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High-Technology Employment in the European Union

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Abstract

We analyse high-tech employment and wage trends in the European Union between 2000 and 2011. Using a broad industry-occupation framework to define high-tech, we find that the 22 million high-tech workers in the EU-27 represented 10 percent of total employment in 2011. High-tech employment grew at more than twice the rate of total employment during this eleven-year period, and spread throughout the continent—on average, increasing most in regions with previously lower concentrations of high-tech activity. High-tech workers face more favourable labour market outcomes as evidenced by lower unemployment rates and a substantial wage premium—indicating the high demand for these workers and the economic value they generate. We also find a sizable secondary local jobs multiplier, where the creation of one high-tech job in a region results in more than four additional non-high tech jobs in the same region.

JEL Codes: C36, J21, J31, L63, L65, L86, O52

Executive Summary

We analyse high-tech employment and wage trends in the European Union (EU-27) between 2000 and 2011.[1] Using a broad industry-occupation framework, we define high-tech workers as those employed in a high-tech industry or a STEM (science, technology, engineering, and math) occupation. This comprehensive analysis of the high-tech workforce highlights the important role high-tech workers play in job creation, income generation, and economic growth.

Among the major findings:

- In 2011, the 22 million high-tech workers employed in the EU-27 represented 10 percent of total employment. At 13.7 percent of total employment, Czech Republic had the highest concentration. Finland, Sweden, Denmark, France, and eight additional countries had high-tech employment shares above 10 percent of total employment.
- At 21.9 percent, Germany contributed the most to overall EU-27 high-tech employment. Germany, along with France, Italy, and the United Kingdom, collectively accounted for 60 percent of total high-tech employment in the EU-27 in 2011.
- High-tech employment grew 20 percent in the EU-27 between 2000-2011, as total employment increased by 8 percent. Each EU-27 country saw high-tech employment increase, and 22 of those had high-tech employment growth outpace total employment growth during the same period.[2]
- High-tech employment growth spread throughout Europe in the decade–on average, increasing the most in countries and regions with lower levels of high-tech employment concentration. This suggests that countries and regions that had been previously less established in high-tech are catching-up and playing an increasingly important role.
- High-tech workers experience more favourable labour market outcomes than workers as a whole, as evidenced by lower unemployment rates, the existence of a substantial wage premium, and stronger wage growth.[3] These factors reflect both the relatively high demand for these workers and the economic value they create.
    - The high-tech unemployment rate has consistently been below 4 percent and was lower than for total unemployment for each EU-27 country in 2010.
    - High-tech workers earn much higher wages than workers in other sectors. Even after controlling for factors outside of industry or occupation that affect wages, high-tech workers earn 19 percent more than comparable workers.
    - Wage growth has been stronger for high-tech workers than for total workers in 20 of the 26 countries where the data are available for this calculation.
- Beyond the direct impact that high-tech workers have on productivity in technology-adopting sectors throughout the economy, the high-tech sector itself is also an important contributor to income generation and economic development. We estimate that the creation of one high-tech job in a local economy creates more than four additional non-high tech jobs in the same region. This includes workers across the skill spectrum—such as lawyers, physicians, waiters, taxi drivers, schoolteachers, managers, and technologists.

[1] The European Union (EU-27) refers to the 27 member-states in 2011 and excludes Croatia, which joined in 2013.
[2] For some countries, the data cover different time periods. See Figure 3 and pages 5-6 for more details.
[3] For some countries, the data cover different time periods. See Figures 10-12, Table 8, and pages 15-18 for more details.

Introduction

In an era of economic stagnation and joblessness throughout much of Europe, identifying the sources of growth is critical as various policies are considered to improve competitiveness in the region. To better inform the debate, we analyse one important source of employment growth in the European Union (EU-27), and in particular, of innovation-driven employment—the high-tech sector.[4]

We begin by advancing what we view as an appropriately broader definition of the high-tech workforce than has been commonly used. By measuring the high-tech workforce from a vertical (industry) *and* horizontal (occupation) basis, we capture millions of workers engaged in highly technical activities in non-high tech firms. These workers have been excluded from traditional measures of the high-tech labour force.

After defining high-tech, we provide a comprehensive analysis of the high-tech workforce by measuring employment and its components, its growth in the recent years, the geographic location of these jobs throughout the European Union, high-tech unemployment and wage statistics, and the secondary economic benefits this segment generates through the estimation of a local jobs multiplier.

In doing so, we show that the high-tech workforce adds substantial economic value and is an important source of growth during what has been otherwise a difficult economic period for much of Europe. Not only does the high-tech workforce create goods, services, and innovative processes that make workers in a wide-range of fields more productive, high-tech workers themselves are an important source of income generation, employment, and economic growth.

Defining High-Tech

We define high-tech workers broadly as those involved in the production of high-tech goods and services, or otherwise engaged in highly technical activities in other industries. This includes all workers in the high-tech industries regardless of occupation (see **Table 1**), as well as those employed in the STEM occupations of science, technology, engineering, and math in non-high tech industries (see **Table 2**).[5]

This broader industry-occupation approach provides a more robust measure of the technology-oriented segment of the European workforce than is commonly used. By focusing only on jobs in the high-tech industries, traditional methods miss millions of workers in technical occupations in non-high tech firms—such as engineers in auto manufacturing, computer programmers in retail trade, quantitative analysts in financial services, or statisticians in health-care administration. We believe these workers are critical to our broader understanding of the high-technology labour market in the European Union.

[4] In this report, the European Union (EU-27) refers to the 27 member-states in 2011 and excludes Croatia, which joined in 2013.

[5] The definition of high-technology industries here follows Eurostat's definition of High-Technology Manufacturing and High-Tech Knowledge-Intensive Services. The definition of technical STEM occupations comes from the Bureau of Labor Statistics in the United States—see Hecker (2005), "High-technology employment: a NAICS-based update," *Bureau of Labor Statistics*, and Bureau of Labor Statistics (2012), "Options for defining STEM (Science, Technology, Engineering, and Mathematics) occupations under the 2010 Standard Occupational Classification (SOC) system." Industry and occupations are slightly different for the United Kingdom. For a detailed discussion of this approach, see Appendix A.

Table 1:
High-Technology Industries (NACE Rev. 1.1)

NACE	Industry
High-Technology Manufacturing	
24.4	Pharmaceuticals, medicinal chemicals and botanical products
30	Office machinery and computers
32	Radio, television and communication equipment and apparatus
33	Medical, precision and optical instruments, watches and clocks
35.3	Aircraft and spacecraft
High-Technology Knowledge-Intensive Services	
64	Post and telecommunications
72	Computer and related activities
73	Research and development

Source: Eurostat

Table 2:
STEM Occupations (ISCO-88)

ISCO	Occupation
Physical and Life Sciences	
211	Physicists, chemists and related professions
221	Life science professionals
321	Life science technicians and related associate professionals
Computer and Mathematical Sciences	
212	Mathematicians, statisticians and related professionals
213	Computing professionals
312	Computer associate professionals
Computer and Mathematical Sciences	
214	Architects, engineers and related professions
311	Physical and engineering science technicians

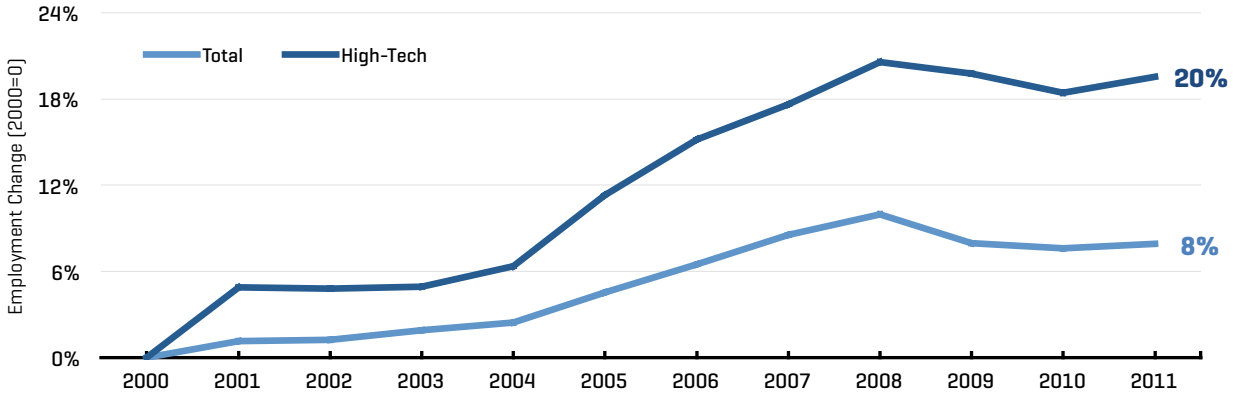
Source: Eurostat; Bureau of Labor Statistics; authors' estimation

High-Tech Employment

High-Tech Employment Growth

Having defined the universe of high-tech jobs, we begin our analysis by examining growth trends in high-tech employment. **Figure 1** shows the cumulative percentage change in employment in the European Union (EU-27) between 2000 and 2011, comparing high-tech employment with total employment. **Figure D1** at Appendix D shows similar trends for the detailed components of high-tech employment.

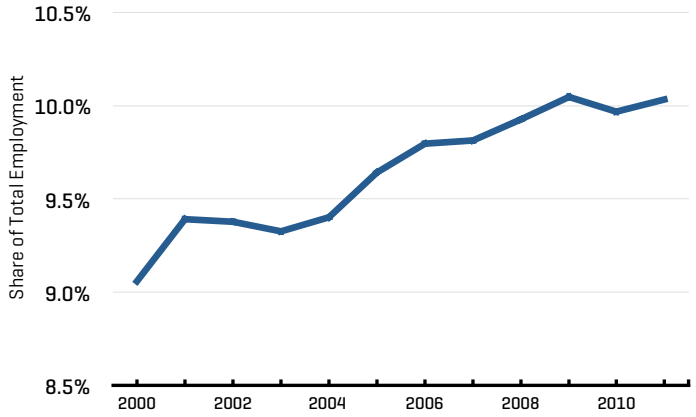
Figure 1:
EU-27 Employment Change versus 2000 by Sector (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

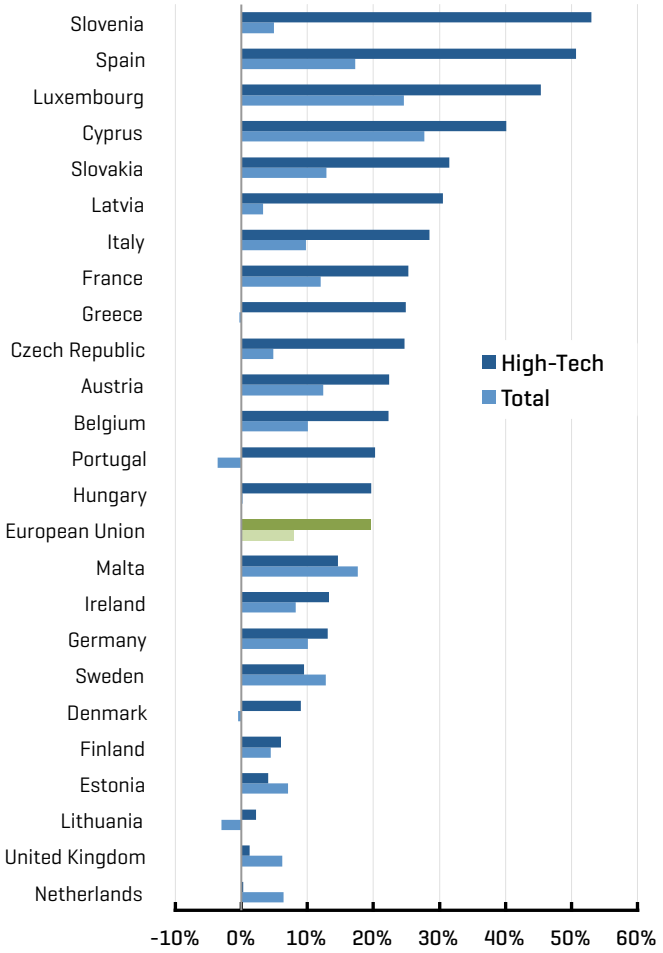
As **Figure 1** illustrates, high-tech has been an important source of employment growth in the last decade, more than doubling total employment growth—20 percent versus 8 percent. High-tech job growth was also more resilient during two recessionary periods—in the early-2000s and late-2000s. Encouragingly, **Figure D1** shows that high-tech employment growth has been driven primarily by the highest-value workers in STEM occupations—both inside and outside the high-tech industries. Even still, non-STEM employment in the high-tech industries grew more than total employment over the decade—reflecting the robust nature of growth in this sector of the economy.

Figure 2:
EU-27 High-Tech Employment Share of Total (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Figure 3:
Employment Change by Country and Sector (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations
Note: Bulgaria, Poland, and Romania are excluded because of insufficient data

As a result of this growth, **Figure 2** illustrates that the high-tech share of total employment increased an entire percentage point during these eleven years. We also see that high-tech employment growth outpaced total job growth for eight of those eleven years.

Turning to the regional dimensions of high-tech employment growth, **Figure 3** shows the percentage change in total and high-tech employment between 2000 and 2011 by country. This chart provides a number of important insights.

First is the widespread nature of growth in high-tech employment. Only twenty-four of the EU-27 countries have sufficient data to make this calculation. Each of them increased high-tech employment over the eleven-year period, and nineteen saw high-tech employment growth outpace growth in total employment.

Some of these high-growth countries started from small bases—Slovenia, Luxembourg, Cyprus, Slovakia, and Latvia—but the data show that they are playing an increasingly important role. Spain is most impressive because its rapid high-tech growth, combined with its large population, amounted to an increase of 441,000 high-tech workers—fourth in the EU-27 behind France, Germany, and Italy.

Despite its below-average growth rate in percentage terms, Germany was responsible for more than 15 percent of EU-27 job growth. Due to large popualtions and strong growth rates, France, Italy, and Spain contributed substantially to overall high-tech employment growth during this period. These three countries, along with Germany, accounted for approximately 60 percent of the more than 3.5 million new high-tech jobs during this period.

Three EU-27 countries—Bulgaria, Poland, and Romania—don't have data available to make this eleven-year calculation. Instead, we offer five-year changes between 2006 and 2011. Each of these countries increased high-tech employment more in percentage terms than they did for total employment: (i) Bulgaria: 2.4% versus -4.9%; (ii) Poland: 15.3% versus 10.8%; and (iii) Romania: 4.9% versus -1.6%. During this same period, EU-27 high-tech employment increased 3.8 percent while total employment increased 1.3 percent.

High-Tech Employment Components

Now that we have defined high-tech and detailed some recent growth trends, we can provide some important information on the scope and scale of high-tech employment in the EU-27. As we mentioned before, it is best to think about high-tech workers as fitting one of three categories along industry and occupation dimensions: (i) high-tech industry, STEM occupation, (ii) high-tech industry, non-STEM occupation, and (iii) non-high tech industry, STEM occupation.

Table 3:
EU-27 High-Tech Employment Components and Shares (2011)

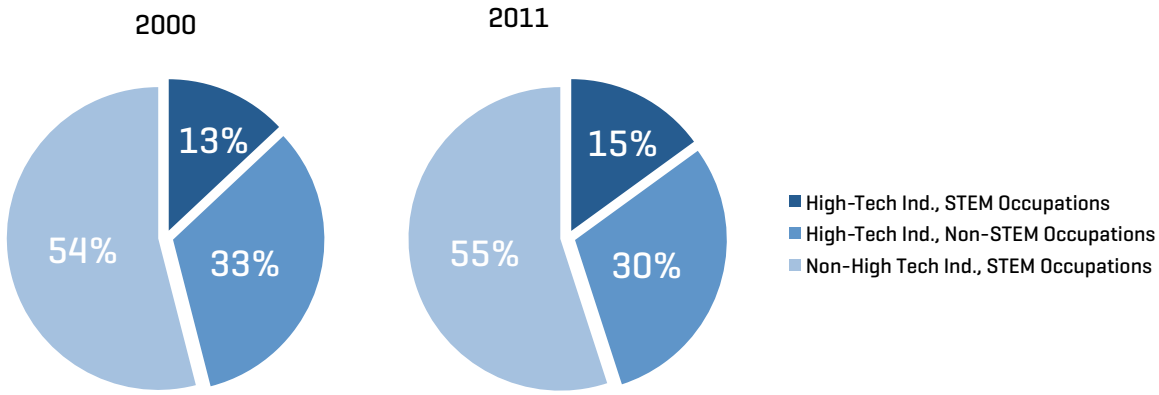
Job Type	Employment (000s)	Share of Total	Share of High-Tech
Total	217,259	100.0%	-
High-Tech (Total)	21,802	10.0%	100.0%
High-Tech Industries	9,783	4.5%	44.9%
STEM Occupations	***3,240***	***1.5%***	***14.9%***
Non-STEM Occupations	***6,543***	***3.0%***	***30.0%***
Non-High Tech Industries	-	-	-
STEM Occupations	***12,019***	***5.5%***	***55.1%***

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Table 3 shows that of the more than 217 million workers employed in the EU-27 in 2011, about 10 percent were in high-tech positions. Of the nearly 22 million high-tech workers, 12 million were employed in STEM occupations in a non-high tech industry—highlighting the significance of these traditionally uncounted workers among the European high-tech economy. STEM workers comprise about one-third of overall high-tech industry employment, or 15 percent of total high-tech jobs. These high-tech industry STEM workers are supported by non-STEM colleagues at a ratio of about one-to-two.

Figure 4 shows how this breakdown has changed over time. As we can see in **Figure E1**, employment in each of these three categories grew throughout the eleven-year period, but **Figure 4** shows that the composition of this employment has changed over the decade. In particular, growth in STEM occupations—both inside and outside of the high-tech industries—has been strongest, as each increased their shares by outpacing growth in the non-STEM workforce at high-tech firms.

Figure 4:
EU-27 High-Tech Employment Components (2000 & 2011)

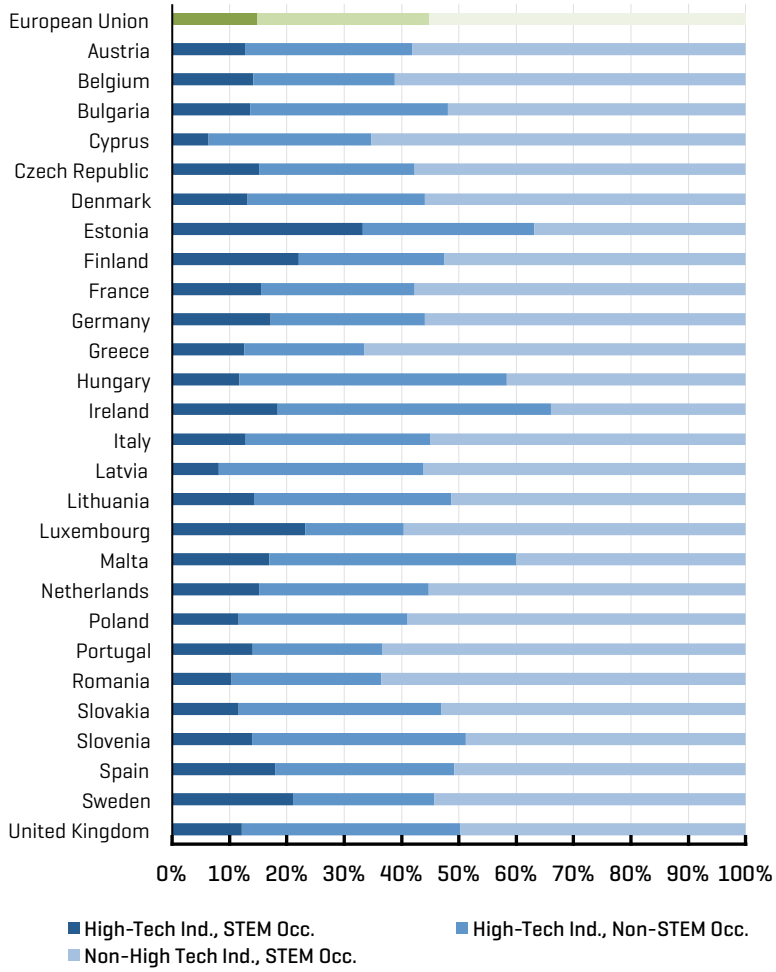


Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Figure 5 shows how these components breakdown across countries in 2011. Ireland, Estonia, Malta, and Hungary had particularly large shares of high-tech employment coming from the high-tech industries. The distributions in Italy, Netherlands, Denmark, Germany, and Sweden were about average. Greece, Cyprus, Romania, Portugal, and Belgium had outsized shares of STEM workers outside of the high-tech industries.

The breakdown of STEM and non-STEM employment within the high-tech industries also reveals a few insights. Luxembourg, Estonia, Finland, Sweden, and Germany had the highest shares of STEM workers in their high-tech firms. On the other end of the spectrum, countries such as Cyprus, Latvia, Hungary, United Kingdom, and Slovenia employ lower shares of technical STEM workers in high-tech firms overall.

Figure 5:
High-Tech Employment Components by Country (2011)

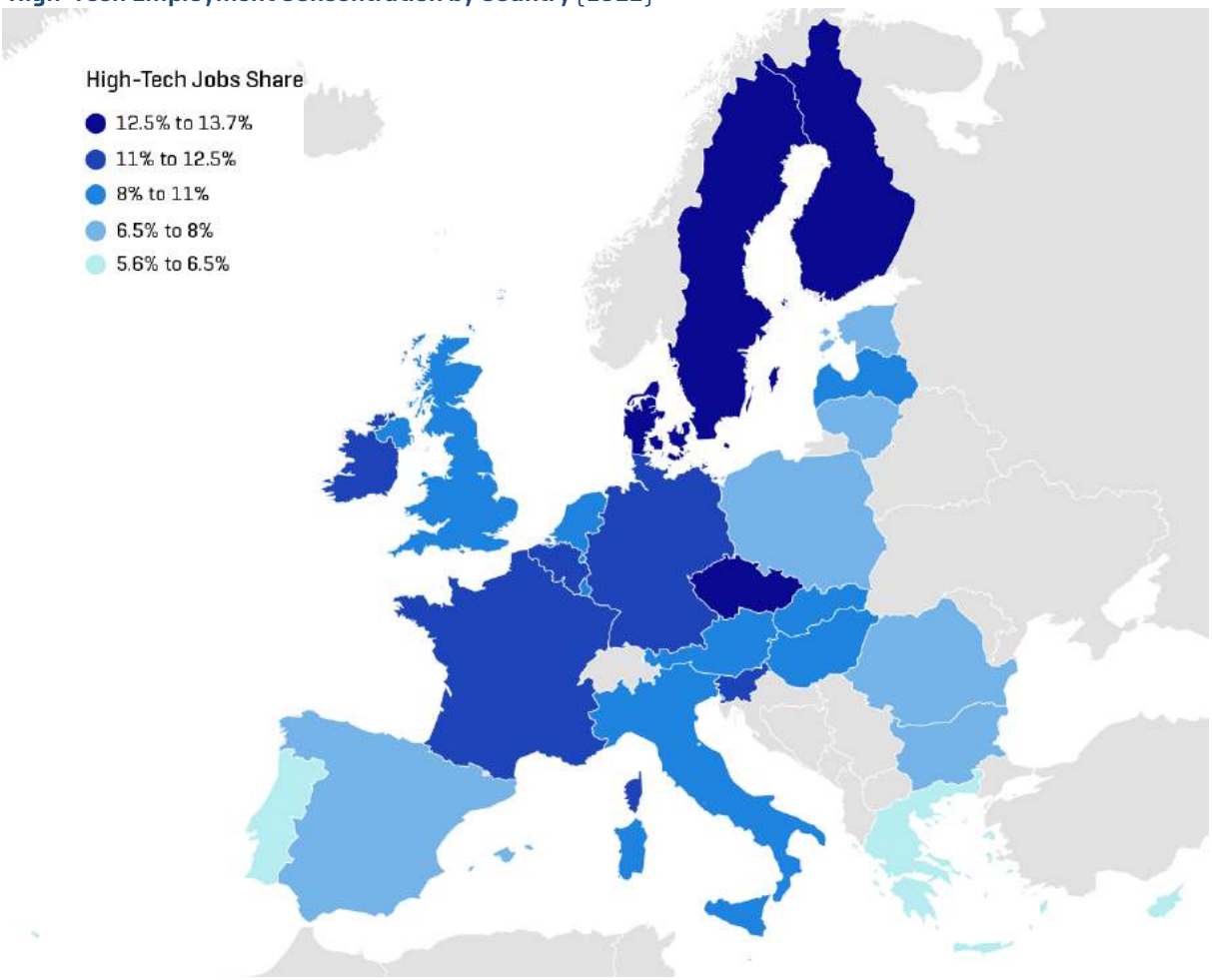


Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

High-Tech Employment Concentration

Next we look at the geographic aspects of high-tech employment. In the figures and tables that follow, we illustrate high-tech employment concentrations and related data throughout Europe. To begin, **Figure 6** maps high-tech employment as a share of total employment for each of the EU-27 countries in 2011. **Table 2** provides more detailed information on high-tech employment and job growth in those countries.

Figure 6:
High-Tech Employment Concentration by Country (2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

When expressed as a share of total employment, the Czech Republic leads the way in 2011; its more than 669,000 high-tech workers accounted for 13.7 percent of total employment, but because of its small size, this accounted for a little more than 3 percent of high-tech jobs across the EU-27. The three Scandinavian EU countries followed, as Finland, Sweden, and Denmark each had high-tech employment shares above 12.7 percent. But again, because of their small size, these three countries collectively accounted for fewer than 6 percent of the high-tech workforce in the EU-27.

Moving to the larger countries, France and Germany had high-tech job concentrations above 12 percent, while Italy and the United Kingdom came in just below the EU-27 average of 10 percent. Because of their relatively high concentrations of high-tech workers and their large size, the nearly 13 million high-tech workers in these four countries account for almost 60 percent of all high-tech employment EU-wide. These four large countries, combined with the Czech Republic and the three Scandinavian countries, accounted for more than two-thirds of high-tech jobs in the EU-27 in 2011.

Belgium, Slovenia, Ireland, Slovakia, Hungary, Malta, and Netherlands also had high-tech shares at or above the EU-27 average, but because of their smaller size, they collectively accounted for just 11 percent of the EU-27 total. Poland and Spain on the other hand, while having below-average high-tech job concentration, combined for nearly 12 percent of the EU-27 total in 2011.

Table 4:
High-Tech Employment and Shares by Country (2011)

Country	Employment (000s)	Emp. Change (2000-2011)	Share of Total Emp.	Share of EU High-Tech
Czech Republic	669	24.7%	13.7%	3.1%
Finland	331	6.0%	13.4%	1.5%
Sweden	592	9.5%	12.7%	2.7%
Denmark	342	9.0%	12.7%	1.6%
France	3,197	25.3%	12.4%	14.7%
Belgium	549	22.3%	12.2%	2.5%
Germany	4,782	13.0%	12.0%	21.9%
Slovenia	106	53.0%	11.3%	0.5%
Ireland	198	13.3%	11.0%	0.9%
Slovakia	253	31.5%	10.8%	1.2%
Hungary	392	19.7%	10.3%	1.8%
Malta	17	14.6%	10.3%	0.1%
Netherlands	834	0.3%	10.0%	3.8%
Austria	404	22.4%	9.8%	1.9%
Italy	2,229	28.5%	9.7%	10.2%
Luxembourg	21	45.3%	9.4%	0.1%
United Kingdom	2,709	1.2%	9.3%	12.4%
Latvia	79	30.5%	8.1%	0.4%
Estonia	48	4.1%	8.0%	0.2%
Poland	1,255	-	7.8%	5.8%
Bulgaria	223	-	7.6%	1.0%
Spain	1,312	50.7%	7.3%	6.0%
Romania	632	-	6.9%	2.9%
Lithuania	90	2.2%	6.6%	0.4%
Cyprus	23	40.1%	6.1%	0.1%
Greece	247	24.9%	6.0%	1.1%
Portugal	268	20.3%	5.6%	1.2%
European Union (27)	**21,802**	**19.5%**	**10.0%**	**100.0%**

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations; Note: Employment changes for Bulgaria, Poland, and Romania are unavailable because of insufficient data

Recall that our definition of high-tech includes workers in the high-tech industries, plus those in STEM occupations in other industries. If we used the traditional definition of high-tech, our rankings would change—particularly for Ireland and Czech Republic. Looking only at high-tech industry shares, Ireland has the highest at 7.3 percent, but it slips to ninth under our definition because it employs fewer workers in STEM fields. This happens to be true both inside and outside of the high-tech industries. In fact, just 38 percent of Ireland's high-tech industry employment was in a technical STEM role—among the lowest in the EU-27. Ireland's STEM workers in non-high tech firms equaled 34 percent of all high-tech employment in 2011—the lowest such share in the EU-27. In short, the high-tech workforce in Ireland is disproportionately employed in non-STEM occupations.

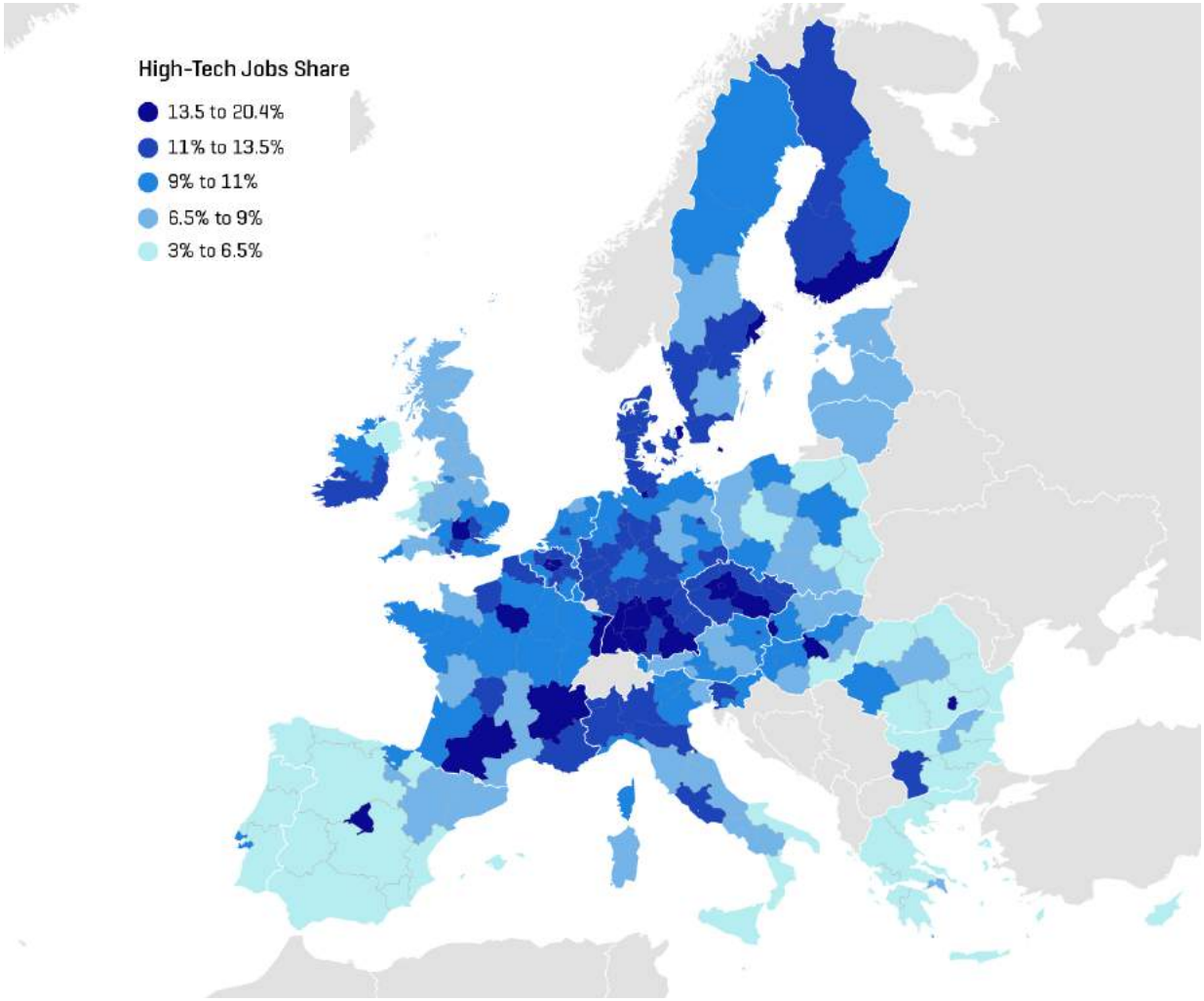
The opposite is true for countries like Belgium and the Czech Republic. When looking only at high-tech industry employment, the Czech Republic ranks seventh at 5.8 percent, while Belgium is fourteenth—just above the EU-27 average at 4.7 percent. But under our definition, not only does the Czech Republic have an above-average STEM/non-STEM split in the high-tech industries, it also has a larger share of STEM workers in other industries. The large number of STEM workers in non-high tech firms drives Belgium's overall high-tech employment.

Next we examine high-tech employment at more granular geographic regions. Here we use data at the level of "NUTS-2"—the second of three levels of geographic granularity used in European economic statistics.[6] **Figure 7** maps high-tech employment as a share of total employment for each NUTS-2 region in the EU-27

[6] It should be noted that our estimates for United Kingdom slightly undercount the level of high-tech jobs. For more, see Appendix A.

countries in 2011. **Tables 5-7** provide detailed information on high-tech employment in these regions, but are disaggregated by regional size.[7]

Figure 7:
High-Tech Employment Concentration by NUTS-2 Region (2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

As we saw before, high-tech jobs tend to be most concentrated in the northern and western portions of Europe, with pockets in the center, east, and south. These tech hubs are in major urban areas throughout the continent, and in regions with highly skilled workforces.

[7] It is important to note that NUTS regions are based on administrative boundaries within each country. They can be somewhat arbitrary from a labour market perspective, and don't necessarily represent the boundaries of a regional economy or labour market. This has the potential to skew employment concentrations one way or another, because each country apportions them differently. For example, NUTS units in Belgium, Germany, and the Netherlands are particularly small spatially, whereas in eastern and southern Europe they tend to be larger. Despite these limitations, overall, NUTS boundaries are quite useful for regional analysis and the insights we provide here are robust.

Table 5:

High-Tech Employment and Shares by Large NUTS-2 Region (2011)

NUTS-2 Region	Country	Employment (000s)	Emp. Change (2000-2011)	Share of Total NUTS-2 Emp.	Share of EU High-Tech
Stockholm	SE	197	14.8%	18.0%	0.9%
Île de France	FR	939	8.0%	17.6%	4.3%
Bucuresti - Ilfov	RO	162	-	15.7%	0.7%
Midi-Pyrénées	FR	194	41.1%	15.4%	0.9%
Karlsruhe	DE	205	23.3%	15.4%	0.9%
Etelä-Suomi	FI	196	4.8%	14.9%	0.9%
Rhône-Alpes	FR	390	32.0%	14.9%	1.8%
Oberbayern	DE	324	19.0%	14.4%	1.5%
Stuttgart	DE	287	16.6%	14.4%	1.3%
Közép-Magyarország	HU	177	23.5%	14.3%	0.8%
Comunidad de Madrid	ES	396	36.8%	14.0%	1.8%
Freiburg	DE	173	35.3%	13.8%	0.8%
Berkshire, Buckinghamshire & Oxfordshire	UK	178	-0.1%	13.6%	0.8%
Köln	DE	260	21.0%	13.0%	1.2%
Lombardia	IT	537	34.4%	12.4%	2.5%
Berlin	DE	198	9.5%	12.2%	0.9%
Lazio	IT	278	29.8%	12.2%	1.3%
Thüringen	DE	135	14.9%	12.1%	0.6%
Düsseldorf	DE	274	12.9%	11.7%	1.3%
Schleswig-Holstein	DE	160	11.3%	11.7%	0.7%
Inner London	UK	178	42.5%	11.5%	0.8%
Outer London	UK	264	11.5%	11.5%	1.2%
Provence-Alpes-Côte d'Azur	FR	228	61.6%	11.4%	1.0%
Southern and Eastern	IE	152	7.1%	11.4%	0.7%
Emilia-Romagna	IT	226	41.7%	11.3%	1.0%
European Union (27)	**EU-27**	**21,802**	**19.5%**	**10.0%**	**100.0%**

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Note: Employment changes for some NUTS regions are unavailable because of insufficient data in the base year

Among large NUTS-2 regions—those with at least one million in total employment—Stockholm had the highest share of high-tech employment in the EU-27. The more than 921,000 high-tech workers in Île de France—the area including and surrounding Paris—represent 17.6 percent of total employment in the region, and are the single largest contributor of overall EU-27 high-tech employment at the NUTS-2 level. Bucharest, Romania, with its highly skilled workforce of information technologists and engineers, was third. Midi-Pyrénées is home to Toulouse-based Airbus and a thriving aerospace sector.

Perhaps not surprisingly, many of these highly concentrated large NUTS-2 regions were also the fastest growing for high-tech employment between 2000 and 2011. The Provence region of France had high-tech employment growth of 62 percent over the decade, while Inner London, Emilia-Romagna, Midi-Pyrénées, and Madrid each had growth rates in excess of 36 percent. Because these regions are large, the explosive growth rates seen there represent nearly 280,000 new high value-add jobs in these four regions alone.

Table 6 shows similar figures for medium-sized NUTS-2 regions—those with between 500,000 and 1 million total employed workers in 2011. Four of the top nine medium-sized regions are located in the Czech Republic, led by Prague with more than 20 percent of its total workforce in high-tech positions. Hamburg and Tübingen in Germany followed, while Hovedstaden—the area including Copenhagen, Denmark—rounded out the top four regions.

Table 6:
High-Tech Employment and Shares by Medium NUTS-2 Region (2011)

NUTS-2 Region	Country	Employment (000s)	Emp. Change (2000-2011)	Share of Total NUTS-2 Emp.	Share of EU High-Tech
Praha	CZ	131	26.6%	20.2%	0.6%
Hamburg	DE	146	54.1%	16.1%	0.7%
Tübingen	DE	141	45.5%	14.7%	0.6%
Hovedstaden	DK	123	-	14.3%	0.6%
Alsace	FR	119	53.7%	13.8%	0.5%
Jihov_chod	CZ	105	12.9%	13.7%	0.5%
Střední Cechy	CZ	83	82.1%	13.6%	0.4%
Mittelfranken	DE	115	18.0%	13.6%	0.5%
Severov_chod	CZ	92	31.2%	13.3%	0.4%
Sydsverige	SE	85	33.4%	12.8%	0.4%
Prov. Oost-Vlaanderen	BE	81	5.0%	12.6%	0.4%
Jihozápad	CZ	72	19.7%	12.4%	0.3%
Dresden	DE	94	10.5%	12.3%	0.4%
Prov. Antwerpen	BE	91	14.5%	12.3%	0.4%
Oberpfalz	DE	84	41.5%	12.1%	0.4%
Midtjylland	DK	75	-	12.1%	0.3%
Östra Mellansverige	SE	90	-4.6%	12.1%	0.4%
Moravskoslezsko	CZ	66	19.2%	12.1%	0.3%
Haute-Normandie	FR	89	30.6%	12.1%	0.4%
Länsi-Suomi	FI	73	6.5%	12.0%	0.3%
Västsverige	SE	113	1.5%	12.0%	0.5%
Detmold	DE	113	18.9%	12.0%	0.5%
Bedfordshire and Hertfordshire	UK	101	-7.4%	11.9%	0.5%
Wien	AT	95	1.1%	11.7%	0.4%
Rheinhessen-Pfalz	DE	111	-	11.6%	0.5%
European Union (27)	**EU-27**	**21,802**	**19.5%**	**10.0%**	**100.0%**

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations
Note: Employment changes for some NUTS regions are unavailable because of insufficient data in the base year

The fastest growing medium-sized NUTS-2 region was Stredni Cechy—the area surrounding central Prague. Hamburg, Tübingen and Oberpflaz (eastern Bavaria) in Germany, and Alsace in France also saw growth rates exceed 41 percent. These impressive eleven-year growth rates are of course somewhat the result of working from smaller bases in these medium-sized regions, but the tens of thousands of high-value jobs they represent are significant.

Table 7 shows similar employment trends for small NUTS-2 regions—those with fewer than 500,000 employed workers in 2011.

Table 7:

High-Tech Employment and Shares by Small NUTS-2 Region (2011)

NUTS-2 Region	Country	Employment (000s)	Emp. Change (2000-2011)	Share of Total NUTS-2 Emp.	Share of EU High-Tech
Bratislavsk_ kraj	SK	68	55.9%	20.4%	0.3%
Prov. Vlaams-Brabant	BE	80	34.3%	16.5%	0.4%
Prov. Brabant Wallon	BE	23	30.6%	14.9%	0.1%
Itä-Suomi	FI	37	10.2%	13.2%	0.2%
Prov. Namur	BE	24	32.5%	12.8%	0.1%
Zahodna Slovenija	SI	57	-	12.7%	0.3%
Sjælland	DK	47	-	12.2%	0.2%
Nordjylland	DK	33	-	12.1%	0.2%
Bruxelles / Brussels	BE	50	39.2%	12.1%	0.2%
Pohjois-Suomi	FI	43	19.8%	11.6%	0.2%
Prov. Limburg	BE	47	40.1%	11.6%	0.2%
Prov. Liège	BE	12	32.1%	10.9%	0.1%
Prov. Luxembourg	BE	23	17.7%	10.9%	0.1%
Flevoland	NL	26	24.3%	10.6%	0.1%
Övre Norrland	SE	50	18.4%	10.6%	0.2%
Prov. Hainaut	BE	14	22.6%	10.4%	0.1%
Burgenland	AT	17	14.6%	10.3%	0.1%
Malta	MT	47	46.0%	10.3%	0.2%
Border, Midland and Western	IE	24	42.0%	10.1%	0.1%
Provincia Autonoma Trento	IT	49	-	10.1%	0.2%
Vzhodna Slovenija	SI	41	25.7%	10.0%	0.2%
Nyugat-Dunántúl	HU	38	27.0%	9.8%	0.2%
Észak-Magyarország	HU	18	44.9%	9.8%	0.1%
Vorarlberg	AT	44	-6.0%	9.7%	0.2%
Közép-Dunántúl	HU	28	0.6%	9.5%	0.1%
European Union (27)	**EU-27**	**21,802**	**19.5%**	**10.0%**	**100.0%**

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Note: Employment changes for some NUTS regions are unavailable because of insufficient data in the base year

The more than 68,000 high-tech workers in Bratislava, Slovakia constituted 20 percent of total local employment in 2011—the highest of any NUTS-2 region in the EU-27 that year. This is the product of high-tech services in information technology and telecommunications, as well as highly skilled STEM workers employed in other sectors. Bratislava is also one of the fastest growing regions for high-tech employment at nearly 56 percent between 2000 and 2011. The region's prosperity may partially explain this: when adjusting for purchasing power parity, this region has among the highest per-capita incomes levels in the entire EU-27.[8]

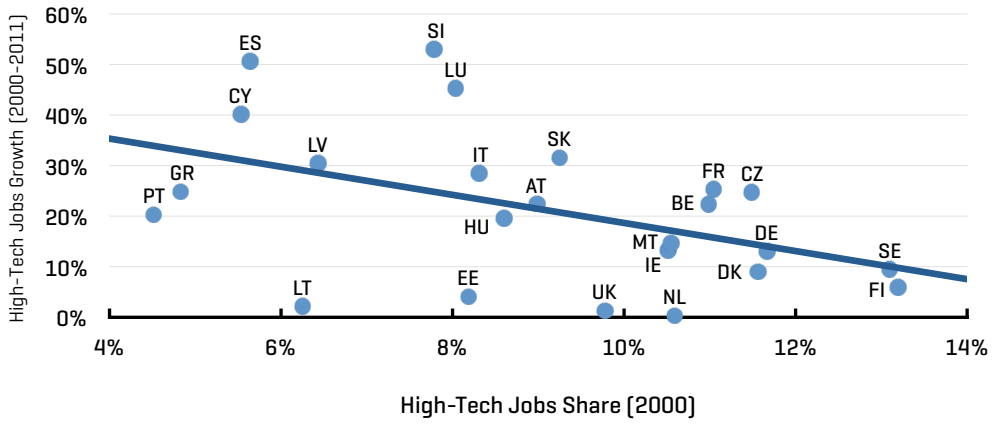
Seven regions in Belgium occupy the top thirteen spots—explained by the highly skilled workforce throughout the country and the fact that its NUTS regions tend to be smaller. Six of these seven regions had high-tech job growth exceed 32 percent over the eleven-year period.

[8] European Commission (2013), "Regional GDP per capita in the EU in 2010," *Eurostat News Release*

High-Tech Employment Concentration and Growth

Now that we have examined patterns of high-tech employment growth and concentration at the EU-27, country, and NUTS-2 levels, we can examine the relationship between these two measures. **Figure 8** plots high-tech employment concentration in 2000 against the percentage change in high-tech employment during the subsequent eleven-year period for the twenty-four EU-27 countries that have sufficient data for this calculation. **Figure 9** illustrates the same relationship but does so for the 182 NUTS-2 regions where the data are available in both 2000 and 2011.

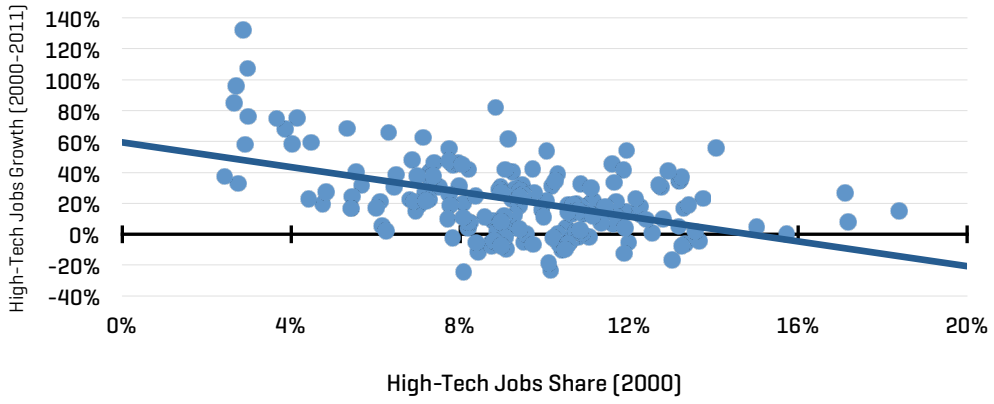
Figure 8:
High-Tech Employment Concentration and Growth by Country (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Note: Data for Bulgaria, Poland, and Romania are unavailable because of insufficient data

Figure 9:
High-Tech Employment Concentration and Growth by NUTS-2 Region (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Note: Data for some NUTS regions are unavailable because of insufficient data in the base year or changes in NUTS classifications

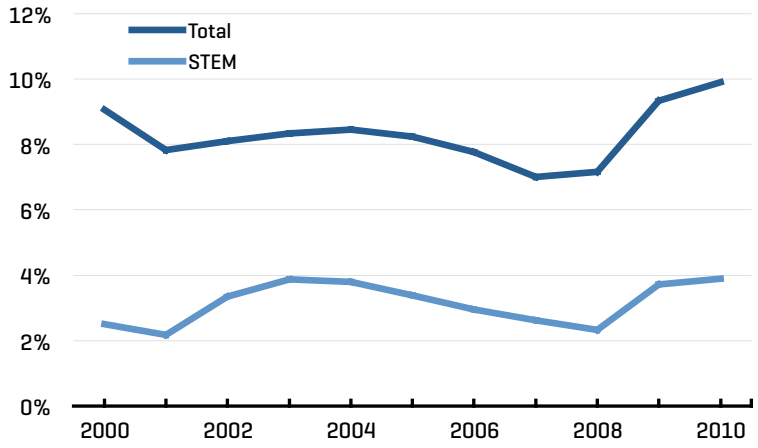
As these two charts make clear, high-tech employment growth tended to be strongest in regions with previously lower shares of high-tech employment concentration. This is partially the result of some high-growth regions starting from smaller bases, but because these trends happen to be true at each regional size class (see **Figures E1-E3** at Appendix E), it is undeniable that high-tech activity has been dispersing throughout Europe in the last decade. In short, while there are clearly established tech hubs of all size classes, many regions are catching-up and playing an increasingly important role.

High-Tech Unemployment and Wages

High-Tech Unemployment

As another metric for the health of the labour market we can look at unemployment rates. Since these data aren't available at the level of industry disaggregation that is required to define the high-tech industries, we can only examine trends by occupation—that is, STEM occupations versus all others.[9] Recall from **Table 3** that STEM workers (across the high-tech and non-high tech industries) constitute 70 percent of all high-tech employment in the EU-27, therefore they serve as a reasonable proxy for all high-tech employment, given the data limitations here.

Figure 10:
EU-27 Unemployment Rates by Sector (2000-2010)



Source: Eurostat, EULFS; authors' calculations
Note: Bulgaria, Germany, France, Malta, Netherlands, Poland, and Slovenia are excluded because of insufficient data

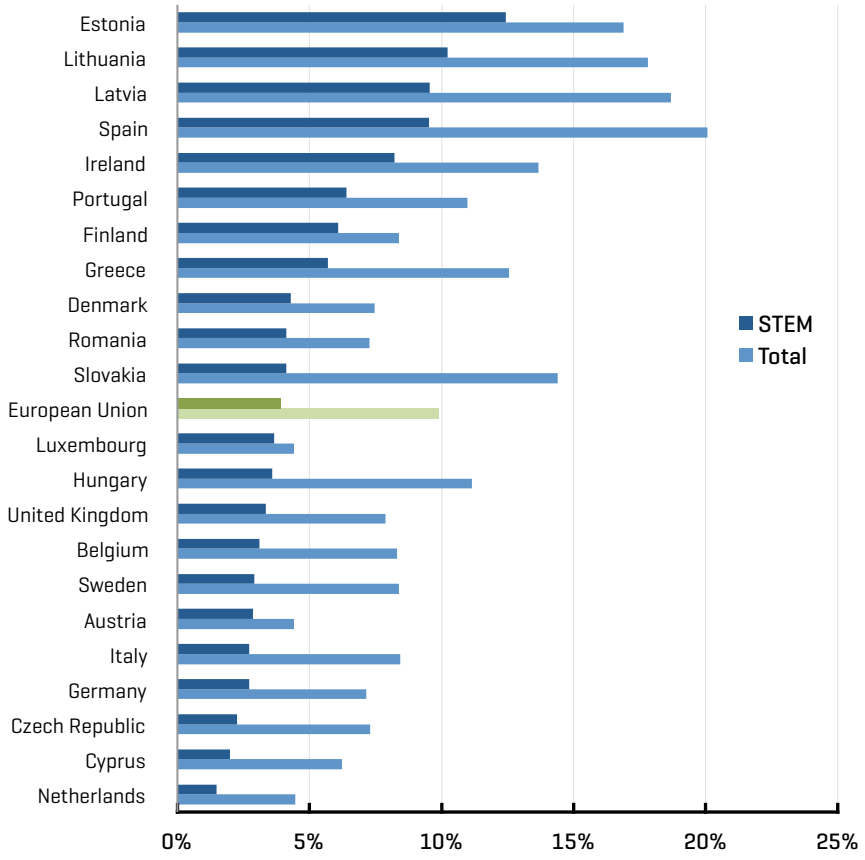
A second limitation to these data is that they are only available through 2010. Still, as **Figure 10** illustrates, a decade's worth of data clearly shows that STEM workers are far less likely to be unemployed than workers across all occupations.

A lower unemployment rate could be the result of fewer STEM workers losing their jobs, or those who do finding new work with greater ease. While this at least partially reflects the fact that these workers are highly skilled and highly educated, the fact that the unemployment rate for STEM workers is far less elevated than the total unemployment rate shows the high demand for workers with these skills.

Figure 11 shows how these unemployment rates apply to the twenty-two EU-27 countries where the data are available in 2010. While in many cases the elevated unemployment rates from a global financial crisis and economic recession were also reaching STEM workers throughout Europe, in each of these twenty-two countries the STEM unemployment rate was lower than the total unemployment rate in 2010—illustrating the robust nature of STEM unemployment stretching across the European continent.

[9] We are also unable to examine STEM occupations at the three-digit ISCO level (which excludes health-care occupations) but instead must examine them at the two-digit ISCO level (which includes health-care occupations). For a detailed description of our definition for STEM occupations, see Appendix A.

Figure 11:
Unemployment Rates by Country and Sector (2010)



Source: Eurostat, EULFS; authors' calculations
Note: Data for Bulgaria, France, Malta, Poland, and Slovenia are not available

High-Tech Wages

Next we turn to wages. Nothing is perhaps more meaningful to workers and households as the income they earn from employment. Wages also reflect the value of a worker compared to their peers, the share of national income that is captured by labour, and the relative supply and demand of workers in their respective fields and regions.

Unfortunately, as with our unemployment data, the wage data are not available at the industry level needed for this analysis. However, the STEM wage data are available and we will rely on them for our wage analysis here. **Table 8** shows wage data for the twenty-one EU-27 countries where the data are available in 2005 and 2010, as well as five additional countries where the data are available during different time intervals. The data for Malta are not available at all. Included are the average wage differentials for STEM and non-STEM occupations in 2010 by country, as well as average annual growth rates for average wages over the relevant time periods (see footnote to **Table 8**).

Table 8:

Wage Differentials (2010) **and Wage Growth** (2005-2010)*,**,***

Country	Average STEM Wage Differential v Non-STEM (2010)	Average Annual Change (2005-2010)	
		STEM	Non-STEM
Austria	28%	3.5%	3.0%
Belgium	17%	1.4%	1.4%
Bulgaria*	45%	24.6%	18.3%
Cyprus***	43%	5.1%	4.9%
Czech Republic	28%	9.9%	9.3%
Denmark	34%	4.0%	2.8%
Estonia	35%	13.5%	11.3%
Finland	35%	3.7%	3.7%
France	42%	0.9%	2.2%
Germany	42%	0.7%	0.1%
Greece	42%	7.7%	6.9%
Hungary	41%	5.9%	4.9%
Ireland***	53%	5.5%	4.0%
Italy	47%	4.1%	2.2%
Latvia*	55%	12.8%	10.5%
Lithuania	53%	11.3%	10.7%
Luxembourg	33%	2.0%	3.4%
Netherlands	20%	2.1%	3.4%
Poland	48%	10.1%	8.1%
Portugal	69%	6.1%	5.9%
Romania**	69%	7.2%	7.4%
Slovakia	26%	13.6%	13.6%
Slovenia	46%	6.4%	6.5%
Spain	50%	3.4%	3.0%
Sweden	30%	0.1%	0.9%
United Kingdom	36%	-1.5%	-1.7%

Note: Malta excluded because of insufficient data; (*) Average annual change is for years 2007-2010; (**) Average annual change is for years 2007-2009; (***) Average annual change is for years 2005-2009

A couple of insights are worth noting. First, in each of the countries listed here, STEM workers earn much higher wages than workers across the economy. In fact, average STEM wages were greater than non-STEM wages in each of the twenty-six countries. At 69 percent, the differences in Portugal and Romania were the greatest, while the 17 percent difference in Belgium was the smallest.

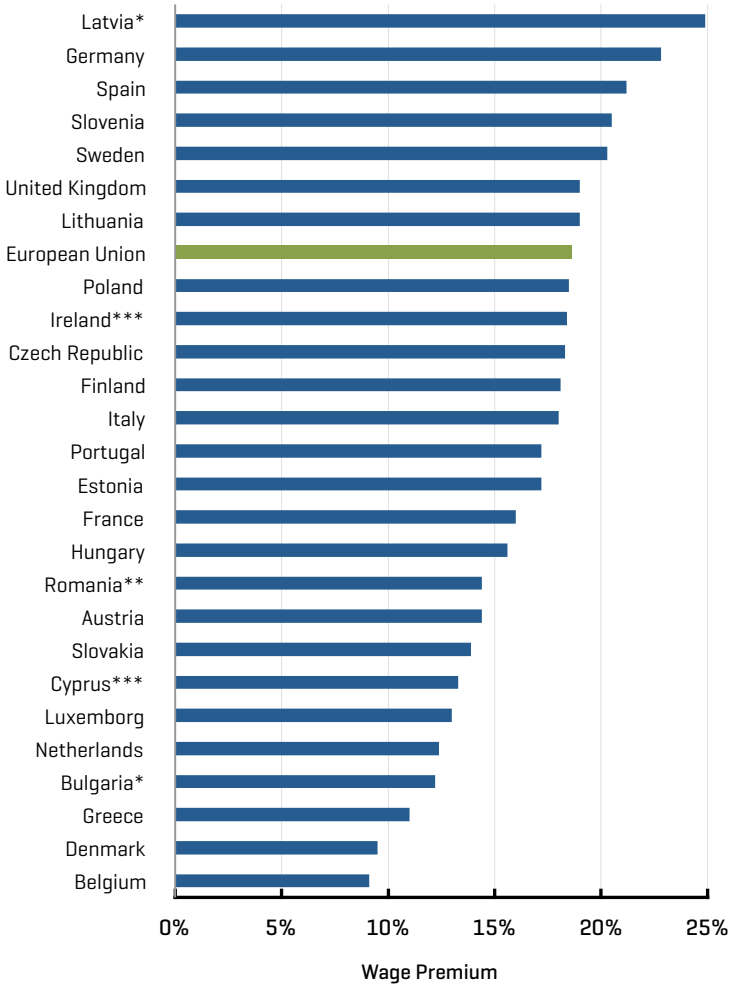
Secondly, the five-year growth rates in average annual STEM wages outpaced those for non-STEM occupations in sixteen of the twenty-one countries. STEM wage growth outpaced non-STEM wage growth in each of the five countries with different timelines for average annual changes. Growth rate differentials between STEM and non-STEM were greatest in Germany, Italy, Denmark, Ireland, Bulgaria, and Poland, while Sweden, France, Luxembourg, Netherlands, United Kingdom, Romania, and Slovenia had STEM wages grow more slowly on average than non-STEM during these time periods.

Combined, the wage levels and changes tell us a few things about the STEM workforce. The wage levels show the relative value-add that these workers have, while the growth rates show that this trend has been increasing over time in a majority of countries. It may also reflect the relative supply and demand of these workers as wages are bid up at an above average rate over the period—illustrating that workers in these fields are in high demand.

One shortcoming of looking at wage level differentials alone, however, is that wages reflect a number of factors outside of industry or occupation—our primary focus here. For example, it is no surprise that STEM workers earn higher wages on average than total workers across the economy based on the simple fact that they are more educated than are workers in lower-skill, lower-earning positions.

To isolate these other effects, we implement a wage premium regression to estimate the impact that employment in a STEM occupation alone has on wages, after adjusting for all other factors outside of occupation (years of education, experience, gender, marital status, hours worked, industry and country). **Figure 12** illustrates the results.

Figure 12:
Regressed STEM Wage Premium (2005-2010)*,,***



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations
Note: Malta excluded because of insufficient data; (*) Average annual change is for years 2007-2010; (**) Average annual change is for years 2007-2009; (***) Average annual change is for years 2005-2009

As our results show, STEM workers across the EU-27 earn 19 percent more on average than comparable workers, even after controlling for all other factors outside of occupation that affect wages (see Appendix B). The existence of the substantial wage premium in STEM occupations partially reflects the fact that, as drivers of innovation and productivity, these technical workers are engaged in work that adds some of the most value across the economy. Income gains, shared among workers, shareholders and governments, have followed accordingly. When combined with very low unemployment rates and strong job growth, rapidly increasing wages also reflect the fact that these workers are in high demand.

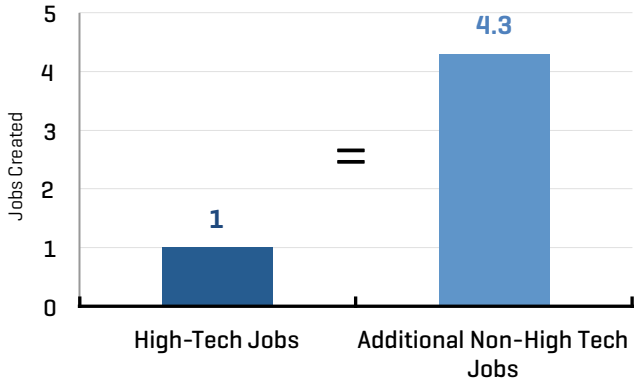
High-Tech Employment Multiplier

Despite the fact that high-tech jobs represent a relatively small share of total employment in the EU-27, policymakers should want to attract and cultivate this segment of the economy due to outsized role in shared economic prosperity. This occurs primarily in two ways—first through income generated by innovation, productivity, and a global marketplace, and second, from the local non-high tech jobs that are supported by that wealth generation.

Here, we estimate the secondary economic impact of the high-tech sector in the EU-27 through a local multiplier framework. Drawing from the previous work of Moretti (2010) and Autor and Dorn (2013), we

estimate the additional non-high tech jobs created in a region as a result of the creation of one high-tech job in the same region (see Appendix C).[21] **Figure 13** illustrates our results.

Figure 13:
High-Tech Local Jobs Multiplier



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

According to our analysis, the creation of one high-tech job in a NUTS 2 region is associated with the creation of more than four additional jobs in the non-high tech segment of the same region. Our result is statistically significant at the 1 percent level, and is remarkably consistent with similar estimates for the United States.[22] These similarities signal the robustness of our results. They also make it reasonable to believe that additional analyses in the U.S. reports that weren't possible with our data could be extended to our findings for the EU-27.

For example, earlier U.S. research showed that the manufacturing sector—often a favourite target of policymakers and economic development authorities—has a secondary jobs multiplier at about one-third that of high-tech workers. What is more, the secondary jobs created by high-tech employment are distributed relatively evenly across both the low-skill and high-skill worker segments. That means the presence of high-tech workers in a region are likely to create additional jobs for a wide range of occupations—such as such as lawyers, physicians, waiters, taxi drivers, schoolteachers, and other technicians.

In short, the high-tech workforce generates a considerable amount of income that supports local economies. This is a critical concept to grasp, because although not everyone will have the opportunity to work in a technical STEM field or for a high-tech company, many non-high tech jobs are increasingly reliant on the income generated by this high-value segment of the economy.[23] High-tech firms and workers have access to, and compete, in a global market place—driving innovation, productivity, and income growth in the process.[24]

[21] Moretti (2010), "Local Multipliers," *American Economic Review: Papers & Proceedings 100*; Autor and Dorn (2013), "Inequality and Specialization: The Growth of Low-Skilled Service Jobs in the United States", *American Economic Review*, 103(5), 1553-1597.
[22] Hathaway (2012), "Technology Works: High-Tech Employment and Wages in the United States," *Bay Area Council Economic Institute*; Moretti (2010), "Local Multipliers," *American Economic Review: Papers & Proceedings*, Volume 100, Issue 2.
[23] For more on this, see Moretti (2013), *The New Geography of Jobs*, Mariner Books.
[24] For more on the tradable sector's role in economic growth, see Spence and Hlatshwayo (2011), "The Evolving Structure of the American Economy and the Employment Challenge," Comparative Economic Studies; for European competitiveness in high-tech, see A.T. Kearney (2012), *The Future of Europe's High-Tech Industry*

Conclusion

We have advanced a broad-based, systematic definition of the high-tech workforce in the European Union, and have provided a comprehensive analysis of employment and wages covering an eleven-year period between 2000 and 2011. Our analysis shows that high-tech is an important source of employment, income, and economic growth during what has otherwise been a difficult economic period across the EU-27. Our findings also show that high-tech workers enjoy favourable labour market outcomes, as evidenced by lower unemployment and a substantial wage premium relative to their non-high tech peers.

Perhaps more importantly, our research also illustrates that the high-value job creation from high-tech is spreading throughout the continent—reaching far beyond regions that are well-known tech hubs. Indeed, this segment of the economy has been driving growth in regions that are geographically and economically diverse. While larger and more established "tech hubs" have been most responsible for the *level* of growth in high-tech employment across Europe, smaller and lesser-established regions are gaining ground as their importance increases.

Looking ahead, we offer recommendations for future research. First, the challenges associated with harmonizing data across twenty-seven very different EU member-nations required a number of tradeoffs and assumptions. As a result, further study on an individual country or regional basis could provide additional insights. Secondly, we recommend further comparative study on the contributions of the high-tech sector through the lens of other measures of economic vitality, such as entrepreneurship, economic output, research and development, and productivity. This will further our understanding of the economic impact of this sector. Finally, because it is an important source of economic growth, research highlighting any obstacles to growth in high-tech would be helpful as various public policies are explored.

Appendices

Appendix A: High-Tech Employment Data

A1: Construction of the employment dataset
Employment is characterized by an ISCO occupation code relating to an employee's level and field of study, and a NACE sector code relating to the employer's business activities. The definition of high-tech employment that is used throughout the main text combines employment in STEM occupations (both in high-tech and low-tech industries) and employment in non-STEM occupations in high-tech industries. Employment in high-tech industries for each NUTS-2 region is available from Eurostat's Regional Science and Technology Statistics Database that we combine with employment in STEM and non-STEM occupations aggregated from the European Labour Force Survey (EULFS) micro data set.

We start with EULFS data from 2000 to 2007 that contains employment by two-digit ISCO occupation and two-digit industry for all EU countries. In this dataset we can calculate the share of high-tech jobs that is done by STEM workers for each country and year:

$$\alpha_{ct} = \frac{STEMhigh_{ct}}{STEMhigh_{ct} + nonSTEMhigh_{ct}}$$

This share α_{ct} is then linearly extrapolated to the year 2008-2010. Note that the STEM definition used here is broader than the STEM occupations defined in the main text since we use the two-digit rather than three-digit ISCO occupations[25], and we return to this issue below.

Multiplying high-tech employment from Eurostat with this share α_{ct} gives us STEM employment in the high-tech industries for each NUTS-2 region. Once we have STEM employment in the high-tech industries, we also know non-STEM employment in the high-tech industries (since we have data on total high-tech industry employment). Note that we multiply regional high-tech employment with country-level shares (α_{ct}), hence making the assumption that the share of STEM occupations in high-tech industry employment is the same for every region of a country.

In the most recent version of the EULFS, that has data up to 2010, we have two-digit STEM employment for every NUTS-2 region. [26] Subtracting the just-calculated STEM employment in high-tech industries from total STEM employment taken from the EULFS, gives us STEM employment in non-high tech industries. This gives us a dataset containing high-tech employment (that is, employment in STEM occupations in high-tech and non-high tech industries as well as in non-STEM occupations in high-tech industries), where STEM is defined at the two-digit ISCO level, from 2000 to 2010 at the NUTS-2 region.

A2: Correcting for a more restrictive definition of STEM occupations
As two-digit STEM occupations contain some occupations that should not be classified as STEM (primarily in health-care), we have to adjust the STEM employment data. From the most recent EULFS data we can calculate the ratio of three-digit STEM employment to two-digit STEM employment for every NUTS-2 region and every year. We can safely assume that the two-digit STEM jobs that are not in the three-digit STEM classification are concentrated in the non-high tech industries. Therefore, we subtract the difference between two-digit STEM and three-digit STEM for STEM employment in the non-high tech industries and add it to non-STEM non-high tech industry employment. This gives us a dataset containing high-tech

[25] The two-digit STEM occupations are: 21, 22, 31 and 32.
[26] This EULFS version only contains one-digit NACE codes and could therefore not be used for making the distinction between high-tech and non-high tech.

industry employment, where STEM is defined at the more restrictive three-digit ISCO level, from 2000 to 2010 at the NUTS-2 region.

Not all necessary data are present in Eurostat's Regional Science and Technology Statistics Database and the EULFS. So, we made the following adjustments:

- As we did not have data on STEM employment in high-tech industries for Romania, Poland, Bulgaria, and Malta, for the share of STEM in high-tech industry employment we used α_{ct}, the average share of the new member states[27] for each year in the sample.
- The EULFS only provides two-digit ISCO employment for Bulgaria, Slovenia, and Poland. So, we made the adjustment from two-digit to three-digit STEM using the average three-digit to two-digit ratio of the new member states.
- The ratio of three-digit to two-digit STEM employment for Germany is only available from 2002 so it was linearly extrapolated to 2000 and 2001 (only at the country-level).
- The EULFS only provides one-digit ISCO employment for Malta, which makes it impossible to calculate total STEM, and therefore also STEM employment in non-high tech industries and non-STEM employment in non-high tech industries. To solve this issue, we assume that the share of total STEM employment in total employment equals the following:

$$STEMshare_{MT} = STEMshare_{EU} \frac{\alpha_{MT}}{\alpha_{EU}}$$

- Germany, Austria and the UK only provide STEM employment at the NUTS-1 level. We therefore assumed that the share of total STEM employment in total employment was the same for every NUTS-2 region of a NUTS-1 region.
- The Netherlands and Denmark only provide STEM employment at the country level. We therefore assumed that the share of total STEM employment in total employment was the same for every NUTS-2 region of a country.
- For 2011 we only have the Eurostat data on total employment and high-tech industry employment. In order to get the rest of the data, we assume that the share of total STEM employment in total employment and the share of STEM in high-tech industry employment (α_{ct}) are the same as in 2010.

The final dataset contains employment for our broader definition of high-tech for each NUTS-2 region in the EU for the period 2000-2011.

A3: Construction of United Kingdom employment data
For the United Kingdom we do not use the EULFS, but the country's own national labour force survey (UKLFS). This survey uses a different occupational classification, namely the Coding of Occupations (SOC90). We classify the following occupations as STEM:

- Natural Scientists (20)
- Engineers and technologists (21)
- Architects, town planners and surveyors (26)
- Scientific technicians (30)
- Computer analysts/programmers (32)

[27] The new member states are CY, MT, BG, RO, PL, CZ, HU, EE, LV, LT, SI, SK.

Though not exactly the same as the STEM occupations in the ISCO classification, these occupations are very similar to the ones defined in **Table 2** (STEM ISCO occupations). For the industry classification, the UKLFS uses the Standard Industrial Classification of Economic Activities (SIC92). We classify the following industries as high-tech industries:

- Manufacture of office machinery and computers (30)
- Manufacture of radio, television and communication equipment and apparatus (32)
- Manufacture of medical, precision and optical instruments, watches and clocks (33)
- Post and telecommunications (64)
- Computer and related activities (72)
- Research and development (73)

Remark that both occupational and industry codes have been made consistent over time. As the UKLFS only provides two-digit industry codes, we cannot include the sectors "Manufacture of pharmaceuticals, medicinal chemicals and botanical products (24.4)" and "Manufacture of aircraft and spacecraft (35.3)". Therefore our UK high-tech employment data will slightly underestimate the true value.

As our UKLFS data are only available until 2010, we use the growth rate of total employment from Eurostat in 2011 and to obtain values for our different employment categories in 2011.

The UKLFS only provides data at the NUTS-1 level (defined as combinations of government office regions), with the exception of London, which is divided into its NUTS-2 regions Inner London (UKI1) and Outer London (UKI2). The following steps were followed to impute high-tech employment at the NUTS-2 level:

- Using Eurostat total employment data, we calculate for each NUTS-2 region its share in total employment of the corresponding NUTS-1 region.[28] We apply this share to the total employment data of the EULFS to get total employment at the NUTS-2 level.
- To get total employment in high-tech industries we apply the same method to Eurostat high-tech employment data.[29]
- For STEM employment at the NUTS-2 level, we assume that the STEM share of total employment is the same for every NUTS-2 region of a NUTS-1 region.
- After applying the share of STEM in high-tech (α_{ct}) to total high-tech at the NUTS-2 level, we can calculate employment for all different categories

Appendix B: High-Tech Wage Data

Construction of the wage data set and estimation of the wage premium
To obtain country-level wages we use the European Survey on Income and Living Conditions (EU-SILC) micro data set from 2004 to 2010. The EU-SILC contains two-digit ISCO occupations and one-digit NACE sectors. We can therefore regress wages only to a STEM/non-STEM indicator using the two-digit rather than three-digit ISCO definition of STEM. The variable "employee cash or near cash income" will serve as the basis of our wage variable. This wage variable refers to gross income and in addition to wages and salaries, contains other types of cash income such as bonuses and allowances. As some countries do not always provide data on this income variable, we replace missing values with "gross monthly earnings for

[28] The total employment data differ only slightly between the European and the UK labour force.
[29] Though the high-tech employment data from the European LFS and the UK LFS show substantial differences, the distribution of HT employment over the NUTS-1 regions is very similar. We therefore assume that the distribution over the NUTS-2 regions will also be reliable.

employees".[30] As "employee cash or near cash income" is expressed per year, we divide it by 12 to get the average monthly income.

We estimate the wage premium of being in a STEM occupation using the following regression equation:

$$Log(wage) = \beta_0 + \beta_1 STEM + \beta_2 age + \beta_3 gender + \beta_4 maritalstatus + \beta_5 hours + \beta_6 year + \beta_7 education + \beta_8 industry\ (+\beta_9 country) + \varepsilon$$

where STEM is a dummy variable for STEM occupations, and β_1 is the coefficient of interest. The other variables are included as controls:

- Age = year of birth
- Gender = 1 if male, 2 if female
- Marital status (1-5, included as dummies):
    - never married (1)
    - married (2)
    - separated (3)
    - widowed (4)
    - divorced (5)
- Hours = number of hours usually worked per week in main job
- Year = year of the survey
- Education = highest ISCED level attained (0-6, included as dummies):
    - Pre-primary education (0)
    - Primary education (1)
    - Lower secondary education (2)
    - (upper) secondary education (3)
    - Post-secondary non-tertiary education (4)
    - First stage of tertiary education (not leading directly to an advanced research qualification) (5)
    - Second stage of tertiary education (leading to an advanced research qualification) (6)
- Industry = NACE industries (12 broad groups, included as dummies)
- Country = country dummies, only added in the EU regression.

Appendix C: Estimating Local Multipliers

To estimate local multipliers from high-tech employment we use the data described earlier in this Technical Appendix and the following regression equation:

$$\Delta\widetilde{LT}_{rt} = \alpha + \beta\Delta\widetilde{HT}_{rt} + \gamma_{ct} + \varepsilon_{rt}$$

where ▪ indicates absolute 5-year employment changes (t = 2000-2005 or 2005-2010) in region r. $\widetilde{HT}$ is high-tech employment (employment in STEM occupations in high-tech and non-high tech industries and non-STEM occupations in high-tech industries) and $\widetilde{LT}$ is employment in non-STEM occupations in non-high tech industries. We also include a country(c)-year(t) fixed effect, γ_{ct} , and the local multiplier is given by an estimate for β. This local multiplier estimates how many non-STEM jobs in non-high tech industries ("non-high tech jobs") are created locally due to the presence of one high-tech worker in the same region. However, the interpretation of the local multiplier that high-tech jobs create non-high tech jobs is no longer causal if, for example, there are regional level shocks that have an impact on both high-tech and

[30] This is only the case for Spain (2004-2005), Greece (2004-2006), Italy (2004-05-06) and Portugal (2004-2006).

non-high tech employment. A solution to this is to find an instrument for high-tech employment. We define this instrument as follows:

$$\Delta\widetilde{HT}_{rt} = \frac{\widetilde{HT}_{r(t-s)}}{\widetilde{HT}_{c(t-s)}}\left(\widetilde{HT}_{ct} - \widetilde{HT}_{c(t-s)}\right)$$

This instrument attributes a part $\frac{\widetilde{HT}_{r(t-s)}}{\widetilde{HT}_{c(t-s)}}$ of the national change in high-tech jobs to a region using the distribution of high-tech employment over the regions in the initial year. A similar instrument is used by Autor and Dorn (2013) in their analysis on the rise of low-skill service jobs in the US.[31]

The results for both the OLS regressions and the Instrumental Variable (IV) regressions are shown in the following table.

	OLS	IV
$\Delta\widetilde{HT}_{it}$	2.58^{***}	4.34^{***}

***All estimated coefficients are significant at the 1% level.

Our instrument differs from that used by Moretti (2010) in his paper on local multipliers for the US.[32] Moretti (2010) uses the following instrument for high-tech employment:

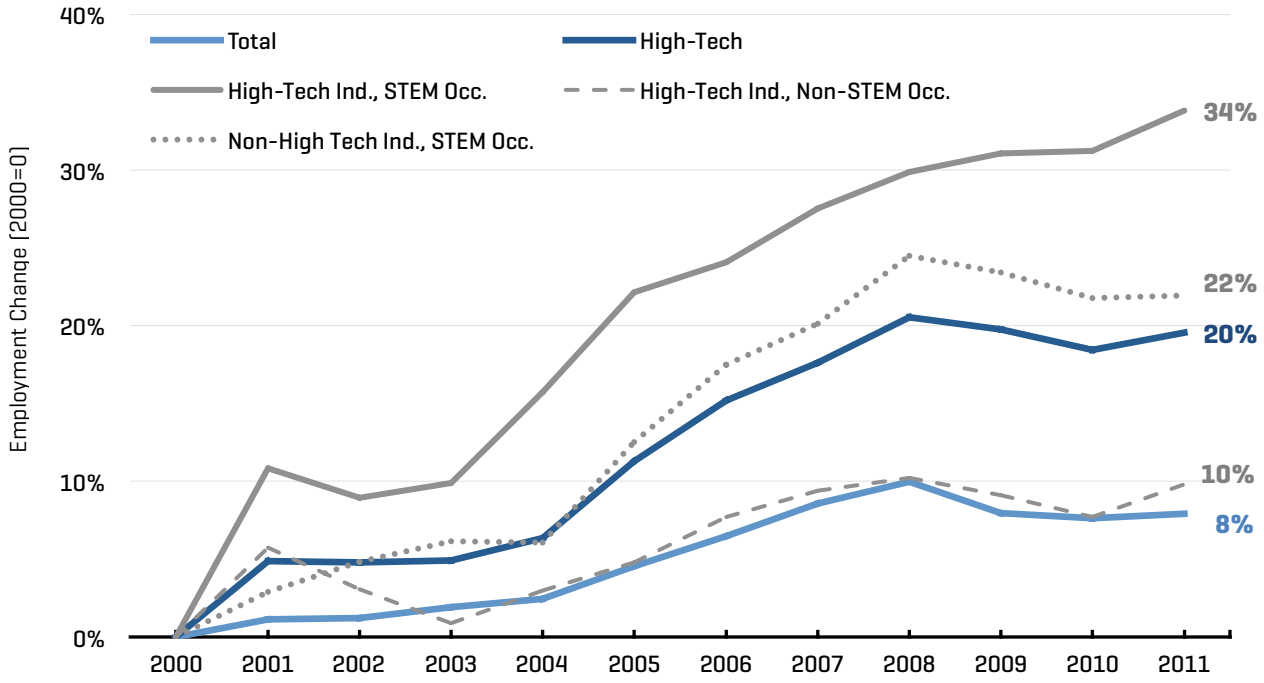
$$\Delta\log\left(HT_{irt}\right) = \sum_{i\in HT}\frac{E_{ir(t-s)}}{\sum_{i\in HT}E_{ir(t-s)}}\left(\log\left(E_{ict}\right) - \log\left(E_{ic(t-s)}\right)\right)$$

where E_{irt} is employment in an industry (i) in region (r) in any year (t) (where a metropolitan area defines a region). The instrument can be seen as a weighted average of region-level changes in industry employment. The weights represent the importance of a specific industry in total high-tech employment in a region. Note that this instrument is expressed in percentage changes, rather than absolute changes. To get the absolute changes, the estimated coefficient (β) has to be multiplied by $\frac{LT_{rt}}{HT_{rt}}$. This instrument cannot be used in our analysis since we do not have industry-level data at the regional level, which makes it impossible to split up high-tech employment into its industry component

[31] Autor and Dorn (2013), "Inequality and Specialization: The Growth of Low-Skilled Service Jobs in the United States", *American Economic Review*, 103(5), 1553-1597.
[32] Moretti (2010), "Local Multipliers," *American Economic Review: Papers & Proceedings*, Volume 100, Issue 2.

Appendix D: Detailed Employment Growth

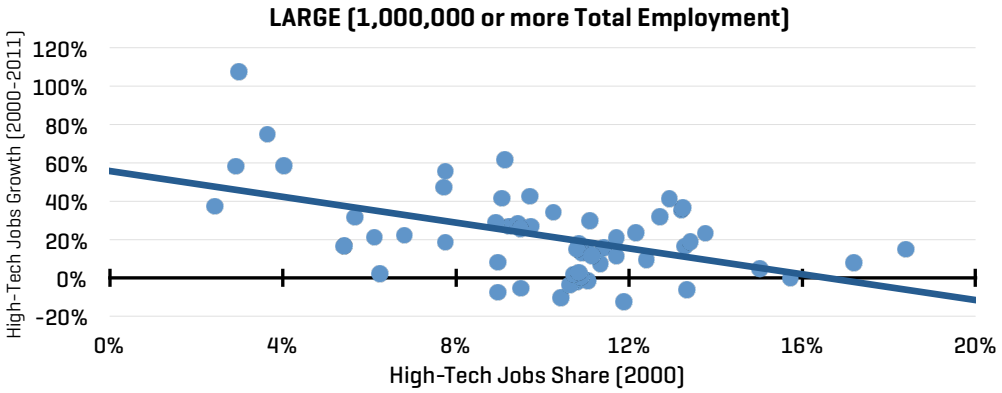
Figure D1:
EU-27 Employment Change versus 2000 by Sector and High-Tech Subgroup (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

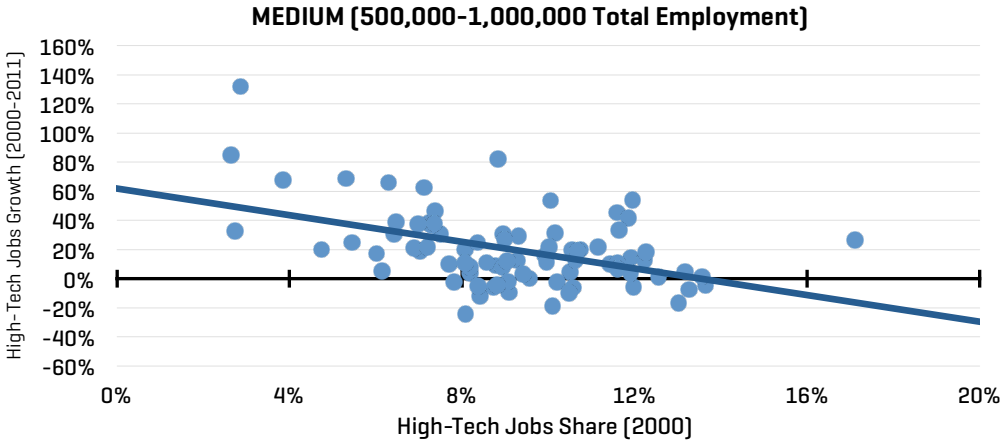
Appendix E: Employment Concentration and Growth Charts by Region Size

Figure E1:
High-Tech Employment Concentration and Growth by NUTS-2 Region (2000-2011)



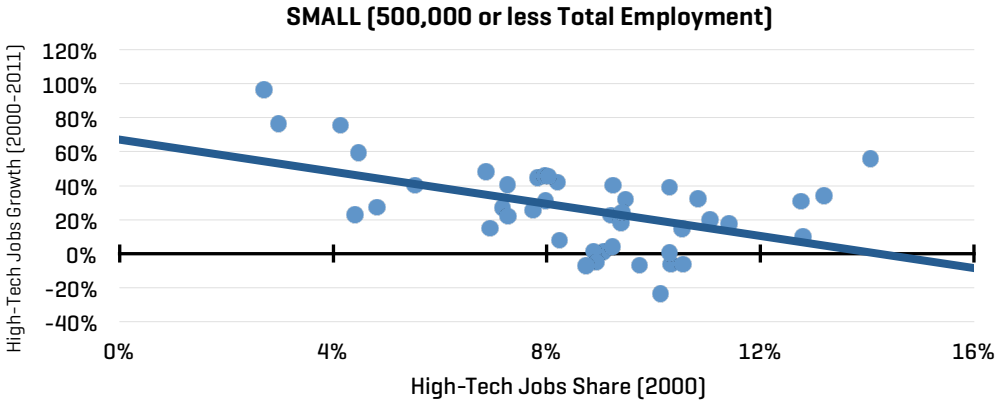
Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Figure E2:
High-Tech Employment Concentration and Growth by NUTS-2 Region (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Figure E3:
High-Tech Employment Concentration and Growth by NUTS-2 Region (2000-2011)



Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Appendix E: Detailed Employment Data Tables

Name	Country	High-Tech Employment (2011)		High-Tech Employment Change	
		Thousands	% of Total Emp.	2000-2011	2006-2011
European Union	**EU**	**21,802**	**10.0%**	**19.5%**	**3.8%**
Austria	AT	404	9.8%	22.4%	11.4%
Burgenland	AT	14	10.4%	22.6%	23.6%
Niederösterreich	AT	81	10.2%	16.0%	13.2%
Wien	AT	95	11.7%	1.1%	10.4%
Kärnten	AT	25	9.5%	31.0%	6.0%
Steiermark	AT	52	8.7%	38.5%	3.5%
Oberösterreich	AT	62	8.7%	30.6%	8.1%
Salzburg	AT	25	9.2%	40.5%	18.7%
Tirol	AT	31	8.7%	48.2%	12.7%
Vorarlberg	AT	18	9.8%	44.9%	25.4%
Belgium	BE	549	12.2%	22.3%	6.5%
Bruxelles / Brussels	BE	50	12.1%	39.2%	21.3%
Prov. Antwerpen	BE	91	12.3%	14.5%	-5.0%
Prov. Limburg	BE	43	11.6%	19.8%	11.2%
Prov. Oost-Vlaanderen	BE	81	12.6%	5.0%	-0.5%
Prov. Vlaams-Brabant	BE	80	16.5%	34.3%	15.1%
Prov. West-Vlaanderen	BE	47	9.3%	19.9%	-2.5%
Prov. Brabant Wallon	BE	23	14.9%	30.6%	2.3%
Prov. Hainaut	BE	50	10.6%	18.4%	6.7%
Prov. Liège	BE	47	11.6%	40.1%	13.5%
Prov. Luxembourg	BE	12	10.9%	32.1%	21.2%
Prov. Namur	BE	24	12.8%	32.5%	27.6%
Bulgaria	BG	223	7.6%	-	2.4%
Severozapaden	BG	17	5.7%	-	-23.4%
Severen tsentralen	BG	22	6.7%	-	11.5%
Severoiztochen	BG	23	6.1%	-	5.1%
Yugoiztochen	BG	22	5.3%	-	1.4%
Yugozapaden	BG	107	11.2%	-	13.3%
Yuzhen tsentralen	BG	32	5.7%	-	-14.4%
Cyprus	CY	23	6.1%	40.1%	11.4%
Kypros	CY	23	6.1%	40.1%	11.4%
Czech Republic	CZ	669	13.7%	24.7%	13.4%
Praha	CZ	131	20.2%	26.6%	16.9%
Střední Cechy	CZ	83	13.6%	82.1%	28.1%
Jihozápad	CZ	72	12.4%	19.7%	9.0%
Severozápad	CZ	58	11.4%	29.3%	20.0%
Severov_chod	CZ	92	13.3%	31.2%	14.1%
Jihov_chod	CZ	105	13.7%	12.9%	7.4%
Střední Morava	CZ	61	11.0%	-5.5%	-1.3%
Moravskoslezsko	CZ	66	12.1%	19.2%	11.1%
Denmark	DK	342	12.7%	9.0%	5.0%
Hovedstaden	DK	123	14.3%	-	-
Sjælland	DK	47	12.2%	-	-
Syddanmark	DK	64	11.5%	-	-
Midtjylland	DK	75	12.1%	-	-
Nordjylland	DK	33	12.1%	-	-
Estonia	EE	48	8.0%	4.1%	5.0%
Eesti	EE	48	8.0%	4.1%	5.0%
Finland	FI	331	13.4%	6.0%	-2.3%
Itä-Suomi	FI	25	9.3%	0.9%	-2.8%
Etelä-Suomi	FI	196	14.9%	4.8%	-1.9%

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations
Note: NUTS-2 figures may not sum to country totals because of rounding; data for some regions are not available

Name	Country	High-Tech Employment (2011)		High-Tech Employment Change	
		Thousands	% of Total Emp.	2000-2011	2006-2011
European Union	**EU**	**21,802**	**10.0%**	**19.5%**	**3.8%**
Länsi-Suomi	FI	73	12.0%	6.5%	-6.0%
Pohjois-Suomi	FI	37	13.2%	10.2%	1.5%
France	FR	3,197	12.4%	25.3%	9.7%
Île de France	FR	939	17.6%	8.0%	-0.1%
Picardie	FR	71	9.3%	36.7%	0.9%
Haute-Normandie	FR	89	12.1%	30.6%	13.3%
Centre	FR	115	10.8%	27.0%	-7.0%
Basse-Normandie	FR	53	8.8%	46.4%	8.2%
Bourgogne	FR	60	9.0%	8.7%	31.1%
Nord - Pas-de-Calais	FR	172	11.0%	55.7%	19.9%
Lorraine	FR	90	9.4%	11.0%	40.5%
Alsace	FR	119	13.8%	53.7%	31.2%
Franche-Comté	FR	55	10.6%	21.7%	3.5%
Pays de la Loire	FR	156	10.2%	29.0%	7.0%
Bretagne	FR	142	10.5%	28.3%	4.5%
Poitou-Charentes	FR	53	7.4%	19.0%	-4.8%
Aquitaine	FR	144	10.8%	27.0%	37.3%
Midi-Pyrénées	FR	194	15.4%	41.1%	28.6%
Rhône-Alpes	FR	390	14.9%	32.0%	21.5%
Auvergne	FR	52	9.0%	24.8%	-14.4%
Languedoc-Roussillon	FR	77	7.9%	37.9%	-8.9%
Provence-Alpes-Côte d'Azur	FR	228	11.4%	61.6%	19.6%
Germany	DE	4,782	12.0%	13.0%	2.6%
Stuttgart	DE	287	14.4%	16.6%	3.0%
Karlsruhe	DE	205	15.4%	23.3%	-3.3%
Freiburg	DE	173	13.8%	35.3%	9.8%
Tübingen	DE	141	14.7%	45.5%	23.9%
Oberbayern	DE	324	14.4%	19.0%	-5.1%
Oberpfalz	DE	84	12.1%	41.5%	11.7%
Mittelfranken	DE	115	13.6%	18.0%	-5.3%
Schwaben	DE	112	11.6%	21.6%	-9.5%
Berlin	DE	198	12.2%	9.5%	-9.1%
Brandenburg - Südwest	DE	62	9.0%	-	-
Hamburg	DE	146	16.1%	54.1%	31.9%
Darmstadt	DE	216	11.3%	-6.2%	-17.4%
Mecklenburg-Vorpommern	DE	84	10.8%	4.3%	63.1%
Braunschweig	DE	88	11.5%	10.2%	15.0%
Hannover	DE	121	11.2%	15.6%	11.6%
Lüneburg	DE	88	10.0%	13.0%	23.0%
Düsseldorf	DE	274	11.7%	12.9%	-3.4%
Köln	DE	260	13.0%	21.0%	9.0%
Münster	DE	138	10.8%	17.8%	-6.9%
Detmold	DE	113	12.0%	18.9%	9.0%
Arnsberg	DE	192	11.3%	13.4%	8.0%
Koblenz	DE	86	11.4%	-	38.5%
Rheinhessen-Pfalz	DE	111	11.6%	-	18.1%
Dresden	DE	94	12.3%	10.5%	-16.0%
Sachsen-Anhalt	DE	98	8.9%	-10.4%	21.9%
Schleswig-Holstein	DE	160	11.7%	11.3%	12.7%
Thüringen	DE	135	12.1%	14.9%	12.4%
Residual	DE	679	-	-	-
Greece	GR	247	6.0%	24.9%	-7.5%
Kentriki Makedonia	GR	40	5.9%	19.7%	-4.9%

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

Note: NUTS-2 figures may not sum to country totals because of rounding; data for some regions are not available

Name	Country	High-Tech Employment (2011)		High-Tech Employment Change	
		Thousands	% of Total Emp.	2000-2011	2006-2011
European Union	**EU**	**21,802**	**10.0%**	**19.5%**	**3.8%**
Dytiki Ellada	GR	14	5.5%	23.0%	-0.3%
Attiki	GR	107	7.0%	31.7%	-11.2%
Residual	GR	86	-	-	-
Hungary	HU	392	10.3%	19.7%	4.7%
Közép-Magyarország	HU	177	14.3%	23.5%	-0.6%
Közép-Dunántúl	HU	44	9.7%	-6.0%	10.4%
Nyugat-Dunántúl	HU	41	10.0%	25.7%	10.1%
Dél-Dunántúl	HU	28	8.4%	15.1%	-1.3%
Észak-Magyarország	HU	38	9.8%	27.0%	28.9%
Észak-Alföld	HU	33	6.6%	24.5%	-2.1%
Dél-Alföld	HU	31	6.4%	27.5%	10.9%
Ireland	IE	198	11.0%	13.3%	-2.9%
Border, Midland and Western	IE	47	10.3%	46.0%	17.2%
Southern and Eastern	IE	152	11.4%	7.1%	-6.8%
Italy	IT	2,229	9.7%	28.5%	0.7%
Piemonte	IT	213	11.2%	25.7%	-0.6%
Liguria	IT	68	10.4%	27.0%	11.3%
Lombardia	IT	537	12.4%	34.4%	3.2%
Provincia Autonoma Trento	IT	24	10.1%	42.0%	18.5%
Veneto	IT	222	10.2%	47.4%	7.3%
Friuli-Venezia Giulia	IT	47	9.0%	7.6%	-12.4%
Emilia-Romagna	IT	226	11.3%	41.7%	10.6%
Toscana	IT	131	8.3%	18.6%	-11.6%
Umbria	IT	29	7.8%	7.7%	3.1%
Marche	IT	57	8.6%	37.6%	-0.3%
Lazio	IT	278	12.2%	29.8%	1.3%
Abruzzo	IT	39	7.5%	10.1%	-1.3%
Campania	IT	118	7.4%	21.2%	-8.8%
Puglia	IT	78	6.2%	16.8%	10.5%
Calabria	IT	35	6.0%	5.5%	-5.0%
Sicilia	IT	86	5.9%	16.7%	-11.8%
Sardegna	IT	44	7.2%	21.2%	-1.2%
Latvia	LV	79	8.1%	30.5%	3.9%
Latvija	LV	79	8.1%	30.5%	3.9%
Lithuania	LI	90	6.6%	2.2%	-2.4%
Lietuva	LI	90	6.6%	2.2%	-2.4%
Luxembourg	LU	21	9.4%	45.3%	25.8%
Luxembourg	LU	21	9.4%	45.3%	25.8%
Malta	MT	17	10.3%	14.6%	8.3%
Malta	MT	17	10.3%	14.6%	8.3%
Netherlands	NL	834	10.0%	0.3%	2.0%
Groningen	NL	28	9.5%	0.6%	-1.9%
Friesland	NL	27	8.4%	1.4%	-2.1%
Drenthe	NL	22	9.2%	4.1%	2.5%
Overijssel	NL	56	9.6%	12.5%	9.5%
Gelderland	NL	102	9.9%	-2.0%	2.8%
Flevoland	NL	23	10.9%	17.7%	14.0%
Utrecht	NL	73	11.2%	4.2%	2.6%
Noord-Holland	NL	140	9.9%	-1.5%	2.9%
Zuid-Holland	NL	177	9.9%	-3.6%	-1.2%
Noord-Brabant	NL	131	10.4%	0.4%	3.2%
Limburg	NL	55	10.0%	-2.4%	-2.4%

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations
Note: NUTS-2 figures may not sum to country totals because of rounding; data for some regions are not available

Name	Country	High-Tech Employment (2011)		High-Tech Employment Change	
		Thousands	% of Total Emp.	2000-2011	2006-2011
European Union	**EU**	**21,802**	**10.0%**	**19.5%**	**3.8%**
Poland	PL	1,255	7.8%	-	15.3%
Lódzkie	PL	95	7.4%	-	19.9%
Mazowieckie	PL	274	10.9%	-	18.9%
Malopolskie	PL	100	7.5%	-	13.2%
Slaskie	PL	177	8.9%	-	13.7%
Lubelskie	PL	63	6.2%	-	27.6%
Podkarpackie	PL	53	6.2%	-	22.5%
Swietokrzyskie	PL	29	4.7%	-	18.6%
Podlaskie	PL	29	5.9%	-	24.3%
Wielkopolskie	PL	90	6.3%	-	6.2%
Zachodniopomorskie	PL	40	7.1%	-	-2.9%
Lubuskie	PL	29	6.6%	-	18.4%
Dolnoslaskie	PL	109	9.5%	-	18.1%
Kujawsko-Pomorskie	PL	55	7.0%	-	52.2%
Warminsko-Mazurskie	PL	33	6.1%	-	3.6%
Pomorskie	PL	79	9.6%	-	31.4%
Portugal	PT	268	5.6%	20.3%	-6.9%
Norte	PT	81	4.8%	58.2%	10.9%
Centro	PT	40	3.7%	37.1%	-5.5%
Lisboa	PT	114	9.3%	-5.3%	-22.3%
Residual	PT	32	-	-	-
Romania	RO	632	6.9%	-	4.9%
Nord-Vest	RO	67	5.9%	-	29.5%
Centru	RO	63	6.8%	-	-13.1%
Nord-Est	RO	73	4.3%	-	1.2%
Sud-Est	RO	56	5.2%	-	1.3%
Sud - Muntenia	RO	71	5.6%	-	-3.7%
Bucuresti - Ilfov	RO	162	15.7%	-	7.0%
Sud-Vest Oltenia	RO	65	6.5%	-	17.5%
Vest	RO	76	9.6%	-	41.7%
Slovakia	SK	253	10.8%	31.5%	16.6%
Bratislavsk_ kraj	SK	68	20.4%	55.9%	63.0%
Západné Slovensko	SK	84	10.0%	62.5%	3.6%
Stredné Slovensko	SK	48	8.6%	0.1%	6.5%
V_chodné Slovensko	SK	54	9.0%	12.1%	12.2%
Slovenia	SI	106	11.3%	53.0%	13.4%
Vzhodna Slovenija	SI	49	10.1%	-	7.8%
Zahodna Slovenija	SI	57	12.7%	-	18.7%
Spain	ES	1,312	7.3%	50.7%	-1.1%
Galicia	ES	62	5.7%	107.4%	18.8%
Principado de Asturias	ES	26	6.5%	75.4%	-0.7%
Cantabria	ES	12	5.1%	-	16.2%
País Vasco	ES	89	9.5%	66.1%	7.9%
Comunidad Foral de Navarra	ES	17	6.3%	59.4%	3.5%
Aragón	ES	43	8.0%	68.5%	18.1%
Comunidad de Madrid	ES	396	14.0%	36.8%	2.3%
Castilla y León	ES	57	5.8%	67.9%	13.5%
Castilla-la Mancha	ES	41	5.3%	132.0%	46.0%
Extremadura	ES	18	4.7%	76.5%	18.0%
Cataluña	ES	230	7.5%	22.3%	-13.7%
Comunidad Valenciana	ES	104	5.5%	58.6%	-12.1%
Illes Balears	ES	21	4.5%	96.1%	9.1%

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations
Note: NUTS-2 figures may not sum to country totals because of rounding; data for some regions are not available

Name	Country	High-Tech Employment (2011)		High-Tech Employment Change	
		Thousands	% of Total Emp.	2000-2011	2006-2011
European Union	**EU**	**21,802**	**10.0%**	**19.5%**	**3.8%**
Andalucía	ES	147	5.3%	75.2%	0.2%
Región de Murcia	ES	16	3.0%	32.7%	-48.2%
Canarias	ES	33	4.2%	84.8%	-14.5%
Sweden	SE	592	12.7%	9.5%	9.5%
Stockholm	SE	197	18.0%	14.8%	19.1%
Östra Mellansverige	SE	90	12.1%	-4.6%	-0.4%
Småland med öarna	SE	33	8.3%	22.3%	6.2%
Sydsverige	SE	85	12.8%	33.4%	23.8%
Västsverige	SE	113	12.0%	1.5%	2.6%
Norra Mellansverige	SE	31	8.1%	-5.1%	-3.7%
Mellersta Norrland	SE	16	9.5%	-6.2%	-6.9%
Övre Norrland	SE	26	10.6%	24.3%	9.2%
United Kingdom	UK	2,709	9.3%	1.2%	-2.5%
Tees Valley and Durham	UK	36	7.3%	-11.6%	-18.4%
Northumberland and Tyne and Wear	UK	47	7.5%	-5.9%	-18.1%
Cheshire	UK	42	8.9%	-6.7%	-0.7%
Greater Manchester	UK	112	9.2%	8.1%	1.1%
Lancashire	UK	53	7.8%	-9.7%	8.0%
Merseyside	UK	41	7.3%	-2.4%	-4.5%
North Yorkshire	UK	29	7.6%	-7.3%	5.8%
South Yorkshire	UK	48	8.2%	38.6%	-3.8%
West Yorkshire	UK	85	8.5%	21.5%	8.2%
Derbyshire and Nottinghamshire	UK	80	8.3%	7.9%	-8.2%
Leicestershire, Rutland and Northamptonshire	UK	75	9.2%	3.4%	1.6%
Herefordshire, Worcestershire and Warwickshire	UK	53	8.6%	-1.9%	-7.3%
Shropshire and Staffordshire	UK	60	8.2%	-4.4%	-9.9%
West Midlands	UK	90	8.0%	-7.4%	-13.4%
East Anglia	UK	115	10.0%	1.9%	-9.0%
Bedfordshire and Hertfordshire	UK	101	11.9%	-7.4%	7.0%
Essex	UK	84	10.1%	11.3%	6.9%
Inner London	UK	178	11.5%	42.5%	18.4%
Outer London	UK	264	11.5%	11.5%	16.7%
Berkshire, Buckinghamshire and Oxfordshire	UK	178	13.6%	-0.1%	3.1%
Surrey, East and West Sussex	UK	130	10.6%	-12.5%	-15.8%
Hampshire and Isle of Wight	UK	95	11.4%	-16.5%	-15.6%
Kent	UK	74	10.1%	-6.2%	1.0%
Gloucestershire, Wiltshire and Bristol/Bath area	UK	124	10.6%	2.8%	3.8%
Dorset and Somerset	UK	46	8.8%	-5.2%	-10.1%
Devon	UK	36	7.6%	-23.4%	-20.0%
West Wales and The Valleys	UK	45	5.7%	-24.4%	-25.6%
East Wales	UK	44	8.4%	10.7%	-6.8%
Eastern Scotland	UK	75	8.7%	-18.7%	-18.7%
South Western Scotland	UK	86	8.9%	-9.8%	-6.1%
North Eastern Scotland	UK	33	8.7%	-	-
Northern Ireland	UK	48	5.9%	17.1%	1.9%
Residual	UK	100	-	-	-

Source: Eurostat, EULFS; ONS, UKLFS; authors' calculations

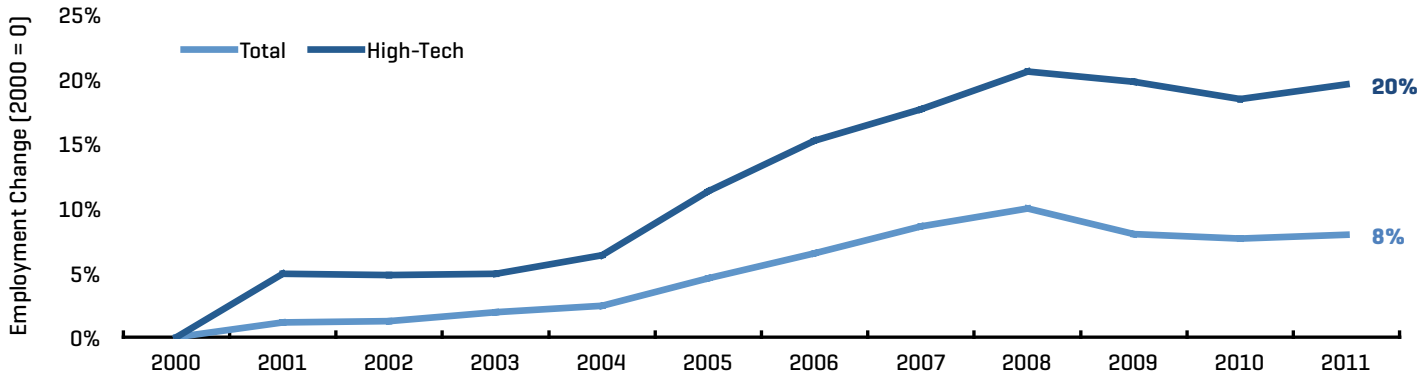
Note: NUTS-2 figures may not sum to country totals because of rounding; data for some regions are not available

Country Profile:

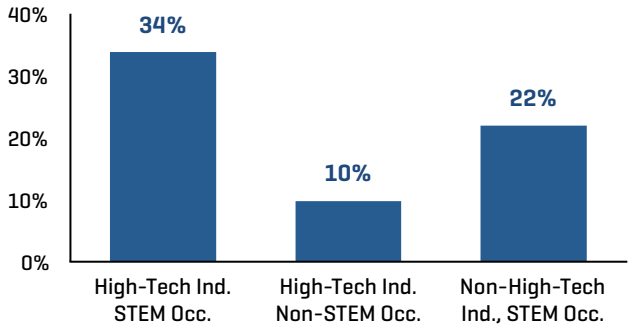
EUROPEAN UNION

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
21.7 MILLION	10.0 PERCENT	20 PERCENT

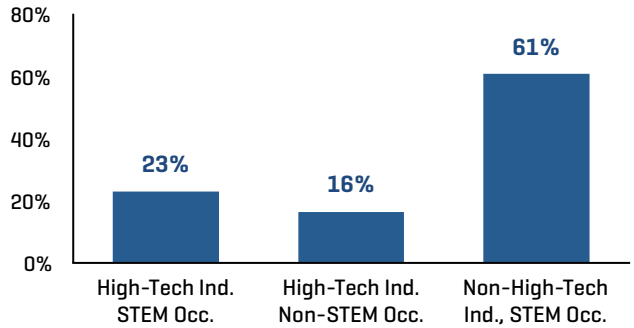
Employment Change versus 2000



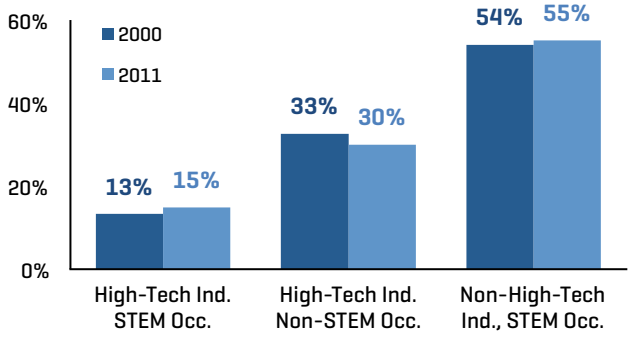
Emp. Change, High-Tech Components (2000 - 2011)



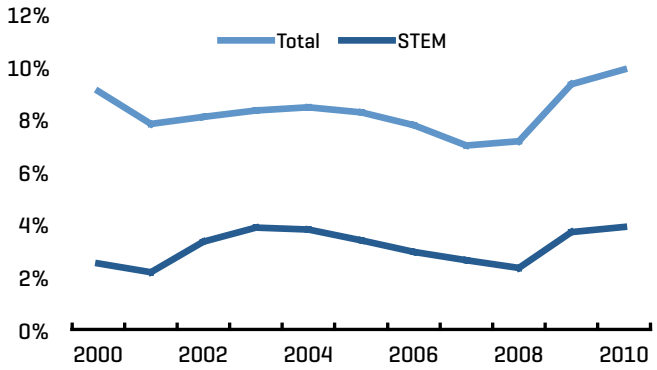
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



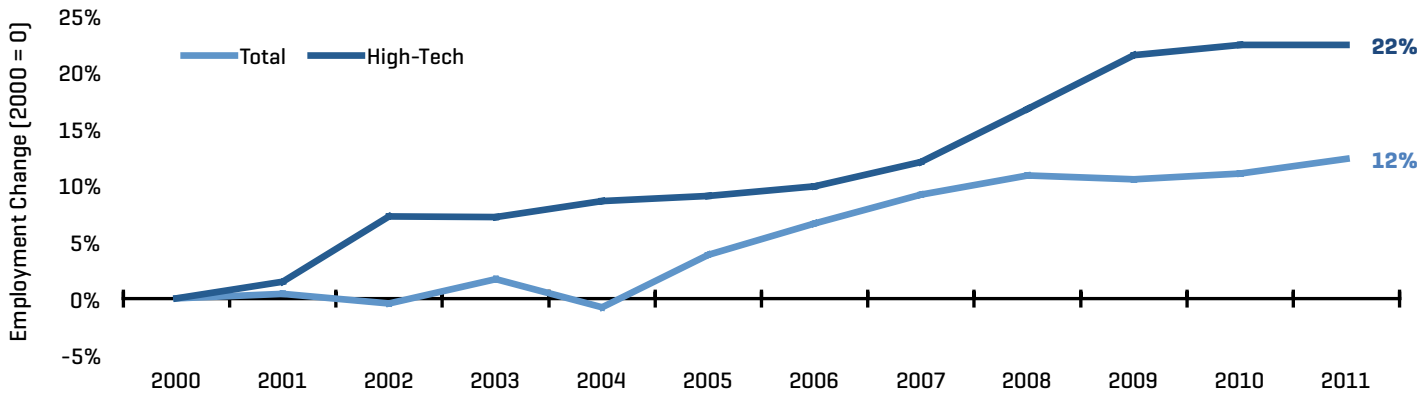
Sources: Eurostat, EULFS; ONS, UKLFS; authors' calculation

Country Profile:

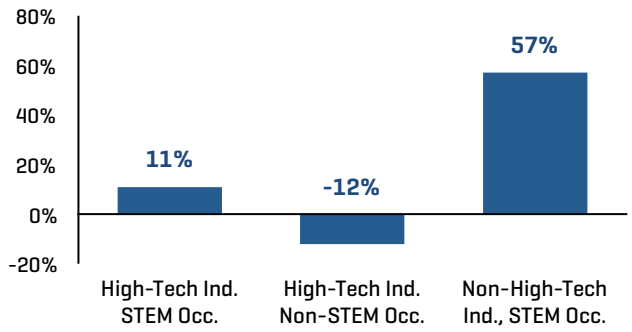
AUSTRIA

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
404 THOUSAND	9.8 PERCENT	22 PERCENT

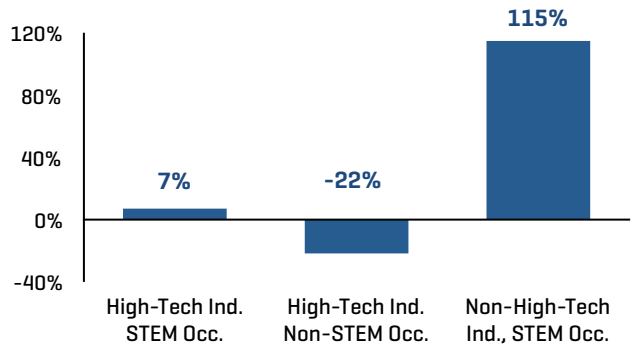
Employment Change versus 2000



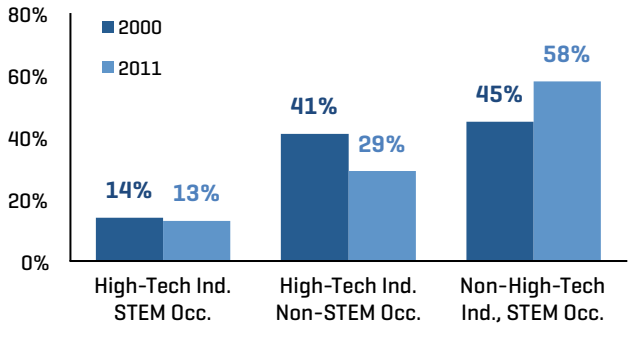
Emp. Change, High-Tech Components (2000 - 2011)



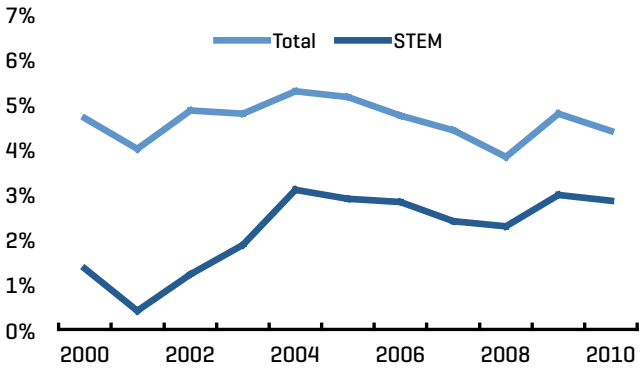
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



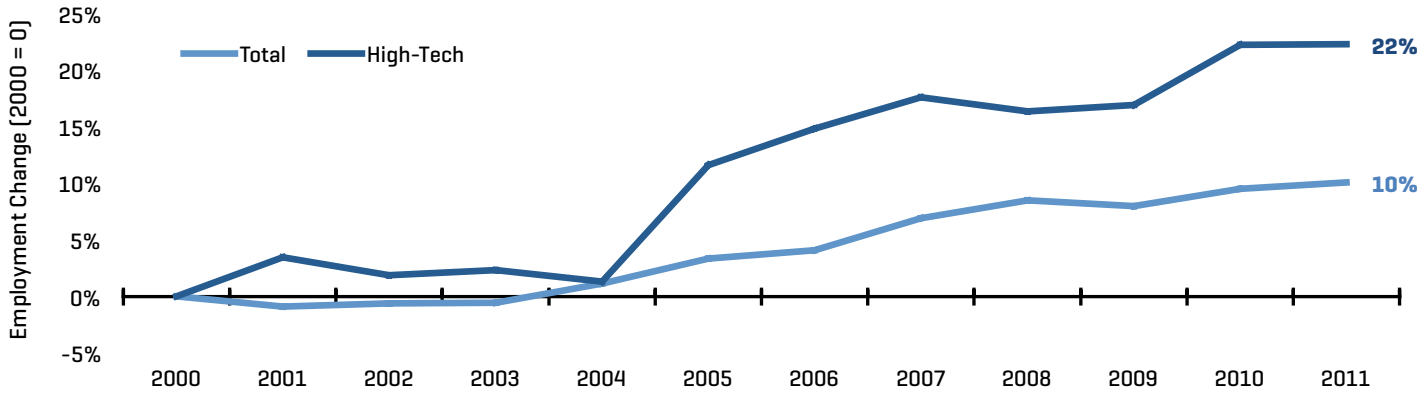
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

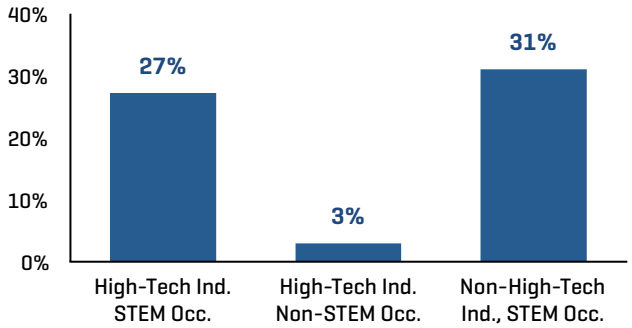
BELGIUM

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
549 THOUSAND	12.2 PERCENT	22 PERCENT

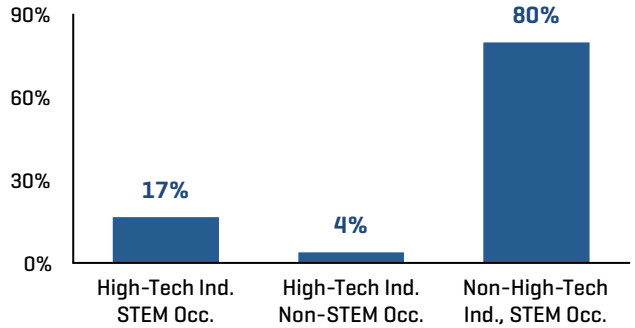
Employment Change versus 2000



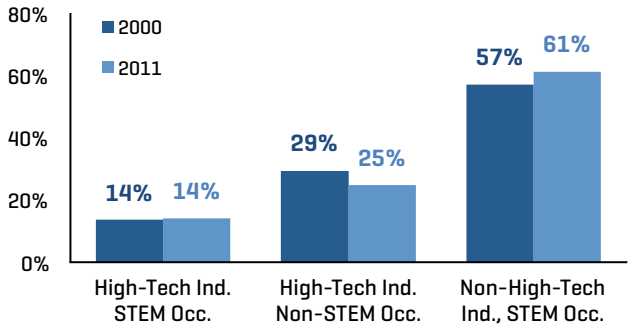
Emp. Change, High-Tech Components (2000 - 2011)



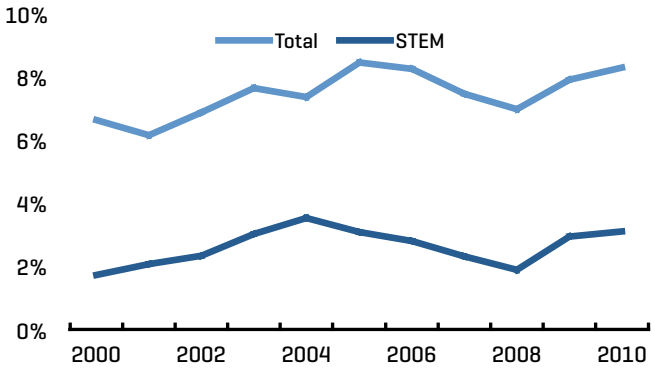
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



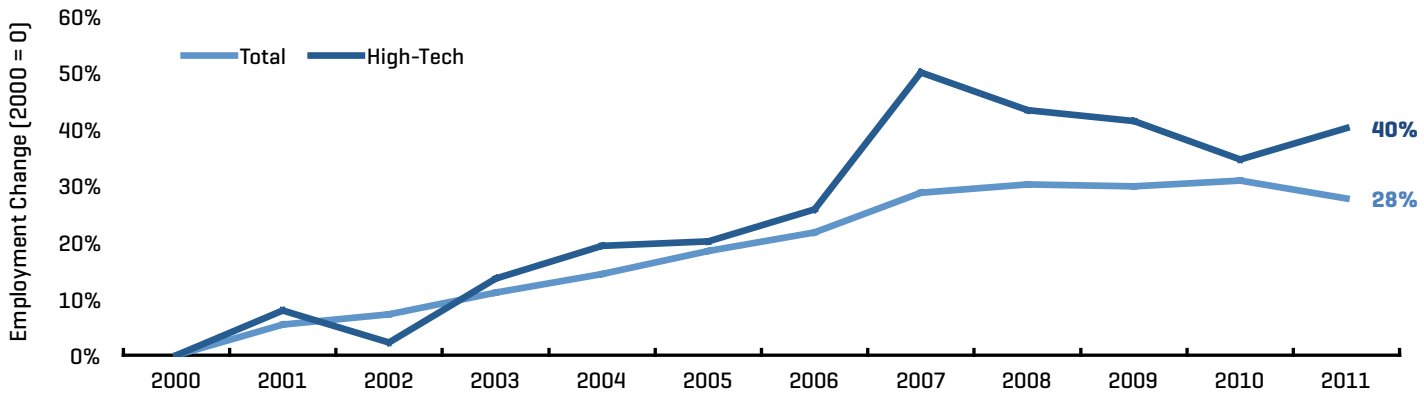
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

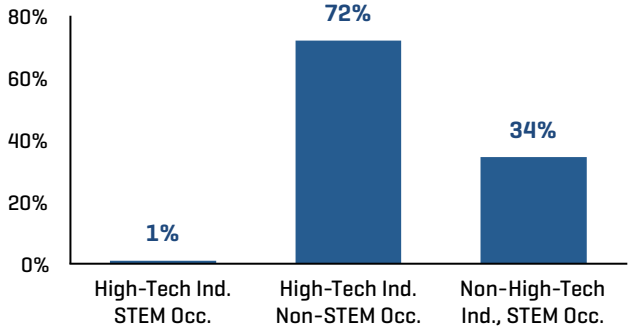
CYPRUS

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
23 THOUSAND	6.1 PERCENT	40 PERCENT

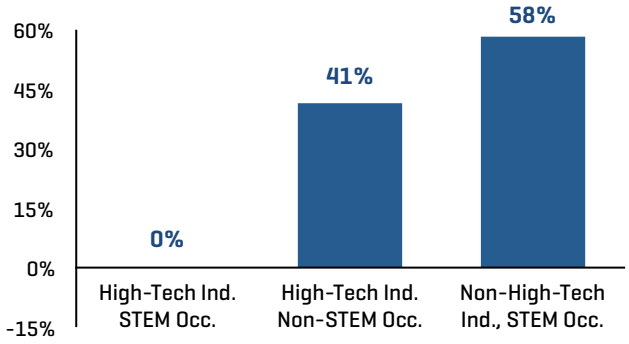
Employment Change versus 2000



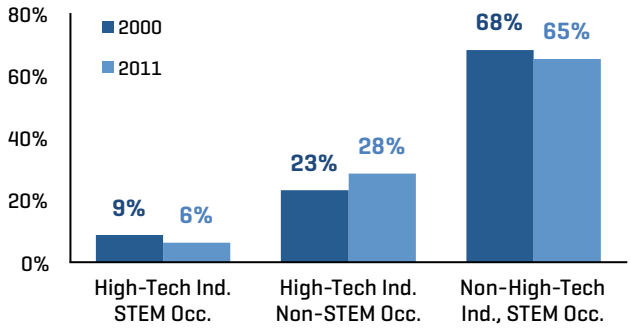
Emp. Change, High-Tech Components (2000 - 2011)



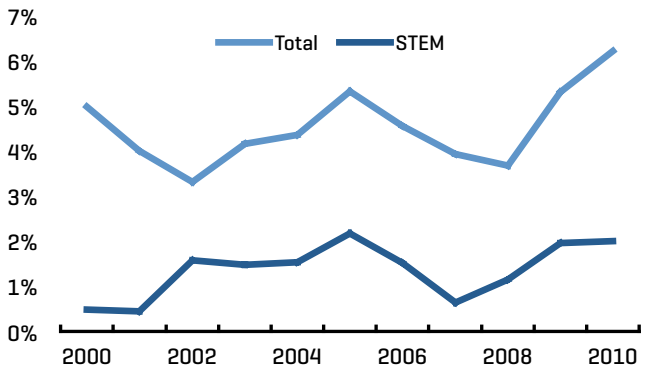
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



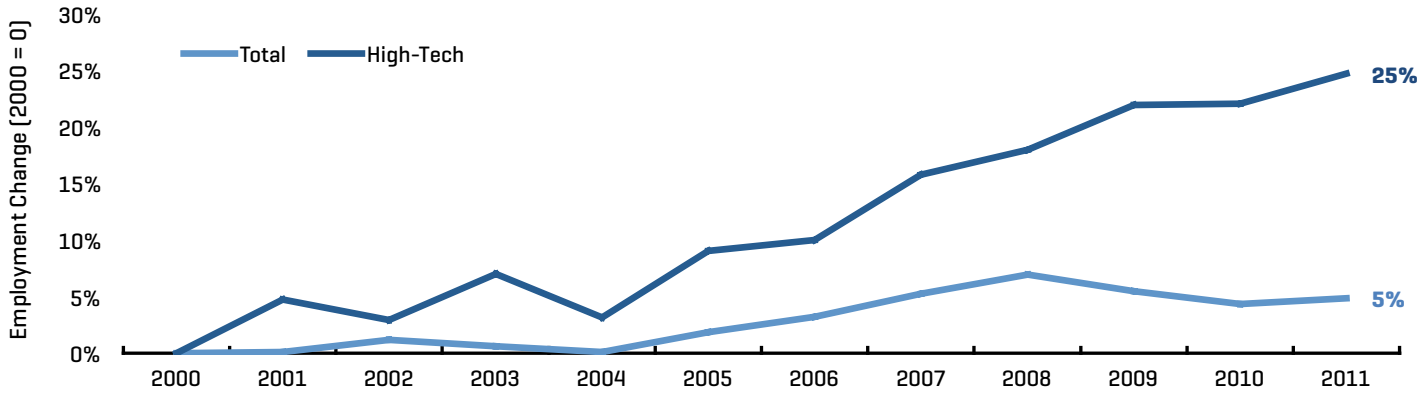
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

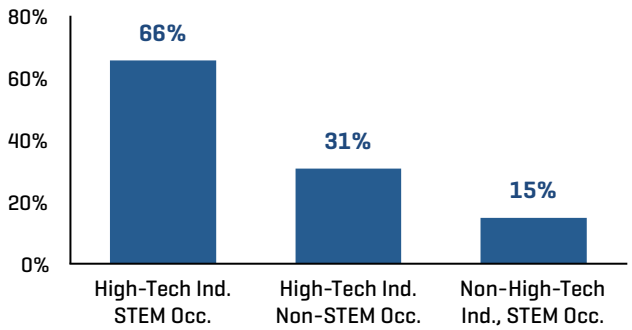
CZECH REPUBLIC

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
669 THOUSAND	13.7 PERCENT	25 PERCENT

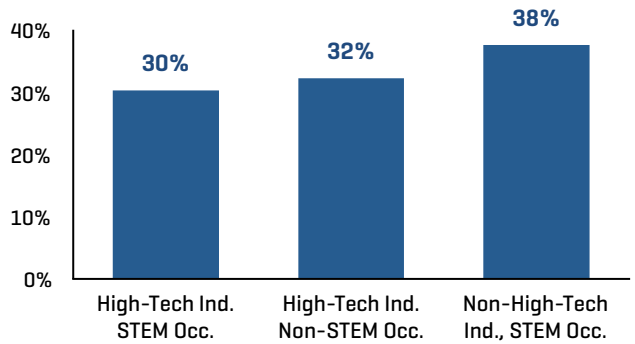
Employment Change versus 2000



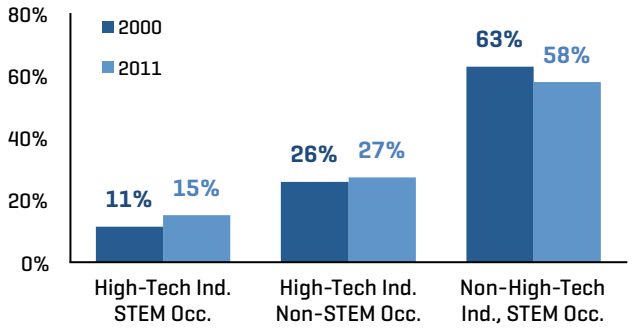
Emp. Change, High-Tech Components (2000 - 2011)



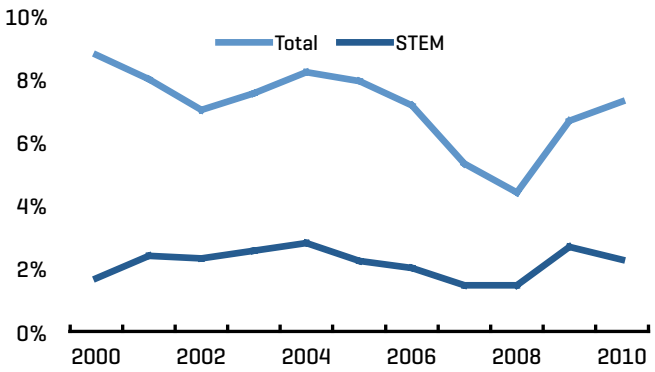
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



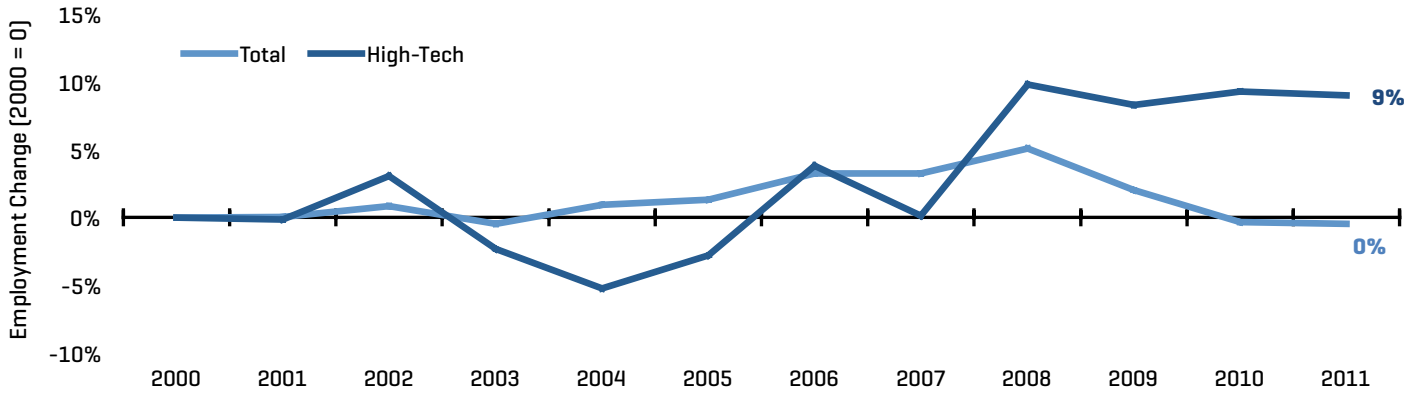
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

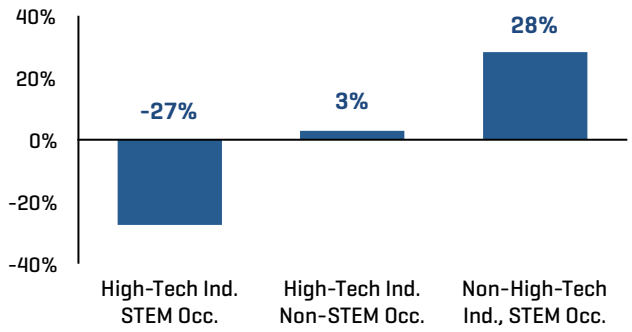
DENMARK

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
342 THOUSAND	12.7 PERCENT	9 PERCENT

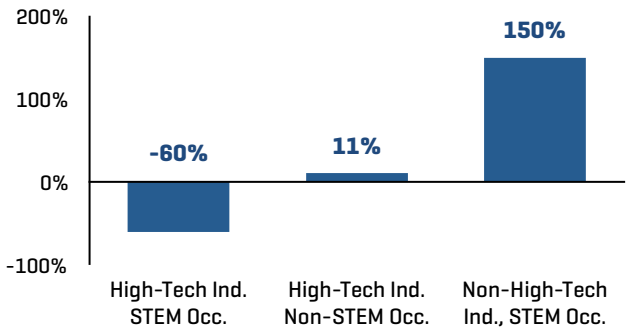
Employment Change versus 2000



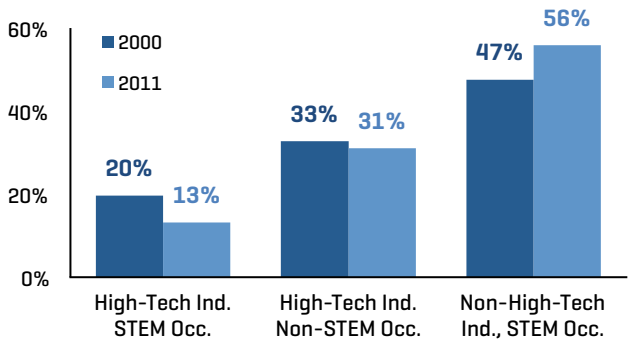
Emp. Change, High-Tech Components (2000 - 2011)



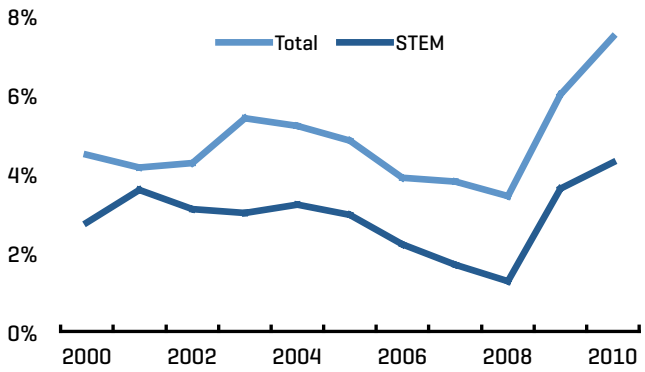
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



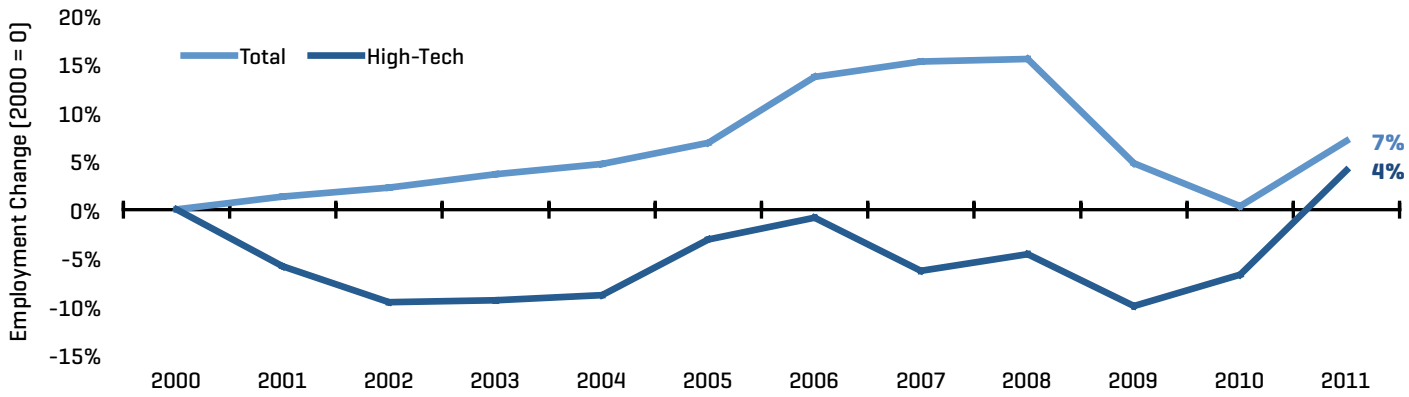
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

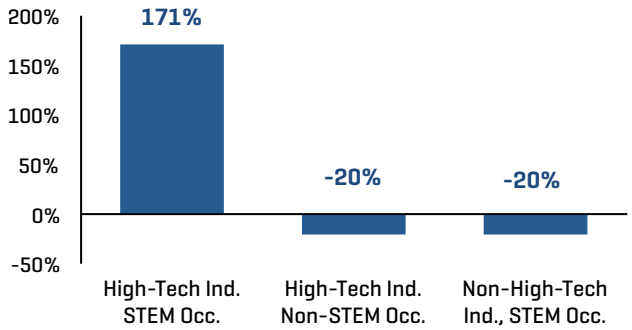
ESTONIA

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
48 THOUSAND	8.0 PERCENT	4 PERCENT

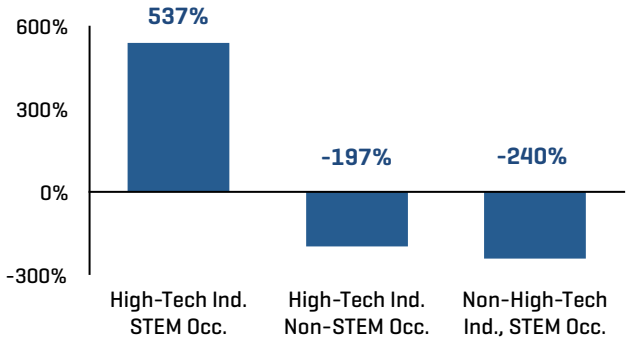
Employment Change versus 2000



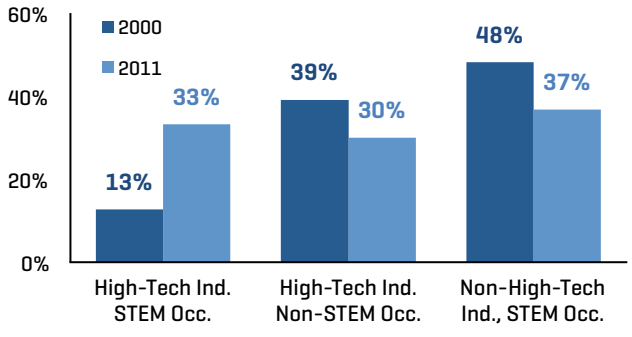
Emp. Change, High-Tech Components (2000 - 2011)



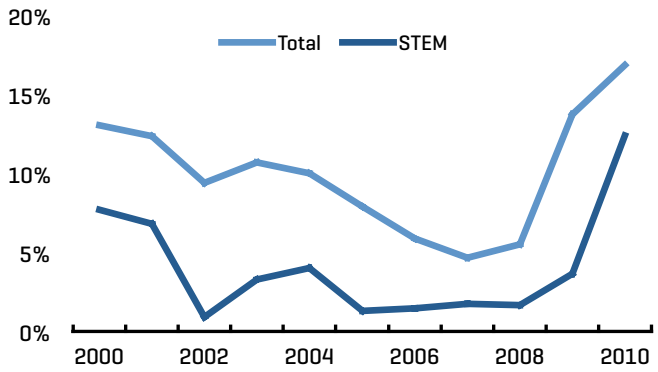
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



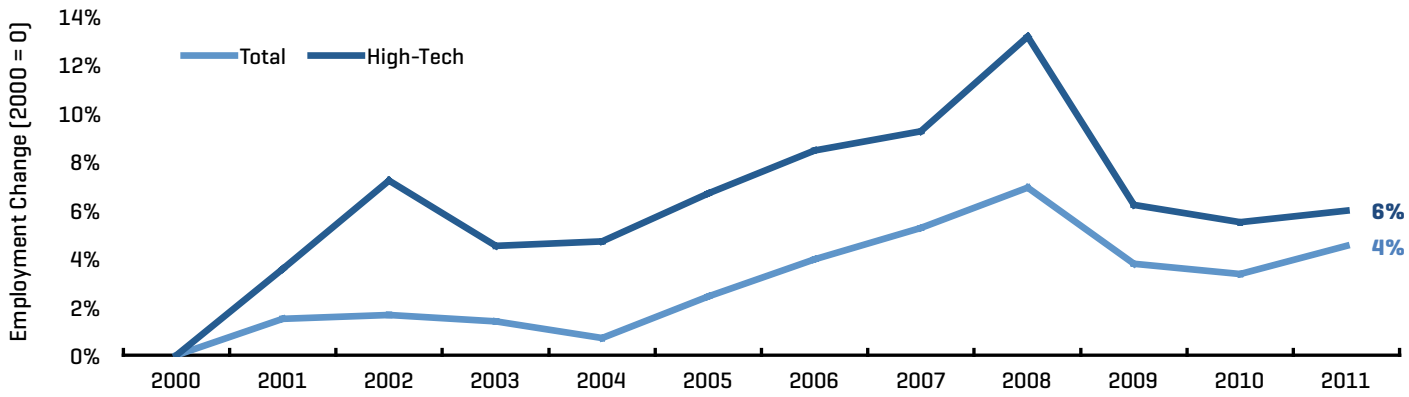
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

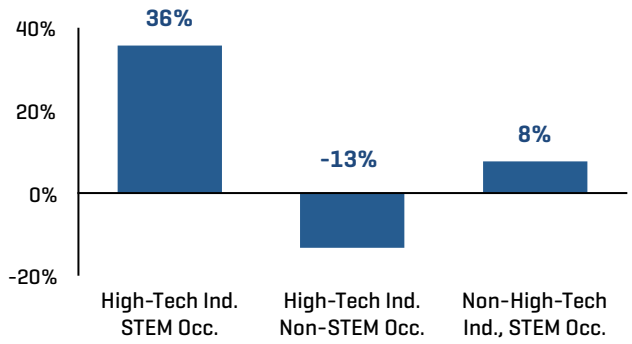
FINLAND

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
331 THOUSAND	13.4 PERCENT	6 PERCENT

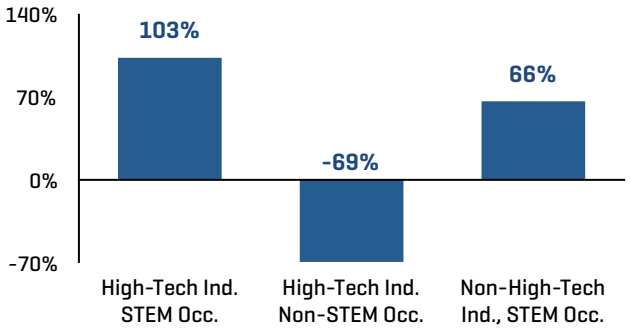
Employment Change versus 2000



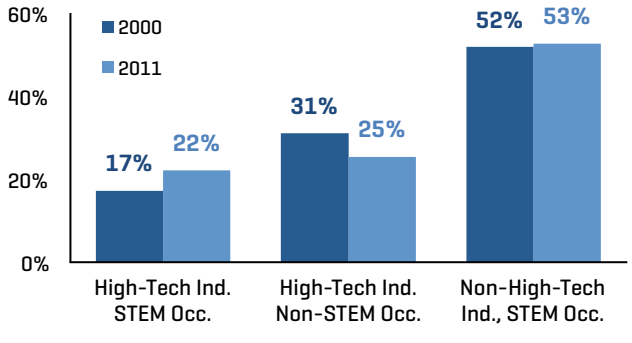
Emp. Change, High-Tech Components (2000 - 2011)



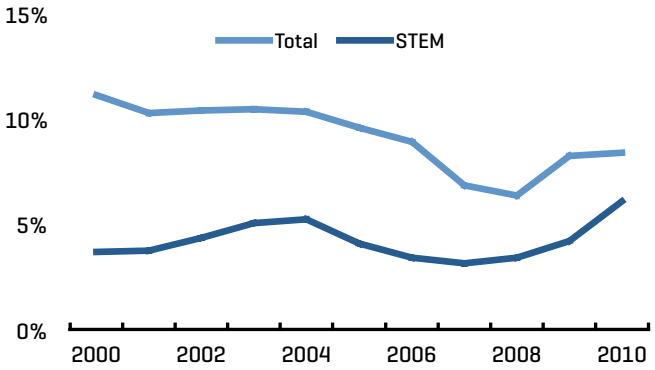
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



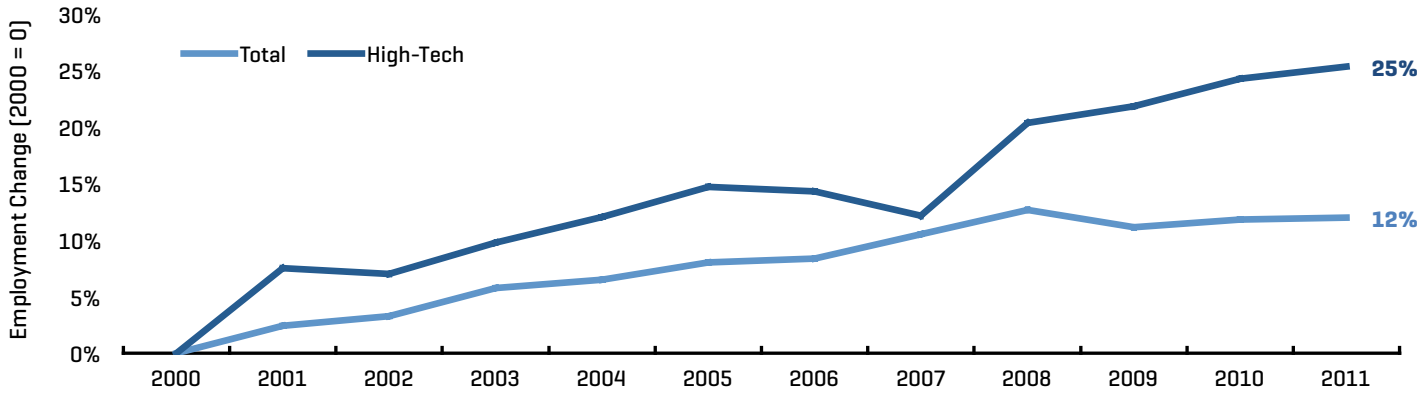
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

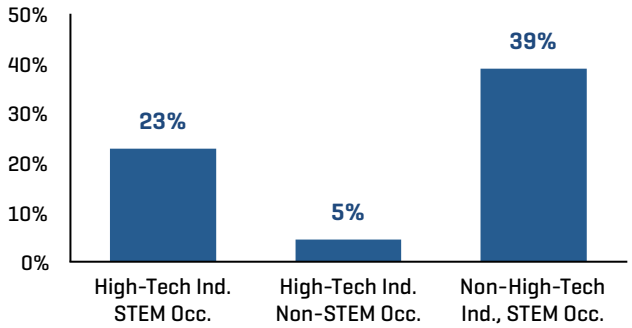
FRANCE

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
3.20 MILLION	12.4 PERCENT	25 PERCENT

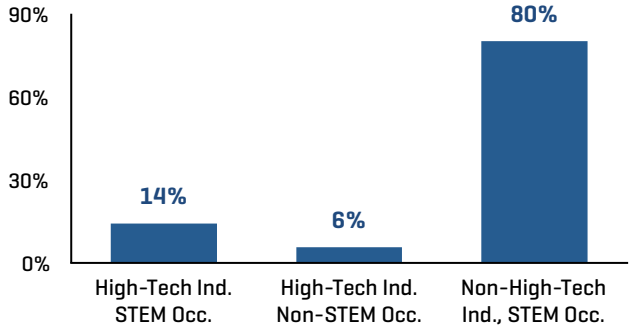
Employment Change versus 2000



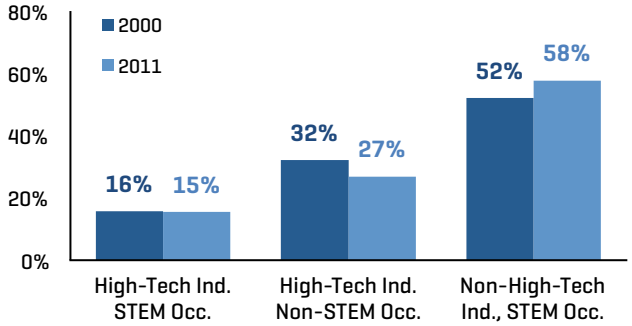
Emp. Change, High-Tech Components (2000 - 2011)



Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



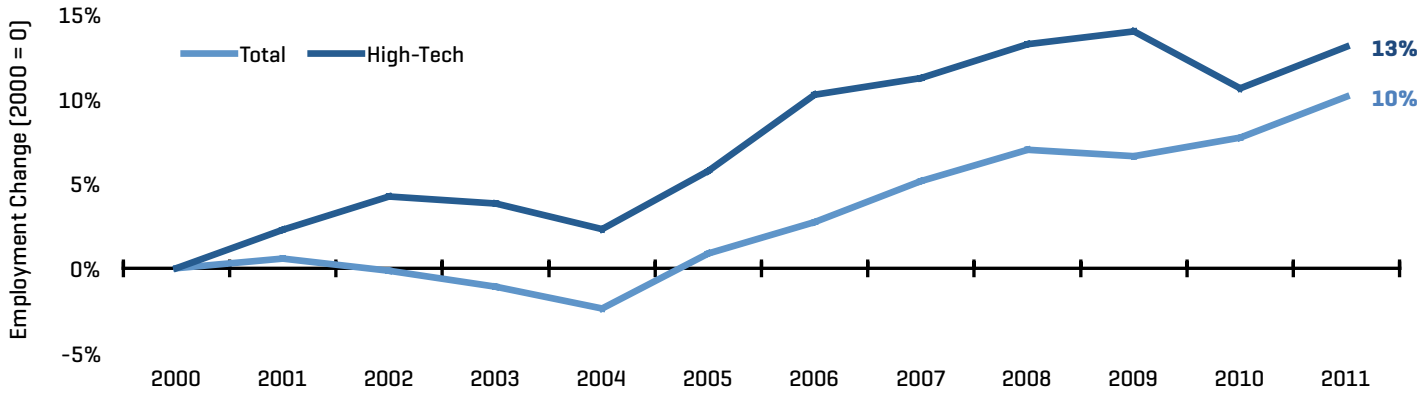
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

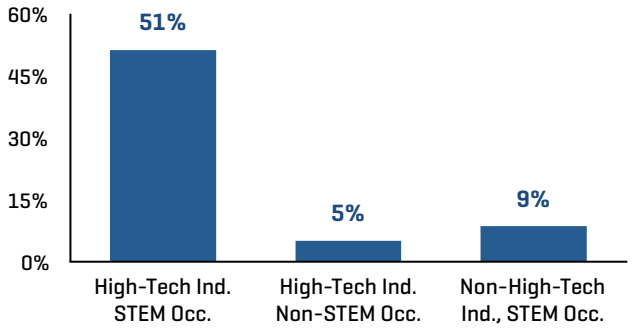
GERMANY

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
4.78 MILLION	12.0 PERCENT	13 PERCENT

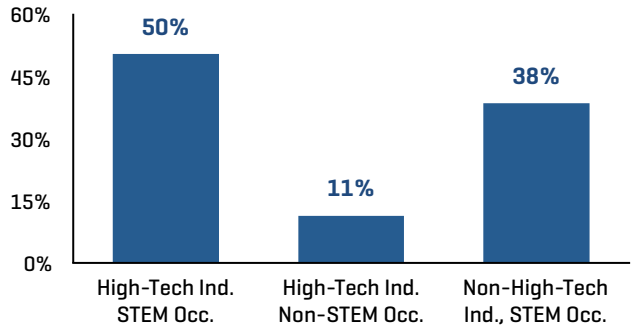
Employment Change versus 2000



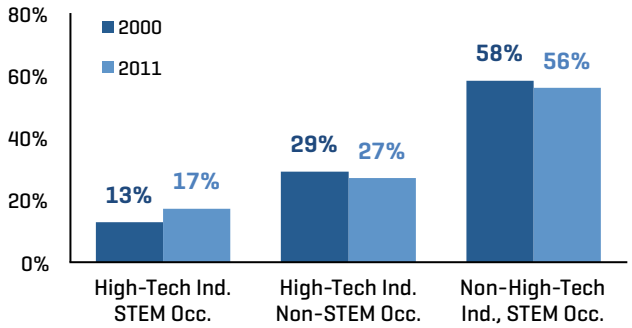
Emp. Change, High-Tech Components (2000 - 2011)



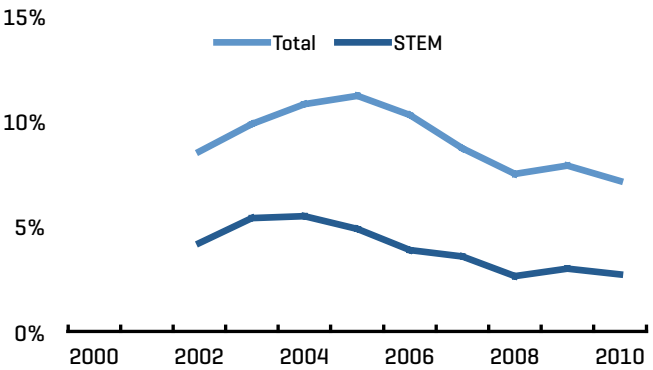
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



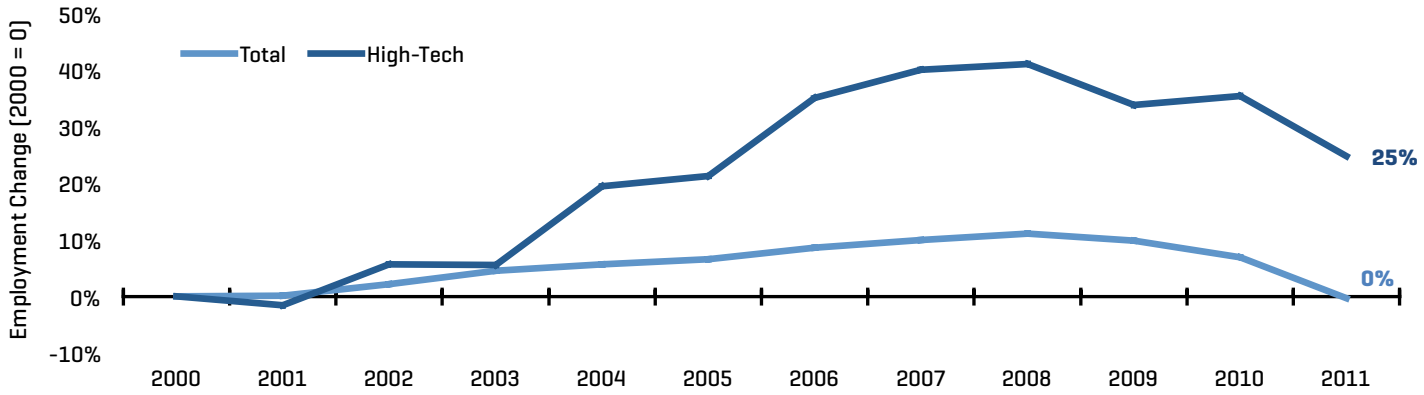
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

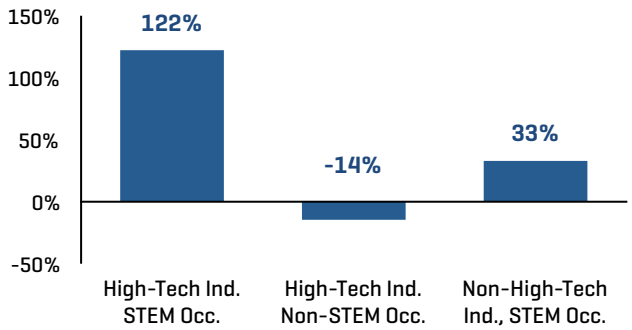
GREECE

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
247 THOUSAND	6.0 PERCENT	25 PERCENT

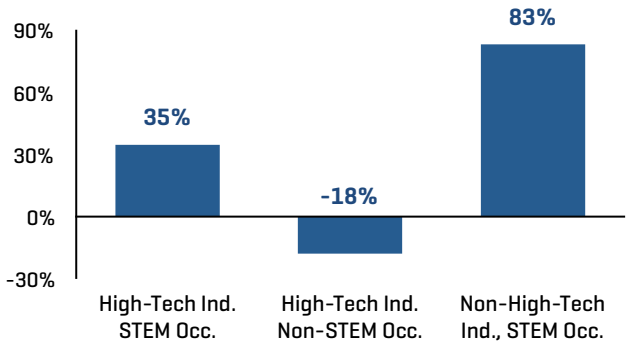
Employment Change versus 2000



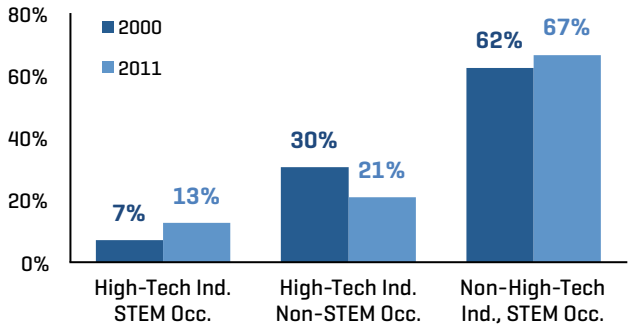
Emp. Change, High-Tech Components (2000 - 2011)



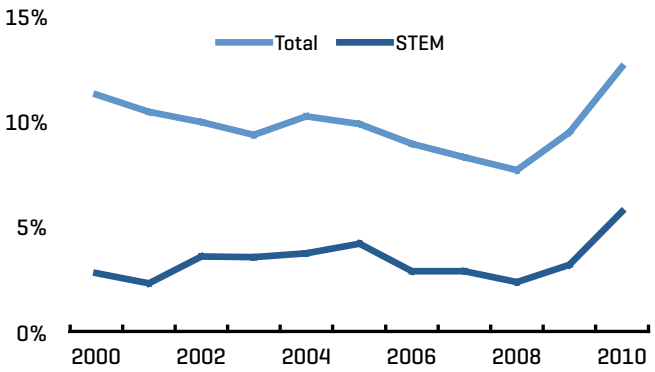
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



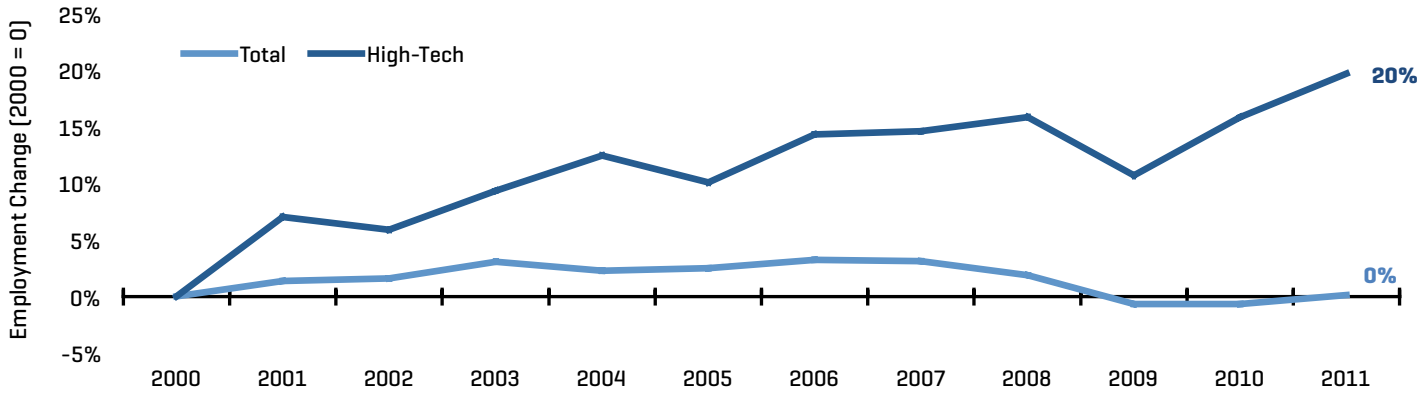
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

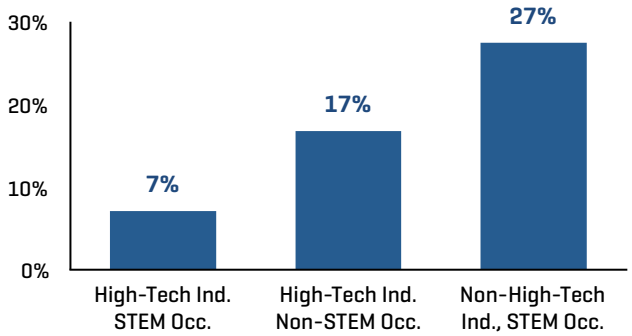
HUNGARY

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
392 THOUSAND	10.3 PERCENT	20 PERCENT

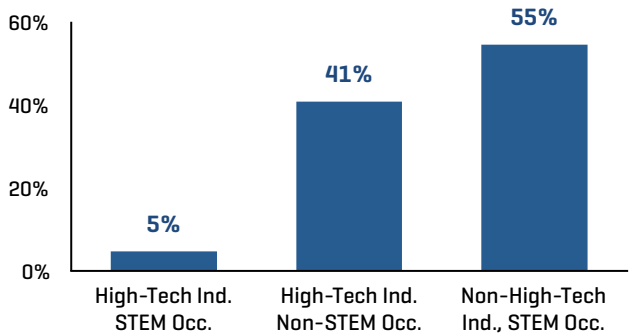
Employment Change versus 2000



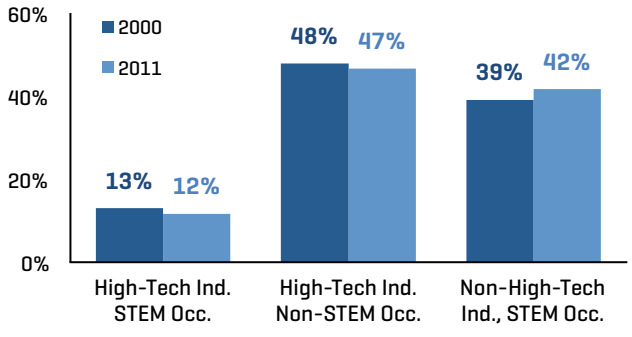
Emp. Change, High-Tech Components (2000 - 2011)



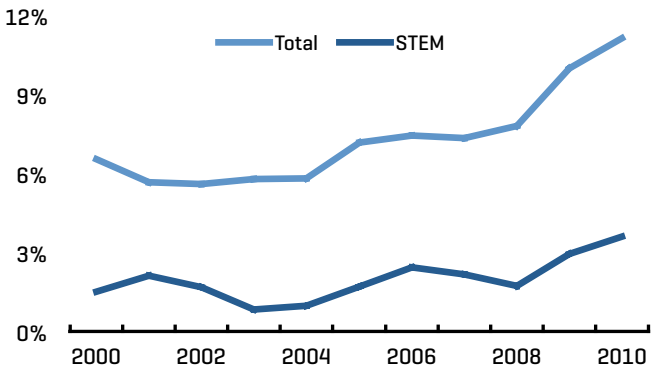
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



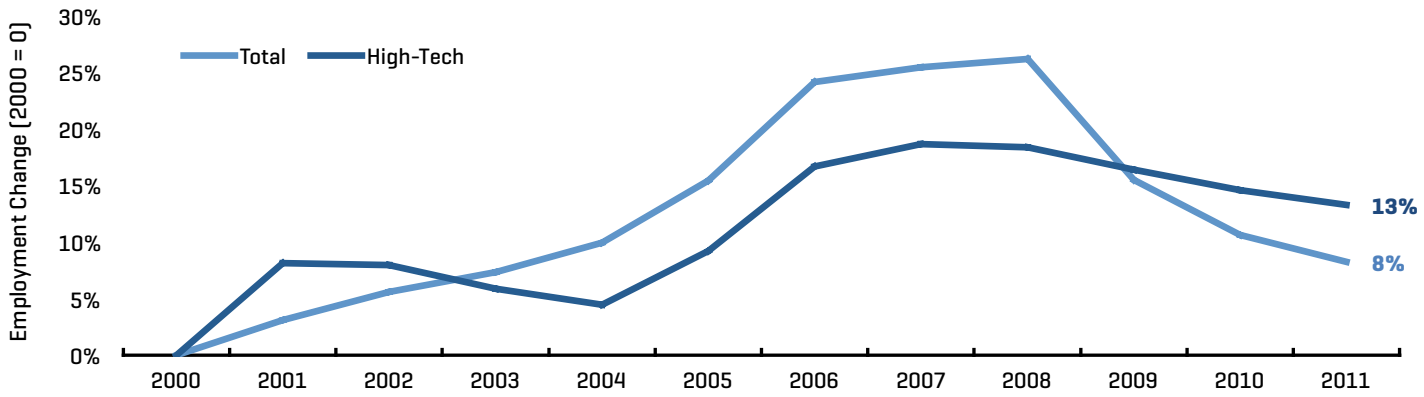
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

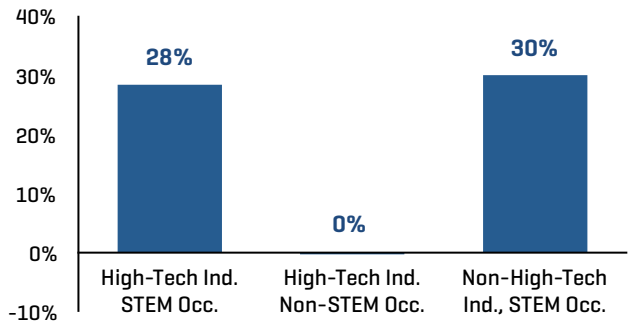
IRELAND

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
198 THOUSAND	11.0 PERCENT	13 PERCENT

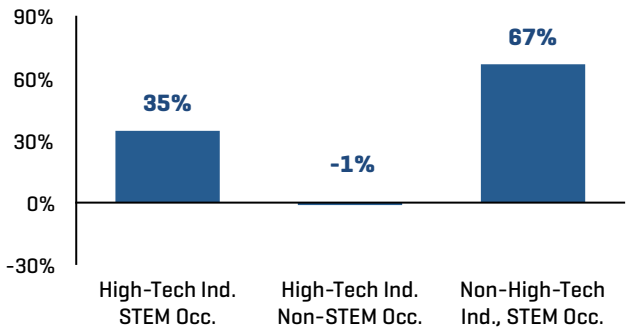
Employment Change versus 2000



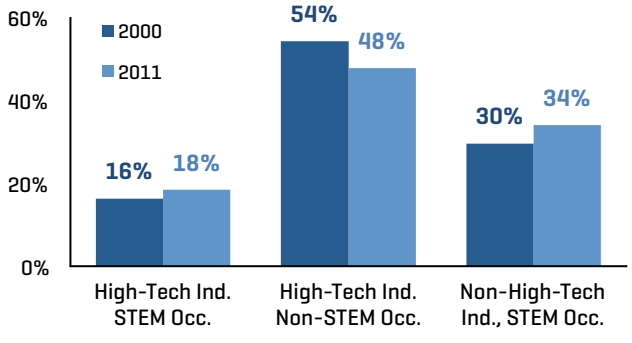
Emp. Change, High-Tech Components (2000 - 2011)



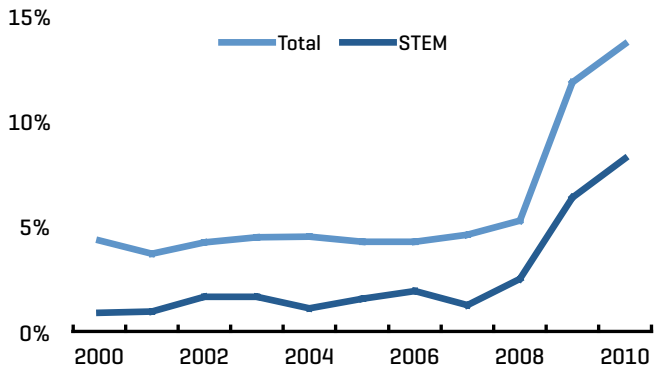
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



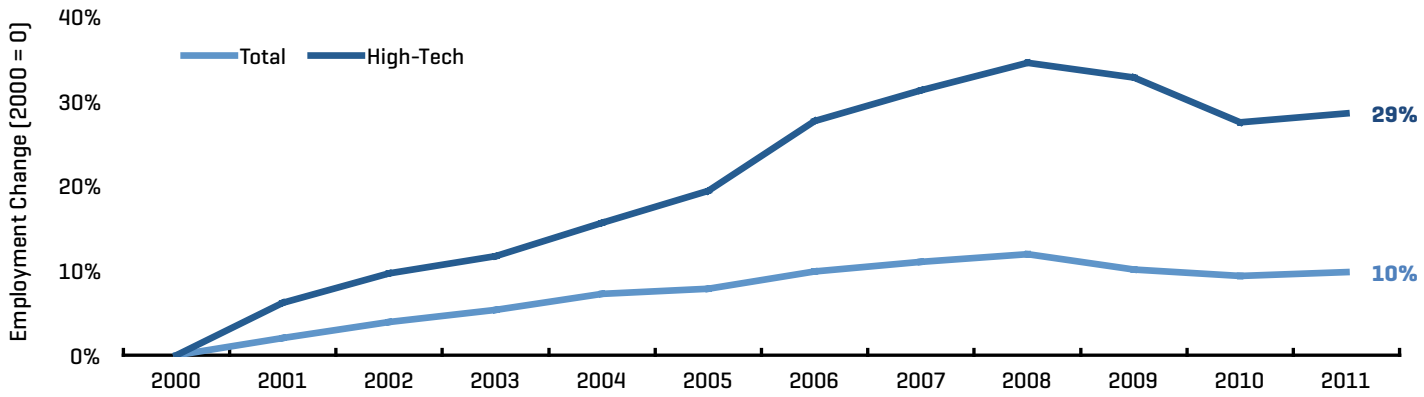
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

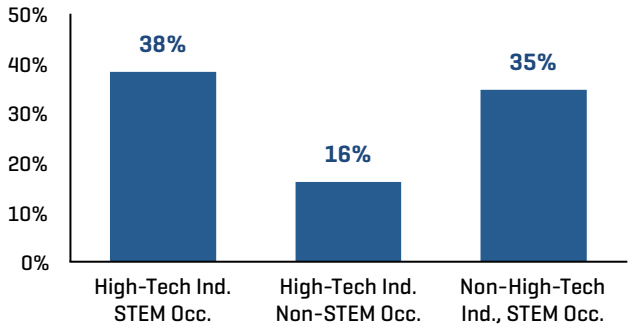
ITALY

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
2.23 MILLION	9.7 PERCENT	29 PERCENT

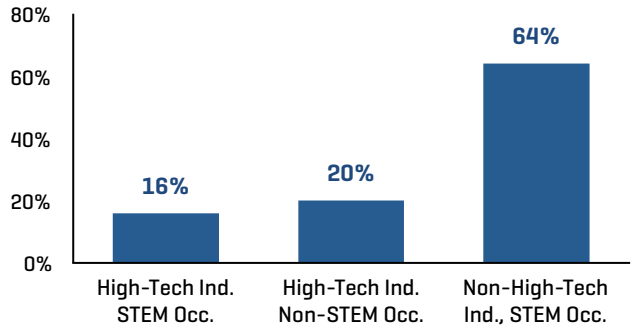
Employment Change versus 2000



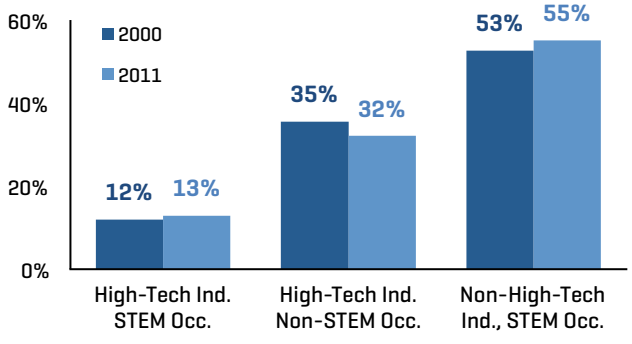
Emp. Change, High-Tech Components (2000 - 2011)



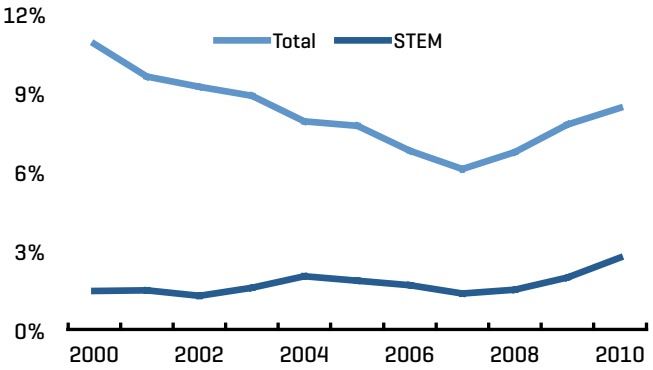
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



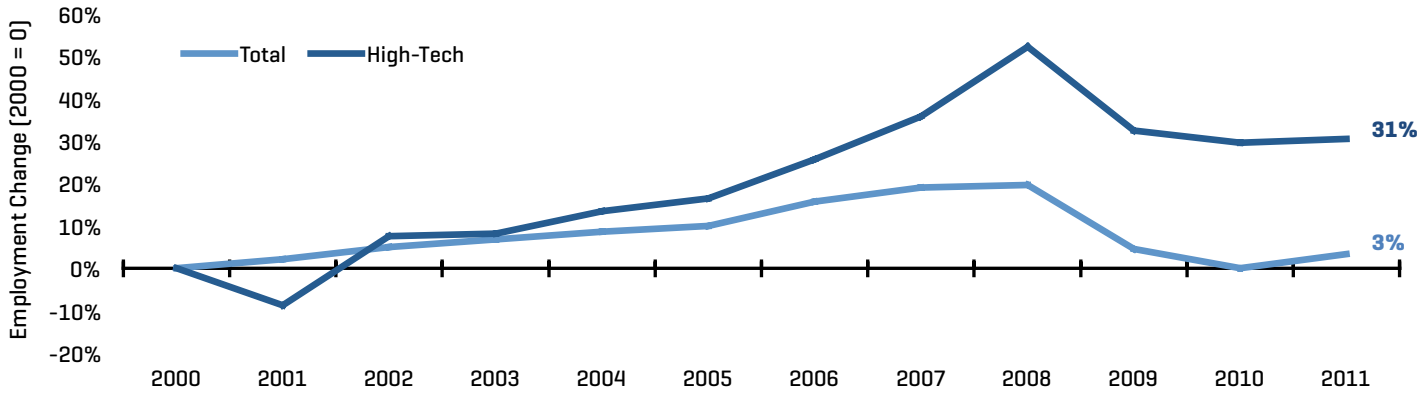
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

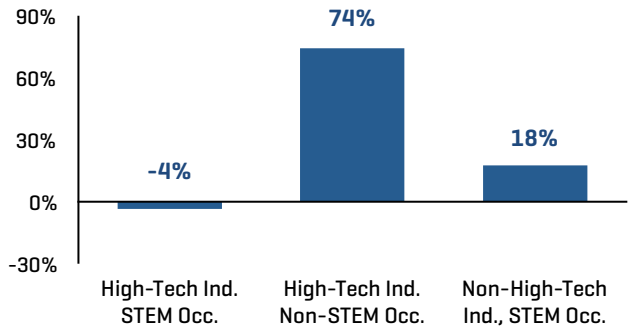
LATVIA

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
79 THOUSAND	8.1 PERCENT	31 PERCENT

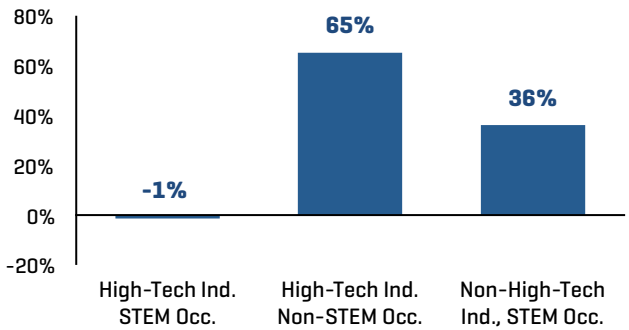
Employment Change versus 2000



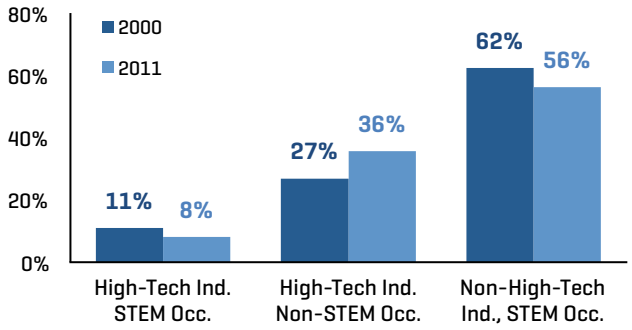
Emp. Change, High-Tech Components (2000 - 2011)



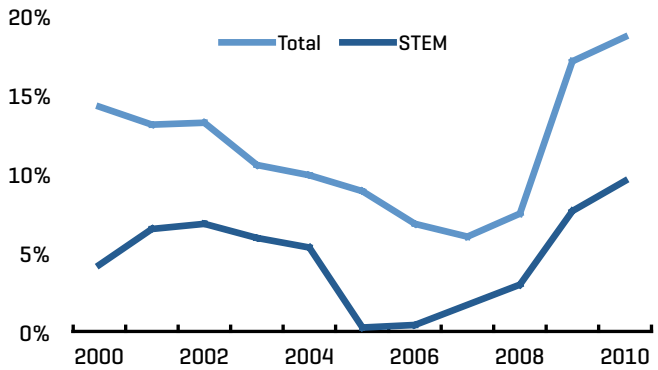
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



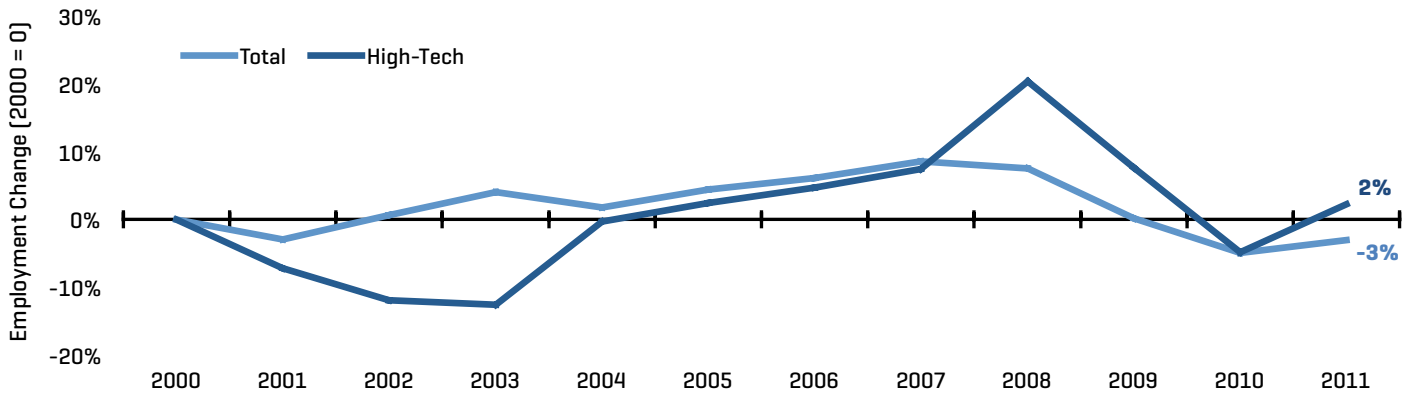
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

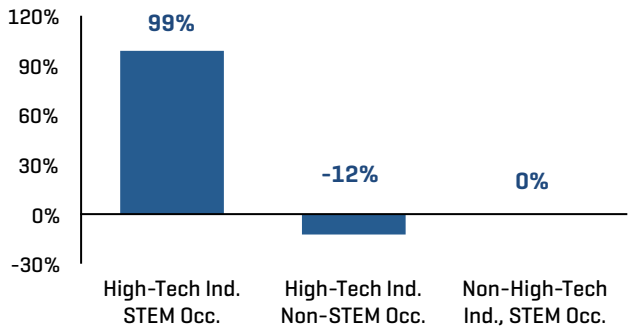
LITHUANIA

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
90 THOUSAND	6.6 PERCENT	2 PERCENT

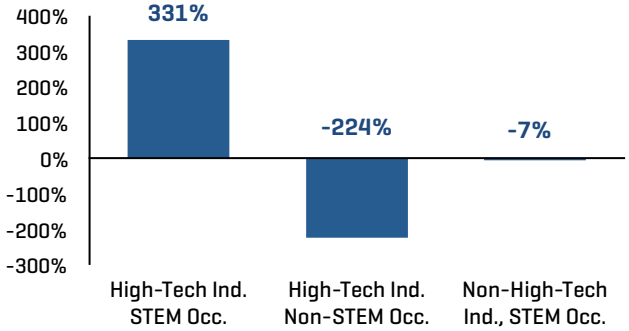
Employment Change versus 2000



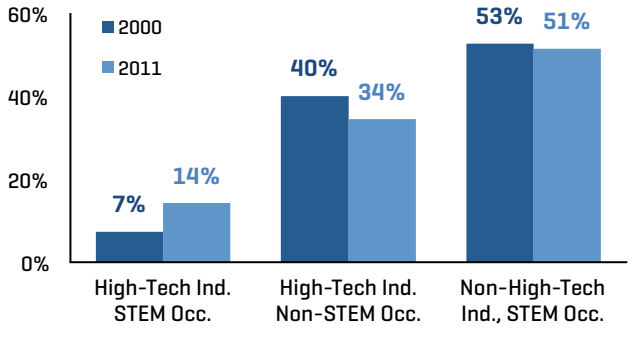
Emp. Change, High-Tech Components (2000 - 2011)



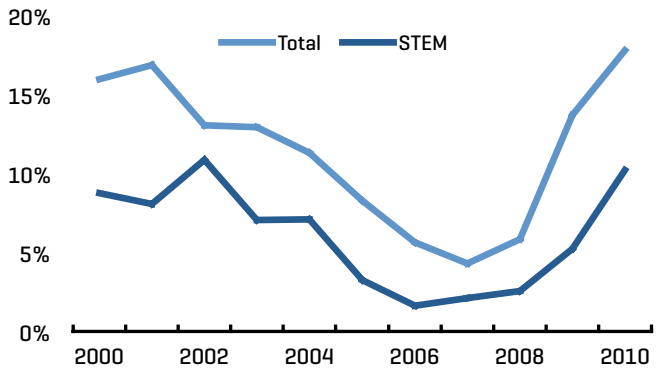
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



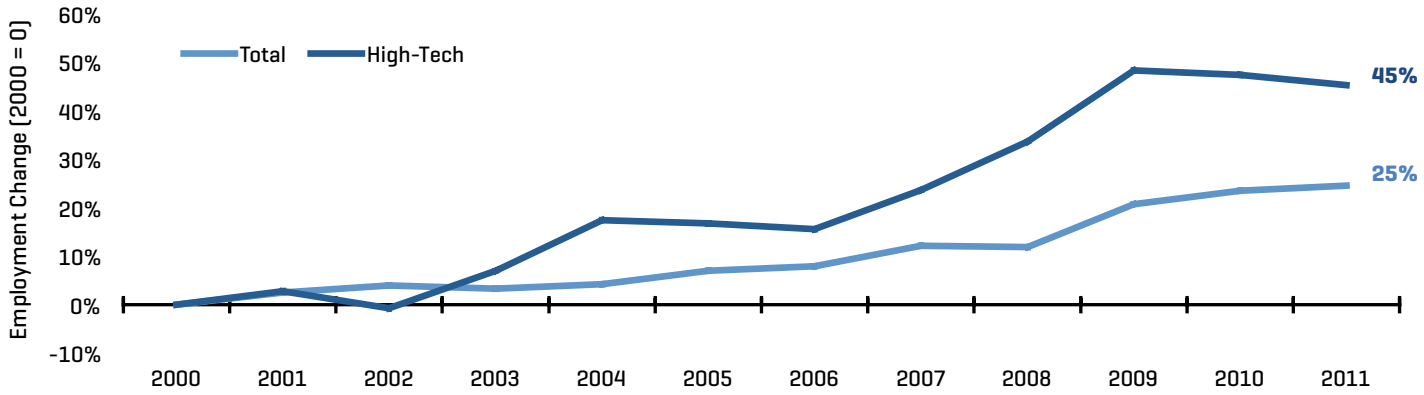
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

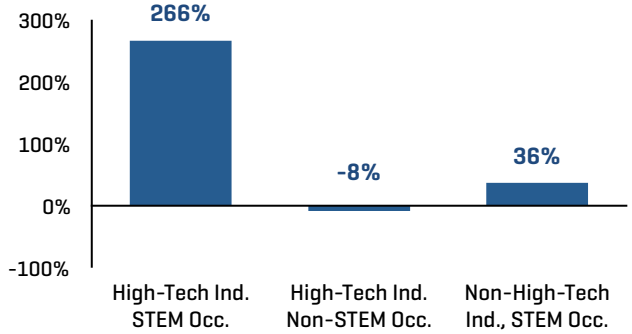
LUXEMBOURG

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
21 THOUSAND	9.4 PERCENT	45 PERCENT

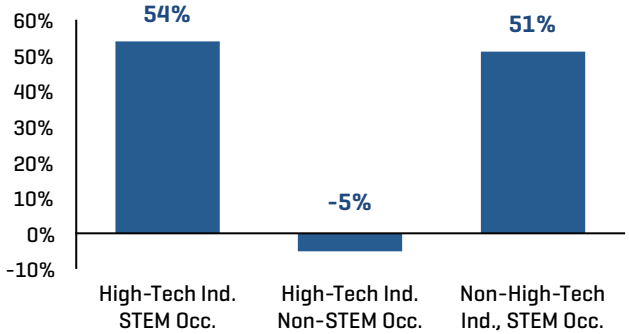
Employment Change versus 2000



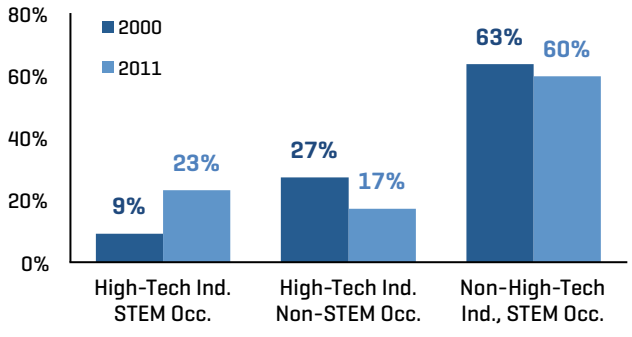
Emp. Change, High-Tech Components (2000 - 2011)



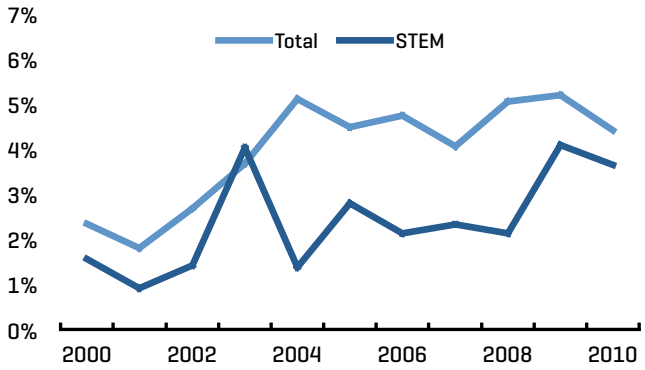
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



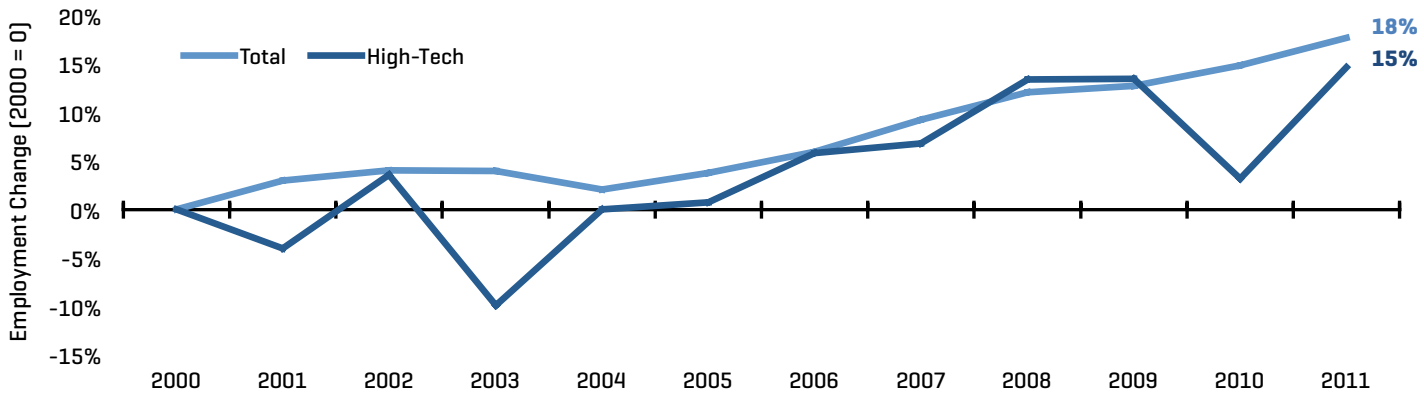
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

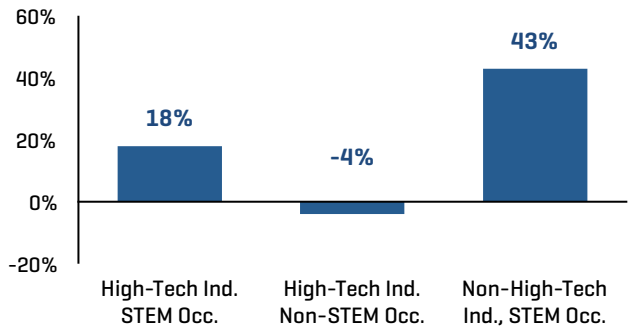
MALTA

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
17 THOUSAND	10.3 PERCENT	15 PERCENT

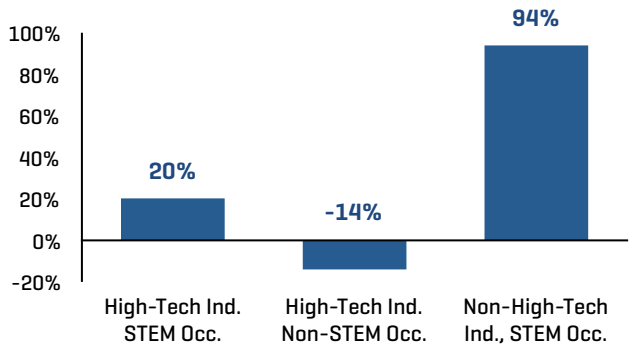
Employment Change versus 2000



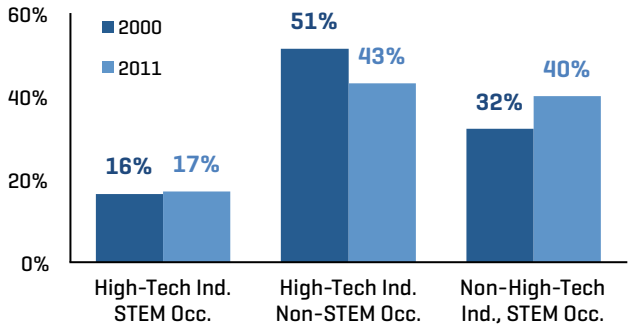
Emp. Change, High-Tech Components (2000 - 2011)



Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



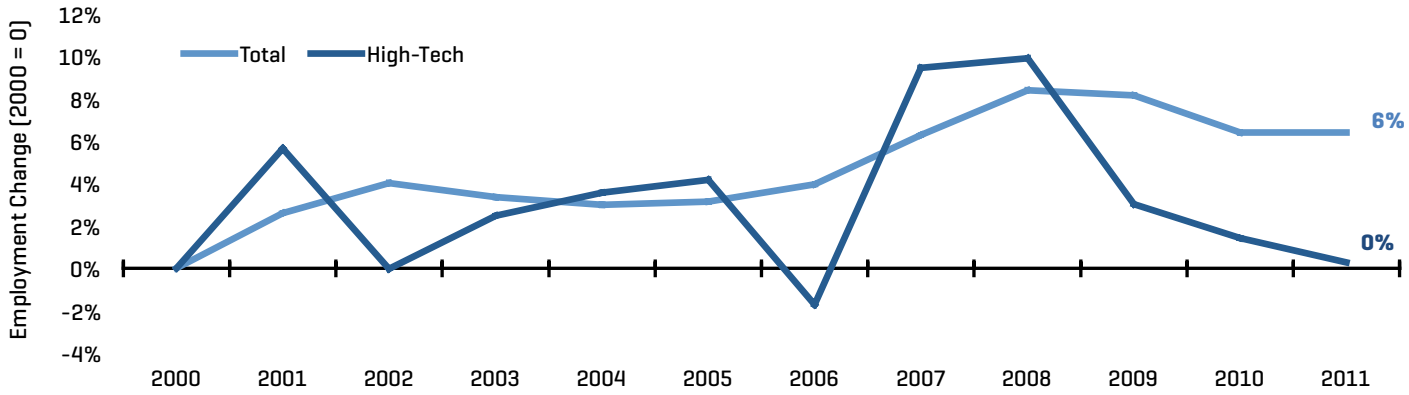
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

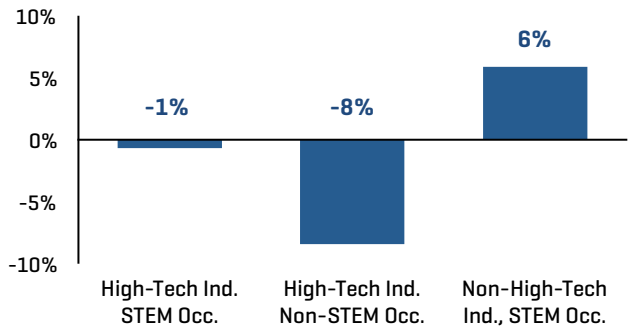
NETHERLANDS

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
834 THOUSAND	10.0 PERCENT	0 PERCENT

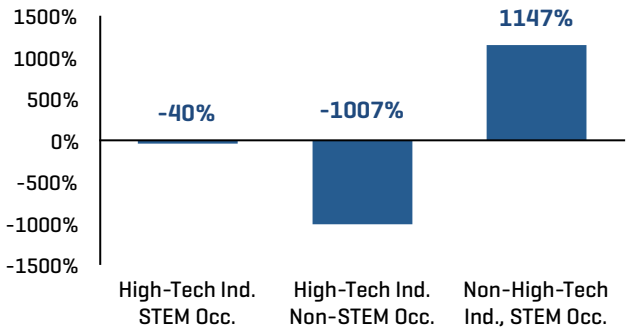
Employment Change versus 2000



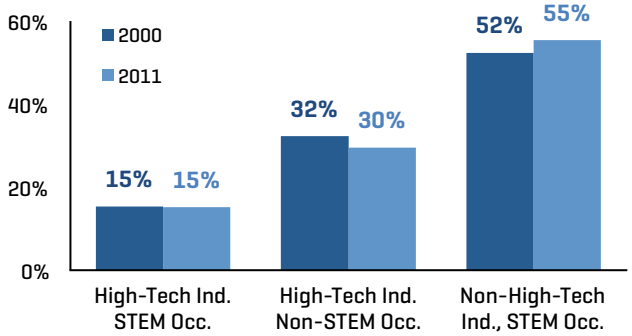
Emp. Change, High-Tech Components (2000 - 2011)



Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



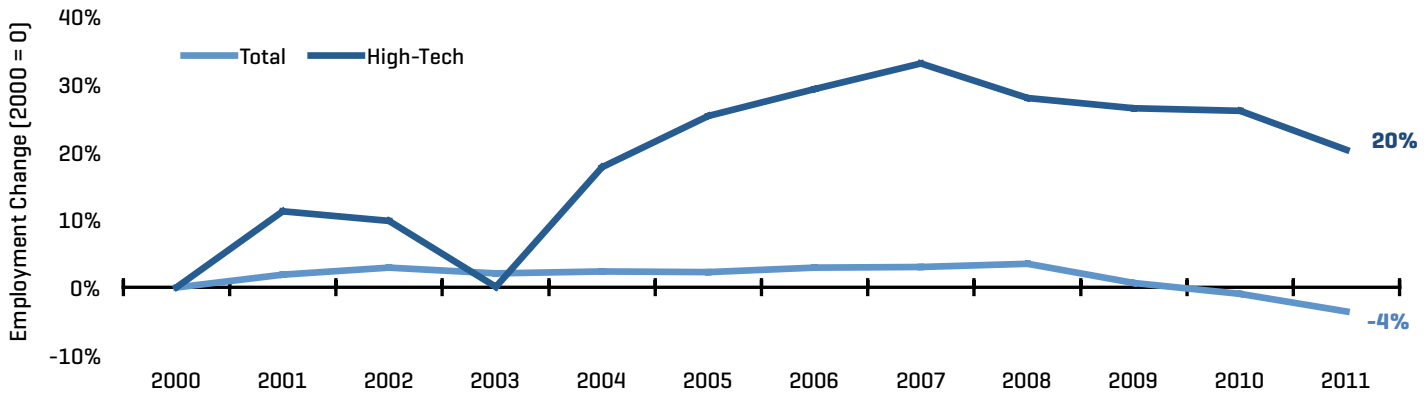
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

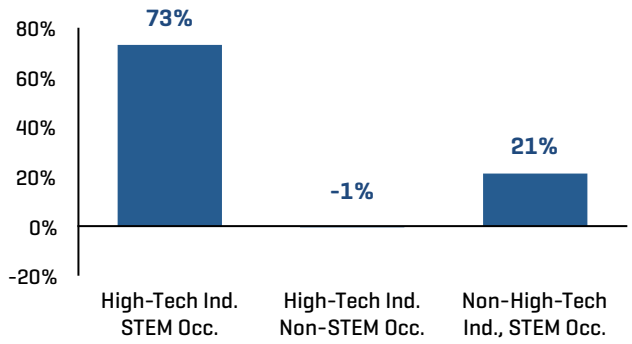
PORTUGAL

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
268 THOUSAND	5.6 PERCENT	20 PERCENT

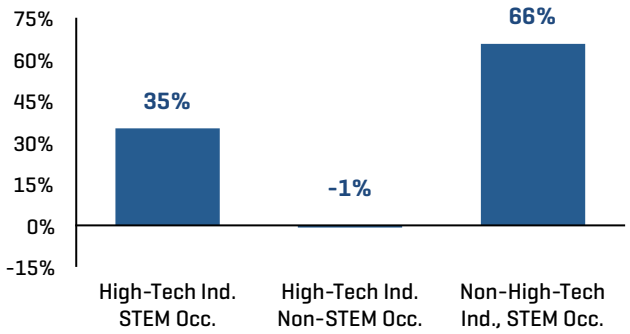
Employment Change versus 2000



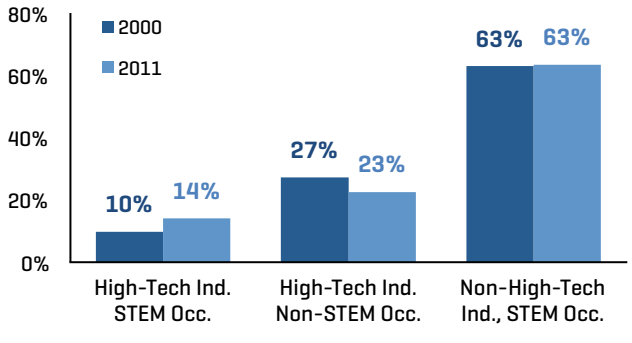
Emp. Change, High-Tech Components (2000 - 2011)



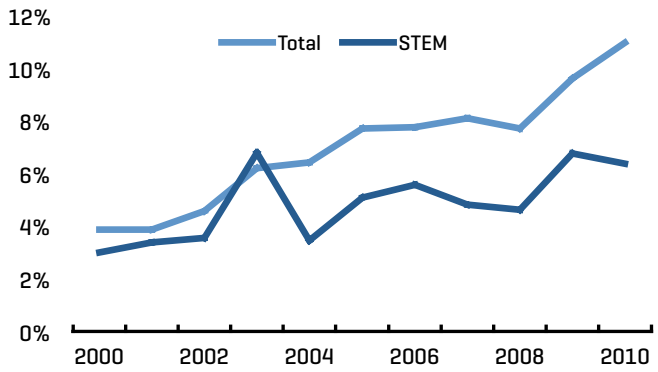
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



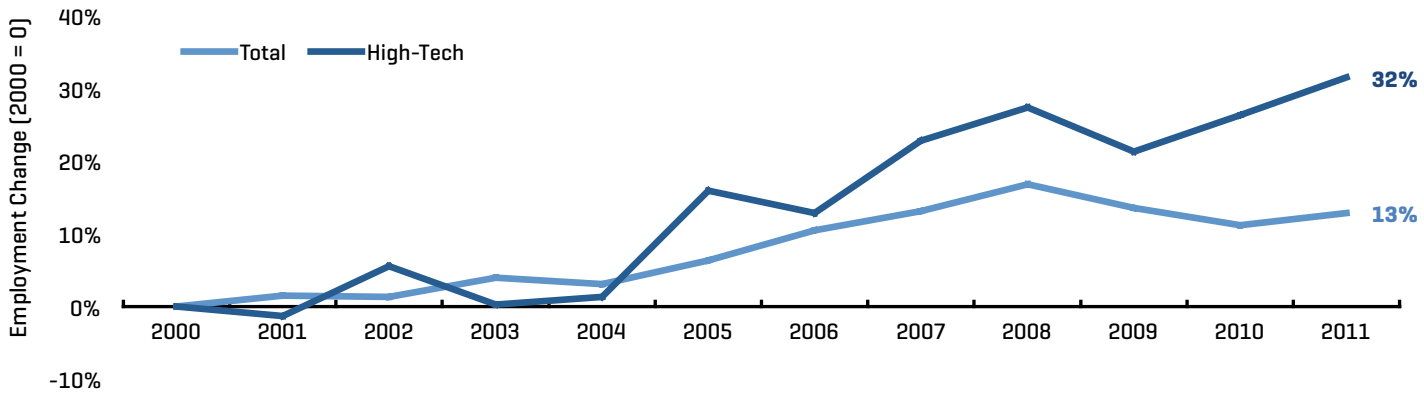
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

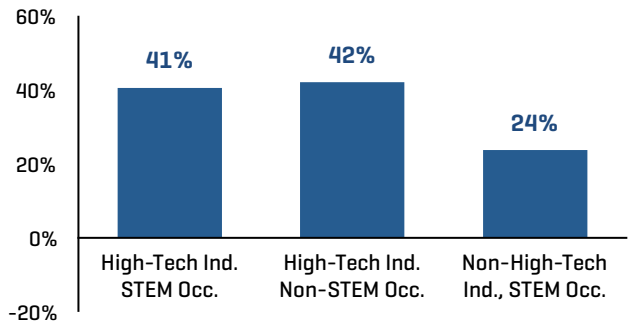
SLOVAKIA

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
253 THOUSAND	10.8 PERCENT	32 PERCENT

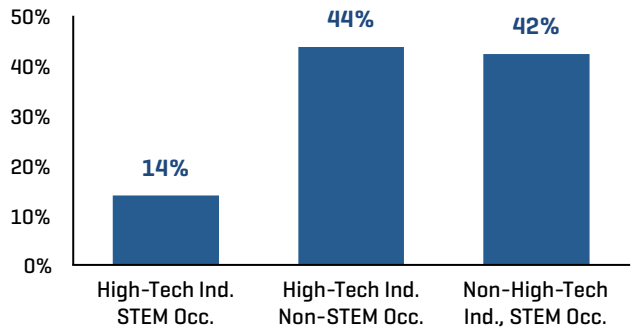
Employment Change versus 2000



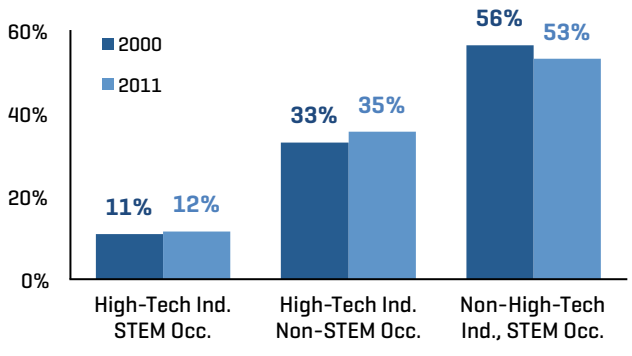
Emp. Change, High-Tech Components (2000 - 2011)



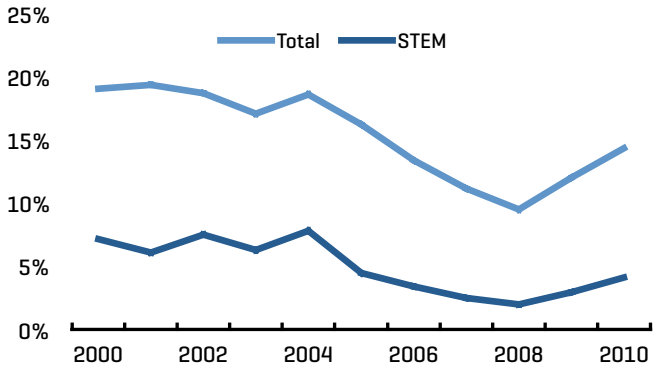
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



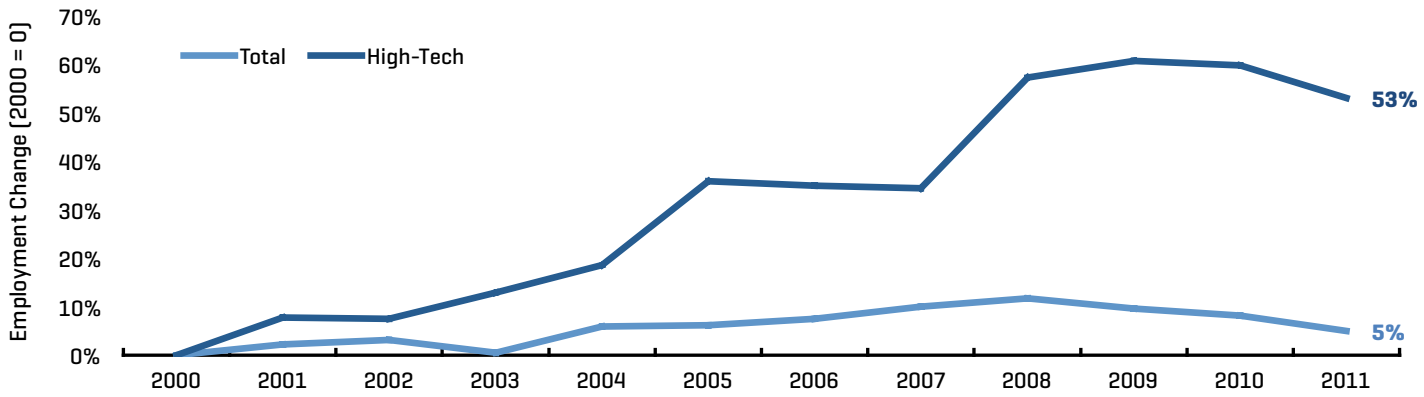
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

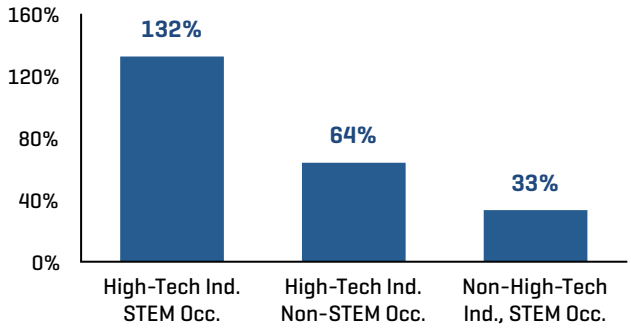
SLOVENIA

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
106 THOUSAND	11.3 PERCENT	53 PERCENT

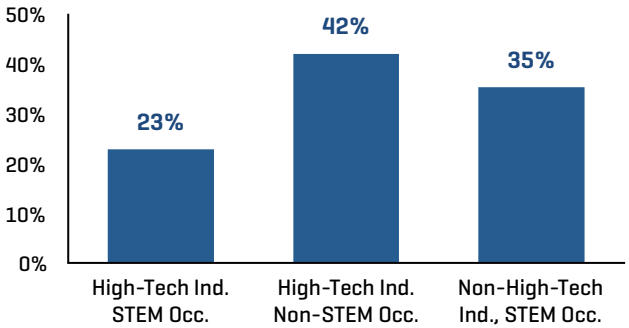
Employment Change versus 2000



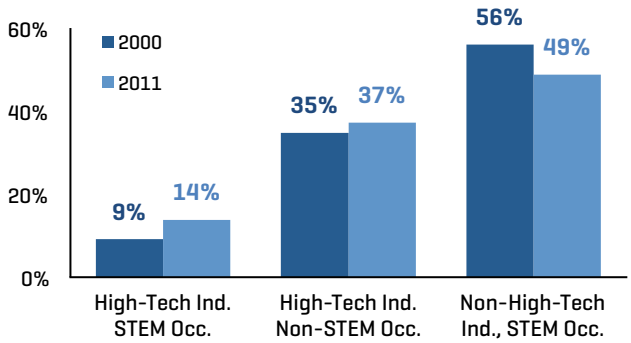
Emp. Change, High-Tech Components (2000 - 2011)



Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



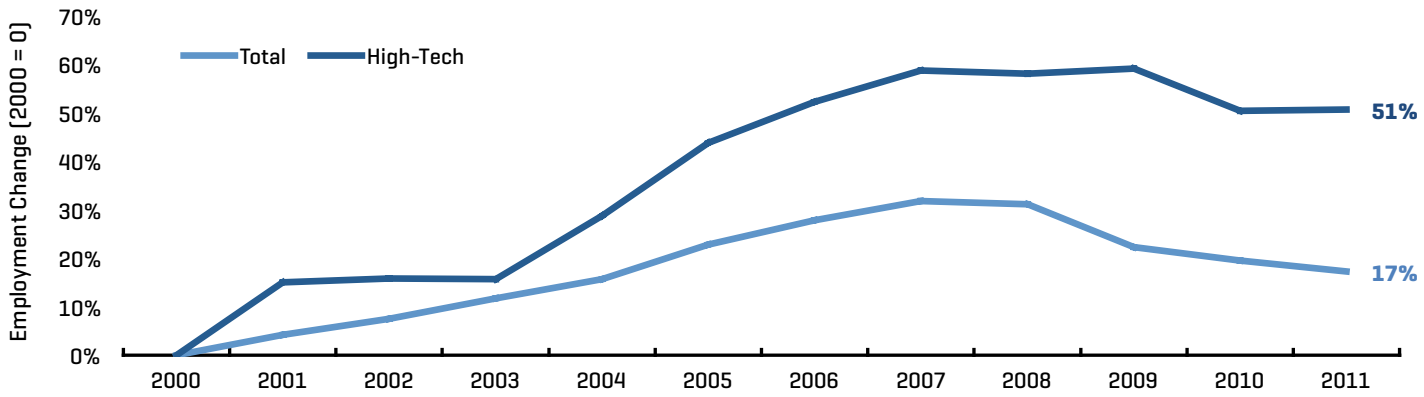
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

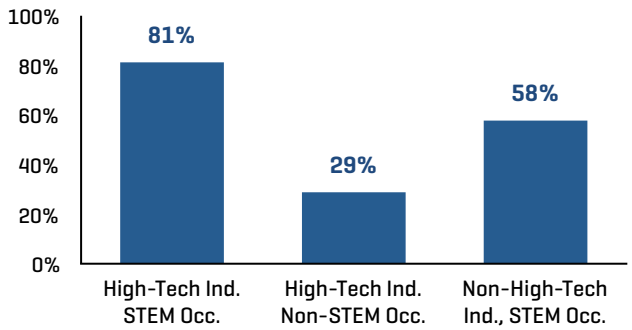
SPAIN

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
1.31 MILLION	7.3 PERCENT	51 PERCENT

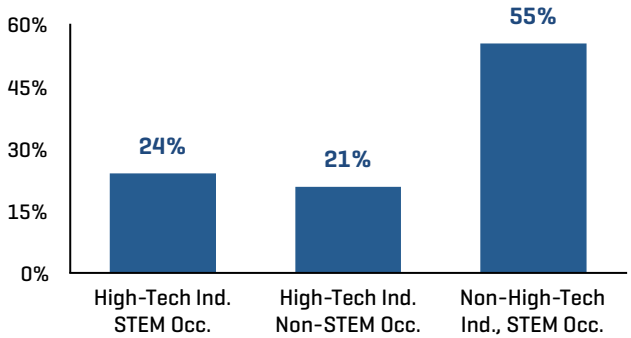
Employment Change versus 2000



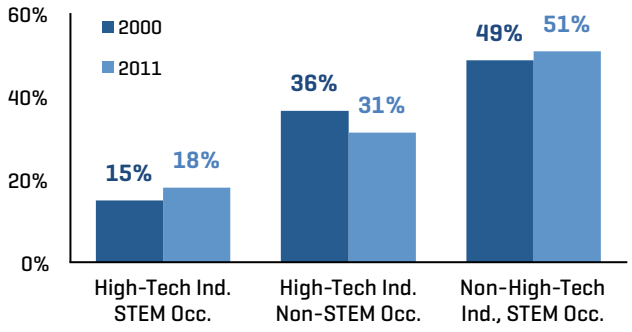
Emp. Change, High-Tech Components (2000 - 2011)



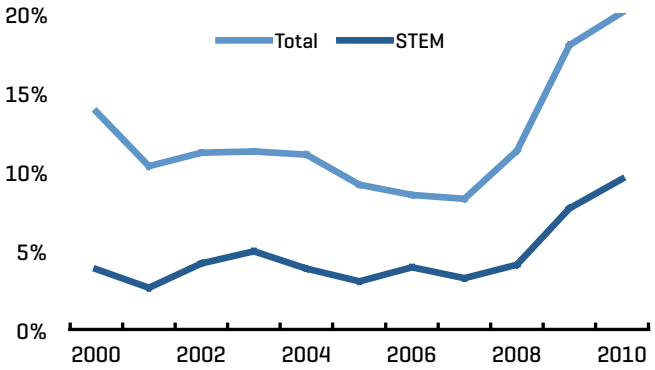
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



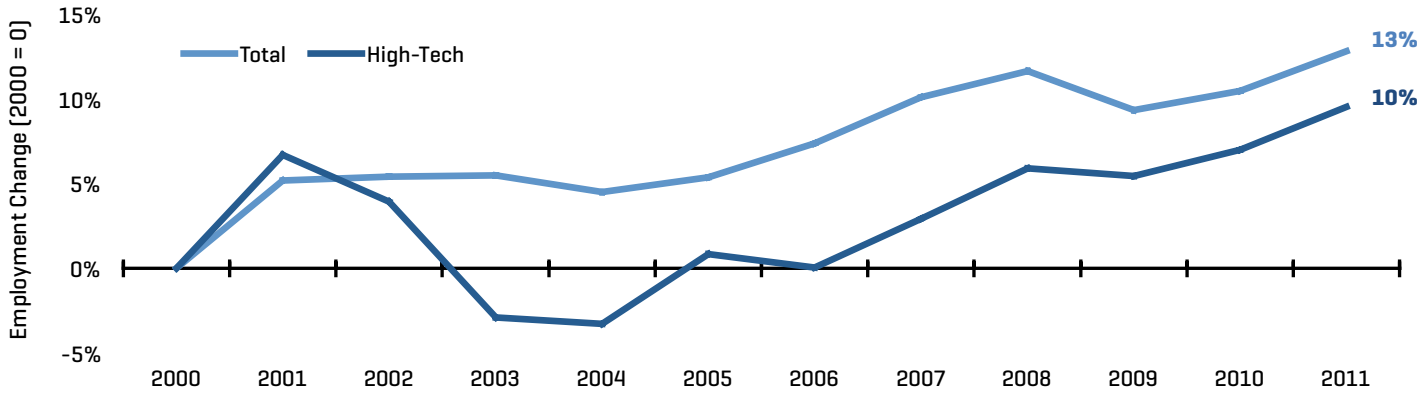
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

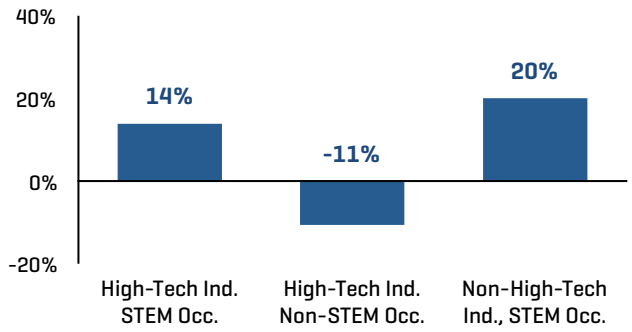
SWEDEN

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
592 THOUSAND	12.7 PERCENT	10 PERCENT

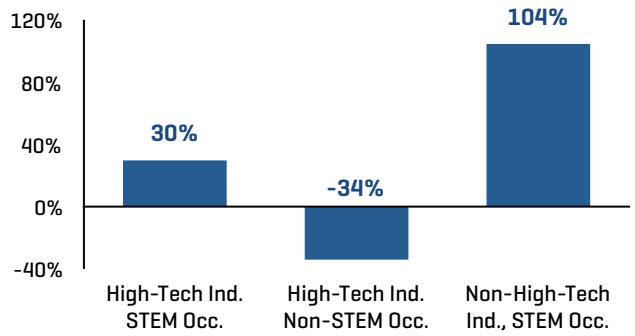
Employment Change versus 2000



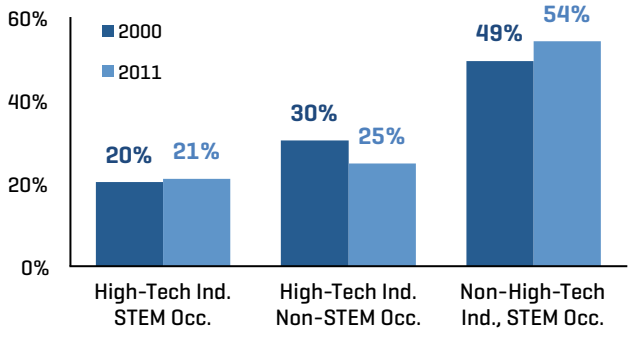
Emp. Change, High-Tech Components (2000 - 2011)



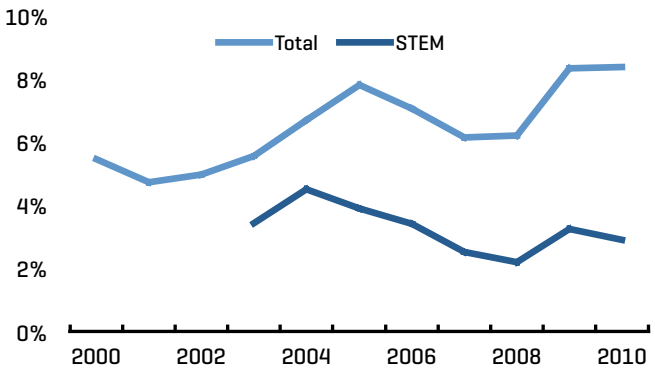
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



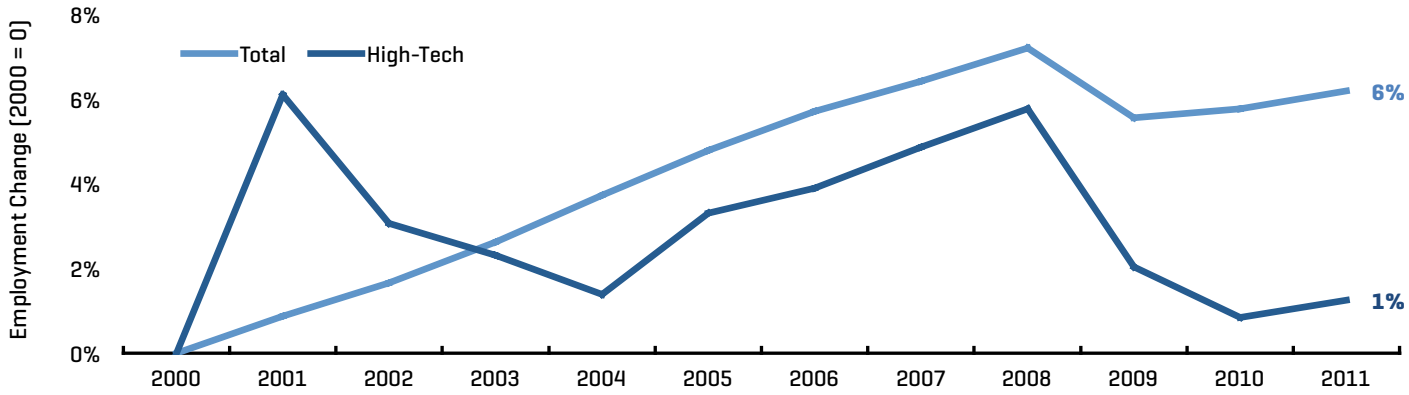
Sources: Eurostat, EULFS; authors' calculation

Country Profile:

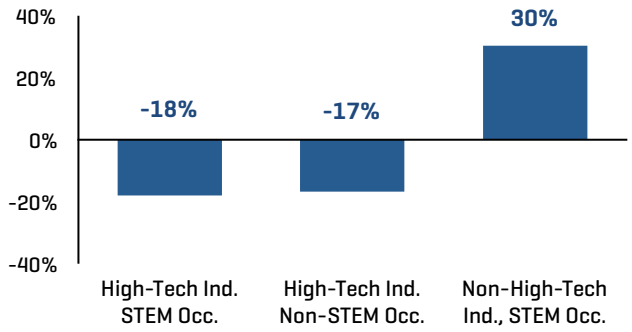
UNITED KINGDOM

High-Tech Employment (2011)	High-Tech Emp. Share (2011)	High-Tech Emp. Growth (2000 - 2011)
2.7 MILLION	9.3 PERCENT	1 PERCENT

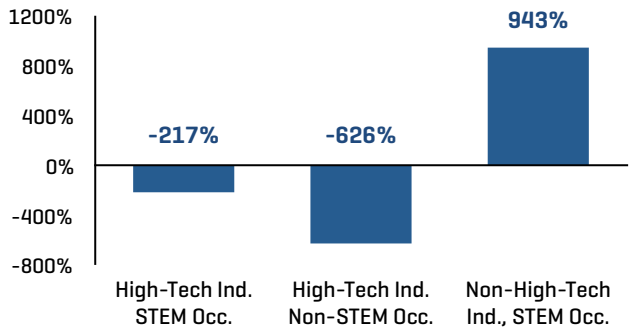
Employment Change versus 2000



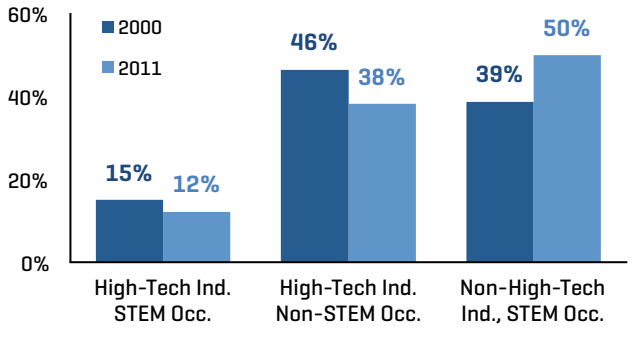
Emp. Change, High-Tech Components (2000 - 2011)



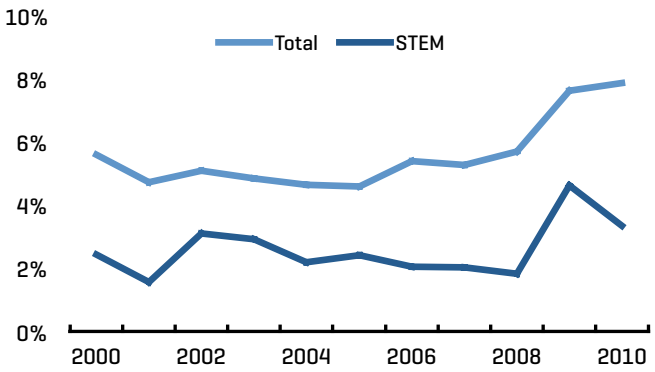
Contribution to High-Tech Emp. Change (2000 - 2011)



High-Tech Emp. Component Shares (2000 and 2011)



Unemployment Rates (2000 - 2010)



Sources: ONS, UKLFS; authors' calculation
Note: Employment estimates for the UK are slightly understated (see Appendix A).