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Sectoral Employment Shifts and the Role of R&D: A Cross Country Comparison for Manufacturing and Service *

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Abstract

In this study we compare the evolution of labour productivity across the majority of EU member countries over the span of 1995-2016. Productivity growth combined with cross-sectoral employment shifts from manufacturing industries towards the service sectors can be observed in all countries. A shift-share analysis suggests that throughout this period most of the labour productivity growth was due to productivity gains within sectors. Labour movements between sectors, on the other hand, had small and often negative impact on labour productivity growth, especially in older EU member countries. Furthermore, the role of sectoral R&D, as one channel affecting productivity and employment is examined. We find considerable heterogeneity across sectors of the correlation between R&D expenditure and employment, but several patterns can be identified. Employment in high-tech sectors both in manufacturing and service exhibits a positive, significant correlation with R&D expenditure, while for low- and medium-tech manufacturing results are predominantly negative but sensitive to dividing the sample into subgroups of countries. There is no significant correlation between R&D expenditure and employment in low-tech service sectors.

Keywords: Innovation, Productivity, Employment

JEL Classification: J23, O30, O47, O57

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1 Introduction

In recent decades EU member countries have experienced an increase in employment in service-related jobs at the expense of manufacturing and agricultural employment. Possible reasons for such structural change that are explored in the literature include demand and supply side explanations, as well as relative productivity arguments. Clark (1957) argues that labour reallocation away from manufacturing is primarily caused by demand shifts. An opposite view is presented by Baumol (2001). In a model with two economic sector with different productivity growth, the author shows that labour tends to move to the "stagnant" sector in order to keep relative output in the two sectors constant. However, such employment reallocation does not contributing to productivity growth because the costs in the sector with slow productivity growth rises. The increasing cost burden due to such productivity lag is referred to as "Baumol's cost disease hypothesis". More recently, Goos and Manning (2007) conclude that the employment polarization observed in many countries which is characterized by simultaneous increase in the highest and lowest paying jobs at the expense of those in the middle in the wage distribution, is a corroboration of Baumol's hypothesis.

In this study we document decreasing average annual labour productivity growth in most EU member countries in our sample over the last 20-25 years. Further, the findings suggest that labour reallocation between different sectors has had a small but negative contribution to overall productivity growth, especially in older EU member countries. We then proceed by examining closer the relationship between R&D investment, as a potentially important channel that has impact on labour productivity, and employment on the sectoral level. Overall, the aim of this paper is twofold. On the one hand, we contribute to the literature on structural change by collecting recent empirical evidence on magnitude of employment shifts between manufacturing, services and agriculture for all EU member countries. Further, we explore whether the observed employment reallocation corresponds to labour productivity gains. Secondly, the paper contributes to the discussion on the effect of innovation activity, measured as R&D investment, on sectoral employment by examining OECD data. More specifically, the following questions are addressed:

i) How has the overall employment share of the manufacturing respectively the service sectors evolved over time in different European countries? Are there qualitative differences in the evolution between 'old' and 'new' EU member countries?

ii) How is the shift in employment shares related to (country-specific) changes in labour productivity? Does it contribute to a faster increase in total labour productivity?

iii) What is the impact of (country- and sector-specific) R&D expenditure on employment in a sector? Is there a systematic difference with respect to this impact between manufacturing and service sectors? Are there qualitative differences in the correlation of sectoral R&D expenditure on employment between 'old' and 'new' EU member countries?

The motivation to explore these questions is twofold. First, it should help to identify the driving forces of the observed sectoral employment shifts. Second, and more importantly, gaining a better understanding of the role of R&D for employment and for sectoral shifts clearly has important implications for innovation policy. If certain sectors can be identified where increases in R&D investments tend to have particularly strong positive effects on employment, then fostering

investments in those sectors would not only have direct effects on productivity and international competitiveness in such sectors but would also contribute to positive second order effects through demand stimulation and human capital improvements, e.g. through learning by doing effects. Here, we contribute to the rich empirical literature which widely identifies significant relationship between innovation and employment where most studies are conducted at the firm-level. We conduct the analysis at the sectoral level, aiming to identify net effects of R&D expenditure on sectoral employment. By distinguishing between old and new EU member countries we intend to explore in how far the observed processes and effects are influenced by the initial conditions (in the 1990s new EU member countries had much lower employment in services and much higher in agriculture compared to the EU15 countries) and also the institutional settings, e.g. on the labor market, often differ between new and old EU member countries.[1]

There is a rich theoretical and empirical literature discussing the employment effect of innovation (see e.g. the surveys by Spiezia and Vivarelli (2002), Calvino and Virgillito (2018) or Dosi and Mohnen (2018)), highlighting the importance of distinguishing between product and process innovation as well as well as between firm-level and more aggregate effects. The majority of studies focuses on firms in manufacturing industries. With respect to product innovation they overwhelmingly find a positive correlation with employment (e.g. Brouwer et al. (1993); Van Reenen (1997); Hall et al. (2008); Lachenmaier and Rottmann (2011); Harrison et al. (2014); Calvino (2018); Crespi et al. (2019)). The results for process innovation are more mixed, and for different countries and industries positive (e.g. Blanchflower and Burgess (1998); Lachenmaier and Rottmann (2011)), as well as negative (e.g. Antonucci and Pianta (2002)) relationships and also no significant effects (e.g. Van Reenen (1997); Hall et al. (2008); Harrison et al. (2014); Crespi et al. (2019)) have been found. Furthermore, it has been highlighted that results obtained on the firm level might qualitatively differ from the sectoral level. For example, Greenan and Guellec (2000), using data on French manufacturing firms for the period 1984-1991, find that at the firm level, both process and product innovation are associated with job creation, whereas process innovation reduces employment for competing firms and therefore at the sectoral level only product innovation leads to higher employment.

Several studies suggest that employment effects of innovation might differ between manufacturing and service sectors. For example, Peters (2004), using German survey data covering the period 1998-2000, finds that process innovation is associated with reduction of employment in manufacturing firms but no such effect is found for service firms. Bogliacino et al. (2012), using a dataset encompassing 677 EU companies over the period 1990-2008, find a positive significant relationship between firm R&D expenditure and employment. However, the magnitude of the effect varies depending on which sector the firm operates in. The results suggest that the positive employment effect of R&D is strongest in high-tech manufacturing and the services but weaker for firms in other manufacturing sectors.

Overall, results at the firm level point at a positive effect of product innovation on employment, while the results with respect to process innovation are less clear-cut. Moreover, results vary for different countries and time spans. In this analysis we look at the relationship between innovation and employment at an aggregate sectoral level covering a relatively large time span between 1995-

[1] New EU member states tend to have lower replacement rates than in Western European countries (van Vliet and Caminada, 2012) and higher efforts seem to go into the activation of the unemployed (OECD, 2007).

2016. The aggregation we use is the two-digit level of ISIC, Rev.4 and the majority of EU member countries are included in the analysis. In this respect the analysis is related to Bogliacino and Vivarelli (2012) who also investigate the job creation effect of R&D at a sectoral aggregation level. Using a panel of 15 European countries, over the period 1996-2005, the authors find that R&D expenditure had a positive employment effect in manufacturing and that the employment gains seem to be concentrated in the high-tech sectors. The novelty of our paper is that we are able to study effects of R&D on employment at finer sectoral definitions and identify heterogeneity within low-, medium- and high-tech industries. Also, we are able to add more service sectors for which R&D data has become available in the latest releases of the OECD ANBERD (Analytical Business Enterprise Research and Development) database. Given that we observe a persistent movement of employment away from agriculture and manufacturing into the service sectors, it is important to analyse the effects that innovation has on these sectors. Moreover, we include more Central and Eastern European countries in the analysis which allows for a discussion of qualitative differences between older and newer EU member countries with respect to cross-sectoral employment shift patterns as well as correlation between innovation and employment.

From a methodological perspective, we combine pure a descriptive treatment of the time series data for different countries and sectors with a shift-share analysis (see e.g. Fagerberg (2000), Maudos et al. (2008) and OECD (2014)), which disentangles productivity dynamics into within-sector effects and changes that are driven by labour movements between sectors. Additionally we carry out pooled as well as sector-specific regression analysing the relationship between R&D and employment. Our main findings from the regression analysis can be summarized as follows:

i) There is a positive, significant correlation between R&D expenditure and employment in high-tech manufacturing and service sectors.

ii) There is no correlation between R&D expenditure and employment in low-tech service sectors.

iii) The sign of the correlation coefficient between R&D expenditure and employment in the medium- and low-tech manufacturing sectors is predominantly negative.

iv) Restricting attention to newer EU member countries: i) and ii) are still true. With respect to iii) the sign of the correlation coefficient between R&D expenditure and employment in medium- and low-tech manufacturing is highly heterogeneous across sectors.

The rest of the paper is organized as follows: Section 2 presents data on general employment patterns in all EU member countries. In section 3 we test whether the observed cross-sectoral employment shifts are related to changes in labour productivity. Section 4 presents the results with respect to the correlation between sectoral employment and R&D investment and Section 5 concludes. Appendix A provides additional figures, while detailed description of the data is presented in Appendix B. Additional results and robustness checks are in Appendix C and further regression results are in Appendix D.

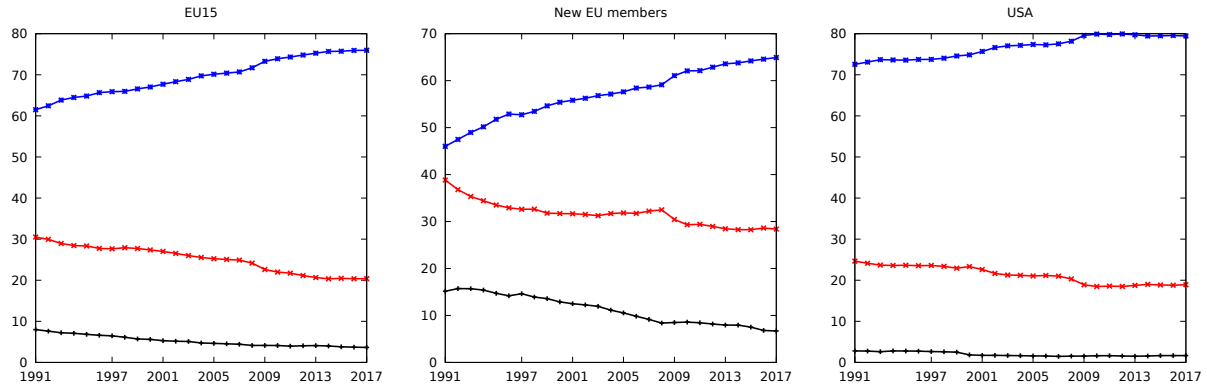

Figure 1: Employment in agriculture (black), services (blue) and industry (red) as percentage of total employment. Left panel: average over EU15 countries. Middle panel: average over rest of EU member countries. Right panel: USA. Data source: ILOSTAT database.

2 Country level evidence on shift between manufacturing and services: an aggregate perspective

We start our analysis with a purely descriptive treatment of the sectoral shifts of employment between industrial production and service from the early 90s until 2017 . Figure 1 depicts the development of the three main economic sectors (agriculture[2], industry[3] and services[4]) and the evolution of their employment shares for EU15 countries, the 13 newer EU members and the U.S. (Data source: ILOSTAT database). The figures for the two groups of EU countries are done by taking yearly averages. There is an evident cross-sectoral shift of labour between manufacturing and services. We can see that the share of workers employed in services has been steadily increasing everywhere over the considered periods. Moreover, the importance of the services is still on the rise, while employment in manufacturing and agriculture is decreasing. Also, it should be noted that, although the employment share of services in the U.S. is considerably above that in the EU, the speed of growth of the service sector in Europe seems larger than that in the U.S. In Figures 4 and 5 in Appendix A we show the breakdown of employment shares for each EU member country. It can be clearly seen that the employment share in the service sector in the new member countries is below that in most countries of the EU15. Qualitatively, all considered countries in the EU share the same upwards trend in the service sector share, however for some the new EU member countries, in particular those where in 1990 a substantial fraction of the work force was still employed in agriculture, the increase in the service sector share has been much more rapid than the average across the EU. Focusing however on the shift from manufacturing to service the patterns seem rather uniform across all considered countries.

3 Role of Productivity Differences: A Shift-Share Analysis

Having observed a clear pattern of an increasing employment share in service across all European countries and the U.S., we will now try to gain a better understanding of what is driving this

[2]Agricultural activities, forestry, hunting and fishing.

[3]Manufacturing, mining, construction, quarrying, public utilities (electricity, gas, and water).

[4]Communications, insurance, financing, real estate, business services, social, community and personal services, trade, hotels and restaurants.

phenomenon and how it differs between various sectors within service and manufacturing. As a first step we explore the question whether the shift in employment is an expression of changes of relative labour productivity across sectors, in a sense that workers move from sectors where their labour becomes (relatively) less productive to those with high labour productivity or faster labour productivity growth. Figure 2 shows the evolution of average labour productivity (measured in local currency in 2010 prices) in all manufacturing and business service sectors covering overall about 61% and 65.5% of total full-time employment equivalents in 2016 in Germany and Czech Republic, respectively, as representatives of old and new EU member countries. In both countries productivity is higher and also faster growing in the manufacturing sector with the exception of the earliest considered years for the Czech Republic where productivity in business service sectors is slightly above that of manufacturing. Putting this together with the insights from the previous section means that overall, workers tend to move towards less productive employment.

To further explore the relationship between employment shifts and productivity changes we carry out a shift-share decomposition of the change in labour productivity in 22 European countries. In particular, we use a shift-share decomposition equation of the following form:

$$\frac{P_{c,t+k} - P_{c,t}}{P_{c,t}} = \underbrace{\frac{\sum_i (p_{c,i,t+n} - p_{c,i,t}) l_{c,i,t}}{P_{c,t}}}_{\text{Within Effect}} + \underbrace{\frac{\sum_i (l_{c,i,t+n} - l_{c,i,t}) p_{c,i,t}}{P_{c,t}}}_{\text{Static Shift Effect}} + \underbrace{\frac{\sum_i (p_{c,i,t+n} - p_{c,i,t})(l_{c,i,t+n} - l_{c,i,t})}{P_{c,t}}}_{\text{Dynamic Shift Effect}}, \tag{1}$$

where $p_{c,i,t}$ is the labour productivity in sector i in country c at time t and $l_{c,i,t} = \frac{L_{c,i,t}}{\sum_i L_{c,i,t}}$ is the employment share of sector i in country c with $L_{c,i,t}$ denoting total employment in sector i in country c at time t. Labour productivity in country c is calculated as a weighted sum of the productivity in the different sectors: $P_{c,t} = \sum_i p_{c,i,t} l_{c,i,t}$.

The *Within Effect* (WE) measures the contribution of the sectoral productivity growth on total productivity growth, assuming that labour input remains constant; the *Static Shift Effect* (SSE) measures the effect of labour mobility between different sectors on total productivity growth, assuming that productivity within each sector remains constant, and the *Dynamic Shift Effect* (DSE) measures the change in the share of labour in each sector, as well as the impact of labour reallocation between sectors with differential productivity growth rates on total productivity growth. Considering the time average of these effects for a given country and a given time window allows to examine whether the increase in labour productivity in a country is primarily driven by productivity increases within the different sector or by employment shifts to sectors that are already more productive or exhibit faster productivity growth. We calculate the shift-share decomposition relying on data from the OECD Structural Analysis (STAN) database. In particular, we take employment data on the sectoral level and calculate sector-specific labour productivity using production (gross product) volumes[5] and again full time equivalent employment at the sectoral level using this database. The considered time window generally spans the years 1990-2016 and is cut in 5-year periods for which the three different effects are calculated. For some countries, due to data

[5]For Estonia, Ireland, Lithuania, Spain and UK this variable is not available so output is measured in value added, national currency 2010 prices.

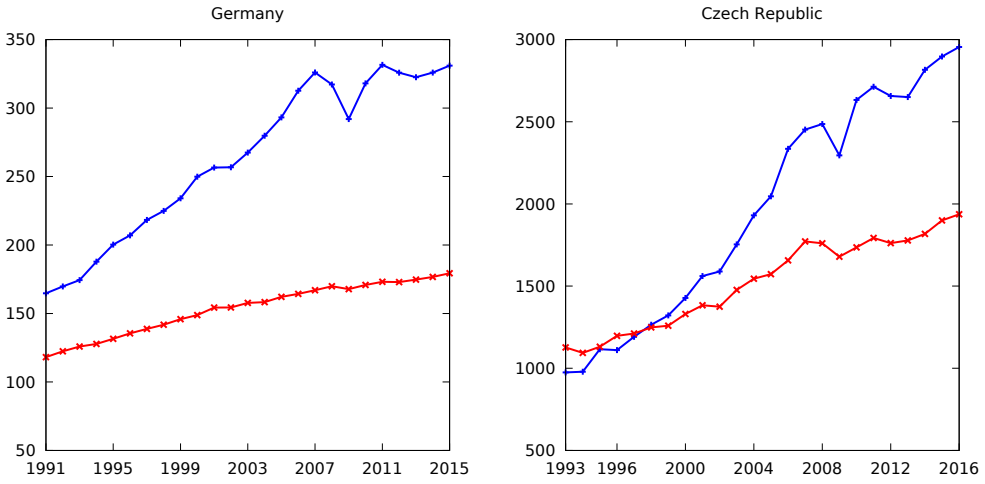

Figure 2: Average labour productivity in Germany (left panel) and the Czech Republic (right panel) in manufacturing (blue line) and business service (red line) sectors. Differences in the scale of the y-axis are due to measurement in national currencies.

restrictions only a subset of these periods could be covered.

Tables 1 and 2 show the results of the shift-share analysis for 22 EU countries. Tables 1 and 2 display the results for EU15 member countries, while the second part of table 2 shows the result for further 7 countries which became EU members during the 2004 enlargement. Apart from a few exception in Italy, Greece and Spain labour productivity has been growing in all countries in all the covered time intervals. Particularly, for the new EU member countries growth rates of labour productivity have been substantial in the 1990s and early 2000s. However the shift-share analysis indicates that consistently throughout the considered time period and across countries the contribution of sectoral employment to that productivity increase is rather limited. For most considered EU15 member countries, both the static shift effect and the dynamic shift effects are negative in almost all periods, indicating that in these countries the employment shift has reduced the increase in labour productivity emerging from the evolution of productivity within the sectors. This negative static shift effect indicates that labour is shifting to industries with lower productivity or, put differently, that high productivity industries are contracting. This is further supported by the often negative dynamic shift effect. Exceptions are Ireland, for which the static shift effect is consistently positive and Greece, Spain and Portugal for which for the majority of the considered time intervals the SSE is also positive. However, the dynamic shift effect is predominantly negative also for those countries. For the new EU member countries in the sample the static shift effect tends to be positive, although much smaller than the within effect. This suggests that in the new EU member countries some productivity gains were made by workers moving to more productive sectors. However, also for these countries the dynamic shift effect is consistently negative, indicating that there is no systematic movement of workers to sectors in which the growth of labour productivity is above average.

Overall, these results imply that an increase in labour productivity in general does not correspond to an expansion of this sector in terms of employment, but they also suggest that in some countries, in particular new EU member countries, there seems to be a weak positive relationship between productivity growth and employment expansion. Generally speaking, these observations

Table 1: Decomposition of Labour Productivity Growth: EU15 p.1

	Period	LPG[a]	WE[b]	SSE[c]	DSE[d]	AALPGR[e]
		percent	points	points	points	percent
Austria	1995–2001	17.16	18.56	−0.33	−1.08	2.68
	2001–2006	15.66	17.01	−0.42	−0.93	2.96
	2006–2011	3.96	4.56	−0.35	−0.25	0.80
	2011–2016	1.62	2.22	−0.48	−0.12	0.32
Belgium	1999–2005	4.06	7.80	−3.19	−0.59	0.67
	2005–2011	3.66	6.89	−2.11	−1.13	0.64
	2011–2016	1.35	3.51	−1.94	−0.22	0.28
Denmark	1990–1995	14.92	14.18	1.15	−0.41	2.83
	1995–2000	8.77	11.00	−1.31	−0.93	1.70
	2000–2005	11.11	13.42	−1.15	−1.16	2.14
	2005–2010	4.46	6.01	−0.13	−1.42	0.90
	2010–2015	5.81	6.61	−0.66	−0.15	1.14
Finland	1990–1996	23.70	22.64	1.72	−0.66	3.63
	1996–2001	13.97	12.28	1.65	0.04	2.66
	2001–2006	12.76	15.64	−1.52	−1.37	2.43
	2006–2011	1.37	5.10	−3.08	−0.65	0.33
	2011–2016	1.18	3.20	−1.91	−0.12	0.24
France	1990–1995	7.63	9.96	−1.47	−0.86	1.48
	1995–2000	11.03	13.04	−0.98	−1.02	2.12
	2000–2005	5.46	6.20	−0.29	−0.45	1.07
	2005–2010	2.15	4.81	−2.15	−0.50	0.45
	2010–2015	3.93	4.99	−0.76	−0.30	0.78
Germany	1991–1996	14.08	16.71	−0.34	−2.30	2.67
	1996–2001	15.30	14.80	1.14	−0.64	2.89
	2001–2006	9.67	11.60	−1.11	−0.83	1.87
	2006–2011	5.90	8.51	−1.92	−0.69	1.19
	2011–2015	1.95	1.81	0.19	−0.05	0.49
Greece	1995–2001	17.49	13.12	4.93	−0.56	2.74
	2001–2006	9.49	6.10	7.62	−4.24	1.87
	2006–2011	−9.10	−9.30	1.34	−1.13	−1.86
	2011–2016	0.34	2.10	−0.84	−0.92	0.07
Italy	1995–2000	11.17	10.21	1.59	−0.63	2.14
	2000–2005	2.31	3.35	−0.43	−0.62	0.46
	2005–2010	−1.73	−0.41	−0.83	−0.49	−0.29
	2010–2015	−2.25	0.46	−2.45	−0.26	−0.44
Ireland	1998–2002	13.16	8.52	5.04	−0.40	3.15
	2002–2006	4.63	6.13	0.09	−1.59	1.14
	2006–2010	13.55	0.75	12.81	−0.01	3.25
	2010–2014	16.06	15.81	0.23	0.01	3.96
Luxembourg	1995–2001	29.30	21.03	9.86	−1.54	4.42
	2001–2006	21.49	25.40	−1.86	−2.05	4.00
	2006–2011	4.89	6.19	−1.10	−0.20	1.10
	2011–2016	15.45	15.69	−0.83	0.59	2.98

[a] Labour Productivity Growth
[b] Within Effect
[c] Static Shift Effect
[d] Dynamic Shift Effect
[e] Average Annual Labour Productivity Growth Rate

Table 2: Decomposition of Labour Productivity Growth: EU15 p.2 and new EU member countries

	Period	LPG[a]	WE[b]	SSE[c]	DSE[d]	AALPGR[e]
		percent	points	points	points	percent
Netherlands	1995–2001	12.55	16.53	−3.27	−0.70	1.99
	2001–2006	6.92	11.09	−2.84	−1.33	1.35
	2006–2011	2.03	5.15	−2.58	−0.53	0.47
	2011–2016	5.83	7.34	−1.14	−0.37	1.14
Portugal	1995–2000	11.04	10.35	1.89	−1.21	2.12
	2000–2005	7.19	10.63	−1.72	−1.71	1.40
	2005–2010	6.44	6.78	0.17	−0.51	1.27
	2010–2015	1.26	0.09	1.24	−0.07	0.25
Spain	1995–2000	−0.26	−4.01	10.61	−6.86	−0.05
	2000–2005	0.86	−0.19	3.31	−2.25	0.17
	2005–2010	8.63	7.37	2.33	−1.07	1.67
	2010–2015	6.63	7.68	−0.49	−0.56	1.30
Sweden	1993–1995	5.03	4.56	0.40	0.06	2.48
	1995–2000	12.80	13.69	−0.62	−0.27	2.45
	2000–2005	11.54	12.85	−0.56	−0.75	2.21
	2005–2010	1.10	3.36	−1.73	−0.53	0.26
	2010–2015	4.06	7.04	−3.19	0.22	0.81
UK	1995–2001	11.37	9.38	2.37	−0.38	1.81
	2001–2006	9.90	8.66	2.84	−1.61	1.91
	2006–2011	0.99	0.45	1.24	−0.70	0.21
	2011–2016	1.85	2.20	−0.14	−0.20	0.37
New EU member countries						
Czech Republic	1993–1996	9.12	7.68	1.47	−0.03	2.97
	1996–2001	20.29	23.47	−1.27	−1.91	3.77
	2001–2006	28.83	27.80	1.70	−0.67	5.24
	2006–2011	6.75	7.82	−1.00	−0.07	1.42
	2011–2016	6.11	4.54	1.47	0.10	1.22
Estonia	2000–2005	29.28	34.53	−0.83	−4.42	5.14
	2005–2010	18.86	20.18	5.54	−6.85	3.58
	2010–2015	5.02	8.73	6.56	−10.26	1.01
Hungary	2010–2015	6.67	10.39	−2.07	−1.66	1.32
Lithuania	1995–2001	36.98	38.23	−0.56	−0.70	5.43
	2001–2006	33.45	32.17	8.61	−7.33	5.97
	2006–2011	19.20	15.65	9.83	−6.27	3.67
	2011–2016	5.49	6.41	0.17	−1.09	1.09
Poland	2000–2005	12.09	10.77	1.99	−0.66	2.36
	2005–2010	17.43	13.09	5.76	−1.41	3.30
	2010–2015	10.90	9.92	1.15	−0.17	2.10
Slovak Republic	1995–2000	28.83	25.83	4.34	−2.44	5.21
	2000–2005	11.89	13.13	1.17	−2.41	2.33
	2005–2010	18.79	20.97	−1.33	−0.85	3.71
	2010–2015	20.36	19.49	0.11	0.77	3.79
Slovenia	2000–2006	27.31	20.22	10.97	−3.88	4.13
	2006–2011	1.84	1.17	1.63	−0.95	0.53
	2011–2016	2.61	3.10	−0.23	−0.26	0.53

[a] Labour Productivity Growth
[b] Within Effect
[c] Static Shift Effect
[d] Dynamic Shift Effect
[e] Average Annual Labour Productivity Growth Rate

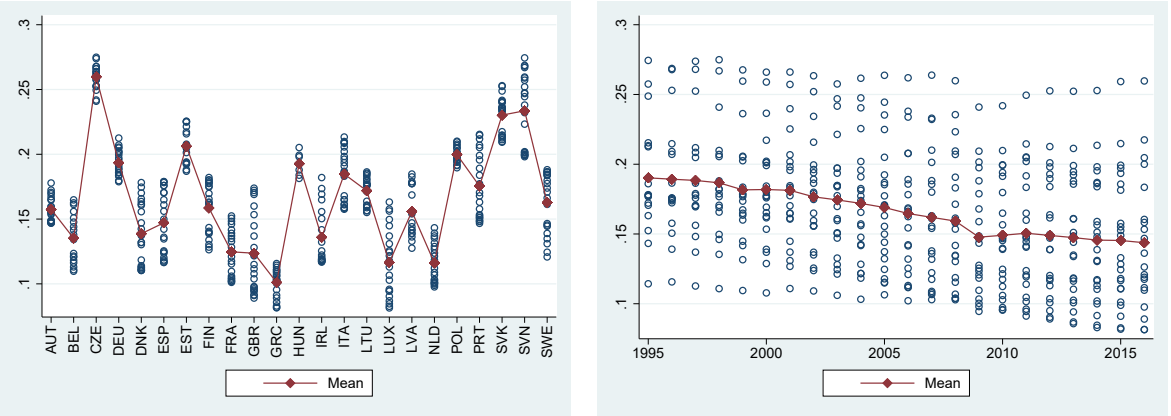

Figure 3: Share of manufacturing employment by country (left panel) and by year (right panel) in full time employment equivalents.

of course give little indication of the causal chains which are responsible for these relationships. For example, the underlying mechanism for a negative relationship between productivity and employment might be that due to productivity increases induced by technological change firms in a sector can reduce the workforce needed to satisfy demand. A similar negative relationship could however also emerges due to a reduction of the firm's output (e.g. because of demand contraction), leading to an elimination of old and less productive machines or less skilled labour from the production process. An analysis encompassing the different potential causal relationships between productivity increase and employment on a sectoral or even a firm level is beyond the scope of this manuscript. However, in the next section, we dig deeper into one particular channel influencing the relationship between productivity and employment, by exploring how sectoral employment depends on the level of R&D activities, and whether this relationship differs between manufacturing and service sectors.

4 R&D expenditure and employment

Our analysis of the relationship between R&D activity and employment relies on country and sector specific regressions. The largest sample contains 23 EU member countries: Austria, Belgium, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, UK, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Netherlands, Poland, Portugal, Slovak Republic, Slovenia and Sweden. However, because of data limitations our panel is unbalanced and some countries are dropped for some of the regression specifications.[6]

4.1 R&D expenditure and the share of employment in manufacturing

First, we consider the decline of the manufacturing sector's employment share as a whole in the period 1995-2016. The Hausman test indicates that the use of a fixed-effects model is appropriate. However, diagnostic tests suggest that the errors are heteroskedastic and autocorrelated. Therefore, we estimate a robust fixed-effects (within) regression with Driscoll and Kraay standard errors. The

[6]Latvia was not included in the shift-share analysis because of lack of full time employment data on the two-digit industry level. However, we can include it for the baseline regression analysis in which we consider total manufacturing employment.

regression equation has the following form:

$$sharemanu_{it} = \beta X'_{it} + \alpha_i + u_{it} \tag{2}$$

where β is the coefficient vector, X'_{it} is the vector of independent variables, α_i captures country fixed effects and u_{it} is the error term. Here i stands for the cross-sectional unit (i.e., the 23 countries) and t denotes time (1995-2016). The dependent variable **sharemanu** is defined as the full time equivalent employment in all manufacturing sectors as a share of full time equivalent total employment in country i. Figure 3, shows that, consistent with the evidence from Section 2, the share of labour employed in manufacturing sectors differs substantially between countries but exhibits a consistent downward trend over time.

We begin by estimating the relationship between gross domestic expenditure on R&D and the share of employment in manufacturing. There are various conceptual issues when trying to estimate relationship between R&D and other economic variables. On the one hand, not all R&D investments translate into successful product or process innovation or if it does there is an unknown time lag between the investment and the actual output from this investment. Also, knowledge spillovers between firms cannot be observed in the data which might distort estimation results (Chennells and Van Reenen, 2002). The last concern is not particularly relevant given the sectoral aggregation we use in the analysis. Regarding the first one, in our baseline estimations we use first lag of the R&D measures so that to keep as many observations as possible in the sample. However, we perform robustness checks by adding longer lag structure. This does not lead to qualitative changes in the relationship between R&D and employment, but might affect the significance level in some of the cases.

The choice of explanatory variables is partially based on previous empirical studies which have focused on possible determinants of sectoral employment. In particular, higher GDP per capita has been found to be associated with higher employment in service sectors (Messina (2005), based on 27 OECD countries for the period (1970-1998), d'Agostino et al. (2006) for EU-15 (1970-2003)). Hence, we expect a negative correlation between GDP per capita and the employment share in manufacturing. On the other hand, different studies find different effects of higher employment regulations (EPL) on the expansion of the service sector. OECD (2000) and d'Agostino et al. (2006) find that on an aggregate level, higher employment protection hinders the expansion of the service sector. On the other hand, Messina (2005) does not find a significant relationship between the two. In addition, we control for demographic changes coming from, for example, migration which is captured in the total employment variable, and for changes in labour cost. Further, we account for the impact of international trade, which is controlled for by a trade openness measure widely used in empirical literature (see, for example, Alesina et al. (2000); Felbermayr et al. (2011); Frankel and Romer (1999)): nominal imports plus nominal exports divided by GDP (again in nominal terms). Keller and Utar (2016), for example, identify a significant impact of Chinese import competition on worker transitions between different sectors in Denmark. Specifically, using matched worker-firm data covering the period 1999-2009, the authors find that import competition explains 17% of the decline in manufacturing, middle-wage jobs. On the flip side, Dosi and Yu (2018) find that sales growth and exports growth is positively correlated with employment at the two-digit manufacturing sectors in China. Our main focus is, however, on the role of R&D on sector

Table 3: Descriptive statistics

	All			***Old EU members***			***New EU members***		
	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.	Obs
Dependent variable									
manufacturing_share	0.17	0.05	498	0.14	0.04	329	0.21	0.04	169
manufacturing_share_FTEN	0.17	0.05	466	0.15	0.03	322	0.21	0.04	144
R&D measures									
GERD	1.56	0.83	487	1.88	0.81	314	0.97	0.48	173
businessRD	1.03	0.66	322	1.27	0.67	202	0.61	0.40	120
businessRD_manu	0.67	0.53	324	0.85	0.56	202	0.37	0.29	122
Controls									
lnempl	8.36	1.28	506	8.72	1.26	330	7.68	1.01	176
gdp/cap	32.37	13.98	506	38.87	12.72	330	20.18	5.51	176
gdpgrowth_l1	2.59	3.49	502	2.10	3.00	330	3.54	4.13	172
labcostgrowth	0.79	6.55	475	0.27	6.21	317	1.84	7.08	158
trade	0.66	0.53	436	0.64	0.43	304	0.72	0.70	132
EPL	2.42	0.67	362	2.43	0.73	273	2.41	0.47	89

Note: FTEN: full time employment equivalent; "GERD": gross domestic expenditure as % of GDP; "businessRD": total business R&D expenditure measured as a % of GDP; "businessRD_manu": business R&D expenditure in all manufacturing sectors as a % of GDP; lnempl: natural log of total employment; gdp/cap is devided by 1000; "labcostgrowth": annual change in unit labour cost in manufacturing (%); trade: value of imports plus exports divided by GDP; EPL: Employment Protection Legislation - measures the strictness of employment protection legislation.

specific employment growth. Table 3 provides descriptive statistics for the used variables in the regressions presented in tables 4, 10 and 11. Most of the data is collected from OECD, in particular we use the OECD STAN database for structural analysis (ISIC Rev. 4) for the employment and labour cost data. Further, we use the BTDIxE Bilateral trade by Industry and End-use (ISIC Rev. 4) database for data on value of imports and exports per industry. The data on business R&D expenditure is collected from the OECD ANBERD Analytical Business R&D database. Finally, additional control variables are collected from OECD annual national accounts statistics. More detailed data description can be found in Appendix B.

As can be inferred from figure 3 and table 3, newer EU member countries have on average a higher share of the working population employed in manufacturing sectors: 21% vs. 15% for EU15 member countries and lower R&D investments, where business R&D expenditures (which are measured as a fraction of countries' GDP) are almost half compared to older EU members. In table 4 the R&D measure used for these regressions is gross domestic expenditure on R&D, as a percentage of GDP (first lag). Quite strikingly, we consistently obtain a statistically significant coefficient for R&D expenditures, which means that, considering all manufacturing sectors, there is a negative correlation between the R&D investment in a country and the share of employment in manufacturing. Using alternative measures for aggregate R&D expenditure per country or using longer lags yields similar results for the relationship between the manufacturing share and R&D expenditure. This is displayed in table 10 in Appendix C where we used total business R&D expenditure in a country, measured in national currency, 2010 prices, divided by GDP, again in national currency, constant prices. Similarly to the specification in table 4, R&D expenditure

Table 4: Manufacturing share of employment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GERD_L1	-0.036***	-0.029***	-0.022***	-0.014***	-0.014***	-0.013***	-0.011*
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)
lnempl		-0.123***	-0.139***	-0.082***	-0.081***	-0.097***	-0.095**
		(0.020)	(0.013)	(0.011)	(0.011)	(0.010)	(0.029)
gdpgrowth_l1			0.002***	0.002***	0.002***	0.002***	0.002***
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
gdp/cap				-0.002***	-0.002***	-0.002**	-0.001*
				(0.000)	(0.000)	(0.000)	(0.001)
labcostgrowth					-0.009	-0.007	-0.023
					(0.009)	(0.011)	(0.013)
trade						-0.007	-0.011**
						(0.004)	(0.003)
EPL							0.001
							(0.007)
Constant	0.222***	1.248***	1.370***	0.935***	0.926***	1.067***	1.058***
	(0.007)	(0.165)	(0.106)	(0.092)	(0.090)	(0.078)	(0.218)
Observations	444	444	441	441	432	374	296
Within R^2	0.294	0.446	0.561	0.628	0.623	0.616	0.650
Num. of countries	23	23	23	23	23	20	20
Country FE	yes	yes	yes	yes	yes	yes	yes

Dependent variable: share of employment in manufacturing based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4), Manufacturing [C]: ISIC 10-33. In specifications (6) and (7) Spain, Latvia and Lithuania are dropped due to missing data.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors.
** p < 0.05, ** p < 0.01, *** p < 0.001*

is negatively, significantly correlated with share of manufacturing employment. Finally, in table 11 in Appendix C we include the second lag of gross domestic expenditure on R&D, as well as business R&D in total economy (first and second lag) and business R&D concentrated only in manufacturing sectors (again first and second lag). In all specification, we observe a negative and significant coefficient of R&D.[7]

Apart from this, we obtain a positive correlation of the employment share in manufacturing with the growth rate of GDP as well as negative correlation with total employment and with GDP per capita. This latter result is consistent with the observation that in particular the new EU member countries are characterized by higher manufacturing shares but lower per capita GDP compared to the old EU member states. It is also consistent with the results of d'Agostino et al. (2006) who study the determinants of employment in the service sectors and establish a strong positive correlation between GDP per capita and the service sector's employment share. Further, labour cost growth in manufacturing is negatively correlated with the manufacturing employment share, but the relationship is insignificant in most of the specifications. On the other hand, we find no significant correlation between the employment protection index (EPL) and the manufacturing employment share. Also, this variable is missing for multiple years and countries and including it restricts our

[7]Only when using the first lag of business R&D in manufacturing, the significance of the coefficient drops below the 1% level.

Table 5: Business R&D

Country	Business R&D	R&D manufacturing	Low-	Medium-	High-tech
	% of GDP	*share*	*distribution of R&D*		
		average 2010-2015			
Austria	2.04	62.87	7.14	14.85	78.01
Belgium	1.58	58.60	8.71	9.30	81.99
Czech Republic	0.95	52.24	7.95	13.00	79.05
Germany	1.92	85.90	3.24	6.72	90.04
Denmark	1.93	55.50	6.71	17.59	75.69
Spain	0.67	45.33	16.42	9.60	73.98
Estonia	0.93	37.82	60.04	4.37	35.59
Finland	2.31	73.00	7.52	4.18	88.30
France	1.43	50.44	8.76	11.57	79.67
UK	1.05	38.67	12.73	6.96	80.31
Greece	0.22	34.17	29.79	10.56	59.65
Hungary	0.86	51.02	7.45	6.77	86.11
Ireland	1.06	40.10	15.85	24.33	59.74
Italy	0.71	72.07	12.68	8.38	79.00
Lithuania	0.26	35.22	11.74	19.58	66.79
Netherlands	1.04	59.36	17.14	6.18	77.44
Poland	0.34	47.02	19.29	14.89	66.20
Portugal	0.65	38.32	32.24	16.86	51.14
Slovak Republic	0.31	62.43	6.18	12.49	80.68
Slovenia	1.77	68.21	9.96	8.06	82.15
Sweden	2.22	70.61	4.82	7.22	87.49

Note: All values are averages for 2010-2015, except for Greece where the time span is 2011-2015. Second column: business R&D expenditure as a % of GDP. Third column: share of business R&D expenditure allocated to manufacturing sectors. Fourth-Sixth columns: share of business R&D in manufacturing allocated to low-, medium- and high-tech manufacturing sectors, respectively.

sample size. Therefore, it is excluded from the controls used in the regressions reported in table 11. Finally, we obtain a negative correlation between trade openness and the share of manufacturing employment. However, the significance of the result is not stable across the different regression specifications. Concerning the negative correlation between the manufacturing share and R&D, in principle this phenomenon is in accordance with our evidence from the previous sections that employment tends to move to sectors with lower growth rates of labour productivity. However, it should be noted that here we consider the whole manufacturing sector and it is not yet clear how R&D expenditure affects employment at more-narrowly defined sectoral levels. Furthermore, we should expect a large heterogeneity across manufacturing sectors with respect to the elasticity of employment with respect to R&D, which clearly limits the informativeness of such considerations on the aggregate level.

4.2 R&D expenditure and employment in manufacturing sectors

To address this shortcoming we now perform sector specific regressions. We begin by looking deeper at the country level heterogeneity with respect to distribution of business R&D expenditure between the different manufacturing sectors. Table 5 displays some summary statistics of business R&D expenditure. Since there are many missing observations for this variable, the table displays

average values, spanning 2010-2015, for which years most observations are present. The second column shows business R&D as a percent of GDP per country. The highest value is Finland's: 2.31% followed by Sweden: 2.22% and Austria: 2.04%. For all other countries in the sample the average business R&D investment for the years 2010 to 2015 is below 2% of GDP. The lowest value is Greece's: 0.22%, followed by Slovak Republic: 0.31% and Poland: 0.34%. Column 3 of the table then looks at what share of this investment was done in the manufacturing sectors. Overall, for the majority of the countries the larger share of business R&D investment was allocated in manufacturing; exceptions are Spain, Estonia, UK, Greece, Ireland, Lithuania, Poland and Portugal. Finally, the last three columns of the table look how the R&D investment in manufacturing is distributed between low-, medium- and high-technology sectors. Low-tech manufacturing sectors are: "Food products, beverages and tobacco", "Textiles, wearing apparel, leather and related products", "Wood and paper products, and printing", "Coke and refined petroleum products" and "Fabricated metal products, except machinery and equipment"; medium-tech manufacturing sectors are: "Rubber and plastic products", "Other non-metallic mineral products", "Basic metals" and "Furniture; other manufacturing: repair and installation of machinery and equipment" and high-tech manufacturing sectors are: "Chemicals and chemical products", "Basic pharmaceutical products and pharmaceutical preparations", "Computer, electronic and optical products", "Electrical equipment", "Machinery and equipment n.e.c.", "Motor vehicles, trailers and semi-trailers" and "Other transport equipment". Most of R&D expenditure is concentrated in high-tech manufacturing industries which is expected since high-tech manufacturing industries are considered those with high R&D intensity. The taxonomy we use is based on the one proposed by Galindo-Rueda and Verger (2016). The authors group manufacturing and non-manufacturing industries in five categories according to their R&D intensities, where R&D intensity is measured as the ratio of R&D expenditure to gross value added. The low-tech specification here corresponds to the "Medium-low R&D intensity industries" in their classification; medium-tech corresponds to "Medium R&D intensity industries" and high-tech combines "Medium-high R&D intensity industries" and "High R&D intensity industries". While overall, majority of R&D expenditure is concentrated in high-tech industries, we observe a considerable variation among the countries in the sample regarding the distribution of R&D investment.

We next run sector-specific regressions to identify whether the overall negative, significant correlation between R&D and employment in manufacturing is preserved at the less aggregate level. The dependent variable in each case in the natural logarithm of total employment in a specific sector. As explanatory variables we include natural logarithm of sectoral business R&D expenditure.[8] Further, we include similar control variables as in the baseline regression, namely natural log of total employment and natural log of GDP per capita as well as GDP growth rate. Next we control for international trade by including log of the sector-specific trade openness measure. Finally, we include changes in hourly wages and salaries using OECD STAN database ("wage_growth" variable) but also include a change in unit cost variable ("labcostgrowth"), which is collected from the OECD Productivity and ULC by main economic activity database. Data on wages and salaries or total hours worked is missing for some sectors of some countries, so for those sectors, in order to not lose too many observations we control for changes in labour cost using the growth in unit labour cost control variable. The drawback of doing so is that it is defined for the whole manufacturing

[8]Measured in national currency, 2010 prices, first lag.

sector. More detailed description of the data can be found in Appendix B. Again, fixed effects (within) regressions with with Driscoll and Kraay standard errors are estimated.

Table 6: Manufacturing and innovation

Sector+Code	**R&D[a]**	**N[b]**	**Countries**	R^{2c}
Low-tech manufacturing				
Dependent variable: Total employment				
Food products, beverages and tobacco	0.053^{**}	262	19	0.590
ISIC 10-12	(0.014)			
Textiles, wearing apparel,	-0.048^{*}	233	18	0.663
leather and related products: ISIC 13-15	(0.023)			
Wood and paper products,	-0.034^{*}	249	18	0.326
and printing: ISIC 16-18	(0.012)			
Coke and refined petroleum products	0.035^{*}	157	14	0.330
ISIC 19	(0.026)			
Fabricated metal products, except	-0.034^{***}	255	19	0.352
machinery and equipment: ISIC 25	(0.026)			
Dependent variable: Full time equivalent employment				
Food products, beverages and tobacco	0.061^{**}	248	19	0.591
ISIC 10-12	(0.013)			
Textiles, wearing apparel,	-0.055^{*}	233	18	0.661
leather and related products: ISIC 13-15	(0.023)			
Wood and paper products,	-0.039^{*}	235	18	0.335
and printing: ISIC 16-18	(0.014)			
Coke and refined petroleum products	0.028	157	14	0.352
ISIC 19	(0.026)			
Fabricated metal products, except	-0.028^{**}	179	15	0.441
machinery and equipment: ISIC 25	(0.007)			
Medium-tech manufacturing				
Dependent variable: Total employment				
Rubber and plastic products	-0.008	229	19	0.471
ISIC 22	(0.019)			
Other non-metallic mineral products	-0.042^{*}	237	19	0.343
ISIC 23	(0.015)			
Basic metals	0.036^{***}	246	18	0.319
ISIC 24	(0.009)			
Furniture; other manufacturing; repair and	-0.017^{*}	245	19	0.150
installation of machinery and equipment: ISIC 31-33	(0.006)			
Dependent variable: Full time equivalent employment				
Rubber and plastic products	-0.026	163	15	0.453
ISIC 22	(0.031)			
Other non-metallic mineral products	-0.077^{***}	171	15	0.334
ISIC 23	(0.015)			
Basic metals	0.030	170	14	0.306
ISIC 24	(0.028)			
Furniture; other manufacturing; repair and	-0.033^{**}	231	19	0.175
installation of machinery and equipment: ISIC 31-33	(0.009)			

[a] First Lag
[b] Number of observations
[c] Within R^2
Note: Dependent variables are in natural log. Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. The full regressions are displayed in tables 16 and 17 in Appendix D. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Starting with low-tech manufacturing, table 12 in Appendix D presents the results for "Food products, beverages and tobacco". In the first four columns, the dependent variable is natural log of total employment in the sector, while in the last four, it is natural log of full time equivalent employment. Differences between specifications (1) and (2); (5) and (6) is that we use the different

controls capturing changes in labour costs. The coefficients for both variables are insignificant for this sector. Also, we divide the sample into EU15 and newer EU member countries (specifications (3) and (4); (7) and (8)) and re-run the regressions. Overall, R&D expenditure is positively correlated with employment in the "Food products, beverages and tobacco" sector. The result is significant at the 0.1% level when considering full-time equivalent employment and at the 1% level for the case of total sectoral employment. Interestingly, the significance level of the result is driven by the group of newer EU member countries, while we observe no significant correlation between R&D expenditure in this sector and employment in EU15 countries. Further, higher GDP per capita is associated with lower full time employment in "Food products, beverages and tobacco" but the highly significant result is driven by the newer EU member countries. Trade openness is negatively correlated with employment in this sector and for most of the specifications the coefficient is statistically significant.

Next, table 13 shows the result for employment in "Textiles, wearing apparel, leather and related products" as a second example of a low-tech manufacturing sector. Here, R&D expenditure is negatively associated with sectoral employment and the result is significant at the 5% level for both full time equivalent and total employment. However, the negative, significant relationship seems to be caused by the EU15 countries, while for the rest of the sample the coefficient of R&D expenditure is positive, but insignificant. Further, the results indicate a not significant relationship between trade openness and employment in "Textiles, wearing apparel, leather and related products" but considering the sub-sample of newer EU member countries there is a positive correlation between the two, significant at the 5% level. On the other hand, hourly wage growth is associated with lower full time employment in the sector in the EU15 countries.

Table 6 summarizes the regression results with respect to the relationship between employment and R&D expenditure for low- and medium-tech manufacturing sectors. The full regression results for low-tech manufacturing sectors are presented in table 16 in Appendix D. On average, in 2015, the share of employment in low-tech manufacturing sectors was 6.3% of total employment. This breaks down into approximately 5.2% for EU15 countries (excluding Luxembourg) and 8.6% for the rest of the countries in the sample (excluding Estonia). We observe that for the majority of low-tech manufacturing sectors for which R&D expenditure is significantly correlated with employment, the sign of the coefficient is negative. The one exception is the sector "Food products, beverages and tobacco" discussed in more detail above. Increase in the unit cost of labour is mostly negatively correlated with employment where the result is highly significant only for the sector "Textiles, wearing apparel, leather and related products". The trade openness measure is also negatively correlated with sectoral employment for most of the low-tech manufacturing sectors. However, the coefficient is predominantly insignificant. Further, similarly to our baseline regression from the previous section we observe a negative, significant relationship between GDP per capita and sectoral employment in four out of the five low-tech manufacturing sectors. The only exception is "Fabricated metal products, except machinery and equipment" for which we obtain a statistically significant and positive coefficient. These results are in line with the overall conclusion from the previous section that R&D expenditure in manufacturing is associated with lower employment.

Next, we turn to the medium-tech manufacturing sectors. Tables 6 and 17 in Appendix D display results with respect to total employment and full time equivalent employment for all medium-tech manufacturing sectors. The average share of employment in these sectors in 2015 across the countries in the sample was 3.47% of total employment. In EU15 countries (excluding Luxembourg)

Table 7: Manufacturing and innovation: part 2

Sector+Code	R&D[a]	N[b]	Countries	R^{2c}
High-tech manufacturing				
Dependent variable: Total employment				
Chemicals and chemical products	0.090**	211	16	0.490
ISIC 20	(0.026)			
Basic pharmaceutical products	0.163**	216	18	0.245
and pharmaceutical preparations: ISIC 21	(0.044)			
Computer, electronic and optical products	0.214**	259	19	0.509
ISIC 26	(0.073)			
Electrical equipment	0.036	259	19	0.147
ISIC 27	(0.024)			
Machinery and equipment n.e.c.	0.024	259	19	0.160
ISIC 28	(0.021)			
Motor vehicles, trailers and	0.036*	258	19	0.449
semitrailers: ISIC 29	(0.015)			
Other transport equipment,	−0.053*	243	19	0.145
ISIC 30	(0.025)			
Dependent variable: Full time equivalent employment				
Chemicals and chemical products	0.076*	197	16	0.417
ISIC 20	(0.033)			
Basic pharmaceutical products	0.093**	199	18	0.462
and pharmaceutical preparations: ISIC 21	(0.031)			
Computer, electronic and optical products	0.198**	245	19	0.520
ISIC 26	(0.069)			
Electrical equipment	0.015	245	19	0.102
ISIC 27	(0.024)			
Machinery and equipment n.e.c.	−0.007	245	19	0.127
ISIC 28	(0.021)			
Motor vehicles, trailers and	0.073**	182	15	0.453
semitrailers: ISIC 29	(0.021)			
Other transport equipment,	−0.114**	173	15	0.170
ISIC 30	(0.039)			

[a] First Lag
[b] Number of observations
[c] Within R^2
Note: Dependent variables are in natural log. Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. The full regressions are displayed in tables 18 in Appendix D. ** p < 0.05, ** p < 0.01, *** p < 0.001.*

the average in 2015 was 2.8% compared to 4.6% for the rest of the countries in the panel. We observe that for "Other non-metallic mineral products" and "Furniture; other manufacturing, repair and installation of machinery and equipment" there is a negative, significant relationship between R&D expenditure and employment for both total and full time equivalent employment specifications. For the sector "Basic metal" this relationship is positive and significant at the 0.1% level. However, this significance disappears when considering full-time employment which might be driven by the fact that the number of observations and countries in the panel for that regression is much smaller due to missing data. GDP per capita preservers its negative, significant correlation with sectoral employment for two out of the four medium-tech manufacturing sectors. Considering the sector "Rubber and plastic products" there is significant, positive correlation between the two. Next, trade openness is associated with lower employment in medium-tech service sector, however, the coefficient is mostly insignificant. Overall, the results for medium-tech manufacturing sectors with respect to the correlation between R&D expenditure and employment are also broadly in line with the conclusion from the previous section.

Last but not least, we run the sector-specific regressions for high-tech manufacturing sectors. Table 14 in Appendix D shows the results for "Computer, electronic and optical products" as a detailed example of one of the high-tech manufacturing sectors. We observe a positive and significant coefficient of R&D expenditure in all regression specifications. Similarly to the overall results for manufacturing, higher GDP per capita is negatively correlated with employment in this sector and the coefficient is highly significant across most specifications. Unlike the overall manufacturing results, however, trade openness is positively correlated with employment in "Computer, electronic and optical products" and the coefficient is significant at the 0.1% level. Finally, hourly wage growth is associated with lower employment in this sector in the newer EU member countries.

Further, table 15 in Appendix D displays result for "Motor vehicles, trailers and semi-trailers" as a second detailed example for high-tech manufacturing sector. Again we observe a significant relationship between R&D expenditure and employment if we consider the whole sample. The coefficient of R&D turns, however, insignificant in the case of total employment in EU15 countries. For newer EU member countries the coefficient is positive and significant at the 0.1% level, considering total employment and at the 1% level regarding full-time employment. Interestingly, higher GDP per capita is associated with higher employment in this sector in newer EU member countries, while there is no statistically significant relationship between the two considering EU15 countries. Higher trade openness is also associated with higher employment in "Motor vehicles, trailers and semi-trailers" in EU15+ countries.

The overall results for high-tech manufacturing sectors are displayed in table 7 and table 18 in Appendix D. These sectors employed on average 4.48% of the working force in 2015, where this percentage is slightly lower if we consider the group of EU15 countries (excluding Luxembourg): 3.76% vs. 5.92% for the rest of the countries (excluding Estonia). Out of the seven considered sectors there are four for which there is a positive significant relationship between R&D expenditure and employment and for one of them: "Other transport equipment" there is a significant negative relationship. The coefficient of growth in unit labour cost is negative, whenever significant while the results with respect to trade openness are mixed. For the other three high-tech manufacturing sectors the coefficient of trade is not statistically significant. GDP growth is positively correlated with employment in the high-tech manufacturing sectors whenever the coefficient is statistically significant. And finally, GDP per capita is negatively correlated with employment in most of the sectors. Exceptions are "Motor vehicles, trailers and semi-trailers", discussed in more detail above, and "Basic pharmaceutical products and pharmaceutical preparation".

Overall, the results with respect to the relationship between R&D expenditure as a proxy for innovation and employment in manufacturing are quite mixed and nuanced. Generally, we observe that higher R&D investment in high-tech manufacturing sectors is associated with higher employment in those sectors while the opposite is true for the low- and medium-tech sectors considered in the analysis. There are, however, exceptions in each group. These results might reflect the dominant innovation strategies, either product or process innovation, in each industry. In this respect, Antonucci and Pianta (2002), report that for firms in "Textiles", "Food, Beverages and Tobacco" and "Printing and Publishing" (according to ISIC Rev. 3) process innovations is the main source of innovation. All of those industries fall in the low-tech category which might be one explanation to why we often observe a negative correlation between R&D expenditure and employment in those sectors. On the other hand, Antonucci and Pianta (2002) find that for firms in "Machinery", "Elec-

Table 8: Services and innovation

Sector+Code	R&D[a]	N[b]	Countries	R^{2c}
Medium-tech services				
Dependent variable: Total employment				
Telecommunications ISIC 61	−0.021 (0.011)	171	19	0.316
Professional, scientific and technical activities: ISIC 69-75	0.022** (0.008)	167	21	0.611
Dependent variable: Full time equivalent employment				
Telecommunications ISIC 61	−0.030** (0.011)	171	19	0.347
Professional, scientific and technical activities: ISIC 69-75	0.016* (0.008)	167	21	0.638
High-tech services				
Dependent variable: Total employment				
Scientific research and development: ISIC 72	0.195*** (0.027)	276	21	0.542
IT and other information services: ISIC 62-63	0.123** (0.027)	184	20	0.867
Dependent variable: Full time equivalent employment				
Scientific research and development: ISIC 72	0.205*** (0.023)	276	21	0.575
IT and other information services: ISIC 62-63	0.120** (0.026)	184	20	0.861

[a] First Lag
[b] Number of observations
[c] Within R^2
Note: Dependent variables are in natural log. Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. The full regressions are displayed in tables 21 in Appendix D. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

trical and Communications Machinery" and "Transport", which are high-tech industries, product innovation is the main source of innovation. This indicates that a positive employment effect of product innovations, as reported in many of the empirical firm-level studies, can also be observed at the sectoral level. One has to be, however, cautious in interpreting our result since we cannot claim causality. Moreover, the positive association between R&D in high-tech industries and employment is also reported in Bogliacino and Vivarelli (2012).[9] The authors find, however, that R&D has a positive but insignificant effect on employment in low- and medium-tech industries. Further, our results indicate that there are qualitative difference between the older and newer EU member countries with respect to the relationship between R&D and employment in some sectors. Diving deeper into the types of innovation in Central and Eastern European firms might provide insight to why this is the case.

4.3 R&D expenditure and service sector employment

Next, we move to the service sectors and again use the taxonomy proposed by Galindo-Rueda and Verger (2016) to cluster the service sectors into three broad groups based on their R&D

[9]The authors group manufacturing and few service industries into the three categories: low-, medium-, and high-tech. So there are two service sectors included in their high-tech definition: "Computer and related activities" and "Research and Development". The other two service sectors which they consider: "Hotels and catering" and "Other business activities" are grouped together with the medium-tech manufacturing sectors.

Table 9: Services and innovation: part 2

Sector+Code	R&D[a]	N[b]	Countries	R^{2c}
Low-tech services				
Dependent variable: Total employment				
Financial and insurance activities ISIC 64-66	−0.002 (0.003)	214	20	0.178
Audiovisual and broadcasting activities: ISIC 59-60	−0.008 (0.008)	72	13	0.345
Wholesale and retail trade, repair of motor vehicles and motorcycles: ISIC 45-47	0.007 (0.004)	251	21	0.710
Administrative and support service activities: ISIC 77-82	0.005 (0.004)	153	21	0.368
Transportation and storage ISIC 49-53	−0.003 (0.002)	191	20	0.329
Accommodation and food service activities: ISIC 55-56	0.015** (0.005)	123	16	0.370
Real estate activities ISIC 68	−0.005 (0.003)	109	17	0.199
Dependent variable: Full time equivalent employment				
Financial and insurance activities ISIC 64-66	−0.005 (0.004)	214	20	0.203
Audiovisual and broadcasting activities: ISIC 59-60	−0.008 (0.010)	72	13	0.340
Wholesale and retail trade, repair of motor vehicles and motorcycles: ISIC 45-47	−0.009 (0.005)	251	21	0.220
Administrative and support service activities: ISIC 77-82	0.001 (0.003)	153	21	0.380
Transportation and storage ISIC 49-53	0.003 (0.002)	191	20	0.118
Accommodation and food service activities: ISIC 55-56	0.010 (0.005)	123	16	0.344
Real estate activities ISIC 68	−0.006 (0.004)	109	17	0.147

[a] First Lag
[b] Number of observations
[c] Within R^2
Note: Dependent variables are in natural log. Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. The full regressions are displayed in tables 22 in Appendix D. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

intensity. Galindo-Rueda and Verger (2016) point out that most service sectors exhibit low R&D intensity. However, "Scientific research and development" and "IT and other information services" are exceptions. What we call "high-tech service sectors" then corresponds to the high and medium-high R&D intensity non-manufacturing industries in their taxonomy. Our "medium-tech service sectors" correspond to the medium-low tier in their clustering, and the "low-tech service sectors" follows the low R&D intensity industries in their classification. Also, we include only the business service sectors[10]. While data on R&D expenditure is more scarce for the service sectors, it is important to understand the link between innovation and employment in them especially given that we observe substantial cross-sectoral shifts of labour towards the services.

Tables 19 and 20 in Appendix D present the results with respect to "Scientific research and development" and "Telecommunications" as examples of high and medium-tech service industries, respectively. As expected, the correlation between R&D expenditures and employment is positive

[10]Code: ISIC D45-82.

and highly significant across all specifications. On the other hand, hourly wage growth and GDP per capita are negatively associated with employment in this sector when considering all countries in the sample. However, looking at the two groups of countries separately reveals conflicting results, such that the coefficient of wage growth is negative and significant at the 0.1% level for the sub-group of newer EU member countries, while it is positive and significant at the 1% level for EU15 countries.

For employment in "Telecommunications" we find a negative, significant correlation between R&D and full time employment but the significance disappears when considering the sub-sample of newer EU member countries. Hourly wage growth is negatively correlated with employment while higher GDP per capital is associated with higher employment in "Telecommunications". The results for high- and medium-tech service sectors are displayed in table 21 in Appendix D and a summary of the relationship between R&D expenditure and employment is shown in table 8. Overall, high tech service sectors employed on average 2.19% of workers across the countries in the panel. This average is slightly higher for EU15 countries (excluding Luxembourg): 2.26% vs. 2.07% for the newer EU member countries. Similarly to "Scientific research and development", also for the other high-tech service sector: "IT and other information services" we observe a highly significant, positive correlation between R&D and employment. Unlike "Scientific research and development", higher GDP per capita is associated with higher employment in "IT and other information services". For the medium-tech service industries the results are mixed. While full-time equivalent employment in "Telecommunications" is negatively correlated with R&D expenditure in that sector, we observe a significant, positive correlation between R&D and employment in "Professional, scientific and technical activities except scientific R&D" for both the total and full time equivalent employment specifications. "Professional, scientific and technical activities except scientific R&D" is quite a broad category which includes legal and accounting activities, architectural and engineering activities, advertising and market research. However, the R&D data is scarce at a more detailed level. Further, hourly wage growth exhibits a significant negative correlation with employment in high- and medium-tech service sectors for both total and full time employment, although as discussed above there are some differences between the two groups for "Scientific research and development". On average medium-tech services accounted for approximately 6% of total employment in 2015 across the considered EU countries (excluding Luxembourg) which breaks down into 6.44% for EU15 and 5.21% for the rest of the countries in the panel.

Finally, the majority of service sectors fall into the low-tech category. Also, these sectors account for a large share of total employment where in 2015 on average across the countries in the panel, 34.8% of workers were employed in one of those sectors. For the group of EU15 countries employment in the low-tech service sectors was on average 36.2% compared to 32.2% for the newer EU member countries. The regression results are displayed in table 22 in Appendix D and table 9 shows a summary. With respect to the correlation between R&D expenditure and sectoral employment we find predominantly that the coefficient of R&D is not significant. The only exception is "Accommodation and food service activities", but the significance of the result drops in the specification with full-time equivalent employment.

Overall, we find that for the majority of business service sectors, for which we establish significant correlation between R&D and employment, the corresponding coefficient is positive. However, for most of the business service sectors, the correlation is not statistically significant. In terms

of differences between the two country groups in our panel, we find that for the high-tech service sectors there are no qualitative differences of the direction of the relationship between R&D expenditure and employment. Considering the medium-tech services, we find a negative but insignificant association between R&D expenditure and employment in Professional, scientific and technical activities, except scientific research and development for the newer EU member countries (result not shown here but available upon request). This implies that the overall result displayed in table 21 is driven by the EU15 countries. As for the low-tech service sectors, in five out of the seven, the sign and significance of the coefficient of R&D coincides between the two groups. Exception is "Financial and insurance activities", but the result is not significant in all cases. Also, for "Accommodation and food service activities" the significance of the result with respect to total employment is due to the EU15 countries where for the rest of the countries in the panel the R&D coefficient is negative and insignificant.

5 Conclusion

The purpose of this study is to provide some empirical diagnostics of the relationship between R&D, productivity growth and employment on a sectoral level and to explore in how far these relationships differ qualitatively between manufacturing and service sectors or between EU15 countries and countries that have joined the EU during or after the 2004 enlargement. As a first step, consistent with the literature, we have documented a clear and persistent movement of employment from manufacturing to service sectors in all EU countries. Second, we have shown that this shift of employment corresponds to a movement from sectors with higher and faster growing productivity to such with smaller and slower growing productivity. This holds particularly true for old EU member countries, whereas for new member countries some movement towards more productive sectors could be observed. Finally, we have shown that there is a negative correlation between the manufacturing share in employment and the gross domestic expenditure on R&D. The result is robust if R&D expenditure is instead measure by business R&D expenditure or by business R&D expenditure in manufacturing. It is also robust with respect to using a different lag structure. Higher GDP per capita is also associated with lower share of employment in the manufacturing sectors while higher GDP growth is related to higher manufacturing share of employment. On the other hand, our estimations suggest no significant effects of growth in unit labour cost or strictness of employment protection on the manufacturing employment share. Trade openness is also negatively correlated with the manufacturing employment share, although its coefficients is not always statistically significant.

In terms of absolute employment (rather than employment share) we find that for most high-tech manufacturing and service sectors an increase in R&D is associated with higher employment. The relationship is, however, reversed for most middle to low-tech manufacturing sectors. Moreover, splitting the sample into two groups—EU15 and EU15+ countries—reveals that for some sectors there are qualitative differences with respect to the relation of R&D and sectoral employment in the two groups. On the other hand, we find no significant relationship between employment in low-tech business service sectors and R&D expenditure in those sectors while the results with respect to the medium-tech service sectors are mixed. A significant determinant of sectoral employment, across most specifications is GDP per capita, while GDP growth is significantly related with em-

ployment mostly for manufacturing industries. Further, growth in hourly wages is significantly, negative correlated with employment in all high- and medium-tech business service sectors. For the low-tech business services the coefficient of wage growth is significant in two out of the seven considered sectors. For majority of manufacturing industries, however, changes in labour cost are not significantly correlated with employment. Whenever, the coefficient of trade openness is significant in low- and medium-tech manufacturing sectors, it is negative. However, there are qualitative difference between the two country groups in the panel for some manufacturing sector with respect to this variable. On the other hand, in high-tech manufacturing the results for trade openness and its correlation with employment are mixed.

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6 Appendix A: Additional figures

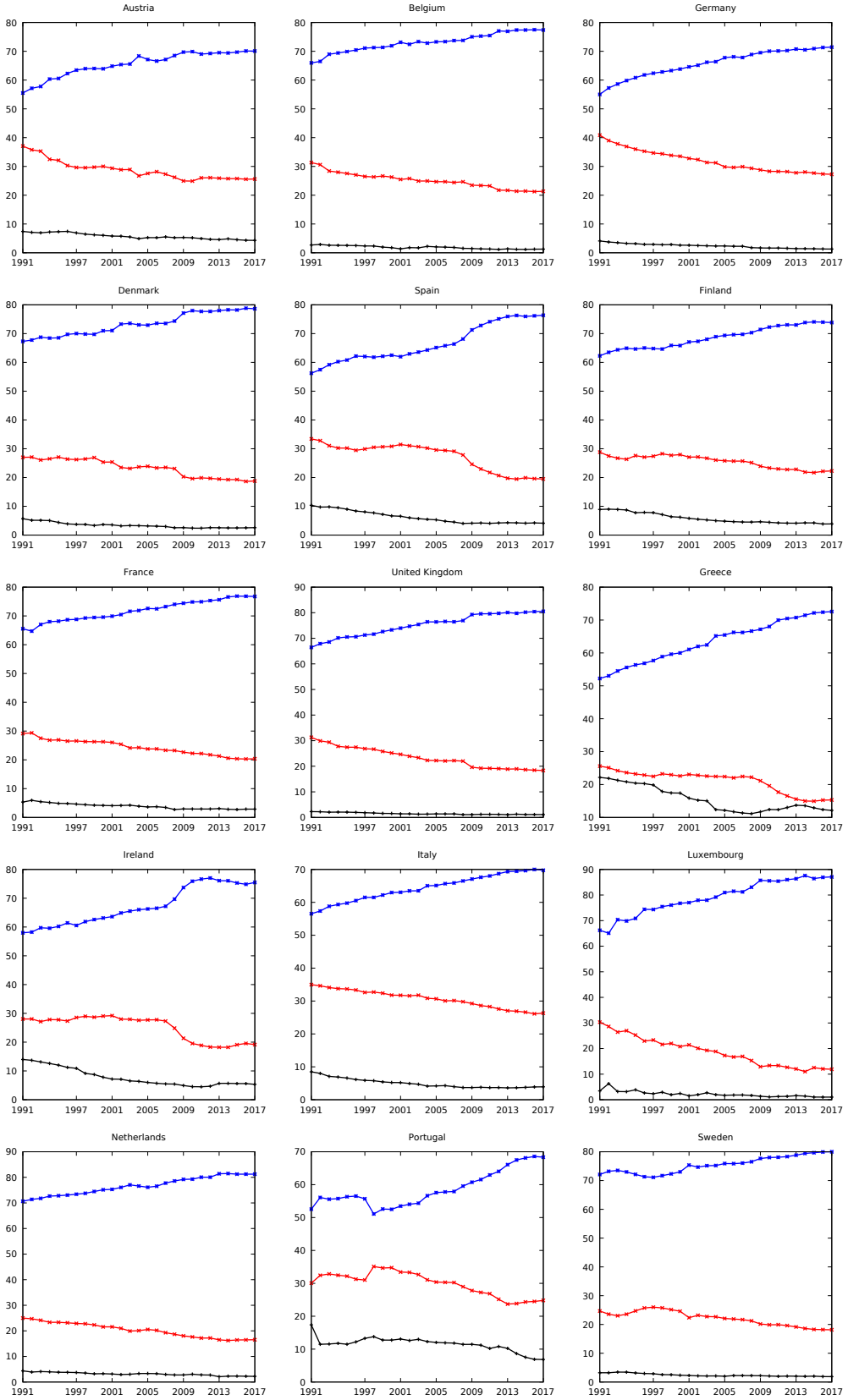

Figure 4: Employment in agriculture (black), services (blue) and industry (red) as percentage of total employment. Data source: ILOSTAT database.

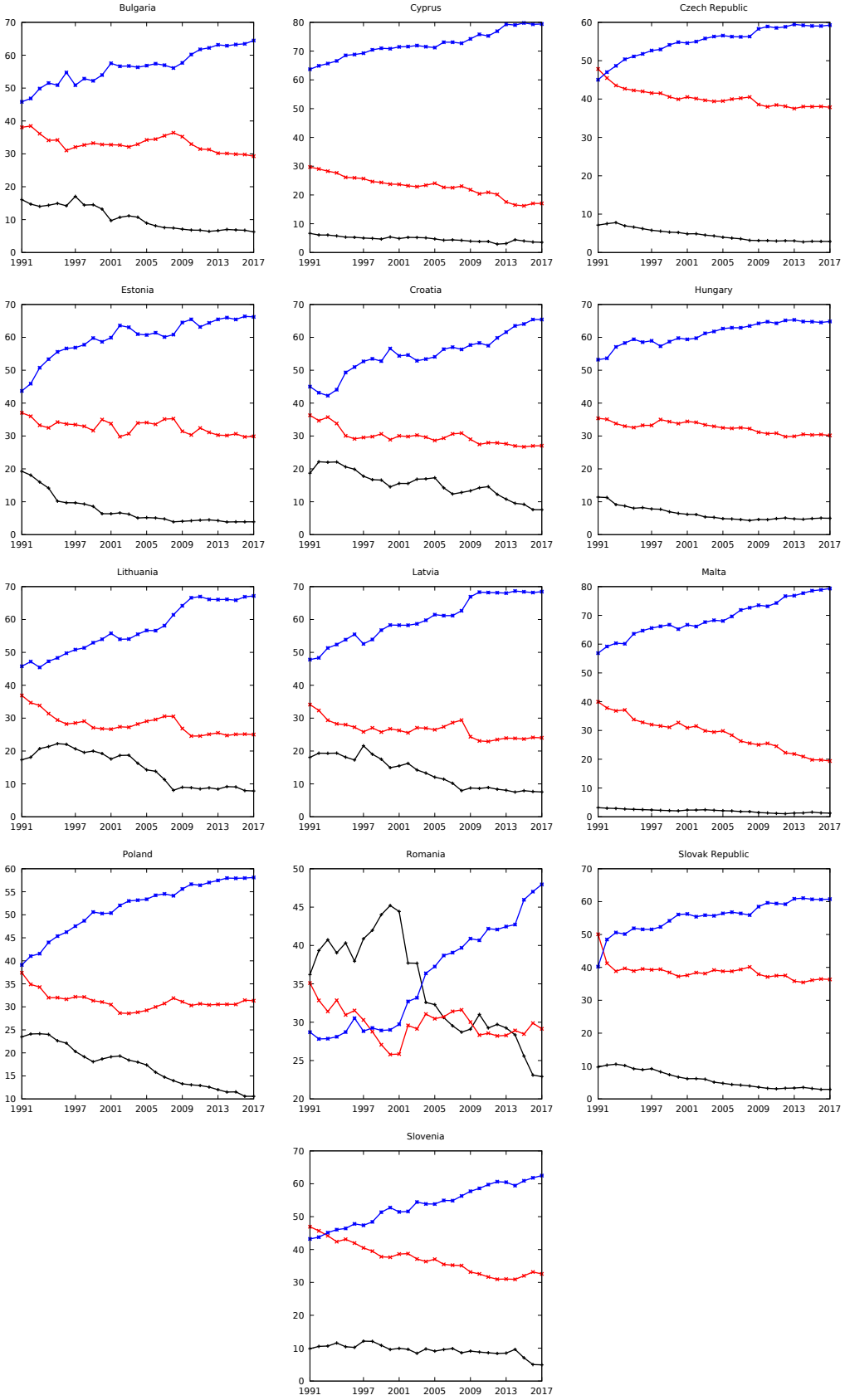

Figure 5: Employment in agriculture (black), services (blue) and industry (red) as percentage of total employment. Data source: ILOSTAT database.

7 Appendix B: Data description

- Share of manufacturing employment regressions
  - *GERDL1*: gross domestic expenditure on R&D, as a percentage of GDP, first lag, source: OECD Main Science and Technology Indicators (MSTI) dataset
  - *lntotalempl*: total employment (measured in number of workers, natural logarithm), source: OECD STAN dataset (ISIC Rev. 4)
  - *gdpgrowth_l1*: first lag of GDPgrowth rate, source: OECD annual national accounts statistics
  - *gdp/cap*: GDP per head, constant prices, constant PPPs, unit is thousands, 2010 base year. Source: OECD annual national accounts statistics
  - *labcostgrowth*: change in unit labour cost in manufacturing, percentage. Source: OECD annual national accounts statistics
  - *trade*: indicator for trade openness: nominal imports plus exports (unit: US dollars, thousands) divided by GDP (unit: national currency, current prices, millions). Source of imports, exports data: Bilateral Trade in Goods by Industry and End-use (BTDIxE), ISIC Rev. 4. Source of GDP data: OECD annual national accounts statistics
  - *EPL*: index of strictness of employment protection: individual and collective dismissals, Version 1
  - *businessRD_L2*: business investment in R&D, total economy, classification criteria: main activity, second lag in national currency, 2010 prices divided by GDP in national currency, 2010 prices. Unit: thousands. Source: OECD ANBERD dataset
  - *busiRD_manu_L2*: business investment in R&D in manufacturing, classification criteria: main activity, second lag in national currency, 2010 prices divided by GDP in national currency, 2010 prices. Unit: thousands. Source: OECD ANBERD dataset
- Sector specific regressions, additional variables
  - *RD_L1*: natural log of business R&D expenditure by industry, classification criteria: main activity, measured in national currency, 2010 prices, source: OECD Analytical Business Enterprise R&D (ANBERD) database
  - *wage_growth*: growth in hourly wages. Hourly wages are constructed by dividing the total wage bill in an industry by total hours worked in that industry. Source: OECD Database for Structural Analysis (STAN), ISIC Rev.4

8 Appendix C: Additional results and robustness checks

Table 10: Manufacturing share of employment by country and year

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
businessRD_l1	-0.004***	-0.003***	-0.003***	-0.002***	-0.002***	-0.002***	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnempl		-0.091***	-0.119***	-0.059**	-0.050**	-0.056**	-0.083*
		(0.023)	(0.024)	(0.020)	(0.017)	(0.017)	(0.039)
gdpgrowth_l1			0.001***	0.002***	0.002***	0.001***	0.002***
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
gdp/cap				-0.001***	-0.002***	-0.001**	-0.000
				(0.000)	(0.000)	(0.000)	(0.001)
labcostgrowth					-0.014	-0.013	-0.031*
					(0.009)	(0.012)	(0.014)
trade						-0.014*	-0.017**
						(0.005)	(0.005)
EPL							0.010
							(0.008)
Constant	0.214***	0.995***	1.222***	0.751***	0.676***	0.724***	0.909**
	(0.006)	(0.202)	(0.203)	(0.171)	(0.151)	(0.141)	(0.301)
Observations	286	286	286	286	285	261	197
Within R^2	0.341	0.401	0.484	0.518	0.517	0.560	0.614
Num. of countries	21	21	21	21	21	19	19
Country FE	yes	yes	yes	yes	yes	yes	yes

Dependent variable: share of employment in manufacturing based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4), Manufacturing [C]: D10T33. Luxembourg and Latvia are excluded due to lack of data on business R&D expenditures. In specification (6) and (7) Lithuania and Spain are dropped.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 11: Robustness checks

	(1)	(2)	(3)	(4)	(5)
GERD_perc_L2	-0.0129**				
	(0.0039)				
lnempl	-0.0994***	-0.0563**	-0.0591**	-0.0621**	-0.0576**
	(0.0098)	(0.0166)	(0.0169)	(0.0182)	(0.0181)
gdpgrowth_l1	0.0021***	0.0015***	0.0015***	0.0019***	0.0019***
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
gdp/cap	-0.0015**	-0.0010**	-0.0008**	-0.0016***	-0.0015***
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
labcostgrowth	-0.0055	-0.0130	-0.0167	-0.0221	-0.0258
	(0.0113)	(0.0125)	(0.0167)	(0.0125)	(0.0148)
trade	-0.0080	-0.0137*	-0.0168**	-0.0111	-0.0127*
	(0.0043)	(0.0054)	(0.0054)	(0.0060)	(0.0057)
businessRD_l1		-0.0022***			
		(0.0003)			
businessRD_l2			-0.0023***		
			(0.0003)		
businessRD_manu_l1				-0.0017*	
				(0.0006)	
businessRD_manu_l2					-0.0024***
					(0.0005)
Constant	1.0872***	0.7244***	0.7461***	0.7774***	0.7433***
	(0.0794)	(0.1414)	(0.1433)	(0.1558)	(0.1537)
Observations	371	261	244	262	246
Within R^2	0.623	0.560	0.573	0.504	0.525
Num. of countries	20	19	19	19	19
Country FE	yes	yes	yes	yes	yes

Dependent variable: share of employment in manufacturing based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4), Manufacturing [C]: ICIS 10-33. (1) excludes Spain, Lithuania and Latvia. (2), (3), (4) and (5) additionally exclude Luxembourg.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors.
** p < 0.05, ** p < 0.01, *** p < 0.001*

9 Appendix D: Sector specific regression results

Table 12: Employment in Food products, beverages and tobacco

	Total employment				Full time equivalent			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD_Food_bev_tobac_L1	0.053**	0.054***	-0.004	0.069***	0.061***	0.063***	-0.002	0.075***
	(0.014)	(0.013)	(0.005)	(0.017)	(0.013)	(0.013)	(0.010)	(0.016)
lnempl	1.227***	1.078***	0.399***	2.313***	1.000***	0.962***	0.084	2.571***
	(0.097)	(0.105)	(0.091)	(0.312)	(0.183)	(0.176)	(0.124)	(0.298)
gdpgrowth_l1	0.010***	0.009***	0.008***	0.005***	0.010***	0.009***	0.008***	0.005***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
ln_gdp/cap	-0.830***	-0.667***	-0.345**	-0.941***	-0.734***	-0.695***	-0.261	-1.064***
	(0.099)	(0.126)	(0.112)	(0.156)	(0.141)	(0.143)	(0.133)	(0.134)
ln_trade	-0.057	-0.090**	-0.027	-0.106*	-0.115***	-0.130***	-0.061**	-0.137**
	(0.030)	(0.029)	(0.021)	(0.045)	(0.024)	(0.028)	(0.020)	(0.038)
labcostgrowth	-0.124				-0.162			
	(0.069)				(0.090)			
wage_growth		-0.032	-0.096	-0.106		-0.065	-0.171	-0.145
		(0.110)	(0.128)	(0.123)		(0.116)	(0.115)	(0.122)
Constant	2.792**	3.391***	9.580***	-5.751*	-9.923***	-9.797***	-2.090*	-21.570***
	(0.958)	(0.841)	(0.499)	(2.198)	(1.416)	(1.384)	(0.827)	(2.091)
Observations	262	246	166	80	248	246	166	80
Within R^2	0.590	0.538	0.382	0.701	0.591	0.589	0.475	0.775
Num. of countries	19	19	13	6	19	19	13	6
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	EU15	EU15+	all	all	EU15	EU15+

Dependent variable: natural log of employment in manufacturing of food products, beverages and tobacco based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4): ISIC 10-12. Specifications (1) - (4) consider total employment while specifications (5) - (8) display results with respect to full time equivalent employment. EU includes all EU15 countries except Luxembourg and Spain, EU15+ includes Czech Republic, Estonia, Hungary, Poland, Slovak Republic, Slovenia. Employment in this sector was on average 2.15% of of total employment in 2015. This breaks down into 1.9% for EU15 countries and 2.6% for EU15+ member countries.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 13: Employment in textiles, wearing apparel, leather and related products

	Total employment				Full time equivalent			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD_Textiles_l1	-0.048*	-0.048*	-0.072***	0.063	-0.055*	-0.055*	-0.077***	0.057
	(0.023)	(0.022)	(0.017)	(0.086)	(0.023)	(0.022)	(0.018)	(0.088)
lnempl	0.168	-0.090	-1.107	2.986*	0.035	-0.275	-1.437*	3.279*
	(0.422)	(0.385)	(0.643)	(1.189)	(0.458)	(0.403)	(0.613)	(1.204)
gdpgrowth_l1	0.035***	0.032***	0.024**	0.027*	0.038***	0.035***	0.026**	0.029*
	(0.008)	(0.008)	(0.008)	(0.010)	(0.008)	(0.009)	(0.008)	(0.011)
ln_gdp/cap	-2.366***	-2.259***	-1.728***	-3.127***	-2.397***	-2.272***	-1.670**	-3.241***
	(0.167)	(0.178)	(0.427)	(0.443)	(0.163)	(0.178)	(0.465)	(0.441)
ln_trade	0.018	0.007	-0.275	0.358*	-0.003	-0.014	-0.302	0.361*
	(0.152)	(0.143)	(0.202)	(0.141)	(0.170)	(0.159)	(0.227)	(0.149)
labcostgrowth	-0.572***				-0.729***			
	(0.146)				(0.147)			
wage_growth		-0.037	-0.190	0.014		-0.142	-0.292*	-0.179
		(0.191)	(0.108)	(0.464)		(0.196)	(0.133)	(0.516)
Constant	18.579***	20.396***	27.407***	-2.343	19.656***	21.859***	29.901***	-4.335
	(3.988)	(3.671)	(5.269)	(7.576)	(4.339)	(3.897)	(5.077)	(7.630)
Observations	233	232	165	67	233	232	165	67
Within R^2	0.663	0.652	0.584	0.817	0.661	0.646	0.584	0.821
Num. of countries	18	18	13	5	18	18	13	5
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	EU15	EU15+	all	all	EU15	EU15+

Dependent variable: employment in textiles, wearing apparel, leather and related products based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4): ISIC 13-15. Specifications (1) - (4) consider total employment while specifications (5) - (8) display results with respect to full time equivalent employment. EU includes all EU15 countries except Luxembourg and Spain, EU15+ includes Czech Republic, Estonia, Poland, Slovak Republic and Slovenia. Employment in this sector was on average 1.04% of of total employment in 2015. This breaks down into 0.79% for EU15 countries and 1.53% for EU15+ member countries.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 14: Employment in computer, electronic and optical products

	Total employment				Full time equivalent			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD_Comp_electronics_L1	0.214**	0.184*	0.287**	0.111*	0.198**	0.189**	0.301**	0.108*
	(0.073)	(0.065)	(0.091)	(0.049)	(0.069)	(0.065)	(0.090)	(0.046)
lnempl	-0.099	0.168	-0.301	1.392	-0.032	-0.087	-0.803*	1.466
	(0.228)	(0.206)	(0.359)	(0.877)	(0.211)	(0.225)	(0.381)	(0.878)
gdpgrowth_l1	0.016**	0.013*	0.014	0.010*	0.016**	0.015*	0.016*	0.012*
	(0.004)	(0.005)	(0.007)	(0.004)	(0.004)	(0.006)	(0.007)	(0.004)
ln_gdp/cap	-1.040**	-1.311***	-1.067*	-1.563***	-1.246***	-1.279***	-0.834*	-1.636***
	(0.277)	(0.258)	(0.383)	(0.399)	(0.223)	(0.243)	(0.382)	(0.405)
ln_trade	0.297***	0.317***	0.318***	0.353***	0.287***	0.307***	0.323***	0.351***
	(0.039)	(0.039)	(0.054)	(0.032)	(0.043)	(0.047)	(0.062)	(0.039)
labcostgrowth	-0.375*				-0.344*			
	(0.140)				(0.139)			
wage_growth		-0.108	0.201	-0.273*		-0.159	0.148	-0.315**
		(0.080)	(0.138)	(0.096)		(0.098)	(0.139)	(0.110)
Constant	11.614***	10.854***	12.154**	3.226	11.779***	12.597***	15.295**	2.758
	(2.626)	(2.457)	(3.805)	(6.377)	(2.562)	(2.692)	(4.021)	(6.298)
Observations	259	241	163	78	245	241	163	78
Within R^2	0.509	0.530	0.590	0.560	0.520	0.524	0.594	0.574
Num. of countries	19	19	13	6	19	19	13	6
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	EU15	EU15+	all	all	EU15	EU15+

Dependent variable: employment in Computer, electronic and optical products based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4), ISIC 26. Specifications (1) - (4) consider total employment while specifications (5) - (8) display results with respect to full time equivalent employment. EU includes all EU15 countries except Luxembourg and Spain, EU15+ includes Czech Republic, Estonia, Poland, Hungary, Slovak Republic, Slovenia. Employment in this sector was on average 0.56% of total employment in 2015. This breaks down into 0.46% for EU15 countries (excluding Luxembourg) and 0.73% for EU15+ countries.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 15: Employment in Motor vehicles, trailers and semi-trailers

	Total employment				Full time equivalent			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD_Motor_vehicles_L1	0.036*	0.056**	0.009	0.048***	0.073**	0.084**	0.159*	0.047**
	(0.015)	(0.015)	(0.026)	(0.012)	(0.021)	(0.023)	(0.066)	(0.012)
lnempl	-1.791***	-1.527***	-0.171	-1.931**	-2.227***	-2.189***	-2.046**	-1.231*
	(0.234)	(0.247)	(0.331)	(0.520)	(0.396)	(0.353)	(0.690)	(0.448)
gdpgrowth_l1	0.012***	0.012***	0.019***	0.010**	0.017***	0.020***	0.024**	0.008*
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	(0.007)	(0.004)
ln_gdp/cap	0.746***	0.592***	-0.423	0.852***	0.804***	0.694**	0.599	0.563***
	(0.184)	(0.129)	(0.382)	(0.116)	(0.168)	(0.193)	(0.316)	(0.122)
ln_trade	0.197**	0.191***	0.070	0.234***	0.176***	0.180**	0.040	0.262***
	(0.058)	(0.038)	(0.078)	(0.041)	(0.045)	(0.054)	(0.071)	(0.035)
labcostgrowth	-0.014		-0.181	-0.119	-0.129		-0.204	-0.024
	(0.099)		(0.112)	(0.220)	(0.173)		(0.196)	(0.263)
wage_growth		-0.346**				-0.483**		
		(0.097)				(0.139)		
Constant	23.508***	20.535***	13.818***	23.437***	25.019***	24.902***	22.355***	18.456***
	(1.603)	(1.832)	(2.425)	(3.827)	(2.771)	(2.399)	(4.058)	(3.283)
Observations	258	180	164	94	182	180	102	80
Within R^2	0.449	0.604	0.198	0.820	0.453	0.543	0.344	0.750
Num. of countries	19	15	13	6	15	15	9	6
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	EU15	EU15+	all	all	EU15	EU15+

Dependent variable: employment in Motor vehicles, trailers and semi-trailers based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4), ISIC 29. Specifications (1) - (4) consider total employment while specifications (5) - (8) display results with respect to full time equivalent employment. EU in specification (3) includes all EU15 countries except Luxembourg and Spain. EU15+ includes Czech Republic, Estonia, Poland, Hungary, Slovak Republic, Slovenia. EU in specification (7) excludes additionally Belgium, Germany, France, UK. Employment in this sector was on average 0.97% of total employment in 2015. This breaks down into 0.62% for EU15 countries (excluding Luxembourg) and 1.58% for EU15+ member countries.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 16: Low-tech manufacturing sectors

	(1) Food_bev_tobac	(2) Textiles	(3) Wood_paper	(4) Coke_refined_petr	(5) Metal
RD_L1	0.053**	-0.048*	-0.034*	0.035	-0.034***
	(0.014)	(0.023)	(0.012)	(0.026)	(0.007)
lnempl	1.227***	0.168	-0.000	0.738	0.365*
	(0.097)	(0.422)	(0.315)	(0.824)	(0.172)
gdpgrowth_l1	0.010***	0.035***	0.015**	0.008	0.001
	(0.001)	(0.008)	(0.005)	(0.005)	(0.002)
ln_gdp/cap	-0.830***	-2.366***	-0.545***	-1.405**	0.400***
	(0.099)	(0.167)	(0.122)	(0.458)	(0.083)
ln_trade	-0.057	0.018	0.095	-0.076	-0.018
	(0.030)	(0.152)	(0.111)	(0.054)	(0.039)
labcostgrowth	-0.124	-0.572***	-0.197	-0.230	0.132
	(0.069)	(0.146)	(0.139)	(0.196)	(0.082)
Constant	2.792**	18.579***	14.248***	5.966	7.560***
	(0.958)	(3.988)	(2.517)	(7.228)	(1.488)
Observations	262	233	249	157	255
Within R^2	0.590	0.663	0.326	0.330	0.352
Num. of countries	19	18	18	14	19
Country FE	yes	yes	yes	yes	yes
EU accession	all	all	all	all	all
Full time empl.					
RD_L1	0.061***	-0.055*	-0.039*	0.028	-0.028**
	(0.013)	(0.023)	(0.014)	(0.026)	(0.007)
lnempl	1.000***	0.035	-0.130	0.472	0.428*
	(0.183)	(0.458)	(0.333)	(0.891)	(0.199)
gdpgrowth_l1	0.010***	0.038***	0.016**	0.009	0.001
	(0.001)	(0.008)	(0.005)	(0.005)	(0.002)
ln_gdp/cap	-0.734***	-2.397***	-0.670***	-1.381*	0.464***
	(0.141)	(0.163)	(0.130)	(0.499)	(0.084)
ln_trade	-0.115***	-0.003	0.100	-0.096	-0.043
	(0.024)	(0.170)	(0.129)	(0.057)	(0.048)
labcostgrowth	-0.162	-0.729***	-0.189	-0.250	0.068
	(0.090)	(0.147)	(0.148)	(0.211)	(0.099)
Constant	-9.907***	19.647***	15.710***	8.143	6.293***
	(1.414)	(4.338)	(2.599)	(7.791)	(1.497)
Observations	248	233	235	157	179
Within R^2	0.591	0.661	0.335	0.352	0.441
Num. of countries	19	18	18	14	15
Country FE	yes	yes	yes	yes	yes
EU accession	all	all	all	all	all

Employment in (1) Food products, beverages and tobacco, ISIC 10-12, (2) Textiles, wearing apparel, leather and related products, ISIC 13-15, (3) Wood and paper products, and printing, ISIC 16-18, (4) Coke and refined petroleum products, ISIC 19, (5) Fabricated metal products, except machinery and equipment, ISIC 25. (3) excludes Spain, Lithuania, Luxembourg, Latvia and Slovak Republic. (4) excludes Denmark, Spain, Estonia, Hungary, Ireland, Lithuania, Luxembourg, Latvia and Sweden. (5) excludes Spain, Lithuania, Luxembourg and Latvia. The full-time equivalent employment additionally excludes Belgium, Germany, France and UK. *Note:* Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 17: Medium-tech manufacturing sectors

	(1) Rubber_plastic	(2) Mineral	(3) Basic_metals	(4) Other_manu
RD_L1	-0.008	-0.042*	0.036***	-0.017*
	(0.019)	(0.015)	(0.009)	(0.006)
lnempl	-0.900***	0.409	0.632**	0.588*
	(0.213)	(0.293)	(0.216)	(0.224)
gdpgrowth_l1	0.001	0.011**	0.015***	0.005*
	(0.002)	(0.004)	(0.002)	(0.002)
ln_gdp/cap	0.932***	-0.624***	-0.644***	-0.071
	(0.070)	(0.113)	(0.128)	(0.066)
ln_trade	-0.035	-0.014	-0.016	-0.051*
	(0.035)	(0.121)	(0.045)	(0.023)
labcostgrowth	0.172	-0.061	-0.164*	-0.042
	(0.107)	(0.103)	(0.078)	(0.076)
Constant	15.272***	9.880**	6.412*	6.739**
	(1.901)	(2.862)	(2.257)	(2.174)
Observations	229	237	246	245
Within R^2	0.471	0.343	0.319	0.150
Num. of countries	19	19	18	19
Country FE	yes	yes	yes	yes
EU accession	all	all	all	all
Full time empl.				
RD_L1	-0.026	-0.077***	0.030	-0.033**
	(0.031)	(0.015)	(0.028)	(0.009)
lnempl	-1.254**	0.688	0.486	0.509*
	(0.382)	(0.484)	(0.448)	(0.199)
gdpgrowth_l1	0.002	0.013**	0.014***	0.006*
	(0.002)	(0.004)	(0.002)	(0.002)
ln_gdp/cap	1.086***	-0.673***	-0.642***	-0.119
	(0.088)	(0.119)	(0.129)	(0.131)
ln_trade	-0.002	0.042	-0.015	-0.065*
	(0.032)	(0.145)	(0.042)	(0.030)
labcostgrowth	0.070	-0.135	-0.280	-0.101
	(0.132)	(0.133)	(0.147)	(0.093)
Constant	17.362***	8.306	7.484*	7.655**
	(2.916)	(4.004)	(3.415)	(2.021)
Observations	163	171	170	231
Within R^2	0.453	0.334	0.306	0.175
Num. of countries	15	15	14	19
Country FE	yes	yes	yes	yes
EU accession	all	all	all	all

Employment in (1) Rubber and plastic products, ISIC 22, (2) Other non-metallic mineral products, ISIC 23, (3) Basic metals, ISIC 24, (4) Furniture; other manufacturing; repair and installation of machinery and equipment, ISIC 31-33. (1) and (2) excludes Spain, Lithuania, Luxembourg and Latvia. The full-time equivalent employment additionally excludes Belgium, Germany, France and UK. (3) excludes Spain, Estonia, Lithuania, Luxembourg and Latvia. The full-time equivalent employment additionally excludes Belgium, Germany, France and UK. (4) excludes Spain, Lithuania, Luxembourg and Latvia. *Note:* Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. *$* p < 0.05$, $** p < 0.01$, $*** p < 0.001$*

Table 18: High-tech manufacturing sectors

	(1) Chemicals	(2) Pharma	(3) Comp	(4) El_equip	(5) Machinery	(6) Vehicles	(7) Transp
RD_L1	0.090**	0.163**	0.214**	0.036	0.024	0.036*	-0.053*
	(0.026)	(0.044)	(0.073)	(0.024)	(0.021)	(0.015)	(0.025)
lnempl	0.511*	1.312***	-0.099	0.574*	0.750**	-1.791***	0.880
	(0.238)	(0.139)	(0.228)	(0.257)	(0.198)	(0.234)	(0.428)
gdpgrowth_l1	0.009***	-0.002	0.016**	0.010*	0.004*	0.012***	0.004
	(0.001)	(0.004)	(0.004)	(0.004)	(0.001)	(0.003)	(0.008)
ln_gdp/cap	-0.586***	0.028	-1.040**	-0.107	-0.221**	0.746***	-0.750***
	(0.131)	(0.316)	(0.277)	(0.094)	(0.072)	(0.184)	(0.169)
ln_trade	-0.106**	-0.087**	0.297***	0.014	0.064	0.197**	0.043
	(0.034)	(0.026)	(0.039)	(0.067)	(0.041)	(0.058)	(0.046)
labcostgrowth	-0.042	0.283	-0.375*	0.060	0.014	-0.014	-0.095
	(0.088)	(0.164)	(0.140)	(0.114)	(0.072)	(0.099)	(0.219)
Constant	5.917**	-5.375**	11.614***	5.423*	5.198**	23.508***	5.634
	(2.048)	(1.534)	(2.626)	(2.564)	(1.497)	(1.603)	(3.192)
Observations	211	216	259	259	259	258	243
Within R^2	0.490	0.245	0.509	0.147	0.160	0.449	0.145
Num. of countries	16	18	19	19	19	19	19
Country FE	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	all	all	all	all	all
Full time empl.							
RD_L1	0.076*	0.093**	0.198**	0.015	-0.007	0.073**	-0.114**
	(0.033)	(0.031)	(0.069)	(0.024)	(0.021)	(0.021)	(0.039)
lnempl	0.223	-0.088	-0.032	0.139	0.552**	-2.227***	0.335
	(0.230)	(0.211)	(0.211)	(0.271)	(0.177)	(0.396)	(0.509)
gdpgrowth_l1	0.008***	-0.007	0.016**	0.011*	0.005**	0.017***	-0.006
	(0.002)	(0.004)	(0.004)	(0.004)	(0.002)	(0.004)	(0.008)
ln_gdp/cap	-0.419**	0.859***	-1.246***	0.015	-0.048	0.804***	-0.482*
	(0.141)	(0.201)	(0.223)	(0.120)	(0.073)	(0.168)	(0.203)
ln_trade	-0.151***	-0.065*	0.287***	-0.005	0.040	0.176***	0.052
	(0.038)	(0.024)	(0.043)	(0.070)	(0.053)	(0.045)	(0.080)
labcostgrowth	-0.171	0.319*	-0.344*	0.013	-0.095	-0.129	0.136
	(0.126)	(0.141)	(0.139)	(0.137)	(0.048)	(0.173)	(0.202)
Constant	7.878***	5.349*	11.779***	8.852**	6.628***	25.019***	10.183*
	(1.957)	(2.301)	(2.562)	(2.496)	(1.374)	(2.771)	(3.886)
Observations	197	199	245	245	245	182	173
Within R^2	0.417	0.462	0.520	0.102	0.127	0.453	0.170
Num. of countries	16	18	19	19	19	15	15
Country FE	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	all	all	all	all	all

Employment in (1) Chemicals and chemical products, ISIC 20, (2) Basic pharmaceutical products and pharmaceutical preparations, ISIC 21, (3) Computer, electronic and optical products, ISIC 26, (4) Electrical equipment, ISIC 27, (5) Machinery and equipment n.e.c., ISIC 28, (6) Motor vehicles, trailers and semi-trailers, ISIC 28, (7) Other transport equipment, ISIC 30. (4) and (5) excludes Spain, Lithuania, Luxembourg and Latvia. (2) additionally excludes Estonia and (1) additionally excludes Denmark and Sweden. (7) excludes Spain, Lithuania, Luxembourg and Latvia. he full-time equivalent employment additionally excludes Belgium, Germany, France and UK. *Note:* Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 19: Employment in Scientific research and development

	Total employment				Full time equivalent			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD_Scientific_research_L1	0.194***	0.195***	0.204***	0.199***	0.207***	0.205***	0.180***	0.212***
	(0.028)	(0.027)	(0.029)	(0.029)	(0.023)	(0.023)	(0.025)	(0.027)
lnempl	2.600***	2.484***	2.431***	2.967***	2.366***	2.281***	1.891***	2.919***
	(0.305)	(0.314)	(0.516)	(0.583)	(0.271)	(0.277)	(0.454)	(0.510)
gdpgrowth_l1	-0.005	-0.006	-0.003	-0.011*	-0.006	-0.006*	-0.006	-0.012**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)
ln_gdp/cap	-0.713***	-0.662***	-0.673*	-0.771***	-0.734***	-0.710***	-0.260	-0.905***
	(0.056)	(0.055)	(0.257)	(0.121)	(0.060)	(0.059)	(0.209)	(0.110)
labcostgrowth	-0.360**				-0.326*			
	(0.125)				(0.142)			
wage_growth		-0.206***	-0.187**	-0.346***		-0.328***	-0.140*	-0.504***
		(0.051)	(0.065)	(0.080)		(0.048)	(0.067)	(0.069)
Constant	-13.853***	-13.025***	-13.318**	-15.307**	-12.208***	-11.508***	-9.663*	-14.917***
	(2.647)	(2.739)	(4.159)	(4.051)	(2.288)	(2.331)	(3.661)	(3.507)
Observations	283	276	182	94	279	276	182	94
Within R^2	0.540	0.542	0.580	0.543	0.552	0.575	0.618	0.612
Num. of countries	21	21	14	7	21	21	14	7
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	EU15	EU15+	all	all	EU15	EU15+

Dependent variable: employment in Scientific research and development based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4), ISIC 72. Specifications (1) - (4) consider total employment while specifications (5) - (8) display results with respect to full time equivalent employment. EU includes all EU15 countries except Luxembourg. EU15+ includes Czech Republic, Estonia, Poland, Hungary, Lithuania, Slovak Republic, Slovenia. On average 0.52% of workers were employed in this sector in EU15 countries (excluding Luxembourg) in 2015, compared to 0.39% for the rest of the countries in the panel.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** p < 0.05, ** p < 0.01, *** p < 0.001*

Table 20: Employment in Telecommunications

	Total employment				Full time equivalent			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD_Telecom_L1	-0.021*	-0.021	-0.039***	-0.003	-0.030**	-0.030**	-0.048***	-0.001
	(0.009)	(0.011)	(0.006)	(0.035)	(0.009)	(0.011)	(0.008)	(0.035)
lnempl	-1.582***	-1.530***	-1.184**	-1.684	-1.806***	-1.748***	-1.617**	-0.370
	(0.172)	(0.234)	(0.404)	(1.755)	(0.221)	(0.279)	(0.426)	(1.785)
gdpgrowth_l1	-0.003	-0.001	-0.003	0.004	-0.003	-0.000	-0.004	0.005
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.005)
ln_gdp/cap	0.665***	0.471**	-0.011	0.845	0.784***	0.576**	0.331	0.374
	(0.164)	(0.144)	(0.283)	(0.437)	(0.102)	(0.160)	(0.300)	(0.444)
labcostgrowth	0.016				0.002			
	(0.308)				(0.282)			
wage_growth		-0.418**	-0.346**	-0.429*		-0.453**	-0.374**	-0.534*
		(0.124)	(0.097)	(0.153)		(0.153)	(0.124)	(0.170)
Constant	22.192***	22.395***	22.143***	18.940	23.726***	23.926***	24.828***	10.484
	(1.530)	(1.951)	(2.838)	(12.564)	(1.964)	(2.280)	(3.018)	(12.753)
Observations	172	171	135	36	172	171	135	36
Within R^2	0.191	0.316	0.396	0.362	0.224	0.347	0.446	0.352
Num. of countries	19	19	13	6	19	19	13	6
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	EU15	EU15+	all	all	EU15	EU15+

Dependent variable: employment in Telecommunications based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4), ISIC 61. In specifications (1)-(4) the dependent variable is natural logarithm of total employment while in specifications (5) - (8) natural log of employment is in full time equivalents. EU includes all EU15 countries except Luxembourg and Sweden. EU15+ includes Czech Republic, Estonia, Poland, Hungary, Lithuania, and Slovenia. On average 0.48% of workers were employed in this sector in EU15 countries in 2015, compared to 0.56% for the rest of the countries in the panel.

Note: Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 21: Employment in high- and medium-tech service sectors

	High-tech services				**Medium-tech services**			
	Total empl.		Full time		Total empl.		Full time	
	Scientific	IT	Scientific	IT	Telecom	Profess	Telecom	Profess
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD_L1	0.195***	0.123***	0.205***	0.120***	-0.021	0.022**	-0.030**	0.016*
	(0.027)	(0.027)	(0.023)	(0.026)	(0.011)	(0.006)	(0.011)	(0.005)
lnempl	2.484***	0.358	2.281***	0.293	-1.530***	0.567	-1.748***	0.554
	(0.314)	(0.707)	(0.277)	(0.658)	(0.234)	(0.369)	(0.279)	(0.297)
gdpgrowth_l1	-0.006	-0.010	-0.006*	-0.008	-0.001	-0.003	-0.000	-0.002
	(0.003)	(0.005)	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.001)
ln_gdp/cap	-0.662***	1.506***	-0.710***	1.400***	0.471**	0.873***	0.576**	0.834***
	(0.055)	(0.211)	(0.059)	(0.215)	(0.144)	(0.167)	(0.160)	(0.163)
wage_growth	-0.206***	-0.381***	-0.328***	-0.393***	-0.418**	-0.278***	-0.453**	-0.336***
	(0.051)	(0.084)	(0.048)	(0.071)	(0.124)	(0.047)	(0.153)	(0.057)
Constant	-13.025***	0.500	-11.508***	1.336	22.395***	4.192	23.926***	4.396
	(2.739)	(5.792)	(2.331)	(5.350)	(1.951)	(2.668)	(2.280)	(2.068)
Observations	276	184	276	184	171	167	171	167
Within R^2	0.542	0.867	0.575	0.861	0.316	0.612	0.347	0.638
Num. of countries	21	20	21	20	19	21	19	21
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	all	all	all	all	all	all

Dependent variable in (1) and (3): employment in Scientific research and development, ISIC 72. Dependent variable in (2) and (4): employment in IT and other information services, ISIC 62-63. Dependent variable in (5) and (7): employment in Telecommunications, ISIC 61. Dependent variable in (6) and (8): employment in Professional, scientific and technical activities, except scientific research and development, ISIC 69-75X, based on the International Standard Industrial Classification of all economic activities, Revision 4 (ISIC Rev. 4). (1) and (3) exclude Luxembourg and Latvia. (2) and (4) exclude Luxembourg, Latvia and Sweden. (5) and (7) exclude Luxembourg, Latvia, Slovak Republic and Sweden. (6) and (8) exclude Luxembourg and Latvia. *Note:* Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Table 22: Employment in low-tech service sectors

	(1) Financial	(2) Audiovis	(3) Retail	(4) Admin	(5) Transport	(6) Accomm	(7) Real_estate
RD_L1	-0.002	-0.008	0.007	0.005	0.003	0.015**	-0.005
	(0.003)	(0.008)	(0.004)	(0.004)	(0.002)	(0.005)	(0.003)
lnempl	0.058	1.521***	0.707***	1.011*	0.390***	1.030*	0.711***
	(0.166)	(0.199)	(0.099)	(0.372)	(0.090)	(0.416)	(0.139)
gdpgrowth_l1	-0.003*	0.001	-0.000	-0.002	0.002*	-0.003	-0.000
	(0.001)	(0.001)	(0.000)	(0.002)	(0.001)	(0.003)	(0.002)
ln_gdp/cap	0.069	-0.419**	-0.012	0.523*	0.034	0.353	0.135
	(0.090)	(0.126)	(0.029)	(0.221)	(0.054)	(0.267)	(0.191)
wage_growth	-0.338***	-0.191	-0.117**	0.013	0.049	0.095	-0.118
	(0.054)	(0.154)	(0.041)	(0.155)	(0.071)	(0.082)	(0.090)
Constant	11.292***	-1.679	7.451***	1.919	9.135***	2.101	4.603*
	(1.229)	(1.433)	(0.815)	(2.640)	(0.786)	(3.240)	(1.541)
Observations	214	72	251	153	191	123	109
Within R^2	0.178	0.345	0.710	0.368	0.329	0.370	0.199
Num. of countries	20	13	21	21	20	16	17
Country FE	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	all	all	all	all	all
Full time empl.							
RD_L1	-0.005	-0.008	-0.009	0.001	0.003	0.010	-0.006
	(0.004)	(0.010)	(0.005)	(0.003)	(0.002)	(0.005)	(0.004)
lnempl	0.011	1.464***	0.412*	1.036*	0.205	0.925**	0.301
	(0.180)	(0.195)	(0.164)	(0.377)	(0.118)	(0.320)	(0.177)
gdpgrowth_l1	-0.002	0.002	0.001	-0.002	0.002	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)
ln_gdp/cap	-0.033	-0.494**	-0.036	0.565*	0.003	0.155	0.346
	(0.080)	(0.119)	(0.041)	(0.253)	(0.076)	(0.214)	(0.265)
wage_growth	-0.419***	-0.159	-0.212***	-0.052	0.046	-0.039	-0.177
	(0.051)	(0.205)	(0.033)	(0.155)	(0.094)	(0.078)	(0.092)
Constant	11.903***	-1.095	10.189***	1.353	10.714***	3.589	7.315***
	(1.409)	(1.333)	(1.322)	(2.511)	(1.011)	(2.449)	(1.436)
Observations	214	72	251	153	191	123	109
Within R^2	0.203	0.340	0.220	0.380	0.118	0.344	0.147
Num. of countries	20	13	21	21	20	16	17
Country FE	yes	yes	yes	yes	yes	yes	yes
EU accession	all	all	all	all	all	all	all

Dependent variable in (1): employment in Financial and insurance activities, ICIC 64-66, (2): employment in Audiovisual and broadcasting activities, ICIC 59-60, (3): employment in Wholesale and retail trade, repair of motor vehicles and motorcycles, ICIC 45-47, (4): employment in Administrative and support service activities, ICIC 77-82, (5): employment in Transportation and storage, ICIC 49-53, (6): employment in Accommodation and food service activities, ICIC 55-56, (7): employment in Real estate activities, ICIC 68. (1) excludes Hungary, Luxembourg and Latvia. (2) excludes Belgium, Germany, Estonia, France, UK, Lithuania, Luxembourg, Latvia, Slovak Republic and Sweden. (3) and (4) exclude Luxembourg and Latvia. (5) excludes Luxembourg, Latvia and Slovak Republic. (6) excludes Austria, Estonia, Hungary, Luxembourg, Latvia, Poland and Slovak Republic. (7) excludes Ireland, Luxembourg, Latvia, Portugal, Slovak Republic and Sweden. *Note:* Fixed-effects (within) regression with Driscoll and Kraay standard errors. Standard errors in parenthesis. ** $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*