_{\{CRS\}} = M_{\{CS\}} \times \frac{EMP_{\{CRS\}}}{EMP_{\{CS\}}}$$

An alternative regional weight is the share of regional manufacture GVA in the national manufacture GVA (Autor et al., 2013). In order to control for the economic size of the region, regional imports are normalised by regional GDP.

The trade vulnerability indicator has been constructed for all types of imports aggregated together, and also broken down by end-use (i.e. intermediate, households' consumption, capital goods, mixed end use and other).