Looking for a virtuous pattern of growth. Some insights for discussion

Este artículo busca arrojar un poco más de luz en el actual debate «manufacturas frente a servicios» y su papel en el crecimiento económico, tomando como punto de partida la Comunicación de la CE *Por un Renacimiento Industrial Europeo*. Se presentan dos criterios para evaluar las razones que justifican el apoyo a determinados sectores económicos (ya sea manufacturas o servicios): 1. la capacidad de generar empleo y 2. la capacidad de presentar un crecimiento positivo de la productividad. El artículo evalúa las manufacturas y los servicios en función de estos dos criterios, utilizando la base de datos PREDICT, caracterizada por su elevada desagregación sectorial. La conclusión a la que se llega es que los sectores de servicios cumplen en general con los dos criterios mencionados, mientras las manufacturas no lo hacen. También se pone de manifiesto la importancia de los sectores TIC y los intensivos en I+D, tanto manufactureros como de servicios.

Artikulu hau «fabrikazioa zerbitzuen kontra» egungo eztabaidari buruzkoa da, hazkunde ekonomiko berriztatua nola lortu gaiaren baitan, eta abiapuntu gisa EBko komunikazio hau hartu da: Europako Berpizkunde Industriala. Sektore ekonomikoei (bai fabrikaziokoei bai zerbitzukoei) laguntzeko arrazoiak ebaluatzeko bi irizpide aurkezten ditugu: 1. Enplegua sortzeko gaitasuna eta 2. Ekoizpen-hazkundearen adierazle positibo bat erakusteko gaitasuna. PREDICT datu-basea erabiltzen da bereizketa-maila esanguratsuekin, bi sektore horiek irizpide horiekiko ebaluatu daitezen. Artikuluaren ondorioa da zerbitzu-sektoreek aipatutako bi irizpideak betetzen dituztela; fabrikazio-sektoreek, ordea, ez dituzte betetzen. Era berean, IKT eta IKT ez diren I+G intentsiboen jardueretan oinarritutako zerbitzu- eta fabrikazio-azpisektoreek duten garrantzia azpimarratzen da.

This paper addresses the current «manufacturing *versus* services» debate in relation to the question of how to unlock renewed economic growth, taking as point of departure the EC Communication *For a European Industrial Renaissance*. We present two criteria with which to evaluate the grounds for supporting economic sectors (either manufacturing or services): 1 The capacity to generate employment and 2 The ability to display a positive rate of productivity growth. The highly disaggregated PREDICT database is used in order to evaluate both sectors on these criteria. Our paper concludes that service sectors fulfil both of the above-mentioned criteria, whereas manufacturing sectors do not. The importance of service and manufacturing sub-sectors rooted in ICT and non-ICT R&D-intensive activities is also highlighted.

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1. **INTRODUCTION**

The European Commission Communication (2014), *For a European Industrial Renaissance,* clarifies the position of the EC on the issue of «how to unlock renewed economic growth?», when it states: «Europe urgently needs to strengthen the basis for post-crisis sustainable growth and modernization. To that end, it must send a clear signal of its commitment to reindustrialization, the modernization of Europe´s industrial base and the promotion of a competitive framework for EU industry» (pg. 22). After listing a set of measures to achieve this goal, it concludes by defining a very precise target: «Finally, the objective of revitalization of the EU economy calls for the endorsement of the reindustrialization efforts in line with the Commission´s aspiration of raising the contribution of industry to GDP to as much as 20% by 2020» (pg. 23).

The size of the industry (or manufacturing) sector is subject to much discussion due to the process of vertical disintegration of activities, as well as the globalization

of the production process favoured by the development of new technologies. According to the so-called «value chain approach», industrial activities also include the services that are used in manufacturing activities for the provision of final manufactured goods. However, even when this perspective is adopted, «a process of «deindustrialization» can be observed in the EU as a whole, since applying a «value chain approach» reveals a decline in the combined manufacturing and related services share of GDP from 25.7% in 1995 to 22% in 2011.

There are a number of reasons for this trend, including overall shifts in demand, significant improvements in productivity, companies externalizing business services to outside Europe, off-shoring of core manufacturing activities (notable in Asian countries) and changes in relative prices in favour of services – cfr. Baumol's cost disease[1] (ECSIP, 2014, p. 9).

In the present paper we will not follow the «value chain approach», but the National Accounts (NA) approach. That implies that we will consider the definition of manufacturing and service sectors according to the NA classifications as published by National Statistical Offices, and gathered by EUROSTAT in the case of the EU countries. Our aim is to contribute to the manufacturing /services debate on the basis of a NA data analysis.

We will use these datasets to evaluate the role that is played by manufacturing and service sectors in economic growth according to two criteria. The first criterion is the contribution of manufacturing and service sectors to aggregate employment growth. One of the main problems facing the EU is the difficulty to generate enough employment quantity-wise and quality-wise in order to maintain welfare levels and the standard of living for current and future generations. This problem is especially acute in those countries who have suffered most from the austerity measures during the recent crisis. Our second criterion is the performance of each sector in terms of productivity growth. Productivity growth is a prerequisite for long term income growth per capita, which serves as an important yardstick for welfare. As Paul Krugman (1994) stated «Productivity isn´t everything, but in the long run it is almost everything».

On that basis, we posit that a sector follows a *virtuous* path when it complies with both criteria of creating employment and achieving labour productivity growth. When these two conditions hold, then we will conclude that the presence of such a sector deserves to be reinforced within the overall structure of economies. This will be our focus, although we admit that further criteria could be considered within the context of the manufacturing versus services debate, such as: the opening to foreign markets through trade and its implication on the internationalization of firms; the contribution to improve the general competitiveness of the economy; or

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[1] Baumol's cost disease refers to a rise of salaries in jobs that have not experienced increases in labour productivity, but whose salaries rise in response to rising salaries in other jobs that did witness labour productivity growth.

the creation and diffusion of technological knowledge through R&D and Innovation on behalf of the respective sectors. However, it is also true that the majority, if not all, of the potential alternative criteria end up being overshadowed by the increase in productivity growth criterion.

By following these criteria, we do not restrict the analysis to the manufacture and service aggregates on a whole, but instead we use a highly disaggregated database which puts special emphasis on *ICT sub-sectors* –according to the OECD (2007) ICT definition- and a group of *Non-ICT R&D-intensive sub-sectors*. This database has been produced within the PREDICT[2] (*Prospective Insights on R&D in ICT*) project and is currently expanded and updated by the DICTA (*Data for European ICT Industries Analysis*) study. The Information Society Unit of the *Institute for Prospective Technological Studies* (JRC-IPTS) and the *Valencian Institute of Economic Research* (Ivie) have respectively contributed from 2006 and 2013 to the development of the PREDICT database. The PREDICT database is managed by JRC-IPTS for the Directorate General for Communications Networks, Content and Technology (DG CONNECT) of the European Commission. So far the database covers the period 2006-2013, although a back casting to 2000 is due to be released in 2016. The information covers the 28 countries integrating the actual EU, plus a set of developed and developing countries: US, Japan, Korea, Taiwan, China, India, Brazil, Switzerland, Norway, Australia, Canada and Russia.

The present paper is structured into four sections. After the current introduction, section 2 provides an overview of the evolution of manufacturing and service sectors during the 1995-2014 period from an aggregate perspective. It uses different sources in order to highlight the behaviour of these sectors during the complete economic cycle which started in the mid-nineties in the last century, through to the most recent economic recovery that started in the EU in 2013. Section 3 focuses on the most recent period, 2006-2013, making use of the PREDICT database. It takes a more disaggregated view on sectoral evolutions during these years, and puts a separate view on a set of *ICT sub-sectors* and *Non-ICT R&D-intensive sub-sectors* from both the manufacturing and services realm. The subsequent results that are presented in section 3 confirm, among others, the superiority of the US economy over the EU in terms of both criteria. Finally, section 4 summarizes the main conclusions.

2. **MANUFACTURING AND SERVICES (1995-2014). AN OVERVIEW**

This section reviews the performance of the manufacturing and service sectors in all the countries included in our sample for the period 1995-2014. Those years cover a period that spans the years between the economic upturn from the mid-nineties, over

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[2] PREDICT database is available at: http://is.jrc.ec.europa.eu/pages/ISG/PREDICT/PREDICT2015/ 2015database.html.

the crisis period that started in 2007/2008 and the most recent economic recovery, which started -at least for a number of European countries- in 2013. To make our findings more relevant for «manufacturing *versus* services» debate, we analyze data both at the level of EU28, and separately for the EU15 and the New Member States (hereafter: NMS). As far as available data allows to maintain this three-fold focus, we keep up this distinction throughout the paper. As indicated before, we also include data on a number of non-European countries that serve as external points of reference.

Table 1 (pages 92 and 93) offers start and end-of-period information for the manufacturing and service sector on two variables: Gross Value Added (hereafter: GVA) and employment. The employment variable is measured in terms of persons employed. While tends to be considered a less adequate measure than number of hours worked, due to the lack of statistical information (especially for the beginning of the period of analysis), we had to compromise on this. As highlights from the way GVA in the manufacturing sector evolved, we can point at the following.

First, the annual growth rate for the EU28, EU15 and the New Member States (NMS) was positive, but much higher in the NMS (4.95%) than in the EU15 (1.1%). Almost all EU countries experienced a positive GVA growth rate. The only exceptions were Cyprus (-1.8%), Greece (-0.8%), Italy (-0.4%) and Luxembourg (-0.1%). On the opposite side of the spectrum, the fastest growing countries belonged to the NMS group. Slovakia (6.9%), Poland (6.6%), Lithuania (6.1%), the Czech Republic (5.5%) and Estonia (5.4%) showed the highest rates.

Second, the loss of weight of GVA manufacturing over total GVA was a general phenomenon. At the level of the EU15, the share of manufacturing over total GVA dropped from 19.6% in 1995 to 15.1% in 2014, while for the NMS this decline was of a minor magnitude, going from 20.9% to 20.3%, notably thanks to a positive evolution in the Czech Republic, Hungary, Bulgaria, Lithuania and Poland. Within the EU15 only Germany maintained its manufacturing share around 22.5% throughout the period of analysis.

Thirdly, for the remaining –i.e., non-European– countries it is interesting to notice that all of them experienced a positive annual GVA growth rate, especially China (10.0%), India (6.1%) and Korea (6.4%). It is also worth mentioning that the US (2.3%) showed a more dynamic behaviour than the EU28 (1.6%) with regard to the evolution of manufacturing GVA. However, this did not impede that the US also witnessed a declining share of manufacturing over total GVA from 16.8% in 1995 to 12.0% in 2014. The US economy is, therefore, a more services-reliant economy than the EU economy.

Finally, the countries with the highest share of manufacturing in terms of GVA in 2014, were: Korea (31.0%), China (29.9%) and Taiwan (29.0%). These figures stand in sharp contrast with the low shares shown by Australia (6.8%), Norway (7.8%) and Canada (10.4%).

When looking at the service sector data, it can be observed that GVA sector growth was particularly strong among EU15 countries, which also explains why service sector GVA in the EU28 on a whole grew at a higher rate than that of manufacturing (2.0% vs. 1.6%). In the NMS the opposite was the case (2.7% vs. 4.9%). This result highlights the importance of manufacturing for the NMS, whereas the service sector is the most dynamic sector in the EU15. The higher GVA dynamism on behalf of service sectors is also characteristic for the non-EU countries we looked into, with the exception of Switzerland, Japan, Korea and Taiwan.

In addition, service sector GVA increased its share in the total GVA in all countries, with the sole exception of Norway. EU28 services' share rose from 66.8% to 73.3% between 1995 and 2014, more than 6 percent points (hereafter: pp). For the NMS this increase was even greater, as in some countries the share of the service sector in the total GVA increased by more of 10 pp. (Cyprus, Latvia, Malta, Romania, etc.). The increase of the service sector share in the total GVA was more moderate in the case of the non-European countries, with the exception of China and India. In these two economies the weight of the service sector over the total GVA also grew with more than 10 pp. Thus, service GVA presents not only more dynamism, but also a general increase in its importance over total GVA within the sample of countries selected.

The employment data for the manufacturing sector reveal rather different trends than what one derives from the GVA data. First of all, all EU28 countries (with the exception[3] of Luxembourg) experienced negative annual rates, albeit in different degrees, with the UK showing a particularly negative tendency (-2.6%). The overall annual decline in the EU28 and EU15 amounted to -1.1%, and to -1.0% for the NMS. Within the group of non-EU countries, China (1.7%), India (1.2%) and Taiwan (1.1%) were the only ones displaying positive annual rates of manufacturing labour growth. Second, the share of manufacturing employment on total employment fell in all countries with the sole exception of China and Taiwan. In the US, it lost 5 percentage points (pp), from 15.3% in 1995 to 10.2%, a drop of a similar magnitude to that in the EU28, where it also fell 5 pp from 19.0% to 14.0%. In the case of the EU28, the decline was led primarily by the EU15 countries, as the drop experienced by the NMS was less important (around 3 pp). Moreover, these countries kept a higher share of employment in manufacturing compared to the EU15 countries, with particularly the Czech Republic (26.1%), Slovakia (21.6%) and Slovenia (20.3%) leading the way in manufacturing employment. Among the non-EU countries, Taiwan (27.3%) followed by China (18.7%), were the ones with the highest share of employment in manufacturing.

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[3] As for all small EU countries, data on Luxembourg has to be taken with caution.

Table 1. **SHARE OVER TOTAL GVA / EMPLOYMENT AND ANNUAL GROWTH RATES OF MANUFACTURING AND SERVICES. 1995-2014**

(percentage)

	Share of total GVA				GVA annual growth rates 1995-2014		Share of total employment				Employment annual growth rates 1995-2014	
	Manufacturing		Services		Manufacturing	Services	Manufacturing		Services		Manufacturing	Services
	1995	2014	1995	2014			1995	2014	1995	2014		
Austria	20.0	18.4	65.4	70.6	2.3	2.0	18.7	14.7	63.8	72.5	-0.3	1.6
Belgium	20.4	13.8	69.6	77.2	1.8	1.7	17.5	11.2	72.9	80.4	-1.5	1.4
Bulgaria	14.0	14.7	61.0	67.6	2.7	1.8	22.6	17.1	46.1	55.6	-1.6	0.8
Croatia	20.5	14.3	60.5	69.8	1.2	2.4	-	17.1	-	63.6	-	-
Cyprus	10.5	5.0	73.1	86.9	-1.8	3.1	14.7	7.7	67.0	80.2	-2.3	2.0
Czech Republic	23.7	26.6	56.7	59.3	5.5	1.8	26.5	26.1	54.5	59.9	-0.1	0.5
Denmark	17.0	13.5	71.2	75.6	0.8	1.6	16.5	10.3	72.2	80.1	-2.2	0.9
Estonia	19.8	15.7	62.4	68.4	5.4	4.0	24.7	18.4	55.6	67.4	-1.8	0.8
Finland	25.4	16.7	62.0	70.6	2.6	1.8	19.3	13.7	65.6	73.1	-0.8	1.6
France	16.2	11.2	72.7	78.9	1.4	1.8	15.0	9.9	73.1	79.6	-1.5	1.2
Germany	22.8	22.6	66.0	69.0	1.7	1.5	21.2	17.5	65.8	73.9	-0.4	1.2
Greece	12.1	9.4	70.3	80.4	-0.8	1.3	11.2	8.4	62.3	73.9	-1.8	0.6
Hungary	21.5	23.5	61.0	64.4	3.7	1.9	22.0	19.2	54.0	65.9	-0.4	1.3
Ireland	23.0	19.7	61.5	72.8	4.8	4.5	-	11.1	63.1	76.0	-1.8	2.6
Italy	20.9	15.4	67.6	74.3	-0.4	0.8	21.2	16.2	65.1	72.4	-0.9	1.1
Latvia	20.0	12.2	60.8	73.4	2.7	4.6	-	13.7	54.9	68.8	-1.9	0.7
Lithuania	18.7	19.3	57.4	66.0	6.1	4.3	17.3	15.1	55.0	66.1	-1.3	0.3
Luxembourg	13.3	4.9	76.7	87.8	-0.1	3.8	-	8.1	70.3	79.3	0.3	3.8
Malta	20.7	10.0	68.0	82.8	-	-	24.5	12.0	65.0	78.9	-2.4	2.4

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Netherlands	17.2	12.1	69.6	77.0	1.5	2.3	12.9	8.8	76.2	82.9	-1.0	1.4
Poland	18.2	18.6	56.5	64.6	6.6	3.4	-	19.1	45.2	58.3	-0.3	1.7
Portugal	18.1	13.3	66.4	76.1	1.0	1.7	22.2	15.4	52.6	65.9	-2.0	1.2
Romania	25.2	23.0	42.5	58.4	2.3	2.7	21.2	18.1	26.9	42.0	-2.4	0.8
Slovakia	25.7	20.9	57.5	62.0	6.9	2.2	26.2	21.6	54.1	65.6	-0.8	1.3
Slovenia	25.3	23.1	61.0	64.7	3.1	2.6	30.0	20.3	47.0	62.4	-2.0	1.5
Spain	17.6	13.2	65.1	75.1	0.9	2.7	17.2	11.1	65.3	78.2	-0.9	2.3
Sweden	22.8	16.4	65.9	72.6	3.2	2.3	17.5	12.3	72.6	77.1	-1.2	1.0
United Kingdom	18.8	10.6	68.5	78.4	0.0	2.7	15.8	8.1	74.5	83.0	-2.6	1.5
EU28	19.7	15.5	66.8	73.3	1.6	2.0	19.0	14.0	63.0	73.2	-1.1	1.3
EU15	19.6	15.1	68.0	74.8	1.1	1.9	18.0	12.7	68.6	77.1	-1.1	1.4
New Member States (NMS)	20.9	20.3	55.6	63.3	4.9	2.7	22.3	19.4	43.8	57.1	-1.0	1.2
Norway	12.5	7.8	63.8	60.1	1.6	2.8	12.9	9.2	74.6	76.9	-0.4	1.5
Switzerland	19.8	19.0	71.3	73.0	2.3	1.8	-	14.0	-	74.3	-	-
Australia	14.0	6.8	67.8	70.2	0.8	3.4	14.2	8.7	72.1	76.3	-0.8	2.1
Canada	17.4	10.4	67.9	70.5	0.7	4.2	14.0	9.6	74.6	78.2	-0.6	1.8
China	34.8	29.9	32.9	46.1	10.0	10.1	15.7	18.7	24.8	38.1	1.7	3.1
India	17.4	12.9	46.2	57.0	6.1	8.1	12.4	11.4	21.1	26.3	1.2	2.9
Japan	23.5	20.4	63.7	70.4	1.4	0.8	20.4	15.1	61.2	71.3	-1.9	0.6
Korea	27.8	31.0	54.6	59.3	6.4	4.1	22.7	16.9	55.6	70.0	-0.4	2.4
Taiwan	27.4	29.0	61.0	64.8	5.9	3.6	27.1	27.3	50.7	59.6	1.1	2.0
US	16.8	12.0	74.7	78.5	2.3	2.5	15.3	10.2	73.8	79.8	-1.3	1.3

Note: Latest available data on GVA for Australia, Canada, China, India, Japan, Korea, Romania and Taiwan corresponds to 2013. Latest available data on employment for Canada, China, India, Japan and Taiwan corresponds to 2013. Malta is not included in EU28 and NMS GVA rates of growth. Croatia is not included in EU28 and NMS employment rates of growth.

Source: ABS, APO, BEA, Canada Statistics, Eurostat, ILO, OECD and own elaboration.

Table 2. **MANUFACTURING AND SERVICES LABOUR PRODUCTIVITY. 1995-2014**

(Euros PPS per person and percentages)

	1995			2014			Annual growth 1995-2014			Contibution to labour productivity growth (pp.)	
	Total	Manufacturing	Services	Total	Manufacturing	Services	Total	Manufacturing	Services	Manufacturing	Services
Austria	46,536	47,594	49,328	55,578	79,044	53,292	0.93	2.67	0.41	0.51	0.28
Belgium	53,580	50,709	55,330	63,321	93,862	58,624	0.88	3.24	0.30	0.55	0.22
Bulgaria	13,618	8,100	19,950	20,232	18,211	23,850	2.08	4.26	0.94	0.61	0.60
Croatia	21,543	-	-	30,616	25,646	34,525	1.85	-	-	-	-
Cyprus	35,890	27,161	37,741	42,774	29,623	46,238	0.92	0.46	1.07	0.04	0.85
Czech Republic	25,730	17,188	29,857	39,715	49,262	38,215	2.28	5.54	1.30	1.39	0.75
Denmark	41,215	40,272	40,151	48,780	70,896	45,743	0.89	2.98	0.69	0.45	0.50
Estonia	13,932	7,980	17,135	32,315	31,266	31,394	4.43	7.19	3.19	1.28	2.08
Finland	41,380	40,102	43,609	50,402	76,083	45,732	1.04	3.37	0.25	0.71	0.17
France	48,613	41,556	50,962	57,181	72,320	56,892	0.85	2.92	0.58	0.40	0.44
Germany	45,959	47,923	46,953	53,230	70,407	49,835	0.77	2.02	0.31	0.46	0.21
Greece	35,142	32,925	41,649	42,889	39,311	46,919	1.05	0.93	0.63	0.10	0.47
Hungary	21,651	16,337	27,966	31,262	35,990	30,967	1.93	4.16	0.54	0.94	0.34
Ireland	53,681	57,920	56,677	73,085	133,973	67,997	1.93	5.24	1.14	1.12	0.76
Italy	51,479	46,081	55,398	50,714	50,736	52,364	-0.08	0.51	-0.30	0.09	-0.21
Latvia	12,598	9,880	15,948	30,915	23,796	33,990	4.72	4.63	3.98	0.74	2.67
Lithuania	13,750	12,387	15,863	34,905	50,825	33,396	4.90	7.43	3.92	1.41	2.42
Luxembourg	71,357	52,071	81,119	72,404	48,272	80,091	0.08	-0.40	-0.07	-0.04	-0.06
Malta	-	-	-	-	-	-	-	-	-	-	-

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Netherlands	47,377	52,354	44,266	57,064	85,063	52,840	0.98	2.55	0.93	0.37	0.68
Poland	17,758	12,268	26,184	34,727	45,713	36,282	3.53	6.92	1.72	1.27	1.04
Portugal	29,684	19,476	39,045	37,096	33,938	43,362	1.17	2.92	0.55	0.46	0.39
Romania	10,709	11,569	20,316	21,867	28,402	29,044	3.76	4.73	1.88	1.14	0.95
Slovakia	23,456	12,681	30,073	41,599	54,677	35,717	3.02	7.69	0.91	1.79	0.54
Slovenia	25,864	18,099	35,547	41,805	48,102	43,721	2.53	5.14	1.09	1.24	0.68
Spain	46,342	43,223	46,584	52,382	61,787	49,883	0.64	1.88	0.36	0.29	0.25
Sweden	40,415	36,453	41,090	55,516	83,540	51,907	1.67	4.36	1.23	0.86	0.85
United Kingdom	45,340	44,233	42,876	56,479	71,832	54,324	1.16	2.55	1.25	0.38	0.91
EU28	39,781	36,050	44,065	49,715	60,099	49,728	1.17	2.69	0.64	0.48	0.45
EU15	46,343	44,330	47,557	54,023	67,347	52,530	0.81	2.20	0.52	0.38	0.37
NMS	17,127	12,924	25,142	31,739	40,329	33,924	3.25	5.99	1.58	1.24	0.94
Norway	60,146	46,687	43,079	67,149	69,112	55,381	0.58	2.06	1.32	0.21	0.82
Switzerland	48,997	-	-	56,818	81,720	55,347	0.78	-	-	-	-
Australia	46,719	43,165	43,383	60,015	57,898	54,354	1.39	1.63	1.25	0.17	0.86
Canada	48,373	50,842	33,340	57,079	63,697	51,194	0.92	1.25	2.38	0.17	1.65
China	3,293	6,055	4,857	15,227	27,162	17,095	8.51	8.34	6.99	2.70	2.76
India	3,887	5,144	8,312	9,480	12,539	21,518	4.95	4.95	5.28	0.75	2.73
Japan	44,980	44,925	49,490	53,251	81,443	51,283	0.94	3.31	0.20	0.73	0.13
Korea	26,107	26,161	28,700	47,262	92,118	39,128	3.30	6.99	1.72	2.06	0.98
Taiwan	37,775	35,769	47,903	64,327	84,849	64,784	2.96	4.80	1.68	1.35	1.05
US	62,119	51,895	64,623	83,375	102,287	81,621	1.55	3.57	1.23	0.51	0.94

Note: Latest available year for Australia, Canada, China, India, Japan, Korea and Taiwan corresponds to 2013. EU28 and NMS do not include Croatia and Malta. The contributions to labour productivity of manufacturing and services do not add up the labour productivity growth due to the contribution of the other remaining activity sectors and the reallocation effect.

Source: ABS, APO, BEA, Canada Statistics, Eurostat, ILO, OECD and own elaboration.

The employment evolution in the service sector was the opposite of what was observed for the manufacturing sector. All countries, without exception, experienced positive annual growth rates with regard to service sector employment. In the EU28 it amounted to 1.3%, similar to in the EU15 (1.4%) and higher than in the NMS. It is interesting to highlight that the highest rates of annual growth in the service sector corresponded to China (3.1%) and India (2.9%). Also the share of the service sector in total employment followed an opposite trajectory than the manufacturing sector. This share grew in all countries without exception, especially in the NMS group thanks in part to their lower initial levels. Within the non-EU countries, the most significant gains occurred in China, India and Korea. Moreover, it is worth pointing out that the most developed countries present a higher share of employment in the service sector (about 80%): Denmark (80.1%), Netherlands (82.9%), UK (83.0%), France (79.6%), the US (79.8%), Canada (78.2%), etc.

The above facts can be summarized under three headlines. First, the loss of weight of manufacturing activity on total economic activity is (almost) a general phenomenon, as it is reflected both in terms of its share in overall GVA and employment. However, while GVA in manufacturing continued to increase in most of the countries (albeit at a lower rate than total GVA), the destruction of manufacturing employment in absolute terms is a generalized fact. Second, the service sector presented positive growth rates in all countries without exception, both in terms of GVA and employment. And third, there is a general tendency for manufacturing activities to abandon the most developed countries. The NMS in Europe and the Asian countries are becoming the factories for the world, as an expression of the changing positions that respective countries play in global value chains.

Obviously, the way that (manufacturing and service sector) GVA and employment evolve have consequences on labour productivity performances. Table 2 provides an overview of evolutions with regard to this variable for the period 1995-2014, distinguishing again between manufacturing and service sectors. The most important observations that follow from this table are the following.

Firstly, there are noticeable differences in labour productivity between countries. In 2014 total labour productivity amounted to 83,375 €PPS[4] per person in the US; in the EU28 it was 60% of that figure (49,715 €PPS) while China and India stayed below 16,000 €PPS. Even among EU countries, there are considerable differences ranging from 20,232 €PPS in Bulgaria to 73,085 €PPS in the case of Ireland. In fact, within Europe, EU15 countries show a labour productivity that is more than 70% above the NMS average.

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[4] PPS stands for Purchasing Power Standard, an antificial currency unit used to express magnitudes of different countries into a common price frawework. PPP figures are obtained adjusting national currency figures using PPPs, are the currency conversion rates that equalize the purchasing power of different currencies by eliminating the differences in price levels between countries. In their simplest form, PPPs are relative prices that show the ratio of the prices in national currencies of the same good or service in different countries.

Secondly, the superiority of labour productivity in the manufacturing sector cannot be considered to be a fact across the board in all countries and over time. In 1995, for instance, labour productivity in services was higher than in manufacturing in EU28, EU15, the NMS, Australia, India, Japan, Korea, Taiwan and the US. However, in 2014 (and as a consequence, among other factors, of manufacturing's higher rate of job destruction together with ongoing process of off-shoring of lower added value activities) labour productivity in manufacturing was higher in all countries with the sole exception of India among the non-European countries, and Bulgaria, Croatia, Cyprus, Estonia, Greece, Italy Latvia, Luxembourg, Portugal and Romania among the EU countries.

Thirdly, even though the annual growth rate of labour productivity in manufacturing was higher than in services in almost all countries (Canada, India, Cyprus and Luxembourg being the exceptions), the contribution to aggregate productivity growth of services was, in general, higher if we look at the non-European countries, excluding Japan, Korea and Taiwan. The former is a consequence of the lower growth rates of services productivity together with its higher share in the GVA aggregate. However, in the EU28 both contributions to productivity growth were almost similar (0.48 pp for manufacturing and 0.45 pp for services), as in the majority of EU Member States (19 out of 28 countries) the manufacturing sector had a higher contribution than services to productivity growth. Only in Cyprus, Denmark, Estonia, France, Greece, Latvia, Lithuania, Netherlands and the UK the contribution of the service sector to overall productivity growth was higher.

As a consequence, it turns out that productivity growth relies more on the manufacturing sector in the case of EU countries for the timeframe considered[5]. This is not the case for the non-EU countries, as in most of them (except for Japan, Korea and Taiwan) the contribution of the service sector to the aggregated productivity growth is higher than that of manufacturing in almost all countries. Thus, these countries present in general higher levels of productivity than the EU28 and they rely more on the service sector.

The above-mentioned results can be summarized by the following assertion: manufacturing sectors are not more productive than services in all cases or everywhere. In fact, in some countries services have a higher impact than manufacturing in aggregate productivity, this result being particularly clear for countries with higher aggregated productivity levels, such as the US, Norway and Australia.

As mentioned at the outset, the present paper assesses the *virtuous* contribution of the manufacturing and service sector to economic growth on the basis of two criteria: 1. capacity to generate employment and 2. ability to display a positive rate of productivity. The information provided in Figure 1 breaks the GVA annual growth rate for the period 1995-2014 down into the respective contributions of those two variables. Panel a) refers to the total economy. On the left-hand side, it shows the

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[5] The reallocation of manufacturing activities to some NMS countries as well as intense job losses in manufacturing during the crisis could partly explain this result (see Timmer *et al.*, 2013; and Marin, 2006).

values for the three EU ensembles (EU28, EU15 and NMS) together with the set of non-European countries included in the sample. The right-hand side provides the information for the five biggest EU15 countries. As can be observed, there are striking differences between the respective countries and groups of countries. In China, India, Korea, and the NMS, GVA growth stemmed mainly from labour productivity growth. In the US and the EU28 labour productivity was the main driver for GVA growth. The EU15, however, saw how both sources contributed almost equally to GVA growth. Looking more closely to the right-hand side of the table, one sees that while in the UK labour productivity had a higher contribution, the opposite was true for Spain and Italy.

Panels b) and c) provide insights at sector level into manufacturing and services, showing to what extent productivity and employment variations explain the evolution of sectoral GVA. Panel b) shows how GVA growth among manufacturing sectors is largely due to positive evolutions in terms of labour productivity and negative evolutions in terms of job creation. Only in China, India and Taiwan did employment show a positive contribution to GVA growth. Panel c), referring to services, provides a different picture: there one sees how both sources contribute positively to GVA growth in all countries, except for Italy. What stands out, is that only in China, India, Canada and the NMS was GVA growth more due to productivity growth than it was due to employment growth, while in the US, Taiwan and the UK both sources were equally responsible for the GVA growth in these three countries.

Figure 1. **CONTRIBUTIONS OF EMPLOYMENT AND LABOUR PRODUCTIVITY TO TOTAL, MANUFACTURING AND SERVICES GVA GROWTH IN EU AND NON-EU COUNTRIES. 1995-2014**
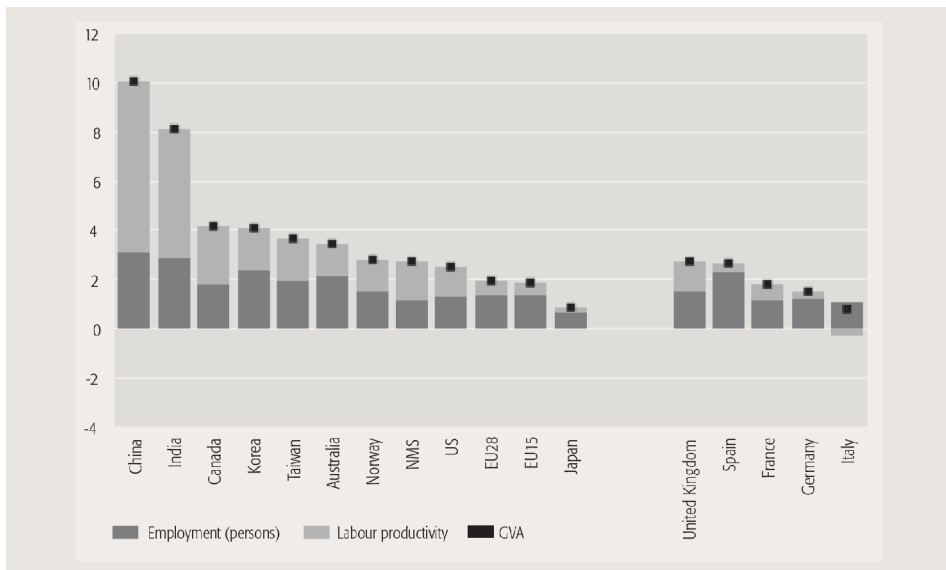
a) Total economy

(percentage)

.../...
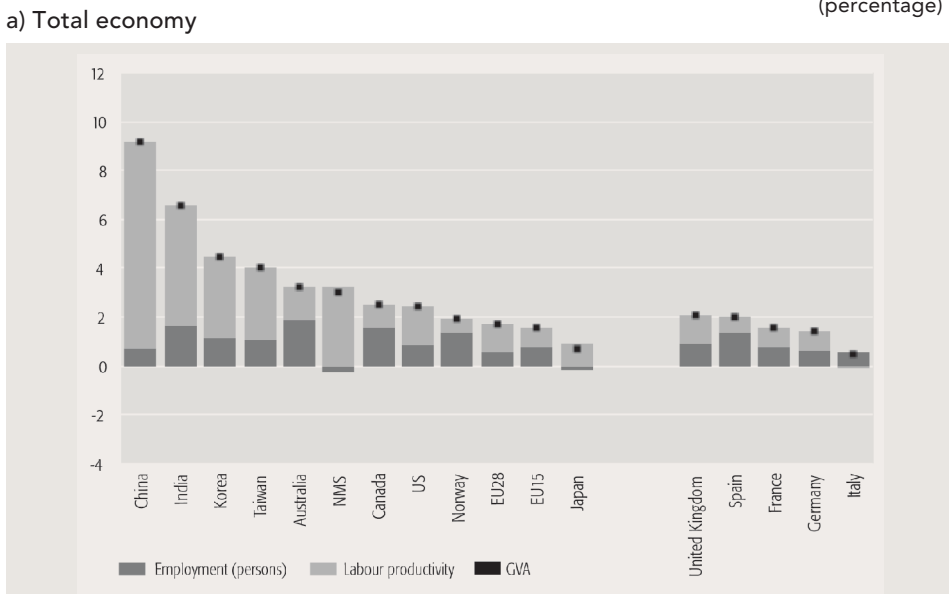
b) Manufacturing
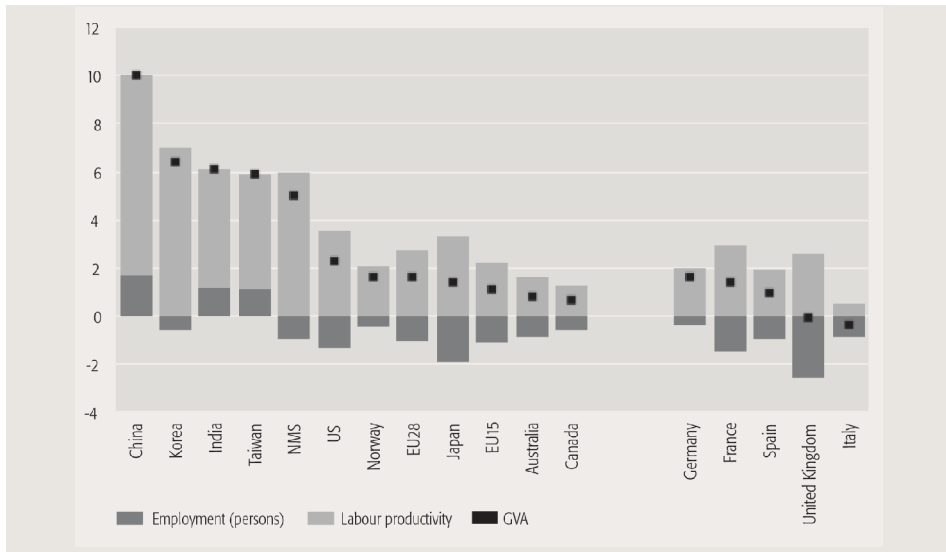
c) Services

Note: 1995-2013 for Australia, Canada, China, India, Japan, Korea and Taiwan. EU28 and NMS do not include Croatia and Malta.

Source: ABS, APO, BEA, Canada Statistics, Eurostat, ILO, OECD and own elaboration.

Consequently, if we posit that a *virtuous* contribution to economic growth should be underpinned simultaneously by a positive evolution of productivity and employment creation, and we look at how the manufacturing and service sectors performed on those two criteria, it is clear that service sectors complied more with the indicated premise during the period 1995-2014.

3. FURTHER EVIDENCE FROM THE 2006-2013 PERIOD

After presenting results at aggregated (sectoral) levels based on a period of 20 years of time in the previous section, it is worth analyzing more deeply what is happening within manufacturing and service sectors, particularly regarding the behaviour of labour productivity per sector. PREDICT database contains a wealth of information which enables us to gain further insight into this issue thanks to its very detailed sectoral breakdown.

3.1. Dynamics of productivity differences

Thereupon, Figure 2 provides a complementary view of the dynamics for the EU28 countries as compared to a set of non-European countries, but in this case for a more limited period of time, i.e., the years 2006-2013, for which PREDICT data is available. The figures plot the differences between the non-EU countries and the EU28 average in terms of labour productivity in the initial and final year of the 2006-2013 period. Panel a) refers to the differences in labour productivity at the level of the economy as a whole, while panels b) and c) draw up similar comparisons at the level of manufacturing and service sectors. In the figure the zero line indicates

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Figure 2. **DYNAMICS OF PRODUCTIVITY DIFFERENCES OF OTHER ECONOMIES VS. THE EU28 AVERAGE. 2006 AND 2013**

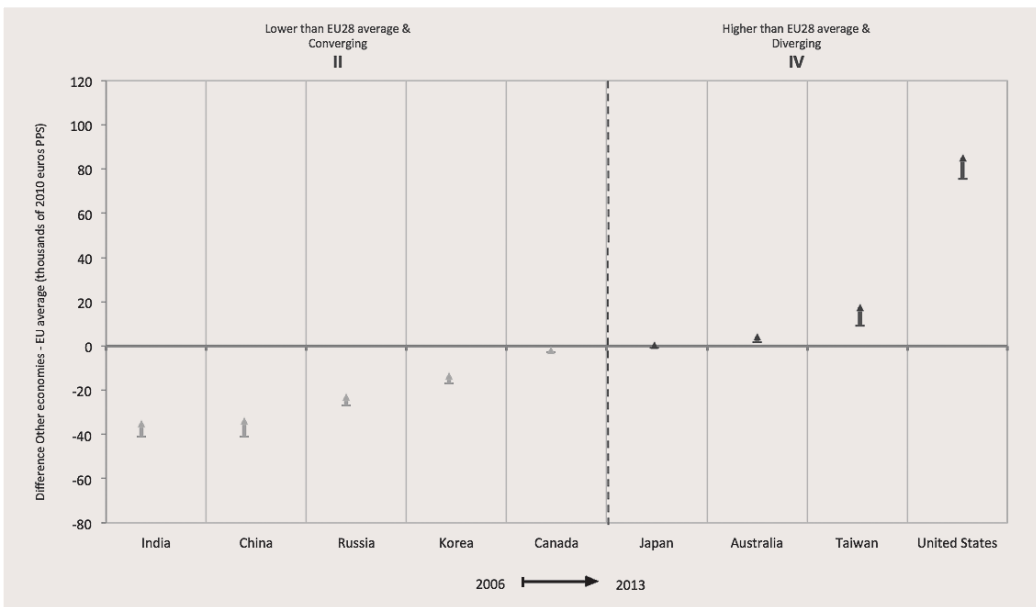a) Total economy   (Thousands of 2010 Euros PPS)

.../...
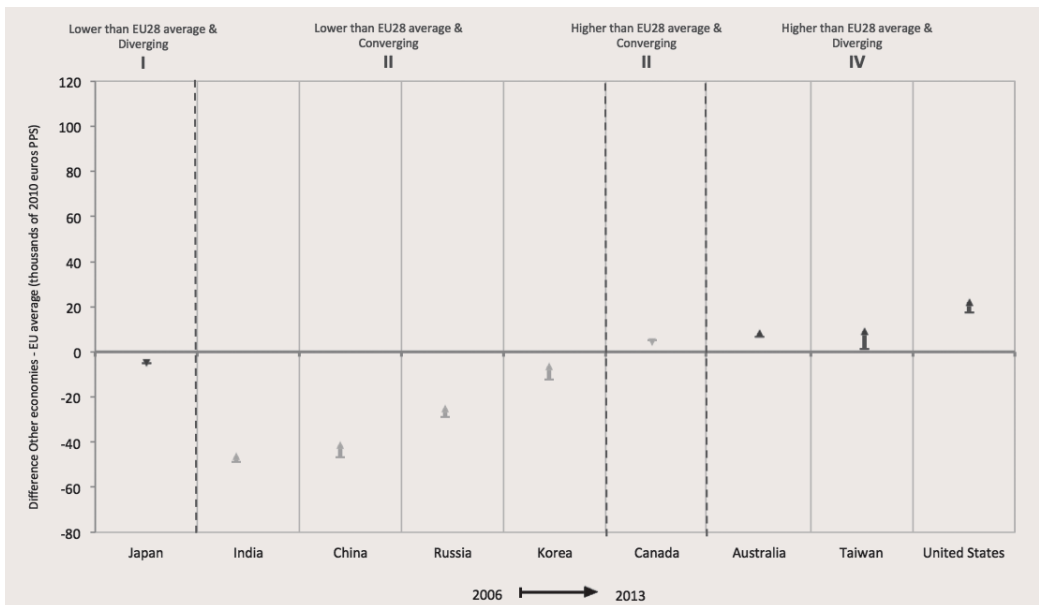
b) Manufacturing
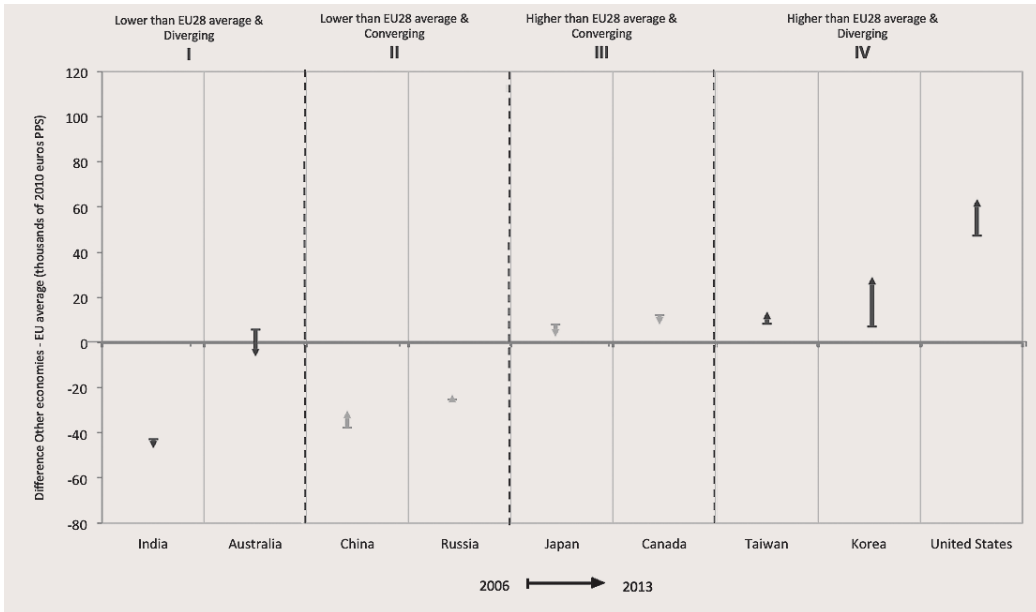
c) Services

Note: EU28 aggregated labour productivity in 2006 = 56.4; in 2013 = 58.2. EU28 manufacturing labour productivity in 2006 = 53.7; in 2013 = 57. EU28 services labour productivity in 2006 = 52; in 2013 = 52.8. Latest available data for Canada and Japan corresponds to 2012.

Source: PREDICT database elaborated by Ivie and JRC-IPTS.

the value of the EU28 average, while the arrowhead indicates the deviation from that ···/···
value for each country in the final year (2013), and the bottom shows its deviation
in the initial year, 2006. In principle, each panel is divided into four areas.[6] The dis-
tinction between these four areas is based on two criteria: 1. the productivity level,
which can be higher or lower than the EU28 average (above or below zero on the y-
axis), and the dynamics followed: converging or diverging to the EU28 average, de-
pending on whether the differences with the EU28 average have decreased or increa-
sed in the analyzed period (that is, if the countries' arrows are moving towards or
away from zero). Thus, the four areas that can be distinguished are (from left to
right): *I. Lower productivity than EU28 average and diverging*; *II. Lower productivity
than EU28 average and converging*; *III. Higher productivity than EU28 average and
converging*; and *IV. Higher productivity than EU28 average and diverging.*

In panel a) there are three countries that belong to the group of countries that go
under the label of *Higher productivity than EU28 average and diverging.* These are Aus-
tralia, Taiwan, and the US. Particularly the US had a productivity level that was higher
than the EU28 in 2006. While the US and Taiwan increased this gap in 2013, the gain
of Australia over the EU28 had only expanded marginally in 2013. Most countries in
panel a) fall into the group *Lower productivity than EU28 average and converging*,
which includes India, China, Russia and Korea. Finally, the positions of Canada and
Japan almost remained constant in relation to the EU28. The evolution of the produc-
tivity level in these two countries was similar to that of the EU28 but while Canada's
productivity level was above EU28 average, for Japan it was below this value.

Based on the same parameters and measurement point, albeit exclusively with
regard to manufacturing sectors, panel b) shows how two Asian countries, Taiwan
and Korea (particularly the latter), while belonging to group IV (*Higher productivity
than EU28 average and diverging*), gained positions during the 2006-2013 period.
However, within the group of countries with a higher labour productivity level than
the EU28, it was especially the US that expanded its lead over the EU28 when com-
paring 2013 to 2006. Meanwhile, India and Australia (belonging to the *Lower pro-
ductivity than EU28 and diverging*-group) presented a deteriorating performance
compared to the EU28 from 2006 to 2013. The same happened in the case of Japan
and Canada, although these two countries were above the EU28 productivity avera-
ge (*Higher productivity than EU28 average and converging*), which allowed the EU28
to improve its position. On the other hand, China and Russia approached the EU28
average during this period, with both of them starting off from a lower labour pro-
ductivity level (*Lower productivity than EU28 average and converging*-group).

In a similar way as panel b), panel c) visualizes labour productivity evolutions at
the service sectoral front. It highlights the increasing labour productivity gap in ser-
vices between the US and the EU28, which was already very significant in 2006. In

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6   Take note that for one or more areas there are no observations.

that year, labour productivity in the US service sector was 145.6% higher than in the EU28, while in 2013 the gap increased to 161.3%. At the other end, India, China, Russia, Korea and Canada approached EU28 levels over time, thus showing a convergence towards the EU28 (belonging to group II). Overall, the service data indicate that the non-EU countries included in the sample performed better than the EU28 during the 2006-2013 period.

A similar conclusion can be drawn when we look at productivity evolutions at the level of the entirety of economic activities (shown in figure 2a). Only in Australia, Canada and Japan did the overall productivity rate grow at a similar pace as it did for the EU28.

Figure 3. **EMPLOYMENT AND LABOUR PRODUCTIVITY CONTRIBUTIONS TO TOTAL GVA GROWTH IN EU AND NON-EU COUNTRIES. 2006-2013**   (percentage)
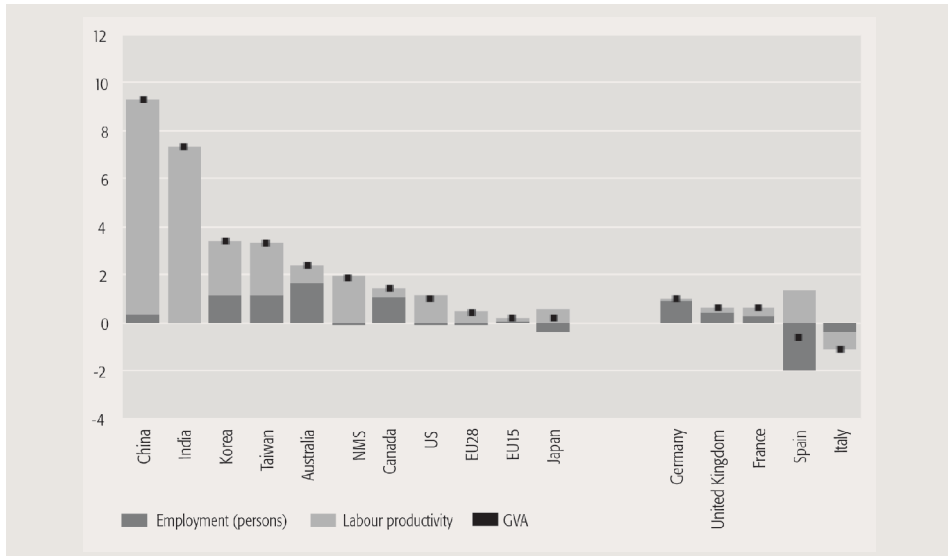
Note: 2006-2012 for Canada and Japan.
Source: PREDICT database elaborated by Ivie and JRC-IPTS.

3.2. **Productivity growth at sectoral disaggregation level**

Figures 3 assesses further how the entire set of economic activities in different (groups of) countries behave in terms of GVA growth, of labour productivity growth and employment creation growth between 2006 and 2013. We can observe striking differences between China and India, as well as Korea and Taiwan (albeit to a lesser extent), and the remaining countries, especially the EU15. The first two countries presented GVA annual growth rates of more than 7%, based almost exclu-

sively on labour productivity growth. Although the US and the NMS had lower rates of GVA growth, it was also based on the same driver. In fact, except for Australia and Canada, the labour productivity performance is the main basis for the GVA growth in the non-EU countries and the EU aggregations.

Of the five big EU15 countries considered, the performance was very modest for Germany, the UK and France, while Spain and Italy showed negative GVA rates of growth. However, it is interesting to notice that while Spain experienced increases in labour productivity and job destruction simultaneously, in the case of Italy both sources contributed negatively to GVA growth (contributed positively to GVA decrease).

Figure 4 broadens the perspective given in Figure 3 by making use of the sectoral disaggregations provided by the PREDICT database presented in Table 3. According to this table, the total GVA[7] of manufacturing and service sectors can be classified in three groups: 1. ICT[8]; 2. Non ICT but R&D intensive; and 3. Other. Figure 4a) offers the information for manufacturing sectors and 4b) for services.[9]

Figure 4a) shows some facts worth highlighting. First, panel 4a.1) confirms the general profile already shown in Figure 1.b) for period 1995-2014 of a GVA growth in manufacturing based fundamentally on labour productivity accompanied by job destruction. This second characteristic was more pronounced in the period 2006-2013 as a consequence of the economic crisis. Second, contrary to what could be expected, panel 4a.2) shows a very sharp decrease in employment in the ICT manufacturing sector, together with a relatively low labour productivity growth in some countries (such as the US, Canada and the NMS) and negative in others (EU28 and EU15 –including Germany and France but not the UK or Spain–, India or Japan). Third, the group of manufacturing sub-sectors which has fared better is the one labelled as *Non ICT manufacturing R&D intensive* sub-sectors in table 3. It is interesting to notice that in most countries labour productivity growth was positive, and that job variation was either positive or, if negative, of a lower intensity than in the case of ICT manufacturing sub-sectors. And fourth, and as was to be expected, the group corresponding to *Other manufacturing sub-sectors* showed a mixed pattern

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[7] The PREDICT database considers the following variables, with the same level of sectoral disaggregation as the one presented in table 3: GVA, Employment (number of workers); labour productivity (in terms of employed workers); Business R&D expenditure; Business R&D Personnel; and Business R&D Researchers.

[8] The ICT group follows the OECD (2007) definition.

[9] The selection of these sectoral groups is due to the important role assigned to ICT industries in terms of productivity performance in the last years and the necessity of distinguishing, within the non-ICT sectors, between intensive and non-intensive knowledge sectors. The basis to elaborate this distinction are the available Eurostat classifications of sectors by level of knowledge intensity (High-Tech industries, KIS (knowledge intensive services) and KIA (knowledge intensive activities)) combined with R&D intensity data by sector.

but with a landscape dominated by job destruction and relatively low rates of productivity growth, with the usual exception of China and Korea.

*Table 3.*   **SECTORAL CLASSIFICATION**

Sectors	NACE Rev. 2
Total Manufacturing	**05-33**
ICT Manufacturing	
Manufacture of electronic components and boards	261
Manufacture of computers and peripheral equipment	262
Manufacture of communication equipment	263
Manufacture of consumer electronics	264
Non-ICT manufacturing R&D intensive	
Manufacture of chemicals and chemical products	20
Manufacture of pharmaceuticals, medicinal chemical and botanical products	21
Manufacture of machinery and equipment	27-28
Manufacture of motor vehicles, trailers and semi-trailers	29
Manufacture of other transport equipment	30
Other manufacturing	n.e.c.
Total services	**45-99**
ICT Services	
Telecommunications	61
Computer and related activities	5820, 62, 631, 951
Non-ICT Services R&D intensive	
Transportation and storage	49-53
Information and communication (except ICT services)	58-63
Financial and insurance activities	64-66
Professional, scientific and technical activities	69-75
Administration and support service activities	76-82
Education	85
Human health and social work activities	86-88
Other services	n.e.c.

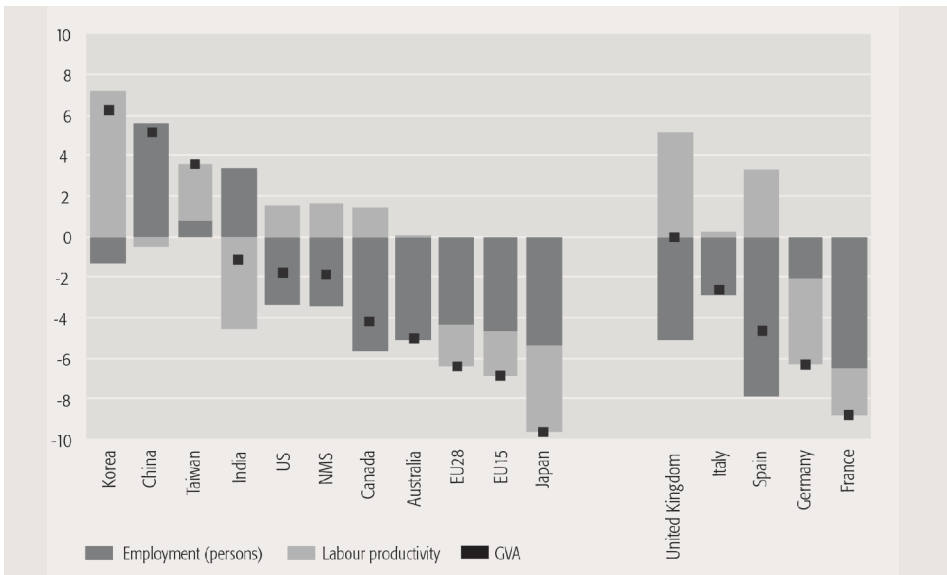*Source: Own elaboration.*

Figure 4.(a) **MANUFACTURING SECTOR: EMPLOYMENT AND LABOUR
PRODUCTIVITY CONTRIBUTIONS TO GVA GROWTH BY
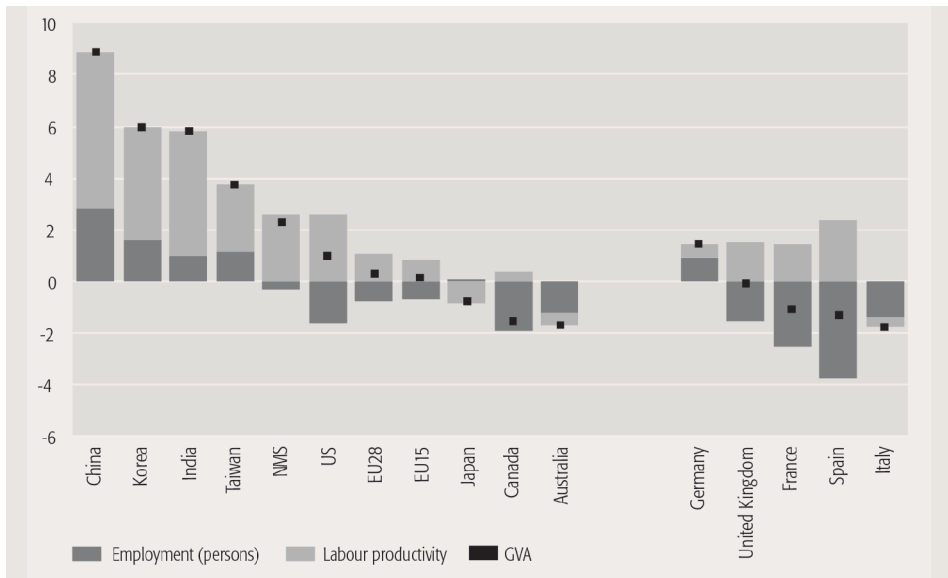SUB-SECTOR TYPE IN EU AND NON-EU COUNTRIES. 2006-2013**
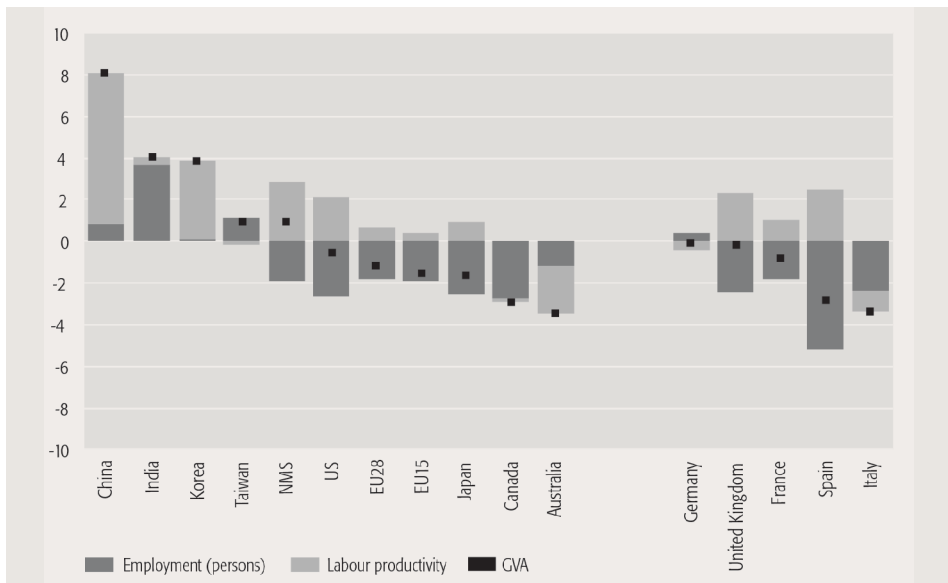
(percentage)

a.1. Total manufacturing
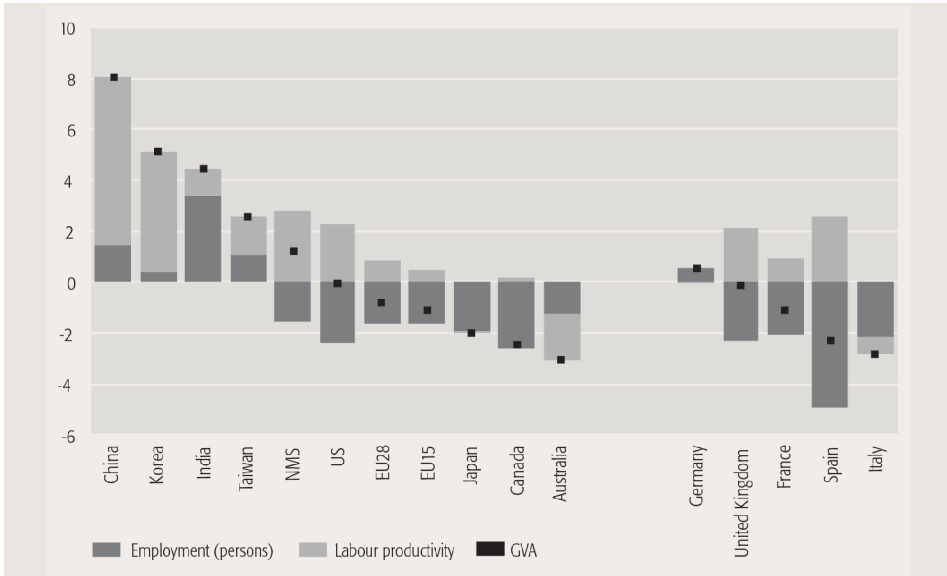
a.2. ICT manufacturing

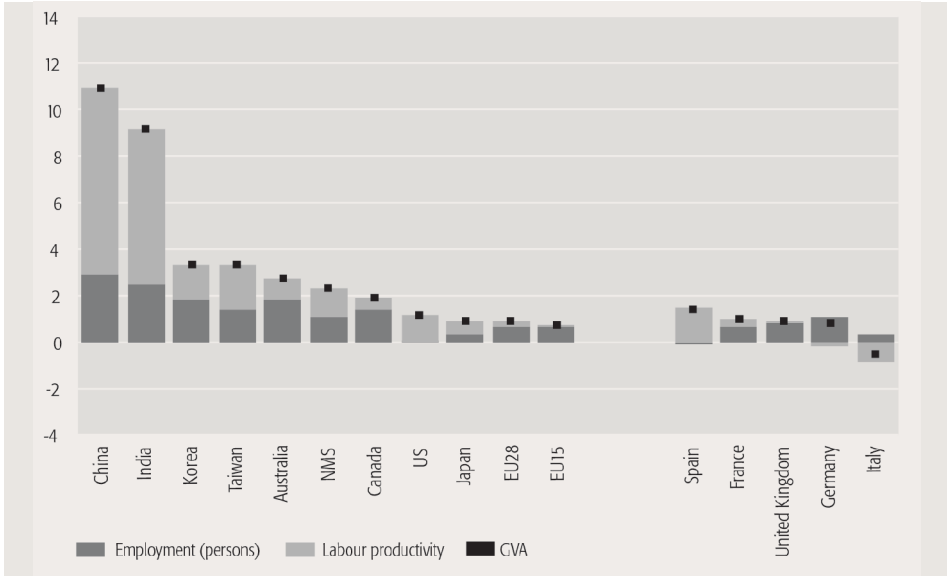### a.3. Non ICT manufacturing

a.4. Other manufacturing

Note: 2006-2012 for Canada and Japan.
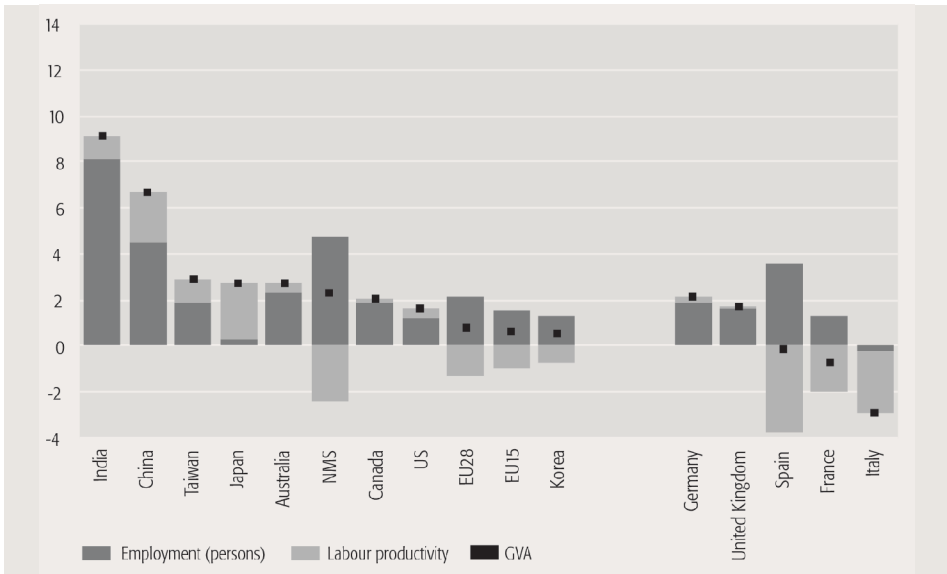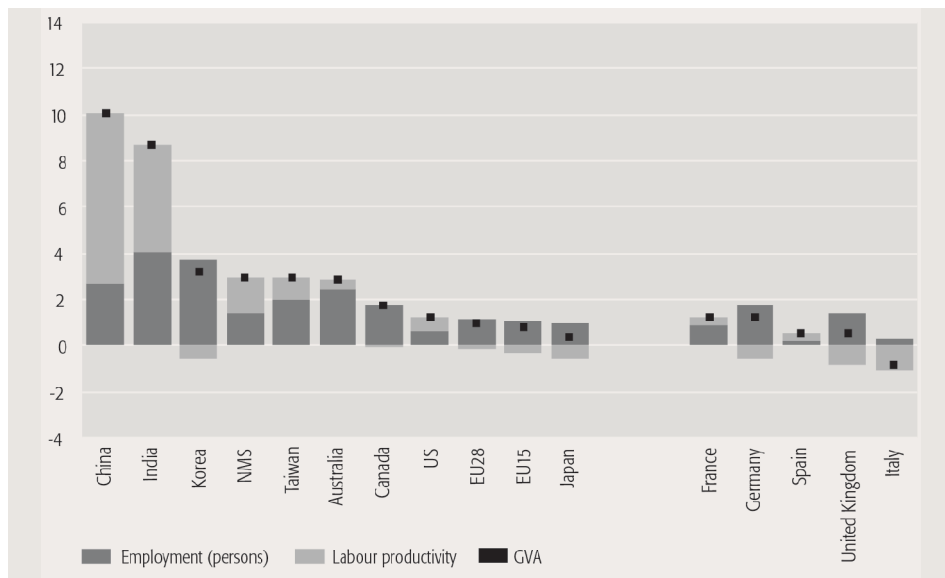*Source: PREDICT database elaborated by Ivie and JRC-IPTS.*

Figure 4.(b) **SERVICE SECTOR: EMPLOYMENT AND LABOUR PRODUCTIVITY CONTRIBUTIONS TO GVA GROWTH BY SUB-SECTOR TYPE IN EU AND NON-EU COUNTRIES. 2006-2013**
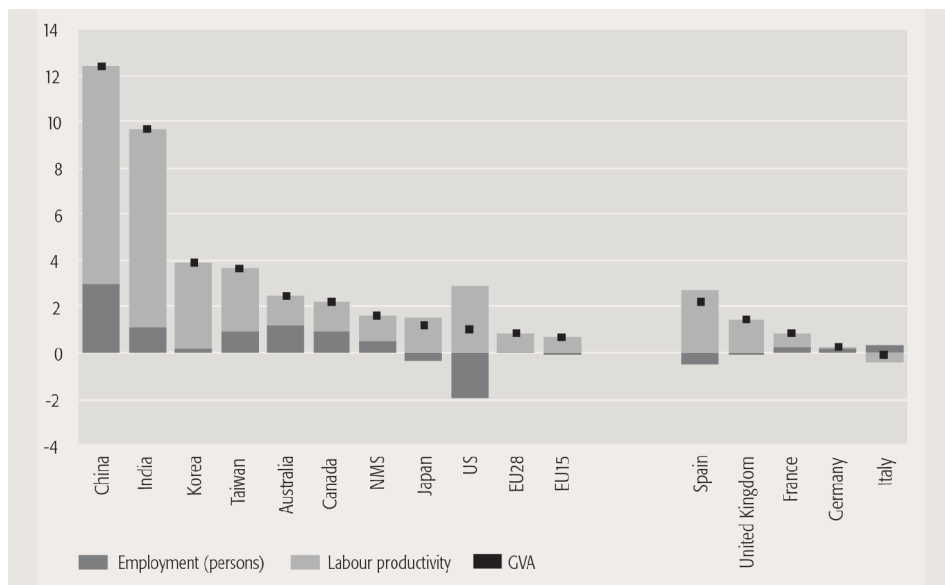
(percentage)

b.1. Total services

b.2. ICT services

b.3. Non ICT services R&D intensive

b.4. Other services

Note: 2006-2012 for Canada and Japan.
Source: PREDICT database elaborated by Ivie and JRC-IPTS.

A rather opposite view is provided by figure 4.b), showing similar information but referring to service sub-sectors. Panel 4b.1) for total services reinforces the view already offered by figure 1c) for the period 1995-2014 of positive job creation together with positive, albeit slow, labour productivity growth, with the exceptions of China and India where it was very intense. Panel 4b.2) illustrates again the same view but now refers to the ICT services sector. Job creation was the rule in all countries but Italy. However, labour productivity had a negative contribution to GVA in the EU (both in the EU15 and the NMS, and thus also in the EU28), where it was particularly intense in Spain, but also worth mentioning in France and Italy. The group denominated *Non ICT services R&D intensive* (panel 4b.3)) showed a virtuous behaviour, as had already happened within the same typology for manufacturing. In this case, although labour productivity contributions were negative in Korea, Japan, EU15 and three of the five biggest European countries (Germany, the UK and Italy), they were not comparable to those observed for ICT service sub-sectors. Finally, and contrary to the *Other manufacturing* group shown in figure 4a.4), the *Other services* group (panel 4b.4)) also presented a virtuous behaviour with a higher contribution of labour productivity growth than of job creation.

3.3. **Productivity growth and the ICT sector**

The upsurge of aggregate labour productivity in the US by the mid-nineties in the last century, as opposed to the more sluggish rate in the EU, was attributed to the ICT revolution whose results started to appear in the statistics a few years after Solow´s (1987) much cited remark: «You can see the computer age everywhere but in the productivity statistics». What became known as *Solow´s computer paradox* refers to the discrepancy between measures of investment in information technology and measures of output at the national level. Since then a great deal of effort was put into improving the measurement of the contribution made by capital services in general, and ICT assets in particular, to productivity growth. The work of Jorgenson, Ho and Stiroh (2005), Jorgenson, Landefeld and Nordhaus (2006) and the two OECD Manuals: *Measuring Productivity* (2001) and *Measuring Capital* (2009) have been fundamental in improving our understanding of the role played by ICT in economic growth.

The primary impact of ICT on productivity growth was signalled in ICT producing sub-sectors *via* technological progress captured by the Multifactor Productivity (MFP) term (see Biagi [2013] for a review). This positive effect spreads to the remaining sectors with a larger impact on those which use ICT assets more intensively. This *spillover* effect is due not only to its direct impact on labour and capital productivity but also due to MFP. Generally speaking, ICT has generated three different types of decisive contributions to: *i)* the economic globalization phenomena; *ii)* the vertical disintegration of the production process; and *iii*) the organizational changes within firms.

ICT assets have broadened the milieu relevant for their users, both for firms and the population at large, who now have access to a (practically) universal knowledge. For this reason, there has been an increase in the competitive pressure on productivity and the need for excellence in the process of production. ICT allows firms to become more productive, but it also puts pressure on the less efficient ones to leave the market. As a consequence, the more productive firms gain market share, raising the average labour productivity. From a political standpoint, the main message is that the increase in size of the most efficient firms should be favoured, while the less productive ones should leave the market.

The effect of ICT on productivity growth operates through the three *classical* channels: *I) labour quality,* since ICT allows this aspect to be improved through education and professional training; *ii) technological progress* embedded in *capital assets*, with the additional advantage of the sustained fall in their prices, especially hardware; and *iii)* Multifactor Productivity (MFP), since it allows the organization and management of firms to be improved, including favouring innovation, the development of new services, the adjustment of products to meet the firm´s needs, new designs and the speed of reaction to changing market conditions, etc.

From the sectoral perspective, we may distinguish between sectors that produce ICT goods and services to sell and the remaining ones that use ICT goods and services as assets for the sake of their own value creation processes. Figure 4 has shown the performance of ICT manufacturing sub-sectors (panel 4a.2) and ICT service sub-sectors (panel 4b.2) from the double perspective of job creation and productivity growth. From the first perspective, the main conclusion was that while ICT manufacturing sub-sectors reduced the number of workers, ICT service sub-sectors increased them. These developments could stem from, at least partly, the vertical disintegration process to which we referred above. At the same time, the increase in the number of workers in the ICT manufacturing sub-sectors in China and India is an example of the globalization process.

Figure 5 offers an alternative representation of the evolution of the second component (labour productivity) in the ICT sector. It shows the annual rates of productivity growth in the ICT sector in a decreasing order for the period 2006-2013. It also shows the different performance of ICT manufacturing and service sub-sectors. The most noticeable facts are the following. First, the highest rates of productivity growth corresponded to the Asian countries, with Korea taking the leading role. Second, of the set of countries included in the sample, only the EU and its aggregates (EU28, EU15 and NMS) presented negative rates of growth. Within the five big EU15 countries, only the UK showed a positive rate of growth. Meanwhile Spain, Italy and France showed negative, and not negligible, rates of variation. Third, a general pattern cannot be found for manufacturing and service sectors. For some countries within the same region, ICT sub-sector productivity growth can be driven by manufacturing while for others services take the lead. On

the other hand, while in some countries, such as Taiwan, Russia and the US, both manufacturing and services presented positive rates of growth, in other countries, such as Korea, Japan, India and the NMS, the two sectors contributed with different signs. Thus, further research is needed.

Figure 5. **ANNUAL GROWTH RATE OF ICT LABOUR PRODUCTIVITY IN EU AND NON-EU COUNTRIES. 2006-2013**
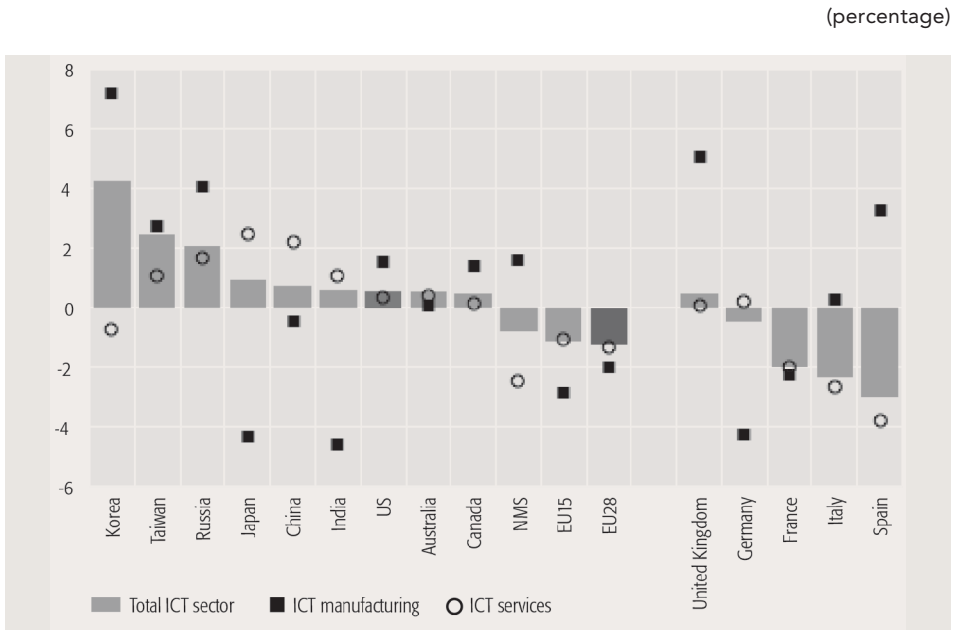
(percentage)

Note: 2006-2012 for Canada and Japan.
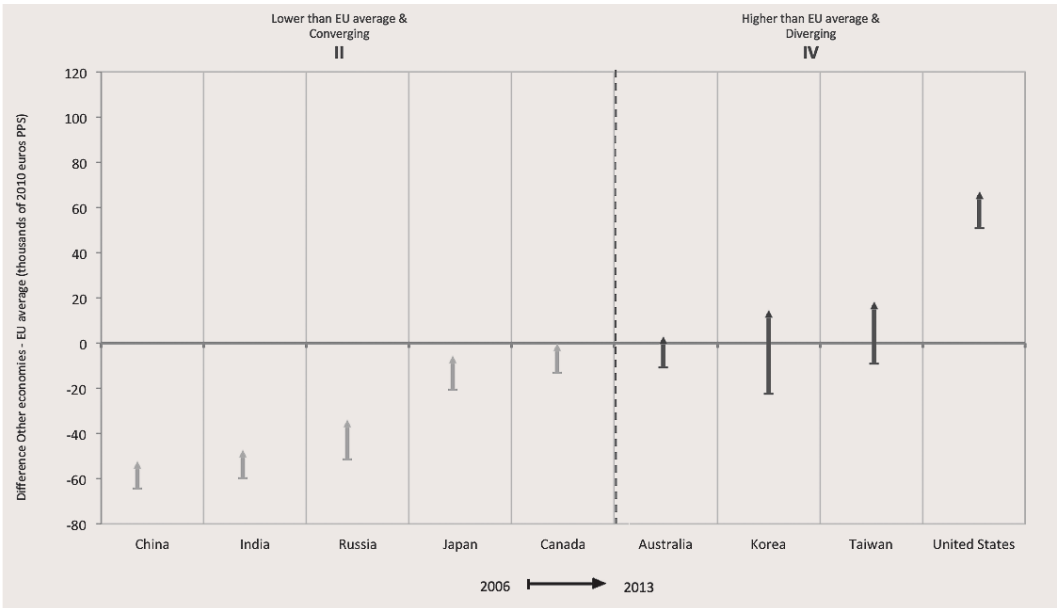Source: PREDICT database elaborated by Ivie and JRC-IPTS.

However, what seems indisputable is that along the period 2006-2013 labour productivity growth in the EU28 ICT sector was lower than in all the countries included in the sample, which had already happened with the total economy, as shown by figure 2.a. Figure 6 illustrates that in 2006 only the US had a higher labour productivity in the ICT sector than the EU28. In the following years, up to 2013, the gap increased due to the superior performance of the US. Three other countries, which in 2006 had a lower labour productivity level than the EU28, had already surpassed it in 2013: Taiwan, Korea and Australia. And the remaining five have all experienced a convergence process to the EU28 average.

The information provided so far has highlighted two relevant facts. First, the superiority of the US economy in almost all aspects analysed. And second, the clear understanding that the *Non-ICT R&D intensive* sub-sectors have performed better than the *ICT sub-sectors*. Figure 7 offers interesting information using a similar presentation

to figures 2 and 6. The reference continues to be the EU28 average, but the comparison is made now with respect to the US belonging to the two groups just mentioned.

Figure 6. **DYNAMICS OF THE ICT SECTOR PRODUCTIVITY DIFFERENCES OF OTHER ECONOMIES VS. THE EU28 AVERAGE. 2006 AND 2013**

(Thousands of 2010 Euros PPS)

Note: EU Labour productivity in 2006 =98.4; EU Labour productivity in 2013 = 89.6. Latest available data for Canada and Japan corresponds to 2012.
Source: PREDICT database elaborated by Ivie and JRC-IPTS.

The first noticeable fact is that the superiority of the US with respect to the EU28, in terms of labour productivity growth, applies to the eighteen sub-sectors analysed without exception both in 2006 and in 2013 (all the arrows are located above the zero line which reflects the EU28 average). Second, in only two sub-sectors, one of which belongs to the *ICT group* (*Manufacture of computers and peripheral equipment*) and the other to the *Non-ICT R&D intensive group* (*Transportation and Storage*), the productivity in the EU28 has grown at a higher rate than in the US. Thus, those two sub-sectors were the only ones (particularly the first) converging to the EU28 average. Third, the most striking fact is, however, the US superiority in two *Non-ICT R&D intensive sub-sectors: Manufacture of pharmaceuticals, medicinal chemical and botanical products,* and *Manufacture of chemicals and chemical products*. In 2006 the productivity in the US of the first sub-sector was 76% higher than in the EU28. In 2013 the gap had increased to 136%.

Figure 7.   **DYNAMICS OF US-EU28 PRODUCTIVITY DIFFERENCES BY SUB-SECTOR. 2006 AND 2013**

(Thousands of 2010 Euros PPS)
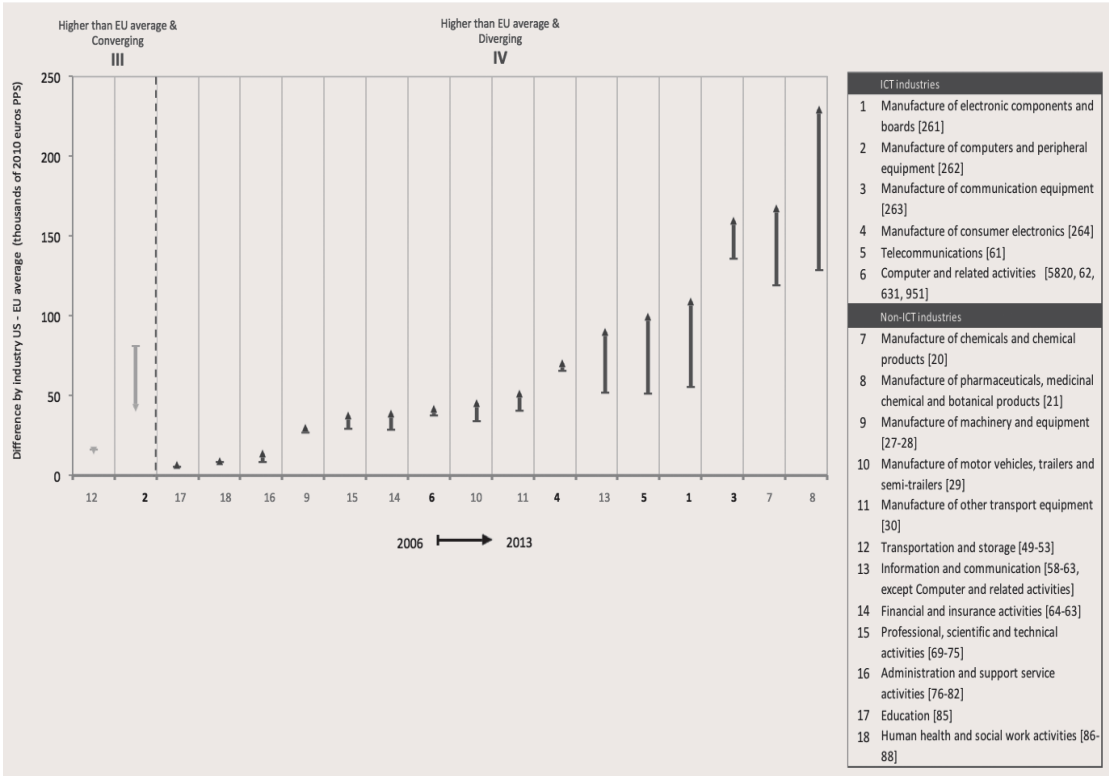
Note: ICT sectors marked in bold. The codification of sector can be found in the box to the left (NACE Rev.2 codes in brackets).

Source: PREDICT database elaborated by Ivie and JRC-IPTS.

These results seem to indicate that the benefits of ICT technologies, which were initially concentrated in the ICT manufacturing sector, have spilled over to other sub-sectors which use them intensively, in combination with also an intensive use of R&D. These *spillover* effects have been particularly intense in the US, favouring the increase of its labour productivity at a much higher rate than in the EU28.

4. **CONCLUDING REMARKS**

This paper contributes to the current reindustrialization debate by offering empirical evidence on the performance of manufacturing and service sectors. The analysis has been carried out within an international context, considering the 28 countries belonging to the EU28 and nine other developed and developing countries. It makes use of the PREDICT database elaborated by Ivie-IPTS (JRC).

The main features of the database are the high level of sectoral disaggregation, as well as the emphasis on ICT producing activities and on R&D expenditures made by the business sector. Our paper proposes a double criterion for evaluating the role played by both types of activities in economic growth: 1. The capacity of a given sector to contribute to aggregate employment creation; and 2. The evolution of labour productivity within a given sector. According to this double criterion, we propose that a given sector deserves support if it shows simultaneously positive employment and labour productivity growth. The main contributions of the paper are the following.

If we refer to the last complete cycle of 1995-2014, we can conclude that: 1. Data confirms that the loss of weight of the manufacturing sector is a (practically) general phenomenon both in terms of GVA and employment. However, while GVA showed positive rates of growth, employment destruction was (almost) the general rule. On the contrary, the service sector presented positive growth rates in all countries without exception, both in terms of GVA and of employment. From a geographical point of view, there is general tendency for manufacturing activities to abandon the most developed countries for developing countries, taking advantage of the «global value chains"[10]. 2. Manufacturing activities are not more productive than services always and everywhere. In fact services have a higher contribution to aggregate productive growth in the most developed countries. 3. If we make use of the proposed double criterion for the period 1995-2014, we might conclude that in (almost) all countries the service sector fulfils both criteria with very few exceptions (i.e. Italy). On the contrary, for the manufacturing sector only China, India and Taiwan showed a virtuous pattern of growth.

If we focus on the most recent period, covered by the PREDICT database, 2006-2013, we may conclude that the performance of the EU28 can only be labelled as modest in terms of productivity growth. For the total economy, seven out of nine countries included in the sample experienced a higher rate of productivity growth than the EU28, while for the remaining two (Japan and Canada) it was similar. For manufacturing activities, the EU28 performed better than four countries (India, Australia, Japan and Canada), while in services the nine countries performed better than the EU28. The US is the indisputable leader in terms of productivity growth.

The PREDICT database allows us to classify the sectors into three sub-groups for both manufacturing and services: i) ICT; ii) Non-ICT R&D intensive; and iii) Other. From the perspective of the proposed double criterion, the main results are the following: 1. With respect to manufacturing sector, the job destruction was generalized in (almost) all countries. This process was especially intense in ICT manufacturing sub-group; only China, Taiwan and India created employment during those years. Something similar could be said about the group «Other» under the

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[10] See Stehrer *et al* (2015), Di Mauro *et al* (2013) and De Backer and Miroudot (2013).

manufacturing sector. The group labelled Non-ICT R&D intensive has shown the best performance according to the double virtuous criterion. 2. With respect to the service sector, the results are quite different. The ICT service sub-group created employment in all countries but it was accompanied by negative labour productivity growth rates in the EU countries, especially in the NMS. However, the fulfilment of the double virtuous criterion was (almost general) for the service sub-group Non-ICT R&D intensive and also for sub-group «Other».

Thus, the ICT manufacturing sub-group did not fulfill the double criterion due to the process of job destruction. In the case of ICT service sub-group only the EU28 (and also the EU15 and the NMS) did not fulfil the second criterion since they experienced negative labour productivity growth. Furthermore, the nine non-EU countries experienced higher productivity growth in the ICT sector than the EU28. However, one of the most striking facts revealed by the data is that the US superiority in terms of labour productivity is concentrated in six sub-sectors: three belonging to Non-ICT R&D intensive group: Manufacture of pharmaceuticals, medicinal chemical and botanical products; Manufacture of chemicals and chemical products; and Information and communication, except computer and related activities. And another three to ICT group: Manufacture of communication equipment; Manufacture of electronic components and boards; and Telecommunications. The gap is especially noticeable in the first two sub-sectors.

All in all we may conclude that the EU has two main problems: high unemployment rates -especially in the peripheral countries such as Spain- and a weak performance in terms of labour productivity growth, which has become more acute in the last few years of the crisis. From our point of view, the proposed reindustrialization is not going to solve either one of these problems if we take into account that only some Asian countries (China, India and Taiwan) are creating jobs in manufacturing, and that it is not guaranteed that labour productivity growth is higher in manufacturing than in service sectors. For the EU, the disappointing behaviour of this variable affects both manufacturing and service activities. Thus, the target should not be reindustrialization but rather the general improvement in the functioning of the economy in terms of productivity.

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